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SOLUBILITY DATA SERIES

Volume 61

ALKALI METAL AND AMMONIUM PERCHLORATES PART I: LITHIUM AND SODIUM PERCHLORATES

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ALKALI METAL AND AMMONIUM PERCHLORATES PART I: LITHIUM AND SODIUM PERCHLORATES

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OBITUARY: IVAN NIKONOVICH LEPESHKOV

Ivan Nikonovich Lepeshkov, Professor of Inorganic Chemistry in the Kurnakov Institute of General and Inorganic Chemistry, Russian Academy of Sciences, died on January 30, 1993 in Moscow. His sudden passing after a brief illness came as a great shock to his friends and colleagues.

Prof. Lepeshkov was born into a peasant family on January 15, 1907 in a small village near Smolensk. His early education began in a village school and continued into secondary school in Smolensk. In 1930 he was graduated from the University of Smolensk with a degree in chemistry. The following year he pursued post-graduate studies under the tutelage of Academician N.S. Kurnakov in the Laboratory of General Chemistry in Leningrad (St Petersburg). His thesis for a Candidate's Degree was on the crystallization of natural salts found in the Inder Lake (Kazakhstan) and was completed in 1935 and submitted to the faculty of the Institute of General and Inorganic Chemistry in Moscow (the Chemical Laboratories of the Academy of Sciences in Leningrad was moved to Moscow in 1934). Prof. Kurnakov became the director of this new institute and Prof. Lepeshkov was appointed Professor of Inorganic Chemistry at this same institute in 1943.

Prof. Lepeshkov spent the whole of his active life at the Institute of General and Inorganic Chemistry. He was Head of the Laboratory of Chemistry and Technology of Natural Salts for more than 40 years, and at the time of the Second World War was promoted to Vice-Director of the institute. At this time he also served as chief of the Division of Physico-Chemical Analysis. He participated in numerous scientific expeditions in the Central Asian Republics, Volga-Ural regions and Siberia. Prof. Lepeshkov and his colleagues discovered industrial deposits of bishoffite in the Volvograd Region, and he was active in the solution of the problems connected with Lake Kara-Bugas, and his solutions are presently accepted as the most practical.

Prof. Lepeshkov is best known for his extensive and numerous studies on water-salt equilibria which found important applications in geochemical and chemical engineering aspects of prospecting and processing of salt deposits. He contributed to chemical technology and production of fertilizers, antifreeze formulations and electronic materials. The results of these studies were published in more than 400 papers and several books. He exerted strong influence on the formation and development of inorganic chemistry in Kazakhstan, Kirgizia, Turkmenistan and Kabardino-Balkaria where he helped organize the research groups and Laboratories on Natural Salt Chemistry. Prof Lepeshkov continually stressed the fundamental ideas of his teacher, Prof. Kurnakov, on the principles of physico-chemical analysis, and from amongst his more than fifty students, a number have become professors and members of the Academy of Sciences of the Central Asia Republics.

Prof. Lepeshkov's international activities began in the 1950s when he established contacts with German chemists in the former DDR. He visited China, Bulgaria, Spain and other countries. His most fruitfull cooperation was between his laboratory and the Chemical Division of the Freiberg Bergakademie in Germany and the Laboratory of Inorganic Salts of the Bulgarian Academy of Sciences in Sofia. During the last years of his life Prof. Lepeshkov participated in the IUPAC Solubility Data Project and became a close colleague of many members of IUPAC Commission V.8. At he invitation of Prof. A.S. Kertes (founder of the Solubility Data Project and Chairman of Commission V.8 until shortly before his untimely death in 1988), Prof. Lepeshkov became the first Russian chemist to participate in this international project. His first volume on Alkaline Earth Metal Perchlorates, co-edited with Profs C.-Y. Chan and K.H. Khoo from the University of Malaysia, was published as volume 41 in 1989, and this second volume on the solubilities of perchlorates is dedicated to his memory.

Prof. Lepeshkov will be missed by all who knew him. His work and science lives on and we are indeed richer for his contributions and for his friendship.

V.L. Valyashko and V. Danilov

INTRODUCTION TO THE SOLUBILITY DATA SERIES

SOLUBILITY OF SOLIDS IN LIQUIDS

NATURE OF THE PROJECT

The Solubility Data project (SDP) has as its aim a comprehensive review of published data for solubilities of gases, liquids and solids in liquids or solids. Data of suitable precision are compiled for each publication on data sheets in a uniform format. The data for each system are evaluated and, where data from independent sources agree sufficiently, recommended values are proposed. The evaluation sheets, recommended values, and compiled data sheets are published on consecutive pages.

COMPILATIONS AND EVALUATIONS

The formats for the compilations and critical evaluations have been standardized for all volumes. A description of these formats follows.

Compilations

The format used for the compilations is, for the most part, self-explanatory. Normally, a compilation sheet is divided into boxes, with detailed contents described below.

Components: Each component is listed according to IUPAC name, formula, and Chemical Abstracts (CA) Registry Number. The Chemical Abstracts name is also included if this differs from the IUPAC name, as are trivial names if appropriate. IUPAC and common names are cross-referenced to Chemical Abstracts names in the System Index.

The formula is given either in terms of the IUPAC or Hill (1) system and the choice of formula is governed by what is usual for most current users: i.e., IUPAC for inorganic compounds, and Hill system for organic compounds. Components are ordered on a given compilation sheet according to:

(a) saturating components:
(b) non-saturating components;
(c) solvents.

In each of (a), (b) or (c), the components are arranged in order according to the IUPAC 18-column periodic table with two additional rows:

Columns 1 and 2:	H, alkali elements, ammonium, alkaline earth elements
Columns 3 to 12:	transition elements
Columns 13 to 17:	boron, carbon, nitrogen groups; chalcogenides, halogens
Column 18:	noble gases
Row 1:	Ce to Lu
Row 2:	Th to the end of the known elements, in order of atomic number.

The same order is followed in arranging the compilation sheets within a given volume.

Original Measurements: References are abbreviated in the forms given by Chemical Abstracts Service Source Index (CASSI). Names originally in other than Roman alphabets are given as transliterated by Chemical Abstracts. In the case of multiple entries (for example, translations) an asterisk indicates the publication used for compilation of the data.

Variables: Ranges of temperature, pressure, etc. are indicated here.

Prepared by: The names of all compilers are given here.

Experimental Values: Components are described as (1), (2), etc., as defined in the "Components" box. Data are reported in the units used in the original publication, with the exception that modern names for units and quantities are used; e.g., mass per cent for weight per cent; mol dm^{-3} for molar; etc. Usually, only one type of value (e.g., mass per cent) is found in the original paper, and the compiler has added the other type of value (e.g., mole per cent) from computer calculations based on 1989 atomic weights (2). Temperatures are expressed as $t/°C$, $t/°F$ or T/K as in the original; if necessary, conversions to T/K are made, sometimes in the compilations and always in the critical evaluation. However, the author's units are expressed according to IUPAC recommendations (3) as far as possible.

Errors in calculations, fitting equations, etc. are noted, and where possible corrected. Material inserted by the compiler is identified by the word "compiler" or by the compiler's name in parentheses or in a footnote. In addition, compiler-calculated values of mole or mass fractions are included if the original data do not use these units. If densities are reported in the original paper, conversions from concentrations to mole fractions are included, but otherwise this is done in the evaluation, with the values and sources of the densities being quoted and referenced.

Details of smoothing equations (with limits) are included if they are present in the original publication and if the temperature or pressure ranges are wide enough to justify this procedure and if the compiler finds that the equations are consistent with the data.

The precision of the original data is preserved when derived quantities are calculated, if necessary by the inclusion of one additional significant figure. In some cases, compilers note that numerical data have been obtained from published graphs using digitizing techniques. In these cases, the precision of the data can be determined by the quality of the original graph and the limitations of the digitizing technique. In some cases graphs have been included, either to illustrate data more clearly, or if this is the only information in the original. Full grids are not usually inserted as it is not intended that users should read data from the graphs.

Method: The apparatus and procedure are mentioned briefly. Abbreviations used in Chemical Abstracts are often used here to save space, reference being made to sources of further detail if these are cited in the original paper.

Source and Purity of Materials: For each component, referred to as (1), (2), etc., the following information (in this order and in abbreviated form) is provided if available in the original paper: source and specified method of preparation; properties; degree of purity.

Estimated Error: If estimated errors were omitted by the original authors, and if relevant information is available, the compilers have attempted to estimate errors (identified by "compiler" or the compiler's name in parentheses or in a footnote) from the internal consistency of data and type of apparatus used. Methods used by the compilers for estimating and reporting errors are based on Ku and Eisenhart (4).

Comments and/or Additional Data: Many compilations include this section which provides short comments relevant to the general nature of the work or additional experimental and thermodynamic data which are judged by the compiler to be of value to the reader.

References: The format for these follows the format for the Original Measurements box, except that final page numbers are omitted. References (usually cited in the original paper) are given where relevant to interpretation of the compiled data, or where cross-reference can be made to other compilations.

Evaluations

The evaluator's task is to assess the reliability and quality of the data, to estimate errors where necessary, and to recommend "best" values. The evaluation takes the form of a summary in which all the data supplied by the compiler have been critically reviewed. There are only three boxes on a typical evaluation sheet, and these are described below.

Components: The format is the same as on the Compilation sheets.

Evaluator: The name and affiliation of the evaluator(s) and date up to which the literature was checked.

Critical Evaluation:

(a) Critical text. The evaluator checks that the compiled data are correct, assesses their reliability and quality, estimates errors where necessary, and recommends numerical values based on all the published data (including theses, patents and reports) for each given system. Thus, the evaluator reviews the merits or shortcomings of the various data. Only published data are considered. Documented rejection of some published data may occur at this stage, and the corresponding compilations may be removed.

The solubility of comparatively few systems is known with sufficient accuracy to enable a set of recommended values to be presented. Although many systems have been studied by at least two workers, the range of temperatures is often sufficiently different to make meaningful comparison impossible.

Occasionally, it is not clear why two groups of workers obtained very different but internally consistent sets of results at the same temperature, although both sets of results were obtained by reliable methods. In such cases, a definitive assessment may not be possible. In some cases, two or more sets of data have been classified as tentative even though the sets are mutually inconsistent.

(b) Fitting equations. If the use of a smoothing equation is justifiable the evaluator may provide an equation representing the solubility as a function of the variables reported on all the compilation sheets, stating the limits within which it should be used.

(c) Graphical summary. In addition to (b) above, graphical summaries are often given.

(d) Recommended values. Data are recommended if the results of at least two independent groups are available and they are in good agreement, and if the evaluator has no doubt as to the adequacy and reliability of the applied experimental and computational procedures. Data are reported as tentative if only one set of measurements is available, or if the evaluator considers some aspect of the computational or experimental method as mildly undesirable but estimates that it should cause only minor errors. Data are considered as doubtful if the evaluator considers some aspect of the computational or experimental method as undesirable but still considers the data to have some value where the order of magnitude of the solubility is needed. Data determined by an inadequate method or under ill-defined conditions are rejected. However, references to these data are included in the evaluation together with a comment by the evaluator as to the reason for their rejection.

(e) References. All pertinent references are given here, including all those publications appearing in the accompanying compilation sheets and those which, by virtue of their poor precision, have been rejected and not compiled.

(f) Units. While the original data may be reported in the units used by the investigators, the final recommended values are reported in SI units (3) when the data can be converted accurately.

QUANTITIES AND UNITS USED IN COMPILATION AND EVALUATION OF SOLUBILITY DATA

Mixtures, Solutions and Solubilities

A *mixture* (5) describes a gaseous, liquid or solid phase containing more than one substance, where the substances are all treated in the same way.

A *solution* (5) describes a liquid or solid phase containing more than one substance, when for convenience one of the substances, which is called the *solvent*, and may itself be a mixture, is treated differently than the other substances, which are called *solutes*. If the sum of the mole fractions of the solutes is small compared to unity, the solution is called a *dilute solution*.

The *solubility* of a solute 1 (solid, liquid or gas) is the analytical composition of a saturated solution, expressed in terms of the proportion of the designated solute in a designated solvent (6).

"Saturated" implies equilibrium with respect to the processes of dissolution and precipitation; the equilibrium may be stable or metastable. The solubility of a substance in metastable equilibrium is usually greater than that of the same substance in stable equilibrium. (Strictly speaking, it is the activity of the substance in metastable equilibrium that is greater.) Care must be taken to distinguish true metastability from supersaturation, where equilibrium does not exist.

Either point of view, mixture or solution, may be taken in describing solubility. The two points of view find their expression in the reference states used for definition of activities, activity coefficients and osmotic coefficients.

Note that the composition of a saturated mixture (or solution) can be described in terms of any suitable set of thermodynamic components. Thus, the solubility of a salt hydrate in water is usually given as the relative proportions of anhydrous salt in solution, rather then the relative proportions of hydrated salt and water.

Physicochemical Quantities and Units

Solubilities of solids have been the subject of research for a long time, and have been expressed in a great many ways, as described below. In each case, specification of the temperature and either partial or total pressure of the saturating gaseous component is necessary. The nomenclature and units follow, where possible, ref. (3)

A note on nomenclature. The nomenclature of the IUPAC Green Book (3) calls the solute component B and the solvent component A. In compilations and evaluations, the first-named component (component 1) is the solute, and the second (component 2 for a two-component system) is the solvent. The reader should bear these distinctions in nomenclature in mind when comparing equations given here with those in the Green Book.

1. *Mole fraction* of substance 1, x_1 or $x(1)$for condensed phases, y_1 for gaseous phases:

$$x_1 = n_1 / \sum_{s=1}^{c} n_s \qquad [1]$$

where n_s is the amount of substance of s, and c is the number of distinct substances present (often the number of thermodynamic components in the system). *Mole per cent* of substance 1 is 100 x_1.

2. *Ionic mole fractions* of salt i, x_{i+}, x_{i-}:
For a mixture of s binary salts i, each of which ionizes completely into ν_{i+} cations and ν_{i-} anions, with $\nu_i = \nu_{+i} + \nu_{-i}$ and a mixture of p non-electrolytes k, of which some may be considered as solvent components, a generalization of the definition in (7) gives:

$$x_{+i} = \frac{\nu_{+i}x_i}{1+\sum_{j=1}^{s}(\nu_j-1)x_j}, \quad x_{-i} = \frac{\nu_{-i}x_{+i}}{\nu_{+i}} \quad i = 1...s \tag{2}$$

$$x_k' = \frac{x_k}{1+\sum_{j=1}^{s}(\nu_j-1)x_j}, \quad k = (s+1),...,(s+p) \tag{3}$$

The sum of these mole fractions is unity, so that, with $c = s + p$,

$$\sum_{i=1}^{s}(x_{+i}+x_{-i})+\sum_{i=s+1}^{c}x_i' = 1 \tag{4}$$

General conversions to other units in multicomponent systems are complicated. For a three-component system containing non-electrolyte 1, electrolyte 2 and solvent 3,

$$x_1 = \frac{\nu_{+2}x_1'}{\nu_{+2}-(\nu_2-1)x_{+2}} \quad x_2 = \frac{x_{+2}}{\nu_{+2}-(\nu_2-1)x_{+2}} \tag{5}$$

These relations are used in solubility equations for salts, and for tabulation of salt effects on solubilities of gases.

3. *Mass fraction* of substance 1, w_1 or $w(1)$:

$$w_1 = g_1/\sum_{s=1}^{c} g_s \tag{6}$$

where g_s is the mass of substance s. *Mass per cent* of substance 1 is 100 w_1. The equivalent terms *weight fraction*, *weight per cent* and *g (1)/100 g solution* are no longer used.

4. *Solute mole fraction* of substance 1, $x_{s,1}$:

$$x_{s,1} = m_1/\sum_{i=1}^{s} m_i = x_1/\sum_{i=1}^{s} x_i \tag{7}$$

where c is the number of solutes in the mixture. These quantities are sometimes called Jänecke mole (mass) fractions (8, 9). *Solute mass fraction* of substance 1, $w_{s,1}$, is defined analogously.

5. *Solvent mole fraction* of substance 1, $x_{v,1}$:

$$x_{v,1} = x_1/\sum_{i=s+1}^{c} x_i \tag{8}$$

Here, p is the number of solvent components in the mixture. *Solvent mass fraction* of substance 1, $w_{v,1}$, is defined analogously.

6. *Molality* of solute 1 in a solvent 2, m_1:

$$m_1 = n_1/n_2 M_2 \qquad [9]$$

SI base units: mol kg^{-1}. Here, M_2 is the molar mass of the solvent.

7. *Aquamolality, Solvomolality* of substance 1 in a mixed solvent with components 2, 3 (10), $m_1^{(3)}$:

$$m_1^{(3)} = m_1\overline{M}/M_3 \qquad [10]$$

SI base units: mol kg^{-1}. Here, the average molar mass of the solvent is

$$\overline{M} = x_{v,2}M_2+(1-x_{v,2})M_3 \qquad [11]$$

and $x_{v,2}$ is the solvent mole fraction of component 2. This term is used most frequently in discussing comparative solubilities in water (component 2) and heavy water (component 3) and in their mixtures.

8. *Amount concentration* of solute 1 in a solution of volume V, c_1:

$$c_1 = [\text{formula of solute 1}] = n_1/V \qquad [12]$$

SI base units: mol m^{-3}. The symbol c_1 is preferred to [formula of solute 1], but both are used. The old terms *molarity*, *molar* and *moles per unit volume* are no longer used.

9. *Mass concentration* of solute 1 in a solution of volume V, ρ_1:

$$\rho_1 = g_1/V = c_1M_1/V \qquad [13]$$

SI base units: kg m^{-3}.

10. *Mole ratio*, $r_{1,2}$ (dimensionless) (11):

$$r_{1,2} = n_1/n_2 \qquad [14]$$

Mass ratio, symbol $\zeta_{1,2}$, may be defined analogously (11).

11. *Partial pressure*, $p_1 = y_1p$ for substance 1, where y_1 is the mole fraction of 1 in the vapor phase and p is the total pressure. SI units: Pa; common units: mmHg, Torr. 1 mmHg and 1 Torr differ slightly in definition (3), but are identical numaerically to better than 2×10^{-7} Torr.

12. *Ionic strength*, I_m (molality basis), or I_c (concentration basis):

$$I_m = \frac{1}{2}\sum_i m_i z_i^2, \quad I_c = \frac{1}{2}\sum_i c_i z_i^2 \qquad [15]$$

where z_i is the charge number of ion i. While these quantities are not used generally to express solubilities, they are used to express the compositions of non-saturating components. For a single salt i with ions of charge numbers z_+, z_-,

$$I_m = |z_+z_-|\nu m_i, \quad I_c = |z_+z_-|\nu c_i \qquad [16]$$

Mole and mass fractions and mole ratios are appropriate to either the mixture or the solution point of view. The other quantities are appropriate to the solution point of view only. Conversions between pairs of these quantities can be carried out using the equations given in Table 1 at the end of this Introduction. Other useful quantities will be defined in the prefaces to individual volumes or on specific data sheets.

Salt hydrates are generally not considered to be saturating components since most solubilities are expressed in terms of the anhydrous salt. The existence of hydrates or solvates is noted carefully the critical evaluation.

Mineralogical names are also quoted, along with their CA Registry Numbers, again usually in in the text, and CA Registry Numbers (where available) are given usually in the critical evaluation.

In addition to the quantities defined above, the following are useful in conversions between concentrations and other quantities.

13. *Density*, ρ:

$$\rho = g/V = \sum_{i=1}^{c} \rho_i \qquad [17]$$

SI base units: kg m^{-3}. Here g is the total mass of the system.

14. *Relative density*, $d = \rho/\rho^{o}$: the ratio of the density of a mixture at temperature t, pressure p to the density of a reference substance at temperature t', pressure p'. For liquid solutions, the reference substance is often water at 4°C, 1 bar. (In some cases 1 atm is used instead of 1 bar.) The term *specific gravity* is no longer used.

Thermodynamics of Solubility

Thermodynamic analysis of solubility phenomena provides a rational basis for the construction of functions to represent solubility data, and thus aids in evaluation, and sometimes enables thermodynamic quantities to be extracted. Both these aims are often difficult to achieve because of a lack of experimental or theoretical activity coefficients. Where thermodynamic quantities can be found, they are not evaluated critically, since this task would involve examination of a large body of data that is not directly relevant to solubility. Where possible, procedures for evaluation are based on established thermodynamic methods. Specific procedures used in a particular volume will be described in the Preface to that volume.

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Table 1. Interconversions between Quantities Used as Measures of Solubility
c-component Systems Containing *c* - 1 Solutes *i* and Single Solvent *c*

	x_i	w_i	m_i	c_i
$x_i =$	x_i	$\frac{1}{1+\frac{M_i}{M_c}\left(\frac{1}{w_i}-1+\sum_{j\neq i}^{c-1}\left(\frac{M_c}{M_j}-1\right)\frac{w_j}{w_i}\right)}$	$\frac{1}{1+\frac{1}{m_iM_c}+\sum_{j\neq i}^{c-1}\frac{m_j}{m_i}}$	$\frac{1}{1+\frac{1}{M_c}\left(\frac{\rho}{c_i}-M_i\right)+\sum_{j\neq i}^{c-1}\frac{c_j}{c_i}\left(1-\frac{M_j}{M_c}\right)}$
$w_i =$	$\frac{1}{1+\frac{M_c}{M_i}\left(\frac{1}{x_i}-1+\sum_{j\neq i}^{c-1}\left(\frac{M_j}{M_c}-1\right)\frac{x_j}{x_i}\right)}$	w_i	$\frac{1}{1+\frac{1}{m_iM_i}\left(1+\sum_{j\neq i}^{c-1}m_jM_j\right)}$	$\frac{c_iM_i}{\rho}$
$m_i =$	$\frac{1}{M_c\left(\frac{1}{x_i}-1-\sum_{j\neq i}^{c-1}\frac{x_j}{x_i}\right)}$	$\frac{1}{M_i\left(\frac{1}{w_i}-1-\sum_{j\neq i}^{c-1}\frac{w_j}{w_i}\right)}$	m_i	$\frac{1}{\frac{1}{c_i}\left(\rho-\sum_{j\neq i}^{c-1}c_jM_j\right)-M_i}$
$c_i =$	$\frac{\rho}{M_i+M_c\left(\frac{1}{x_i}-1+\sum_{j\neq i}^{c-1}\left(\frac{M_j}{M_c}-1\right)\frac{x_j}{x_i}\right)}$	$\frac{\rho w_i}{M_i}$	$\frac{\rho}{\frac{1}{m_i}\left(1+\sum_{j\neq i}^{c-1}M_jm_j\right)+M_i}$	c_i

ρ - density of solution; M_i - molar masses of i. For relations for 2-component systems, set summations to 0.

PREFACE

The compilation and evaluation work on solubility data for alkali metal and ammonium perchlorates in aqueous, non-aqueous and mixed solvents resulted in two volumes which have been prepared in accordance with the objectives and format guidelines of the IUPAC Solubility Data Series. The first of these volumes, Part I, covers solubility data for lithium and sodium perchlorates and Part II, the second volume, covers those for potassium, rubidium, cesium and ammonium perchlorates.

The first comprehensive review, and probably the only one of its kind available, on the manufacture, properties, uses and analytical chemistry of perchloric acid, its salts and derivative compounds appeared as an excellent monograph edited by Schumacher (6) in 1960. It also included a brief account of the history and manufacture of perchloric acid and its salts. Potassium perchlorate was the first salt of perchloric acid to be prepared. Its discovery, together with the preparation of perchloric acid, was reported by von Stadion (1) as early as 1816. During the period between 1816 and 1831 the term "oxychlorate" was used to describe salts of perchloric acid. Serullas (2), who reported in 1830 another method of perchloric acid preparation and also the preparation of ammonium perchlorate and most of the more common inorganic metal perchlorates, helped to popularise the use of the term "perchlorate", which has been the preferred term since then. The main industrial and patent interests in the alkali metal and ammonium perchlorates appear to lie in the use of both potassium perchlorate and ammonium perchlorate in the manufacture of explosives and solid rocket propellants, in the use of lithium perchlorate as battery electrolyte, and in the use of sodium perchlorate as starting material in the manufacture of ammonium perchlorate and other perchlorates. Rubidium and cesium perchlorate attract relatively little commercial interest.

The unusual stability of the perchlorate ion is well-known but so is its ability to act as a powerful oxidant which can react explosively with organic materials (6). The alkali metal perchlorates together with ammonium perchlorate form an interesting group in that the lithium and sodium salts are very soluble in water and are hydrated while the potassium, rubidium, cesium and ammonium salts are unhydrated and have low solubilities. Lithium and sodium perchlorates are also much more soluble in alcohols and other non-aqueous solventshan the potassium, rubidium, cesium and ammonium salts. All of them exist as colourless crystalline solids. Reliable solubility data for these perchlorates in water, alcohols

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and other solvents were first published in 1923 by Willard and Smith (4). After that, up until the 1960's, more interest appeared to be focused on the solubility systems of potassium perchlorate in both aqueous and non-aqueous solvents than those of other perchlorates. The period between 1960 and 1980 saw prolific publication of solubility data on ammonium, alkali metal and alkaline earth metal perchlorates in binary and multi-component systems in aqueous, non-aqueous and mixed solvents. The majority of such work was carried out in the Commonwealth of Independent States (formerly USSR) and found only in Russian publications. After 1980 much fewer reports of solubility data for these perchlorates were found.

The primary sources used in the literature survey for relevant information were *Chemical Abstracts* from 1907 to 1990 and the volumes on *Solubilities of Inorganic and Metal Organic Compounds* by Linke (5). Other sources include the monographs by Schumacher (6) and Schilt (8), the article by Carlson (3), and the comprehensive treatise by Mellor (7). While the compilers have made their best effort to compile on all relevant and available data published up to 1990, it is possible that certain pertinent articles published in obscure journals have missed their attention. No compilations have been prepared for data presented only in graphic forms and they involved only a few articles, published in Russian. It is practically impossible to communicate with the authors of the original measurements to obtain the numerical data.

This work is the result of many years of collaboration between the Russian and Malaysian scientists involved in the Solubility Data Project, which has already resulted in volume 41 in the Series (on alcaline earth metal perchlorates, published in 1990). It is worth noting that much of the compilations in the present two Volumes, just as in Volume 41, are on data published in Russian Journals which are not readily available outside the C.I.S. The editors thank the University of Malaya and the Kurnakov Institute of General and Inorganic Chemistry, Moscow, for providing facilities used in the preparation of these volumes. They also wish to acknowledge the much appreciated help and advice from Dr. M. Salomon (U.S.A.), Prof. J.W. Lorimer (Canada), the late Prof. A.S. Kertes (Israel) and Prof. Yagodin (Russia), given in various ways, including liaison and literature search. They also thank all those colleagues in IUPAC Commission V.8 who have given help in one way or another.

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COMPONENTS	EVALUATORS
(1) Lithium Perchlorate; $LiClO_4$; [7791-03-9] 2) Water ; H_2O ; [7732-18-5] (3) Other Solvents	S. Gryzlova; *Kurnakov Institute of General and Inorganic Chemistry, Russian Academy of Sciences, Moscow, Russia Cohen-Adad; Université Claude Bernard Lyon I Villeurbanne, France

CRITICAL EVALUATION

Solubility data for fifty-eight binary systems $LiClO_4$ - solvents are presented in eleven publications (5, 7, 12, 14, 15, 20, 25, 32, 39, 46, 57). There are also data for twenty-four ternary (5, 17, 21-26, 28-30, 36, 38, 42-45, 47, 48, 50, 51, 54, 55, 58) and seven quaternary systems (6, 22, 31, 34, 37, 50, 52).

EXPERIMENTAL METHODS

The solubility of lithium perchlorate has been measured in most cases by the isothermal method. Simmons and Ropp (7) used a visual heating method in sealed tubes; a cooling method is also mentioned in ref. (46).

The solid phase was characterized by evaporation to dryness and, for ternary or quaternary systems, by the Schreinemakers' wet residues method (1). Thermographic and X-ray powder analysis were also employed (38).

ANALYSIS OF SOLUTIONS

Lithium perchlorate in saturated solution was determined by evaporation to dryness or by chemical analysis : Li^+ was titrated gravimetrically by precipitation as sulfate (17) or lithium zinc uranyl acetate (22, 30, 31, 37) or in solution, using the periodate method (21, 30), atomic absorption spectrophotometry (25) or flame photometry (12).

Perchlorate ion was determined gravimetrically as nitron perchlorate (14, 20, 21, 23, 29, 43, 47, 54) or by conversion to chloride and titration as AgCl (14).

SOURCE AND PURITY OF MATERIALS

In most cases lithium perchlorate was prepared by the methods described in references (2, 3, 4) and analysed as nitron perchlorate. It was also obtained by reacting 70 % $HClO_4$ (aq.) with Li_2CO_3, recrystallized twice (20). Keller and Foster used a commercial product

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CRITICAL EVALUATION (continued)

(Atomergic Chemicals Co) dried at 90-120 °C under vacuum. Lithium perchlorate was also dried at 200-250 °C under vacuum (20) or at 150-160 °C for 20-25 hours (15).

The solvents were "Reagent grade products" (14, 25) purified by fractional distillation after drying over anhydrous calcium sulfate (14), metallic lithium (15), zeolites of type NaA (58) or by recrystallization (12). Alcohols were purified by refluxing with calcium and fractional distillation (5). Acetonitrile, ethyl acetate, ether were redistilled from their mixture with P_2O_5 (25). Acetone was refluxed with powdered KOH and purified by the bisulfite process (5). Propylene carbonate (Matheson, Coleman & Bell) spectropure grade was fractionally distilled in the presence of CaH_2 and dry N_2 (25).

Anhydrous perchloric acid was distilled from a mixture of oleum and perchloric acid dihydrate at 100 °C under vacuum (20). Nickel perchlorate was synthetized from nickel carbonate and perchloric acid, followed by recrystallization (29).

Terbium perchlorate was prepared by heating terbium nitrate and dissolving the resulting terbium oxide in 56 % perchloric acid. The salt was recrystallized from aqueous solution and washed with chloroform (42).

I BINARY SYSTEMS

When possible a statistical treatment of data was performed in order to make a critical evaluation or to check the coherence of data

System $LiClO_4$-H_2O

The solubility of lithium perchlorate in aqueous solutions has been studied over a wide temperature range, from 273 K to 445 K and is presented in twenty-three publications

Within the accuracy of the analyses, the solid phases in equilibrium with saturated solutions are stoichiometric. Three solubility curves can be identified, involving anhydrous salt and two congruent melting hydrates $LiClO_4 \cdot H_2O$, $LiClO_4 \cdot 3H_2O$.

Fitting equations

The data of compilation sheets have been analyzed following the procedure described in the preface of volume 47 (59). The curves are represented by equation :

$$Y = f(T) = A/T + B \ln T + CT + D + \ldots \qquad [1]$$

where T is the temperature (K) and Y is the natural logarithm of solubility for the liquidus curve of ice, and is related to the solubility constant for the salts (table 1).

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CRITICAL EVALUATION (continued)

Table 1 $LiClO_4$-H_2O

Expression of Y	
$LiClO_4$	$Y = \ln(4x^2/(1+x)^2)$
$LiClO_4 \cdot H_2O$	$Y = \ln(27x^2(1-x)/(1+x)^3)$
$LiClO_4 \cdot 3H_2O$	$Y = \ln(5^5x^2(1-x)^3/(27(1+x)^5)$

Four coefficients, deduced from experimental data by linear regression, were necessary to represent the data. Their values are given in table 2.

Table 2 System $LiClO_4$-H_2O

Coefficients of fitting equations

Solid Phase	A	B	C	D
$LiClO_4$	-226579.46	-1022.4424	1.1542909	6229.9317
$LiClO_4 \cdot H_2O$	87977.65	446.3249	0.5600779	-2670.172
$LiClO_4 \cdot 3H_2O$	-1943.37	0.503708	-8.49846E-3	5.4328

Solubility of anhydrous $LiClO_4$

Only four data are available so that the coefficients A, B, C, D have been calculated by simple resolution of a system of 4 linear equations and the data above 172 °C must be considered as tentative data. The value 509 K (236 °C) given by Richards and Willard (2) for the melting point of lithium perchlorate has been adopted. The comparison between experimental and calculated values of solubility is presented in table 3.

Table 3 System $LiClO_4$-H_2O

Liquidus of anhydrous $LiClO_4$

t °C	exp $100w_1$	calc	exp $100x_1$	calc	ref
144.2	90.0	90.04	60.4	60.5	7
167.5	91.04	91.06	63.24	63.3	7
172.0	91.11	91.13	63.44	63.5	7
236	100	100	100	100	2

The solid phase in equilibrium with liquid at 144.2 °C is probably anhydrous lithium perchlorate instead of the monohydrate claimed by the authors

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CRITICAL EVALUATION (continued)

Solubility Curve of $LiClO_4 \cdot H_2O$

The solubility Curve of $LiClO_4 \cdot H_2O$ has been determined only by Simmons and Ropp (7). The coherence of experimental results is good except for the data close to the melting point. The congruent melting point is given by solution of the equation :

$$D = -A/T_m - B\ln(T_m) - CT_m \qquad [2]$$

The calculated value is 152.2 °C, the experimental value is 149 °C (5).

Table 4 Liquidus of monohydrate $LiClO_4 \cdot H_2O$

t °C	exp100$w_1$calc		exp100$x_1$calc		deviat.x1000	ev.	ref
93.2	70.5	70.53	28.8	28.84	0	R	7
97.3	71.0	70.95	29.3	29.26	0	R	7
108.9	72.8	72.74	31.2	31.12	3.2	R	7
120.7	75.0	75.23	33.7	33.96	- 8.8	R	7
136.9	80.0	79.38	40.4	39.46	22.7	T	7
144.0	82.5	81.47	44.4	42.68	39.8	T	7
144.2	81.53		42.78				**
148.5	85.0	83.02	49.0	45.29	81.7	A	7
149.3	87.5	83.34		45.87			**
149.3		87.48	54.2	54.2	0	R	7
148.5		87.74		54.8			**
144.2	90.0	88.85	60.4	57.45	50.5	A	7*
136.9		89.87		60.03			**
120.7		92.37		67.2			**
108.9		93.38		70.48			**
97.3		94.01		72.66			**
93.2		94.15		73.15			**

* belongs probably to the liquidus of anhydrous $LiClO_4$ ** calculated by evaluator
R = recommended, T = tentative, A = aberrant value

A comparison between experimental and calculated values of solubility is presented in table 4. The deviation is the quantity $100(x_{exp}-x_{calc})/x_{calc}$. The data have been recommended when dev < 2 % , considered as tentative when 2 % < dev < 5 % and aberrant above 5 %

Solubility Curve of $LiClO_4 \cdot 3H_2O$

The range of solubility of trihydrate has been determined in totality by Simmons and Ropp above 0 °C, but in most papers the data are reported at 25 °C. Lithium perchlorate trihydrate crystallizes from aqueous solutions as short prismatic or needle-like crystals of the hexagonal form. The critical evaluation is given in table 5. The coherence of experimental results is good except for the data close to the melting point. The calculated congruent melting point is 95 °C.

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CRITICAL EVALUATION (continued)

Table 5 Liquidus of trihydrate $LiClO_4 \cdot 3H_2O$

t°C	exp $100w_1$	calc	exp $100x_1$	calc	devx1000	ev.	ref
0.0	29.90	29.91	6.736	6.740	- 0.59	R	7
10.0	32.88	32.90	7.660	7.665	- 0.65	R	7
20.0	35.95	35.91	8.679	8.665	1.62	R	7
25	37.30	37.44	9.170	9.152	- 3.26	R	23
25	37.34	37.44	9.166	9.200	- 3.70	R	30
25	37.34	37.44	9.166	9.200	- 3.70	R	28
25	37.34	37.44	9.166	9.200	- 3.70	R	26
25	37.34	37.44	9.166	9.200	- 3.70	R	51
25	37.34	37.44	9.166	9.200	- 3.70	R	48
25	37.34	37.44	9.166	9.200	- 3.70	R	54
25	37.34	37.44	9.166	9.200	- 3.70	R	47
25	37.38	37.44	9.188	9.200	- 1.30	R	5
25	37.46	37.44	9.209	9.200	0.98	R	55
25.0	37.48	37.44	9.216	9.200	1.74	R	7
25	37.50	37.44	9.223	9.200	2.50	R	45
25	37.52	37.44	9.230	9.200	3.26	R	36
25	37.53	37.44	9.231	9.200	3.26	R	29
25	37.55	37.44	9.241	9.200	4.49	R	44
25	37.58	37.44	9.252	9.200	5.65	R	43
25	37.58	37.44	9.252	9.200	5.65	R	29
25	37.62	37.44	9.266	9.200	7.27	R	21
25	37.66	37.44	9.280	9.200	8.70	R	42
25	37.70	37.44	9.295	9.200	10.33	T	24
25	37.78	37.44	9.323	9.200	13.37	T	38
30.0	38.87	38.96	9.721	9.755	- 3.49	R	17
35	41.09	40.49	10.56	10.330	22.27	A	22
40.0	41.97	42.04	10.91	10.940	- 2.65	R	7
50	45.28	45.18	12.29	12.249	3.67	R	40
64.6	50.0	49.96	14.48	14.460	1.38	R	7
77.9	55.0	54.79	17.15	17.03	7.05	R	7
89.2	60.0	60.02	20.26	20.27	- 0.49	R	7
92.3	62.5	62.12	22.01	21.735	12.65	T	7
94.3	65.0	64.21	23.92	23.30	26.61	A	7
95.1*	66.32		25.01				7
94.8	66.67	67.41	25.30	25.94	- 24.67	A	7
93.2	70.0	69.53	28.3	27.87	15.43	T	7
92.7	70.3	69.93	28.6	28.25	- 58.41	A	7
92.5	70.33	70.08	28.64	28.40	8.45	R	7

R = recommended , T = tentative, A = aberrant value

* The calculated melting point is 95.0 °C

Double saturation points

Two eutectic points can be observed above 0 °C :

liq. ⇔ $LiClO_4 \cdot 3H_2O + LiClO_4 \cdot H_2O$ $T = 92.4$ °C , $x_1 = 0.284$

(continued)

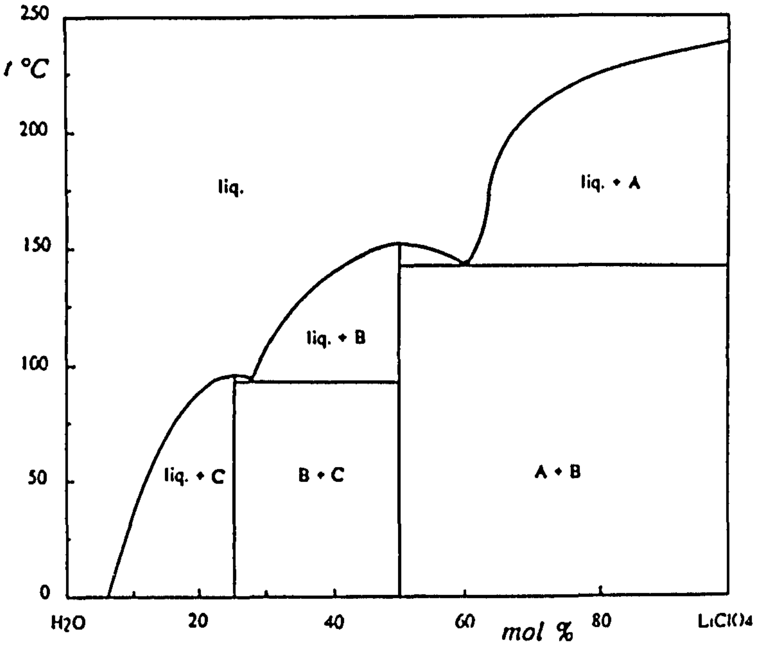
CRITICAL EVALUATION (continued)

liq. → $LiClO_4{\cdot}H_2O + LiClO_4$ $T = 140\ °C, x_1 = 0.592$

Phase diagram

The phase diagram $LiClO_4$ - H_2O between 0 °C and the melting point is presented in figure 1. The calculated solubility of mono and trihydrate are in good agreement with experimental data, the liquidus curve of anhydrous salt must be considered as tentative due to the small number of experimental data.

Figure 1 Solubility of lithium perchlorate in water



A = $LiClO_4$ B = $LiClO_4{\cdot}H_2O$ C = $LiClO_4{\cdot}3H_2O$

Solubility of Lithium Perchlorate in other solvents

Due to the small number of papers it was not possible to perform a critical evaluation, so that all data must be considered as tentative.

The solubility of lithium perchlorate in tetrahydrofuran was 2.2 mol dm^{-3} [35] at 298.2 K and could not be converted in mass units.

In most cases the solubility was measured at 298 K and the data at this temperature are collected in table 6.

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CRITICAL EVALUATION (continued)

Table 6 Solubility of LiClO4 in various solvents

Solvent				g % solvent	*x1*	ref
CH3NO	[75-12-7]		formamide	142.1±0.2	37.6	14
CH_4O	[67-56-1]	methanol	methyl alcohol	182.25	35.44	5
$C_2HF_3O_2$	[76-05-1]	2-trifluoroethanoic acid	trifluoroacetic acid	11.7	11.1	14
C_2H_3N	[75-05-8]	acetonitrile		12.99	5.44	25
				14.46	6.12	46
				13.6±0,1	6.98	14
$C_2H_4O_2$	[64-19-7]	ethanoic acid	acetic acid	108.7±0.1	38.0	14
C_2H_6O	[64-17-5]	ethanol	ethyl alcohol	151.76	39.66	5
$C_2H_6O_2$	[107-21-1]	1-2-ethanediol	ethyleneglycol	96.7±0.4	36.1	14
C_2H_6OS	[67-68-5]	sulfinylbis-methane	dimethylsulphoxide	21.1*	17.4*	12
C_2H_7NO	[141-43-5]	2-aminoethanol		78.9±0.9	31.2	14
$C_2H_8N_2$	[107-15-3]	1,2-ethanediamine	ethylenediamine	48.0±0.3	21.3	14
C_3H_60	[123-38-6]	propionaldehyde	propanal	110.5±0.7	37.6	14
C_3H_60	[75-56-9]	methyloxirane	propylene oxide	91.4± 0.6	33.3	14
C_3H_60	[67-64-1]		acetone	136.52	42.70	5
C_3H_7NO	[68-12-2]	N,N-dimethyl-formamide		7.5±0.2	34.0	14
C_3H_8O	[71-23-8]	1-propanol	n-propyl alcohol	105.0	37.23	5
C_3H_8O	[67-63-0]	2-propanol	isopropyl alcohol	112.1±0.1	38.8	14
C_3H_9N	[107-10-8]	1-propanamine	n-propylamine	59.1±0.3	24.7	14
$C_4H_6O_3$	[108-24-7]		acetic anhydride	8.1	7.2	14
C_4H_8O	[109-99-9]		tetrahydrofurane	27.1±0.2	15.5	14
$C_4H_8O_2$	[141-78-6]		ethyl acetate	95.12	44.1	5
				95.1	44.1	14
$C_4H_8O_2$	[107-92-6]	butanoic acid	butyric acid	60.0±0.3	33.2	14
$C_4H_9NO_2$	[544-16-1]	1-butyl nitrite	n-butyl nitrite	3.4	3.2	14
$C_4H_{10}O$	[60-29-7]	1,1'-oxybis-ethane	diethylether	113.72	44.21	5
$C_4H_{10}O$	[71-36-3]	1-butanol	n-butyl alcohol	79.31	35.59	5
$C_4H_{10}O$	[78-92-2]	2-butanol	sec-butyl alcohol	77.1±0.1	34.9	14
$C_4H_{10}O$	[78-83-1]	2-methyl-1-propanol	isobutylalcohol	58.05	28.8	5
$C_4H_{10}O$	[75-65-0]	2-methyl-2-propanol	t-butyl alcohol	0.6	0.4	14
$C_4H_{10}O_2$	[110-80-5]	2-ethoxyethanol		136.6±0.4	53.6	14
$C_4H_{11}N$	[109-73-9]	1-butanamine	n-butylamine	45.7±0.3	23.9	14
$C_4H_{11}N$	[13952-84-6]	2-butanamine	sec-butylamine	45.7±0.2	23.9	14
$C_4H_{11}N$	[75-64-9]	2-methyl-2-propananamine	t-butylamine	10.7± 0.3	6.8	14
C_5H_5N	[110-86-1]		pyridine	8.7±0.1	6.1	14
C_5H_8O	[120-92-3]		cyclopentanone	63.8±0.2	33.5	14
$C_5H_{10}O_3$	[105-58-9]		diethyl carbonate	52.6±0.1	36.9	14
C_6H_7N	[62-53-3]	benzenamine	aniline	6.1±0.2	5.1	14
$C_6H_{10}O$	[108-94-1]	cyclohexanone		54.0±0.3	33.2	14
$C_6H_{10}O_3$	[141-97-9]	ethyl-3-oxobutanoate	ethyl acetoacetate	76.7±0.1	48.4	14

(continued)

Table 6 (continued)

Solubility of $LiClO_4$ in various solvents at 298 K

		Solvent		mass % solvent	x_1	ref
$C_6H_{12}O$	[108-93-0]	cyclohexanol		5.9±0.1	5.3	14
$C_6H_{12}N$	[108-91-8]	cyclohexanamine	cyclohexylamine	16.9	13.6	14
C_7H_5N	[100-47-0]	benzonitrile		21.9±0.2	17.5	14
C_7H_6O	[100-52-7]	benzaldehyde		51.5±0.3	33.9	14
C_7H_8O	[100-51-6]	benzenemethanol	benzyl alcohol	49.8±0.3	33.6	14
C_7H_8O	[108-39-4]	3-methylphenol		142.1±0.2	37.6	14
C_7H_9N	[100-61-8]	n-methyl benzenamine	n-methylaniline	1.4±0.1	1.4	14
$C_8H_{16}O_2$	[124-07-2]	1-octanoic acid	n-octanoic acid	32.1±0.3	30.3	14
$C_8H_{18}O$	[111-87-5]	1-octanol		43.8±0.3	34.9	14
$C_8H_{18}O$	[123-96-6]	2-octanol		44.7±0.3	35.4	14
$C_8H_{18}O$	[142-96-1]	1-1'-oxybis-butane	n-butylether	13.6±0.2	14.3	14
$C_8H_{19}N$	[111-92-2]	n-butyl-1-butanamine	dibutylamine	45.6±0.4	35.6	14
$C_9H_{10}O_2$	[93-89-0]		ethyl benzoate	29.2±0.2	29.2	14
$C_9H_{10}O_2$	[140-11-4]		benzyl acetate	50.1±0.4	41.4	14
$C_{12}H_{14}O_4$	[84-66-2]	diethyl-1,2-benzene dicarboxylate	diethylphtalate	5.5	1.2	14
$C_{14}H_{26}O_4$	[110-40-7]	diethyldecanedioate	diethylsebacate	21.3±0.1	34.0	14
N_2H_4	[302-01-2]		hydrazine	54.4	14.1	39

* the solid phase is the solvate $2LiClO_4 \cdot 7(CH_3)_2SO$

Some solubilities have been measured at 273 K (table 7)

		Solvent	mol% solvent	x_1	ref
$HClO_4$	[7601-90-3]	perchloric acid	0.107	0.1	20
H_2O_2	[7722-84-1]	hydrogen peroxide	62.3	16.61	57
N_2H_4*	[302-01-2]	hydrazine	47.1	12.4	32

* The solid phase was $LiClO_4 \cdot 2N_2H_4$

Sometimes the measurements have been performed at several temperatures, so that a fitting equation has been derived in order to allow interpolation.

<u>System $LiClO_4$-Acetonitrile</u> [75-05-8]

Tomkins and Turner [46] have measured the solubility of lithium perchlorate in acetonitrile at temperatures between 24.20 and 50.17 °C. A congruent melting point is observed for x_1=0.20. The solid phase is $LiClO_4 \cdot 4CH_3CN$ and the data are fitted by the equation :

(continued)

CRITICAL EVALUATION (continued)

$$\ln(x_1(1-x_1)^4) = A/T + B \qquad [3]$$

where $A = -2119.1747$, $B = 4.0842$.

The agreement between experimental and calculated solubilities is good except in the vicinity of the dystectic point (table 8)

Table 8 System $LiClO_4$-Acetonitrile

100 x_1	t °C exp.	t °C calc	100 d
5.953	24.20	23.19	0.3
7.106	29.16	28.58	0.2
8.076	32.80	32,32	0.15
9.178	36.33	35.87	0.15
10.818	40.12	40.05	0.02
11.693	41.94	41.84	0.03
13.923	45.67	45.26	0.1
15.480	48.28	46.84	0.45
17.694	49.50	48.18	0.4
20.146	49.41	48.60	0.25
20.350	50.17	48.60	0.5
22.780	48.85	48.05	0.2
23.750	41.21	47.62	- 2
24.240	45.66	47.36	- 0.5
25.600	45.43	46.50	- 0.3

The deviation is given by $d = (T_{exp.} - T_{calc.})/T_{calc}$. The congruent melting point (dystectic point) is located at $x_1 = 0.20$ and $t = 49 \pm 1$°C

System $LiClO_4$-DMSO [67-68-5]

The data of Kenttamaa [12] at 25, 35 and 45 °C are not accurate and all data must be considered as tentative.

System $LiClO_4$-Propionitrile [107-12-0]

The solubility of lithium perchlorate in propionitrile at temperatures between 230 and 285 K has been measured by Tomkins and Turner [46]. A congruent melting point is observed for $x_1 = 0.20$. The solid phase is $LiClO_4 \cdot 4CH_3CN$ and the data are fitted by equation [3]. The values of coefficients are

$A = -628.3486$ $\qquad B = -0.17801$

The agreement between experimental and calculated solubilities is good (table 9, figure 2).

(continued)

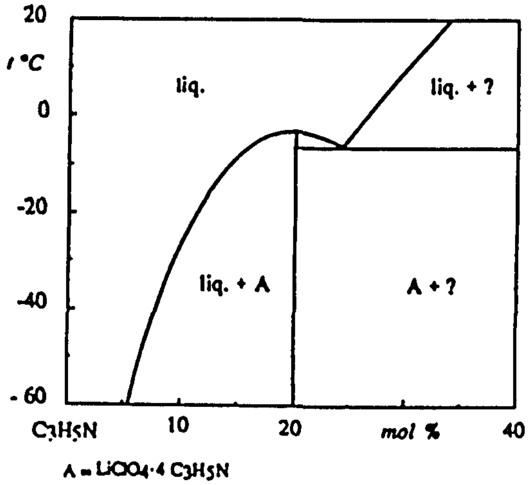
CRITICAL EVALUATION (continued)

Table 9 System $LiClO_4$-Propionitrile

$100x_1$	t°C exp.	t°C calc	100 d	solid phase
7.23	- 43	- 44.935	0.8	$LiClO_4·4C_3H_5N$
12.141	- 21.3	- 16.9	- 1.7	"
14.218	- 12.1	- 10.3	- 0.7	"
17.049	- 0.5	- 4.9	- 1.6	"
18.62	- 3.9	- 3.6	- 0.1	"
27.378	2.1			?
30.97	12			?

The deviation is given by $d = (t_{exp.} - t_{calc.})/t_{calc}$. The congruent melting point is located at $x_1 = 0.20$ and $t = -3.2 \pm 1$°C and the eutectic point are close to $x_1 = 0.243$, $t = - 6.3$ °C.

Figure 2 Solubility of Lithium perchlorate in propionitrile



II TERNARY SYSTEMS

Solubility of $LiClO_4·3H_2O$ in various solvents at 298.15 K

The values of solubility are presented in table 10, the solid phase was not specified. In some cases it is assumed to be $LiClO_4·3H_2O$

Table 10 Solubility of $LiClO_4·3H_2O$ in various solvents

Solvent			mass %	ref.
CH_40	[67-56-1]	Methanol	60.95	5
C_2H_60	[64-17-5]	Ethanol	42.16	5
C_3H_60	[67-64-1]	Acetone	49.04	5
C_3H_80	[71-23-8]	1-Propanol	26.82	5
$C_4H_80_2$	[141-78-6]	Ethyl acetate	27.41	5
$C_4H_{10}0$	[71-36-3]	1-Butanol	21.40	5
$C_4H_{10}0$	[78-83-1]	2-Methyl-1-propanol	18.85	5
$C_4H_{10}0$	[60-29-7]	dithyl ether	0.196	5

(continued)

CRITICAL EVALUATION (continued)

Solubility in mixed solvents

Solubility in solvents containing a trace of water

Determinations at 25 and 60 °C have been made by Keller and Foster (25) with two solvents (propylene carbonate $C_4H_6O_3$ and N,N-dimethylformamide C_3H_7NO) and containing slight quantities of water.

Table 11 Solubility of lithium perchlorate in solvents containing a trace of water

Solvent	T / K	H_2O mg dm^{-3}	$LiClO_4$ c/mol dm^{-3}	ref
C_3H_7NO	298	45	4.4	25
(N,N-dimethylformamide)		1000	3.5	
	333	45	4.8	
		1000	4.9	
$C_4H_6O_3$	298	20	2.1	25
(propylene carbonate)		1000	3.1	
	333	20	3.1	
		1000	3.1	

System $LiClO_4$ - Acetamide - H_2O

The isothermal section 298 K has been determined by Tarakanov (45). Four stoichiometric phases are observed $LiClO_4{\cdot}3H_2O$, $LiClO_4{\cdot}2CH_3CONH_2$, $LiClO_4{\cdot}4CH_3CONH_2$, CH_3CONH_2. The two intermediate compounds are very hygroscopic.

System $LiClO_4$ - Dimethylurea- H_2O

The isothermal section determined by Bestuzheva (55) shows that three solid phases must exist at 298 K : $LiClO_4{\cdot}3H_2O$, dimethylurea $C_3H_8N_2O$ and presumably, according to the compiler, $LiClO_4{\cdot}3C_3H_8N_2O{\cdot}H_2O$. The double-saturation points are not observed and the intermediate compound has a non-congruent solubility.

System $LiClO_4$ - Hexamethylenetetramine - H_2O

Four solubility curves are observed, involving $C_6H_{12}N_4$, $LiClO_4{\cdot}2C_6H_{12}N_4{\cdot}2H_2O$ which is an incongruently soluble compound, $LiClO_4{\cdot}C_6H_{12}N_4{\cdot}3H_2O$ and $LiClO_4{\cdot}3H_2O$ Several anomalies are observed on the data sheet :

- The solubility diagram presented on the compilation sheet is not correct since the ratio $LiClO_4/H_2O$ is not the same for the various compounds, so that their representative points cannot be located on the same straight line.

(continued)

- The nature of the solid phases presented in the last row of the table is not supported by the data.

Table 12 Solubility in mixed solvents at 298 K

Composition of double saturation points

Equilibrium	composition		ref
	(1) mol %	(2)	
System $LiClO_4$-C_2H_5NO-H_2O			
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\,H_2O$ + $LiClO_4 \cdot 4CH_3CONH_2$	18.97	44.74	45
liq. $\leftrightarrow$ $LiClO_4 \cdot 4CH_3CONH_2$ + $LiClO_4 \cdot 2CH_3CONH_2$	17.82	57.86	
liq. $\leftrightarrow$ $LiClO_4 \cdot 2CH_3CONH_2$ + CH_3CONH_2	10.97	72.17	
System $LiClO_4$-$C_3H_8N_2O$-H_2O			
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\,H_2O$ + ?	12.17	9.157	55
liq. $\leftrightarrow$? + $C_3H_8N_2O$	?	?	
System $LiClO_4$-$C_6H_{12}N_4$-H_2O			
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\,H_2O$ + $LiClO_4 \cdot C_6H_{12}N_4 \cdot 3H_2O$	8.89	2.09	43
liq. $\leftrightarrow$ $LiClO_4 \cdot C_6H_{12}N_4 \cdot 3H_2O$ + $LiClO_4 \cdot 2C_6H_{12}N_4 \cdot 2H_2O$	5.83*	7.0*	
liq. $\leftrightarrow$ $LiClO_4 \cdot 2C_6H_{12}N_4 \cdot 2H_2O$ + $C_6H_{12}N_4$	1.62*	11.1*	

* assumed by evaluator

System $LiClO_4$ - Methylacetate - Propylene carbonate

The solubility of $LiClO_4$ has been measured by Il'in and Demakin (58) at 6 temperatures between 283.2 and 323.2 K. A fitting equation proposed by the authors is presented in data sheet; it allows a precision better than 10 %, the calculation of solubility at any composition of solvents and a temperature range between 10 and 50 °C.

Ternary salt systems involving the same anion

$LiClO_4$ - $MClO_4$ - H_2O, (M = Na, K, NH4, Tl)

The systems have been studied at temperatures between 298 and 323 K. All solid phases are stoichiometric: the solid phase involving lithium is always $LiClO_4 \cdot 3H_2O$, the other observed phases are anhydrous perchlorates except for $NaClO_4$ which crystallizes, according to the temperature, as monohydrate or anhydrous salt. In a general way the data are coherent, but as they are presented in a single paper it was not possible to assess the accuracy of the data. The composition of eutonic points of the systems are presented in table 13

(continued)

Table 13 Ternary systems $LiClO_4 - MClO_4 - H_2O$

M = Na, K, NH4, Tl

Composition of eutonic points

T / K	Equilibrium	(1) mol %	(2)	ref
298	liq. ↔ $LiClO_4 . 3 H_2O$ + $NaClO_4 . H2O$	2.36*	20.23*	21
	liq. ↔ $LiClO_4 . 3 H_2O$ + $KClO_4$	9.24*	0.036*	24
	liq. ↔ $LiClO_4 . 3 H_2O$ + NH_4ClO_4	8.92*	0.68*	23
	liq. ↔ $LiClO_4 . 3 H_2O$ + $TlClO_4$	9.26*	0.14*	38
303	liq. ↔ $LiClO_4 . 3 H_2O$ + NH_4ClO_4	9.66*	0.599*	17
308	liq. ↔ $LiClO_4 . 3 H_2O$ + NH_4ClO_4	10.49*	0.519	22
323	liq. ↔ $LiClO_4 . 3 H_2O$ + $NaClO_4$	5.66*	21.40*	40
	liq. ↔ $NaClO_4$ + $NaClO_4. H_2O$	1.47**	27.4**	40

*average ** assumed by evaluator

Taking in account the common ion effect and the variation of the ionic strength of the solution, the ionic product S of $LiClO_4 \cdot 3H_2O$, we have :

$$S = x_1 (x_1+x_2) (1-x_1-x_2)^3 / (1+x_1+x_2)^5 \qquad [4]$$

where x_1 and x_2 are the mole fractions of components. The data can be fitted by equation [5]

$$S = A + B x_1 + C x_1^2 \qquad [5]$$

The coefficients A, B, C are presented in table 14 :

Table 14 Ionic product of $LiClO_4 \cdot 3H_2O$

in ternary systems $LiClO_4 - MClO_4 - H_2O$

M	T/K	A	B	C
Na	298	- 0.5629	64.78	-151
	323	- 2.9187	94.57	-198
K	298	- 0.429	49.09	0
NH4*	298	1.8782	23.75	0
Tl	298	1.3383	30.16	0

*at 303 and 308 K the calculation of coefficients was not possible due to the scattering of experimental data

(continued)

CRITICAL EVALUATION (continued)

Ternary systems $LiClO_4$ - $M(ClO_4)_2$ - H_2O, (M = Ca, Ba, Mn, Co, Ni, Cu)

All systems have been studied at a single temperature 298 K. The isothermal sections have the same shape with two saturation curves and an eutonic point. The solid phases in equilibrium with liquid are $LiClO_4 \cdot 3\ H_2O$ and, according to the system $Ca(ClO_4)_2 \cdot 4\ H_2O$, $Ba(ClO_4)_2 \cdot 3\ H_2O$ or an hexahydrate $M(ClO_4)_2 \cdot 6\ H_2O$ for M = Mn, Co, Ni, Cu). The eutonic points of the systems are given in table 15.

Table 15 Ternary systems $LiClO_4$ - $M(ClO_4)_2$ - H_2O

Composition of eutonic points at 298 K

Equilibrium	(1) mol %	(2)	ref
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\ H_2O$ + $Ca(ClO_4)_2 \cdot 4\ H_2O$	3.14	7.608	36
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\ H_2O$ + $Ba(ClO_4)_2 \cdot 3\ H_2O$	2.62	7.85	48
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\ H_2O$ + $Mn(ClO_4)_2 \cdot 6\ H_2O$	1.13	6.98	51
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\ H_2O$ + $Co(ClO_4)_2 \cdot 6\ H_2O$	1.73*	6.23*	29
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\ H_2O$ + $Ni(ClO_4)_2 \cdot 6\ H_2O$	2.157*	6.00*	29
liq. $\leftrightarrow$ $LiClO_4 \cdot 3\ H_2O$ + $Cu(ClO_4)_2 \cdot 6\ H_2O$	2.78*	7.10	43

* average

If the solvation of ions is not taken in account, the ionic product of trihydrate $LiClO_4 \cdot 3\ H_2O$ is represented by equation [6] :

$$S = x_1\ (x_1 + 2x_2)\ (1 - x_1 - x_2)^3\ /\ (1 + x_1 + 2x_2)^5 \qquad [6]$$

and can be fitted by relation [5]. The coefficients of fitting equations are given in table 16.

Table 16 Ionic product of $LiClO_4 \cdot 3H_2O$

Systems $LiClO_4$ - $M(ClO_4)_2$ - H_2O at 298 K

M	A	B	C
Ca	- 0.0833	64.61	-208
Ba	- 0.1628	68.62	-218
Mn,Co, Ni	0.1017	53.18	-107
Cu	0.8245	18.97	186

The ionic product of $LiClO_4 \cdot 3\ H_2O$ is given by the same equation when M = Mn, CO, Ni showing that the structure of the saturated solution is the same and consequently, in spite of

[continued)

the fact that each system has been determined by a a single author, the solubility data for the isothermal section 298 K of the systems involving Mn, Co and Ni can be recommended.

For the other sytems the data are coherent but no assessment can be done concerning the accuracy.

Ternary systems $LiClO_4$ - $M(ClO_4)_3$ - H_2O (M = Ce, Ga, Tb)

All systems have been studied at a single temperature, 298 K. The isothermal sections have two saturation curves and an eutonic point. The solid phases in equilibrium with liquid are $LiClO_4 \cdot 3\ H_2O$ and, according to the system, $Ce(ClO_4)_3 \cdot 9\ H_2O$, $Ga(ClO_4)_3 \cdot 9\ H_2O$ or $Tb(ClO_4)_3 \cdot 9\ H_2O$. The eutonic points of the systems are presented in table 17

Table 17 Ternary systems $LiClO_4$ - $M(ClO_4)_3$ - H_2O

Composition of eutonic points at 298 K

Equilibrium	(1) mol %	(2)	ref
liq. ↔ $LiClO_4 \cdot 3\ H_2O$ + $Ce(ClO_4)_3 \cdot 9\ H_2O$	1.54*	7.35*	47
liq. ↔ $LiClO_4 \cdot 3\ H_2O$ + $Ga(ClO_4)_3 \cdot 9\ H_2O$	0.38*	5.97*	54
liq. ↔ $LiClO_4 \cdot 3\ H_2O$ + $Tb(ClO_4)_3 \cdot 9\ H_2O$	1.47*	6.64	42

* average

If the solvation of ions is not taken in account, the ionic product of trihydrate $LiClO_4 \cdot 3\ H_2O$ is represented by equation [7] :

$$S = x1\ (x_1+3x_2)\ (1-x_1-x_2)^3\ /\ (1+x_1+3x_2)^5 \qquad [7]$$

and can be fitted by relation [5]. The coefficients of the fitting equations are given in table 18.

Table 18 Ionic product of $LiClO_4 \cdot 3H_2O$

Systems $LiClO_4$ - $M(ClO_4)_3$ - H_2O at 298 K

M	A	B	C
Ce	0.329	45.56	- 60
Ga	0.0678	53.33	-111
Tb	0.0696	60.19	-179

<u>Ternary salt systems involving the same cation</u>

Ternary system $LiClO_4$ - $LiNO_3$ - H_2O

Isothermal sections at 298 and 323 K are reported in three publications. Two of them (28, 30) concern the same set of data and have been condensed in the same data sheet. Two solid

(continued)

phases, $LiClO_4 \cdot 3H_2O$ and $LiNO_3$, are observed. The existence of $LiNO_3 \cdot 5H_2O$ reported by Donnan and Burt (33) was not confirmed by the work of other researchers (8). The coordinates of eutonic points are given in table 19:

Table 19 System $LiClO_4$ - $LiNO_3$ - H_2O

Coordinates of eutonic points

T / K	$LiClO_4$ mol %	LiNO3	ref
298	2.09*	17.79*	28,30
323	4.30*	26.86*	40

* average

Ternary system $LiClO_4$ - Li_2CrO_4 - H_2O

Isothermal sections 298 and 308 K are reported (22, 26). Two solid phases, $LiClO_4 \cdot 3H_2O$ and $Li_2CrO_4 \cdot 2H_2O$, are observed. The coordinates of eutonic points are given in table 20.

Table 20 System $LiClO_4$ - Li_2CrO_4 - H_2O

Coordinates of eutonic points

T / K	$LiClO_4$ mol %	Li_2CrO_4	ref
298	0.455	11.27	26
323	0.344*	2.09*	22

*average

If the solvation of ions is not taken in account, the ionic product of $LiClO_4 \cdot 3\ H_2O$ is represented by equation [6] and can be fitted by relation [5]. The coefficients of fitting equations are given in table 21.

Table 21 Ionic product of $LiClO_4 \cdot 3H_2O$

Systems $LiClO_4$ - Li_2CrO_4 - H_2O

T / K	A	B	C
298	- 0.0411	64.9	- 207
308	- 0.0359	63.75	- 164

III QUATERNARY SYSTEMS

In general a single set of data has been determined so that a critical evaluation cannot be performed.

(continued)

CRITICAL EVALUATION (continued)

Quaternary simple systems

$LiClO_4$ - Ethanol - Ethyl acetate - H_2O

The solubility of lithium perchlorate trihydrate in mixed. solvent ethanol-ethyl acetate is determined at 25 °C (6). The composition of solvent is measured in volume % and the solubility is expressed in mass % of $LiClO_4 \cdot 3H_2O$. The solid phase is assumed to be the trihydrate.

$LiClO_4$ -$Mg(ClO_4)_2$ - Hexamethylenetetramine - H_2O

The solubilities have been measured at 298 K by Kosheleva (52) The isobaric-isothermal monovariant lines and invariant points are determined. Six solid phases are observed $LiClO_4 \cdot 3H_2O$, $Mg(ClO_4)_2 \cdot 2C_6H_{12}N_4 \cdot 8H_2O$, $C_6H_{12}N_4$, $LiClO_4 \cdot 2C_6H_{12}N_4 \cdot 5H_2O$, $LiClO_4 \cdot C_6H_{12} \cdot N_4 \cdot 3H_2O$, $Mg(ClO_4)_2 \cdot 6H_2O$. A diagram has been drawn in Jänecke coordinates (see compilation sheet). Furthermore the quality of the graph shows evidently that all data must be considered as tentative

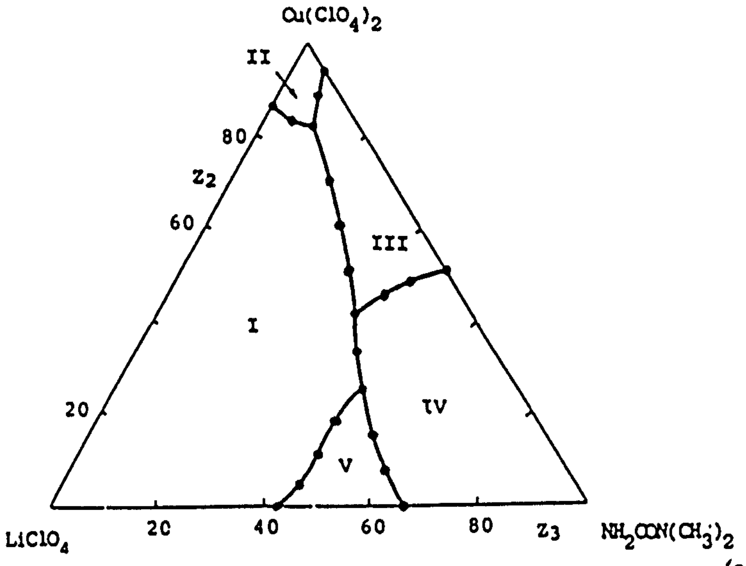
$LiClO_4$ - $Cu(ClO_4)_2$ - N,N-dimethyl carbamide - H_2O

The quaternary system $LiClO_4$ - $Cu(ClO_4)_2$ - N,N-dimethyl carbamide - H_2O has been investigated at 298 K.by Bestuzhzva et al. (50) The isobaric-isothermal monovariant lines and invariant points are determined. Five solid phases are observed :

I=$LiClO_4 \cdot 3H_2O$, II=$Cu(ClO_4)_2 \cdot 6H_2O$, III=$Cu(ClO_4)_2 \cdot 2NH_2CON(CH_3)_2 \cdot 4H_2O$
IV=$NH_2CON(CH_3)_2$, V=$LiClO_4 \cdot 3NH_2CON(CH_3)_2 \cdot H_2O$

A diagram has been drawn in Jänecke coordinates figure (3) where $Z_i = 100x_i(x_1+x_2+x_3)$ and i= compounds (1), (2) or (3).

Figure 3 System $LiClO_4$ - $Cu(ClO_4)_2$ - N,N-dimethylcarbamide - Water



(continued)

CRITICAL EVALUATION (continued)

Quaternary reciprocal systems

Three quaternary reciprocal systems involving $LiCrO_4$ have been investigated. All data must be considered as tentative.

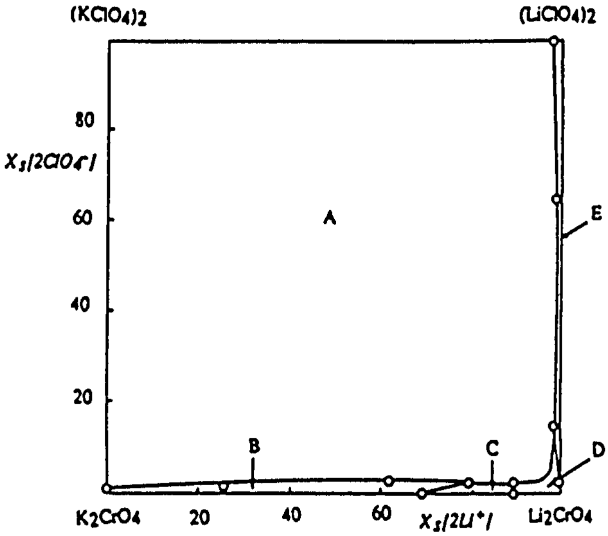
$Li^+, K^+ // ClO_4^-, CrO_4^{2-} - H_2O$

The quaternary system $Li^+, K^+ // ClO_4^-, CrO_4^{2-} - H_2O$ has been investigated at 298 K by Voronina et al. (37). The isobaric-isothermal monovariant lines and invariant points are determined.

Five solid phases are observed $A=KClO_4$, $B=K_2CrO_4$, $C=Li_2CrO_4 \cdot K_2CrO_4 \cdot H_2O$, $D=Li_2CrO_4 \cdot 2H_2O$, $E= LiClO_4 \cdot 3H_2O$. A diagram (figure 4) has been drawn in Jänecke coordinates . The crystallization field of K ClO_4 is very large due to its small solubility .

Figure 4 Qaternary system $Li^+, K^+ / ClO_4^-, CrO_4^{2-} // H_2O$

Isothermal section at 298 K



$Li^+, NH_4^+ // ClO_4^-, CrO_4^{2-} - H_2O$

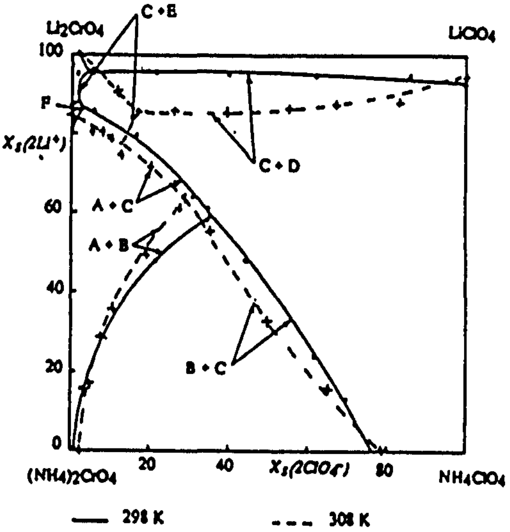
Two isothermal sections of the system Li^+, NH_4^+ // ClO_4^-, CrO_4^{2-} - H_2O have been determined. At 298 K. (31) six solid phases are observed : $A=(NH_4)_2CrO_4$, $B=NH_4ClO_4 \cdot (NH_4)_2CrO_4$, $C=NH_4ClO_4$, $D=LiClO_4 \cdot 3H_2O$, $E=Li_2CrO_4 \cdot 2H_2O$, $F=(NH_4)_2CrO_4 \cdot Li_2CrO_4 \cdot 2H_2O$. The compound F has a non congruent solubility. A diagram (figure 5) has been drawn in Jänecke coordinates. At 308 K (22) the phase diagram is very similar but the hydrated double salt F is no more observed. The isothermal section of the diagram is represented in figure 5 in dotted lines.

(continued)

CRITICAL EVALUATION (continuation)

Figure 5 Quaternary system $Li^+,NH_4^+/ClO_4^-,CrO_4^{2-}//H_2O$

Isothermal sections 298 and 308 K



Li^+, Mg^{2+} //ClO_4^-, CrO_4^{2-} - H_2O

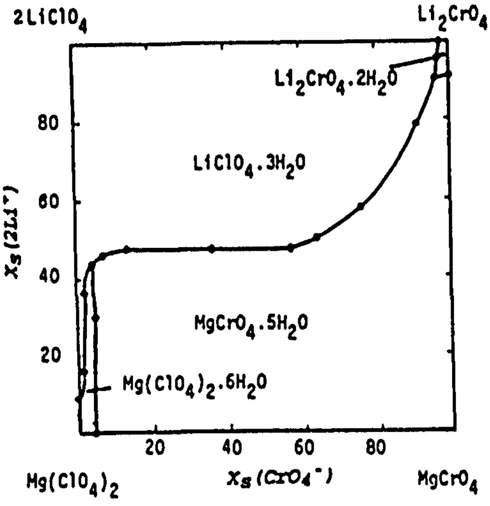
A section of the quaternary system Li^+, Mg^{2+} // ClO_4^-, CrO_4^{2-} - H_2O has been determined at 298 K by Voronina (34). Four solid phases are observed :

A=$LiClO_4{\cdot}3H_2O$, $(NH_4)_2CrO_4$, B=$Mg(ClO_4)_2{\cdot}6H_2O$, C= $MgCrO_4{\cdot}5H_2O$,
D=$Li_2CrO_4{\cdot}2H_2O$.

A graph in Janecke coordinates has been drawn (figure 6)

Figure 6 Quaternary system $Li^+,Mg^{2+}/ClO_4^-,CrO_4^{2-}//H_2O$

Isothermal section 298 K



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CRITICAL EVALUATION (continued)

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COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$ [7791-03-9] (2) Water; H_2O; [7732-18-5]	Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1923, *45*, 286-96.
VARIABLES:	**PREPARED BY:**
One temperature: 298.15 K	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of lithium perchlorate in water at 25.00°C :

mass %	g/100 cm^{-3} sln	mol %	mol dm^{-3}	mol kg^{-1}	satd sln density/g cm^{-3}
37.385	47.42	9.182[b]	4.457	5.612 [b]	1.2683

[a] The solid phase is a mixture of anhydrous $LiClO_4$ and $LiClO_4.3H_2O$.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-250°C in a current of air dried with P_2O_5. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Anhydrous $LiClO_4$ was prepared as described in ref. 1.

ESTIMATED ERROR:

Precision in temp. was ±0.01 °C .

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Simmons, J.P.; Ropp, C.D.L.

J. Am. Chem. Soc. 1928, *50*, 1650-3.

VARIABLES:

Temperature: 273 - 445 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of $LiClO_4$ in water at various temperatures:

t / °C	T^a / K	mass %	mol %[a]	molality[a]/mol kg^{-1}	Solid phase
0.0	273.2	29.90	6.736	4.009	$LiClO_4.3H_2O$
10.0	283.2	32.88	7.660	4.604	"
20.0	293.2	35.95	8.679	5.276	"
25.0	298.2	37.48	9.216	5.635	"
30.0	303.2	38.87	9.721	5.977	"
40.0	313.2	41.97	10.911	6.798	"
64.6	337.8	50.0	14.48	9.40	"
77.9	351.1	55.0	17.15	11.49	"
89.2	362.4	60.0	20.26	14.10	"
92.3	365.5	62.5	22.01	15.67	"
94.3	367.5	65.0	23.92	17.46	"
95.1	368.3	66.32	25.01	18.51	"
94.8	368.0	66.67	25.30	18.80	"
93.2	366.4	70.0	28.3	21.9	"
92.7	365.9	70.3	28.6	22.2	"
92.5	365.7	70.33	28.64	22.28	"
93.2	366.4	70.5	28.8	22.5	$LiClO_4.H_2O$
97.3	370.5	71.0	29.3	23.0	"
108.9	382.1	72.8	31.2	25.2	"
120.7	393.9	75.0	33.7	28.2	"
136.9	410.1	80.0	40.4	37.6	"
144.0	417.2	82.5	44.4	44.3	"
148.5	421.7	85.0	49.0	53.3	"
149.3	422.5	87.5	54.2	65.8	"
144.2	417.4	90.0	60.4	84.6	"
167.5	440.7	91.04	63.24	95.50	$LiClO_4$
172.0	445.2	91.11	63.44	96.33	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Soly measurements at the lower temperatures were carried out by agitating an excess of anhydrous salt with water in a soly tube in a thermostat until constancy in concentration was reached at the set temperature. These determinations were supplemented by results obtained by sealing known amounts of the anhydrous salt and water

SOURCE AND PURITY OF MATERIALS:

Anhydrous $LiClO_4$ was made using Richards and Willard's method (ref. 1). Two analyses using a modification of Lamb's method (ref. 2) gave values of 100.10 % and 100.15 % $LiClO_4$ purity.

ESTIMATED ERROR:

Temp. ± 0.1 °C; soly precision better than ± 0.1% (compiler).

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Alcohols*:

- (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]
- (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]
- (C) 1-Propanol (*n-propyl alcohol*); C_3H_8O; [71-23-8]
- (D) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3]
- (E) 2-Methyl-1-propanol (*iso-butyl alcohol*); $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ in various *alcohols* at 25.00°C :

soly in :	methanol	ethanol	1-propanol	1-butanol	2-methyl-1-propanol
g/100 g sln :	64.57	60.28	51.22	44.23	36.73
g/100 cm^{-3} sln :	89.44	79.41	61.49	49.25	38.94
g/100 g solvent:	182.25	151.76	105.00	79.31	58.05
mol % [b] :	35.44	39.66	37.23	35.59	28.80
mol dm^{-3} :	8.406	7.463	5.779	6.646	3.660
mol kg^{-1} [b] :	17.130	14.265	9.870	7.454	5.457

[a] In terms of the anhydrous salt which was the solid phase.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate trihydrate was prepared as described in ref.1 . Alcohols were purified by refluxing with calcium and fractional distillation.

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) *Alcohols*: (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1] (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5] (C) 1-Propanol (*n-propyl alcohol*); C_3H_8O; [71-23-8] (D) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3] (E) 2-Methyl-1-propanol (*iso-butyl alcohol*); $C_4H_{10}O$; [78-83-1]	Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* <u>1923</u>, *45*, 286-96.

EXPERIMENTAL VALUES: (continued)

	methanol	ethanol	1-propanol	1-butanol	2-methyl-1-propanol
satd sln density/g cm^{-3} :	1.3849	1.3173	1.2006	1.1326	1.0602
pure solvent density/g cm^{-3} :	0.78705	0.78515	0.8026	0.8059	0.7981

AUXILIARY INFORMATION (continued)

METHOD/APPARATUS/PROCEDURE:

thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles, making sure that organic solvent was completely removed before the salt was dried to constant weight at 250°C in a current of air dried with P_2O_5. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C.

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem.Soc.* <u>1922</u>, *44*, 2816.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Simmons, J.P.; Ropp, C.D.L.

J. Am. Chem. Soc. 1928, *50*, 1650-3.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA

Densities of the saturated solutions at the lower temperatures were made by weighing a known volume of each.

Densities of saturated solutions of $LiClO_4$

t / °C :	0	10	20	25	30	40
density / g cm^{-3} :	1.215	1.236	1.258	1.269	1.277	1.300

Saturated solutions of $LiClO_4$ cooled from temperatures between 0 °C to 90 °C, approximately, yielded hydrates which, after careful drying between filter papers, showed upon analysis a water content of 33.90 %, (theoretical value for the trihydrate is 33.68 %). A powdered quantity of the trihydrate placed in a desicator over the anhydrous salt for six weeks yielded a lower hydrate. Determinations of the water content of this hydrate were made at frequent intervals until a constant value of 14.52 % was obtained. The theoretical value of the water content of the monohydrate is 14.48 %.

The transition temperature for $LiClO_4.3H_2O = LiClO_4.H_2O$ was 92.53 °C.

The transition temperature for $LiClO_4.H_2O = LiClO_4$ was 145.75 °C.

The melting point of the trihydrate was 95.1 °C while that for the monohydrate was 149 °C.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: (continued)

in a tube immersed in water and gradually heating until the solid phase disappeared. The tube was cooled until hydrate crystallized out. The temperature was then carefully raised 0.1 °C at a time, with constant agitation, and the temperature noted at which the last trace of solid phase disappeared. This latter method was used for the measurements at the higher temperatures.

REFERENCES:

1. Richards,T.W.; Willard, H.H. *J. Am. Chem. Soc.* 1910, *32*, 4.
2. Lamb; Marden *J. Am. Chem. Soc.* 1912, *34*, 812.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Alcohols* :

- (A) 1,2-ethanediol (*ethylene glycol*); $C_2H_6O_2$; [107-21-1]
- (B) 2-propanol (*isopropyl alcohol*); C_3H_8O; [67-63-0]
- (C) 2-methyl-2-propanol (*t-butyl alcohol*); $C_4H_{10}O$; [75-65-0]
- (D) 2-butanol (*sec-butyl alcohol*); $C_4H_{10}O$; [78-92-2]
- (E) Cyclohexanol; $C_6H_{12}O$; [108-93-0]
- (F) Benzenemethanol (*benzyl alcohol*); C_7H_8O; [100-51-6]
- (G) 1-octanol; $C_8H_{18}O$; [111-87-5]
- (H) 2-octanol; $C_8H_{18}O$; [123-96-6]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ in various *alcohols* at 25.00°C :

	solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(A)	*ethylene glycol*	96.7 ± 0.4	36.1	9.09	Method I
(B)	*isopropyl alcohol*	112.1 ± 0.1	38.8	10.54	" I
(C)	*t-butyl alcohol*	0.6	0.4	0.06	" II
(D)	*sec-butyl alcohol*	77.1 ± 0.1	34.9	7.25	" I

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method I: Solute content was determined by pptn as nitron perchlorate.

Method II: Solute content was determined as AgCl after conversion of perchlorate by fusion with anhydrous Na_2CO_3 in a Pt crucible.

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %).

Solvents were reagent grade.

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) *Alcohols* : (A) 1,2-ethanediol (*ethylene glycol*); $C_2H_6O_2$; [107-21-1] (B) 2-propanol (*isopropyl alcohol*); C_3H_8O; [67-63-0] (C) 2-methyl-2-propanol (*t-butyl alcohol*); $C_4H_{10}O$; [75-65-0] (D) 2-butanol (*sec-butyl alcohol*); $C_4H_{10}O$; [78-92-2] (E) Cyclohexanol; $C_6H_{12}O$; [108-93-0] (F) Benzenemethanol (*benzyl alcohol*); C_7H_8O; [100-51-6] (G) 1-octanol; $C_8H_{18}O$; [111-87-5] (H) 2-octanol; $C_8H_{18}O$; [123-96-6]	Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F. *J. Chem. Eng. Data* 1961, *6*, 325-7.
VARIABLES: One temperature: 298.15 K	**PREPARED BY:** C.Y. Chan

EXPERIMENTAL VALUES: (continued)

Solubility[a] of $LiClO_4$ in various *alcohols* at 25.00°C :

solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(E) *cyclohexanol*	5.9 ± 0.1	5.3	0.55	Method II
(F) *benzyl alcohol*	49.8 ± 0.3	33.6	4.68	" II
(G) *1-octanol*	43.8 ± 0.1	34.9	4.12	" II
(H) *2-octanol*	44.7 ± 0.2	35.4	4.20	" II

[a] The solid phase was the anhydrous salt. [b] Compiler's calculations.

AUXILIARY INFORMATION (continued)

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Three determinations were made from two separate samples. Constancy of density or of refractive index was taken as the criterion for saturation equilibrium. No details of saturation method were given.	Solvents E,F and G were further purified by fractional distillation after drying over anhydrous calcium sulfate. **ESTIMATED ERROR:** ± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Amines* :

- (A) 1,2-ethanediamine (*ethylenediamine*); $C_2H_8N_2$; [107-15-3]
- (B) 1-propanamine (*n-propylamine*); C_3H_9N; [107-10-8]
- (C) 1-butanamine (*n-butylamine*); $C_4H_{11}N$; [109-73-9]
- (D) 2-butanamine (*sec-butylamine*); $C_4H_{11}N$; [13952-84-6]
- (E) 2-methyl-2-propanamine; $C_4H_{11}N$;[75-64-9]
- (F) Pyridine; C_5H_5N; [110-86-1]
- (G) Benzenamine (*aniline*); C_6H_7N; [62-53-3]
- (H) Cyclohexanamine (*cyclohexylamine*); $C_6H_{12}N$; [108-91-8]
- (I) N-methylbenzenamine (*N-methylaniline*); C_7H_9N; [100-61-8]
- (J) N-butyl-1-butanamine (*dibutylamine*); $C_8H_{19}N$; [111-92-2]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ at 25.00°C :

	solvent	g/100g solvent	mol %	$mol\ kg^{-1}$ [b]	Analysis	
(A)	*ethylenediamine*	48.0 ± 0.3	21.3	4.51	Method	I
(B)	*n-propylamine*	59.1 ± 0.3	24.7	5.56	"	II
(C)	*n-butylamine*	45.7 ± 0.3	23.9	4.30	"	I
(D)	*sec-butylamine*	45.7 ± 0.2	23.9	4.30	"	I

---

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method I: Solute content was determined by pptn as nitron perchlorate.

Method II: Solute content was determined as AgCl after conversion of perchlorate by fusion with anhydrous Na_2CO_3 in a Pt crucible.

Three determinations were made from

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %).

Solvents were reagent grade.

Solvents B,C,D,E,F,G and H were

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Amines* :

- (A) 1,2-ethanediamine (*ethylenediamine*); $C_2H_8N_2$; [107-15-3]
- (B) 1-propanamine (*n-propylamine*); C_3H_9N; [107-10-8]
- (C) 1-butanamine (*n-butylamine*); $C_4H_{11}N$; [109-73-9]
- (D) 2-butanamine (*sec-butylamine*); $C_4H_{11}N$; [13952-84-6]
- (E) 2-methyl-2-propanamine; $C_4H_{11}N$;[75-64-9]
- (F) Pyridine; C_5H_5N; [110-86-1]
- (G) Benzenamine (*aniline*); C_6H_7N; [62-53-3]
- (H) Cyclohexanamine (*cyclohexylamine*); $C_6H_{12}N$; [108-91-8]
- (I) N-methylbenzenamine (*N-methylaniline*); C_7H_9N; [100-61-8]
- (J) N-butyl-1-butanamine (*dibutylamine*); $C_8H_{19}N$; [111-92-2]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

EXPERIMENTAL VALUES: (continued)

Solubility[a] of $LiClO_4$ at 25.00°C :

	solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(E)	*t-butylamine*	10.7 ± 0.3	6.8	1.01	Method I
(F)	*pyridine*	8.7 ± 0.1	6.1	0.82	" I
(G)	*aniline*	6.1 ± 0.2	5.1	5.7	" II
(H)	*cyclohexylamine*	16.9 ± 0.1	13.6	1.59	" II
(I)	*N-methylaniline*	1.4 ± 0.1		0.13	" II
(J)	*dibutylamine*	45.6 ± 0.4	35.6	4.29	" II

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION (continued)

METHOD/APPARATUS/PROCEDURE:

two separate samples. Constancy of density or of refractive index was taken as the criterion for saturation equilibrium. No details of saturation method were given.

SOURCE AND PURITY OF MATERIALS:

further purified by fractional distillation after drying over anhydrous calcium sulfate.

ESTIMATED ERROR:

± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Organic acids* :

- (A) Ethanoic (*acetic*) acid; $C_2H_4O_2$; [64-19-7]
- (B) 2-trifluoroethanoic (*trifluoroacetic*) acid; $C_2HF_3O_2$; [76-05-1]
- (C) Butanoic (*butyric*) acid; $C_4H_8O_2$; [107-92-6]
- (D) 1-octanoic (*n-octanoic*); $C_8H_{16}O_2$; [124-07-2]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ in various *organic acids* at 25.00°C :

acid	g/100g solvent	mol %	molality[b] / mol kg^{-1}
(A) acetic	108.7 ± 0.1	38.0	10.217
(B) trifluoroacetic	11.7	11.1	1.10
(C) butyric	60.0 ± 0.3	33.2	5.64
(D) n-octanoic	32.1 ± 0.3	30.3	3.02

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solute content was determined by difference after direct titration of the acid solvent with base. Constancy of density or of refractive index was taken as the criterion for saturation equilibrium. Three determinations were made from two separate samples.

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %). Solvents were reagent grade.

ESTIMATED ERROR:

± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) (A) Acetonitrile; C_2H_3N; [75-05-8]
(B) Benzonitrile; C_7H_5N; [100-47-0]
(C) Formamide; CH_3NO; [75-12-7]
(D) 2-aminoethanol; C_2H_7NO; [141-43-5]
(E) N,N-dimethylformamide; C_3H_7NO; [68-12-2]
(F) Acetic anhydride; $C_4H_6O_3$; [108-24-7]
(G) 2-ethoxyethanol; $C_4H_{10}O_2$; [110-80-5]
(H) 3-methylphenol; C_7H_8O; [108-39-4]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ at 25.00°C :

	solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(A)	acetonitrile	16.3 ± 0.1	5.9	1.53	Method III
(B)	benzonitrile	21.9 ± 0.2	17.5	2.06	" II
(C)	formamide	142.1 ± 0.2	37.6	13.36	" I
(D)	2-aminoethanol	78.9 ± 0.9	31.2	7.42	" I
(E)	N,N-dimethylformamide	75.0 ± 0.2	34.0	7.05	" I

[a] The solid phase was the anhydrous salt.
[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method I : Solute content was determined by pptn as nitron perchlorate.
Method II: Solute content was determined as AgCl after conversion of perchlorate by fusion with anhydrous Na_2CO_3 in a Pt crucible.
Method III: Solute content was determined by evaporation of solvent

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %).
Solvents were reagent grade.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) (A) Acetonitrile; C_2H_3N; [75-05-8]
    (B) Benzonitrile; C_7H_5N; [100-47-0]
    (C) Formamide; CH_3NO; [75-12-7]
    (D) 2-aminoethanol; C_2H_7NO; [141-43-5]
    (E) N,N-dimethylformamide; C_3H_7NO; [68-12-2]
    (F) Acetic anhydride; $C_4H_6O_3$; [108-24-7]
    (G) 2-ethoxyethanol; $C_4H_{10}O_2$; [110-80-5]
    (H) 3-methylphenol; C_7H_8O; [108-39-4]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ at 25.00°C :

	solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(F)	acetic anhydride	8.1	7.2	0.76	Method III
(G)	2-ethoxyethanol	136.6 ± 0.4	53.6	12.84	" II
(H)	3-methylphenol	142.1 ± 0.2	37.6	13.36	" II

[a] The solid phase was the anhydrous salt.
[b] Compiler's calculations.

AUXILIARY INFORMATION (continued)

METHOD/APPARATUS/PROCEDURE:

and prolonged vacuum drying of the residue at 150 °C. Constancy of density or of refractive index was taken as the criterion for saturation equilibrium. Three determinations were made from two separate samples. No details of saturation method were given.

SOURCE AND PURITY OF MATERIALS:

Solvents A,C,E,G,& H were further purified by fractional distillation after drying over anhydrous calcium sulfate.

ESTIMATED ERROR:

± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Aldehydes and ketones* :

- (A) Propanal (*propionaldehyde*); C_3H_6O; [123-38-6]
- (B) Cyclopentanone; C_5H_8O; [120-92-3]
- (C) Cyclohexanone; $C_6H_{10}O$; [108-94-1]
- (D) Benzaldehyde; C_7H_6O; [100-52-7]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ at 25.00°C.

solvent	g/100g solvent	mol %	mol kg^{-1} [b]
(A) *propionaldehyde*	110.5 ± 0.7	37.6	10.39
(B) *cyclopentanone*	63.8 ± 0.2	33.5	6.00
(C) *cyclohexanone*	54.0 ± 0.3	33.2	5.08
(D) *benzaldehyde*	51.5 ± 0.3	33.9	4.84

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[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solute content was determined as AgCl after conversion of perchlorate by fusion with anhydrous Na_2CO_3 in a Pt crucible. Constancy of density or of refractive index was taken as the criterion for saturation equilbrium. No details of saturation method were given. Three determinations were from two separate samples.

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %). Solvents were reagent grade. Solvents A, B and C were further purified by fractional distillation after drying over anhydrous calcium sulfate.

ESTIMATED ERROR:

± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Esters* :

- (A) Ethyl acetate; $C_4H_8O_2$; [141-78-6]
- (B) 1-butyl nitrite; (*n-butyl nitrite*); $C_4H_9NO_2$; [544-16-1]
- (C) Diethyl carbonate; $C_5H_{10}O_3$; [105-58-9]
- (D) Ethyl 3-oxobutanoate (*ethyl acetoacetate*); $C_6H_{10}O_3$; [141-97-9]
- (E) Ethyl benzoate; $C_9H_{10}O_2$; [93-89-0]
- (F) Benzyl acetate; $C_9H_{10}O_2$; [140-11-4]
- (G) Diethyl-1,2-benzenedicarboxylate (*diethyl phthalate*); $C_{12}H_{14}O_4$; [84-66-2]
- (H) Diethyl decanedioate (*diethyl sebacate*); $C_{14}H_{26}O_4$; [110-40-7]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ at 25.00°C :

solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(A) *ethyl acetate*	95.1	44.1	8.94	Method II
(B) *n-butyl nitrite*	3.4	3.2	0.32	" III
(C) *diethyl carbonate*	52.6 ± 0.1	36.9	4.94	" I
(D) *ethyl acetoacetate*	76.7 ± 0.1	48.4	7.21	" II

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method I : Solute content was determined by pptn as nitron perchlorate.

Method II: Solute content was determined as AgCl after conversion of perchlorate by fusion with anhydrous Na_2CO_3 in a Pt crucible.

Method III: Solute content was determined by evaporation of solvent

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %). Solvents were reagent grade.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) *Esters* :

(A) Ethyl acetate; $C_4H_8O_2$; [141-78-6]

(B) 1-butyl nitrite; (*n-butyl nitrite*); $C_4H_9NO_2$; [544-16-1]

(C) Diethyl carbonate; $C_5H_{10}O_3$; [105-58-9]

(D) Ethyl 3-oxobutanoate (*ethyl acetoacetate*); $C_6H_{10}O_3$; [141-97-9]

(E) Ethyl benzoate; $C_9H_{10}O_2$; [93-89-0]

(F) Benzyl acetate; $C_9H_{10}O_2$; [140-11-4]

(G) Diethyl-1,2-benzenedicarboxylate (*diethyl phthalate*); $C_{12}H_{14}O_4$; [84-66-2]

(H) Diethyl decanedioate (*diethyl sebacate*); $C_{14}H_{26}O_4$; [110-40-7]

ORIGINAL MEASUREMENTS:

Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F.

J. Chem. Eng. Data 1961, *6*, 325-7.

EXPERIMENTAL VALUES: (continued)

Solubility[a] of $LiClO_4$ at 25.00°C :

solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(E) *ethyl benzoate*	29.2 ± 0.2	29.2	2.75	Method II
(F) *benzyl acetate*	50.1 ± 0.4	41.4	4.71	" II
(G) *diethyl phthalate*	5.5	1.2	5.2	" II
(H) *diethyl sebacate*	21.3 ± 0.1	34.0	2.00	" II

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION (continued)

METHOD/APPARATUS/PROCEDURE:

and prolonged vacuum drying of the residue at 150 °C. Constancy of density or of refractive index was taken as the criterion for saturation equilibrium. Three determinations were made from two separate samples. No details of saturation method were given.

SOURCE AND PURITY OF MATERIALS:

Solvents B and C were further purified by fractional distillation after drying over anhydrous calcium sulfate.

ESTIMATED ERROR:

± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) *Ethers* : (A) Methyl-oxirane (*propylene oxide*); C_3H_6O; [75-56-9] (B) Tetrahydrofuran; C_4H_8O; [109-99-9] (C) 1,1'-oxybis-butane (*n-butyl ether*); $C_8H_{18}O$; [142-96-1]	Markowitz, M.M.; Hawley, W.N.; Boryta, D.A.; Harris, R.F. *J. Chem. Eng. Data* 1961, *6*, 325-7.
VARIABLES:	**PREPARED BY:**
One temperature: 298.15 K	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4$ at 25.00°C.

solvent	g/100g solvent	mol %	mol kg^{-1} [b]	Analysis
(A) *propylene oxide*	91.4 ± 0.6	33.3	8.59	Method II
(B) *tetrahydrofuran*	27.1 ± 0.2	15.5	2.55	" I
(C) *n-butyl ether*	36.0 ± 0.2	14.3	12.8	" I

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method I : Solute content was determined by pptn as nitron perchlorate.

Method II: Solute content was determined as AgCl after conversion of perchlorate by fusion with anhydrous Na_2CO_3 in a Pt crucible.

Constancy of density or of refrac-index was taken as the criterion for saturation equilibrium. No details of saturation method were given. Three determinations were made from two separate samples.

SOURCE AND PURITY OF MATERIALS:

Anhydrous lithium perchlorate was prepared (ref. 1) and analysed by precipitation as nitron perchlorate. Analysis showed 93.7 % in ClO_4 (theoretical 93.5 %).

Solvents were reagent grade.

Solvents B and C were further purified by fractional distillation after drying over anhydrous calcium sulfate.

ESTIMATED ERROR:

± 0.02 °C in temperature.

REFERENCE:

1. Markowitz, M.M. *J. Phys. Chem.* 1958, *62*, 827.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of lithium perchlorate in acetone at 25.00 °C, the solid phase being the anhydrous salt :

g/100g sln	g/100cm^3 sln	g/100g solvent	mol %	mol dm^{-3}	mol kg^{-1}	satd sln density / g cm^{-3}
57.72	76.38	136.52	42.70[a]	7.1785	12.83[a]	1.3233

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles. The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosion. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was prepared as described in ref. 1. Acetone refluxed with powdered KOH and purified by the bisulfite process. Its density was 0.7852 g cm^{-3} at 25 °C; b.p. 56.16-56.51 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$ [7791-03-9] (2) Tetrahydrofuran; C_4H_8O; [109-99-9]	Markarenko, B.K.; Mendzheritskii, E.A.; Sobolev, R.P.; Povarov, Yu.M.; Sereda, P.A. *Elektrokhimiya* 1974, *10*, 355-8; **Soviet Electrochem. (Engl. Transl.)*, 1974, *10*, 337-40.
VARIABLES:	**PREPARED BY:**
One temperature: 298.2 K	C.Y. Chan

EXPERIMENTAL VALUES:

The solubility of lithium perchlorate in tetrahydrofuran at 25.0 °C is 2.2 mol dm^{-3} and the specific conductivity of the saturated solution is 6.95×10^{-3} S cm^{-1}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method were given. The solubility was determined by polarographic analysis of the ions in the saturated solution. An MM34-04 conductivity meter was used to determine the specific conductivity of the solution.

SOURCE AND PURITY OF MATERIALS:

The perchlorate was recrystallized twice from aqueous solution and dried under vacuum at 150-160 °C for 20-25 hours. Tetrahydrofuran was dried for 5-7 days with metallic lithium. The saturated solution contained not more than 0.02 % water.
Sources of starting materials not given.

ESTIMATED ERROR:

Precision in temp. was ±0.1 °C .

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) 1,1'-oxybis-ethane (*diethyl ether*); $C_4H_{10}O$; [60-29-7]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in *diethyl ether* at 25.00 °C , the solid phase being the anhydrous salt:

g/100g sln	g/100 cm^3 sln	g/100 g solvent	mol %	mol dm^{-3}	mol kg^{-1}	satd sln density / g cm^{-3}
53.21	64.47	113.72	44.21	6.059[a]	10.69 [a]	1.2116

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles.

The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosion.

Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was prepared as described in ref. 1. Ether was purified by refluxing with P_2O_5 and fractional distillation. The density of the fraction used was 0.70817 g cm^{-3} at 25 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) Ethyl acetate; $C_4H_8O_2$; [141-78-6]	Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* <u>1923</u>, *45*, 286-96.
VARIABLES:	**PREPARED BY:**
One temperature: 298.15 K	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in ethyl acetate at 25.00°C, the solid phase being the anhydrous salt :

g/100g sln	$g/100cm^3$ sln	g/100g solvent	mol %	$mol\ dm^{-3}$	$mol\ kg^{-1}$	satd sln density / $g\ cm^{-3}$
48.75	63.40	95.12	44.06[a]	5.958	8.941[a]	1.3005

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles.
The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosion.. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was prepared as described in ref. 1. Ethyl acetate was purified by refluxing P_2O_5 and fractional distillation. Its density at 25°C was 0.8945 $g\ cm^{-3}$; b.p. 77.14 - 77.16 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* <u>1922</u>, *44*, 2816.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$
[7791-03-9]

(2) Hydrazine; N_2H_4; [302-01-2]

ORIGINAL MEASUREMENTS:

Sakk, Zh.G.; Rosolovskii, V.Ya.

Zh. Neorg. Khim. 1972, *17*, 1783-4;
**Russ. J. Inorg. Chem. (Engl. Transl.)* 1972, *17*, 927-8.

VARIABLES:

One temperature: 298.2 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in hydrazine at 25.0 °C was reported as 54.4 g(1)/100 g(2). The corresponding mol % and molality values are 14.08 % and 5.11 mol kg^{-1}, respectively (calculated by compiler).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

4-6 g of the salt and 8-11 cm^3 of hydrazine were thermostated at 25°C for 7-8h with continuous stirring in a vessel isolated from atmospheric moisture. Samples for analysis were removed by withdrawing solution and part of the solid phase into another vessel fitted with a porosity no.4 filter at reduced pressure. After separating the phases, the solution was analysed for hydrazine using the procedure given in ref. 1.

Replicate solubility determinations were carried out.

SOURCE AND PURITY OF MATERIALS:

The methods of purification of the perchlorate and of the preparation of anhydrous hydrazine were as described in ref. 1.

Salt purity was about 99.5-99.9 %.

ESTIMATED ERROR:

Error in soly value was 0.4 %.

Precision in temp. was ±0.1 °C .

REFERENCES:

1. Rosolovskii, V.Ya.; Sakk, Zh.G. *Zh. Neorg. Khim.* 1970, *15*, 2262.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$ [7791-03-9] (2) Hydrazine; N_2H_4; [302-01-2]	Rosolovskii, V.Ya.; Sakk, Zh.G. *Zh. Neorg. Khim.* <u>1970</u>, *15*, 2262-4; **Russ. J. Inorg. Chem. (Engl. Transl.)* <u>1970</u>, *15*, 1169-70.
VARIABLES:	PREPARED BY:
One temperature: 273.2 K	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in hydrazine at 0.0 °C was reported as 47.1 g(1)/100 g(2). The corresponding mol % and molality values are 12.4 % and 4.43 mol kg^{-1}, respectively (calculated by compiler).

The solid phase was $LiClO_4.2N_2H_4$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A solution of the perchlorate in hydrazine in the presence of the solid phase was stirred continuously for 2h in a thermostat at 0.0 °C. The liquid and solid phases were separated and analysed for perchlorate by precipitation as nitron perchlorate. Hydrazine in both phases was analysed by titration with standard iodine solution in the presence of sodium bicarbonate in excess.

SOURCE AND PURITY OF MATERIALS:

$LiClO_4$ was obtained by reacting 70 % $HClO_4$ (aq.) with Li_2CO_3, recrystallized twice from water and dried in a vacuum at 200 - 250 °C to constant weight. The hydrazine was 99.5 - 99.8 % pure.

ESTIMATED ERROR:

Precision in temp. was ±0.1 °C .
Soly precision not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$
[7791-03-9]

(2) Perchloric acid; $HClO_4$;
[7601-90-3]

ORIGINAL MEASUREMENTS:

Rosolovskii, V.Ya.; Sakk, Zh.G.

Zh. Neorg. Khim. <u>1968</u>, *13*, 1115-8;
**Russ. J. Inorg. Chem. (Engl. Transl.)* <u>1968</u>, *13*, 582-4.

VARIABLES:

One temperature: 273.2 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Composition of saturated solution of lithium perchlorate in perchloric acid at 0 °C : (the solid phase was presumably the anhydrous salt)

	mass %	
	$LiClO_4$	$HClO_4$
	0.100	99.36
	0.104	99.37
	0.101	99.38
	0.118	99.34
Mean[a] :	0.106	99.36
Std. dev.[a]:	0.008	0.02

The mean value of the solubility of $LiClO_4$ in perchloric acid is 0.100 mol %, or 0.018 mol kg^{-1} (compiler).

([a] compiler's calculations).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Mixtures of 5-6 g of the perchlorate with 10-12 g of the acid were kept in a thermostat at 0°C (melting ice) for 10-15h with continuous stirring in tubes isolated from atmospheric moisture. After equilibrium has been attained, solid and liquid phases were separated on a glass filter.
ClO_4 was determined gravimetrically as nitron perchlorate. Acid concentrations were determined by acid-base titration. $LiClO_4$ concentration was determined by dissolving a weighed sample of the satd solution (5-8g) in water and then evaporating to dryness. The dry residue was then dissolved in conc. H_2SO_4, the sln evaporated to dryness, and the resulting sulfate heated to constant weight at 600 °C.

SOURCE AND PURITY OF MATERIALS:

$LiClO_4$ was obtained by reacting 70 % $HClO_4$ (aq.) with $LiCO_3$, recrystallized twice from water and dried in a vacuum at 200 - 250 °C to constant weight. Analysis: Li 6.62 %, ClO_4 92.69 %.
Anhyd. $HClO_4$ was distilled from a mixture of oleum and perchloric acid dihydrate at 100 °C under vacuum (ref.1). Acid purity was 99.6-100.2 % w/w as analysed.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Hydrogen peroxide; H_2O_2; [7722-84-1]

ORIGINAL MEASUREMENTS:

Titova, K.V.; Kolmakova, E.I.; Rosolovskii, V.Ya.

Zh. Neorg. Khim. 1986, *31*, 3213-5; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1986, *31*, 1846-7.

VARIABLES:

One temperature: 273 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

The solubility[a] of lithium perchlorate in hydrogen peroxide at 0 °C :

g(1)/ 100 g(2)	mass %	mol %	molality/ mol kg^{-1}
62.3	38.4	16.61	5.86

[a] Mass%, mol% and molality values calculated by compiler.
The solid phase was an unstable solvate.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method was given. Solubility equilibrium was established in 1-1.5 h. The concencentration of the solutions did not change noticeably during the next 3h but after that slow decomposition of peroxide began. The concentration of perchlorate in the satd solution was determined gravimetrically by precipitation as nitron perchlorate. The solvated lithium perchlorate solid phase was too unstable for its composition to be determined.

SOURCE AND PURITY OF MATERIALS:

Sources not given.
The H_2O_2 was 99.8% ± 0.2% pure.
No information on purity of salt.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$ [7791-03-9]

(2) Acetonitrile; C_2H_3N; [75-05-8]

ORIGINAL MEASUREMENTS:

Keller, R.; Foster, J.N.; Hansen, F.F.; Muirhead, J.S.

NASA Contract. Rep. CR-1425 1969, Lewis Research Center, NASA, U.S.A.

VARIABLES:

One temperature: 298 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in acetonitrile at 25 °C is 1.06 mol dm^{-3} (1.40 mol kg^{-1}).
Density of the saturated solution is 0.868 g cm^{-3} and its viscosity is 7.09×10^{-4} N s m^{-2} .

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Saturated solutions were prepared by adding an excess of solute to the solvent in flasks in a dry box, the flasks being then stoppered with glass stoppers. The neck of each flask was then enclosed in a polythene bag containing dry N_2. The flasks were then placed in a bath which was at a temperature well above the final sampling temperature for 1-2 days, the solutions being magnetically stirred. After that they were equilibrated to 25 °C for several days with occasional stirring. Samples of the supernatant liquid were analysed for Li by atomic absorption spectrophotometry.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was 99.9 % pure (Atomergic Chemicals Co.) and dried at 90-120 °C under vacuum. Acetonitrile (J.T. Baker anal. reagent) was redistilled from its mixture with P_2O_5, and the final fraction contained 49 mg dm^{-3} of water but no detectable organic impurities.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Acetonitrile; C_2H_3N; [75-05-8]

ORIGINAL MEASUREMENTS:

Tomkins, R.P.T.; Turner, P.J.

J. Chem. Eng. Data 1975, *20*, 50-2.

VARIABLES:

Temperature: 297.35 K - 323.32 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of $LiClO_4$ in acetonitrile:

No. of determinations	t / °C	molality / mol kg^{-1}	mol %
3	24.20 ± 0.01	1.5419	5.953
3	29.16 ± 0.20	1.8632	7.106
3	32.80 ± 0.15	2.1402	8.076
3	36.33 ± 0.05	2.4615	9.178
3	40.12 ± 0.05	2.9548	10.818
4	41.94 ± 0.05	3.2253	11.693
4	45.67 ± 0.03	3.9402	13.923
3	48.28 ± 0.05	4.4614	15.480
5	49.50 ± 0.03	5.2365	17.694
4	49.41 ± 0.01	6.1452	20.146
2	50.17 ± 0.30	6.2239	20.35
2[b]	48.85 ± 0.05	7.1865	22.78
1[b]	41.21	7.5868	23.75
1[b]	45.66	7.7932	24.24
1[b]	45.43	8.4018	25.60

[b] Poor reproducibility and formation of addition compounds; apparent solubility values only.

METHOD/APPARATUS/PROCEDURE:

A cooling method was used in which the temperature at which crystallization occurred was recorded. Solid $LiClO_4$ and solvent were placed in a Pyrex test tube and stirred with a teflon-coated magnetic stirring bar. The temperature was measured with a calibrated mercury-in-glass thermometer graduated in 0.1 °C intervals. The whole unit was placed in a 250 mL Erlenmeyer flask which served as support and air-jacket. Supercooling of 2-5 °C was observed and corrected for by "back-extrapolation". To reduce supercooling to 1-2 °C, it was necessary to cool the solution until solid formed, then raise the temperature to 3-5 °C above the crystallization point and cycle the temperature 5 or 6 times over a short range to ensure the presence of nuclei in the solution. No details of analysis method was given.

SOURCE AND PURITY OF MATERIALS:

No details available.

ESTIMATED ERROR:

Not stated, except for temp. as tabulated.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$ [7791-03-9]

(2) Sulfinylbis-methane (*dimethyl sulphoxide, DMSO*); C_2H_6OS; [67-68-5]

ORIGINAL MEASUREMENTS:

Kenttamaa, J.

J. Suomen Chemist 1960, *33B*, 179-82.

VARIABLES:

Three temperatures: 298 K, 308 K, 318 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of lithium perchlorate in *DMSO* :

t / °C	mol / 100g *DMSO*	molality / kg^{-1}
25	0.27	2.7
35	0.27	2.7
45	0.29	2.9

[a] The solid phase was the solvate $2LiClO_4.7(CH_3)_2SO$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solute and solvent were contained in glass-stoppered flasks immersed in a thermostat at 50 °C initially and the flasks were shaken from time to time. About two weeks were allowed for attainment of equilibrium, after which the temp. was lowered to the desired temp. and the flasks allowed to stand for another week. The solutions were analysed for lithium by flame photometry. All analyses were in duplicate or triplicate.

SOURCE AND PURITY OF MATERIALS:

DMSO of "practical quality" was purified by repeated crystallization. The final product used had a melting-point of 18.5 °C. The purity of the perchlorate was not specified. The salt was dried for a few days at a temperature "high enough" to remove any moisture.

ESTIMATED ERROR:

Precision in soly. : ± 5 %

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) Propionitrile; C_3H_5N; [107-12-0]	Tomkins, R.P.T.; Turner, P.J. *J. Chem. Eng. Data* 1975, *20*, 50-2.
VARIABLES: Temperature: 230 K - 285 K	PREPARED BY: C.Y. Chan

EXPERIMENTAL VALUES:

		Solubility[a] of $LiClO_4$ in propionitrile:	
No. of determinations	t / °C	molality / mol kg^{-1}	mol %
1	-43	1.4148	7.23
4	-21.3 ± 0.1	2.5088	12.141
4	-12.1 ± 0.2	3.0093	14.218
4	-0.5 ± 3.5	3.7315	17.049
3	-3.9 ± 2.0	4.1544	18.62
2	2.1 ± 0.1	6.8443	27.378
2	12 ± 4	8.1469	30.97

[a] The solid phase was the anhydrous salt.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A cooling method was used in which the temperature at which crystallization occurred was recorded. 15-20 cm^3 samples were cooled with dry ice and methanol. The sample tube was vacuum-jacketted and contents stirred with a propeller through a silicone oil seal. Temperature was measured with a chromel-alumel thermocouple immersed in a silicone oil well and a Keithley 147 null detector used in conjunction with a Moseley X-Y recorder. The thermocouple emf was also read on a digital multimeter. Sample composition was changed over a small range by adding solvent from a weighed syringe through a septum cap on the end of a side arm of the sample tube.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated, except for temperature precision as given above.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) *Alcohols*:

- (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]
- (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]
- (C) 1-Propanol (*n-propyl alcohol*); C_3H_8O; [71-23-8]
- (D) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3]
- (E) 2-Methyl-1-propanol (*iso-butyl alcohol*); $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of $LiClO_4.3H_2O$ in various *alcohols*[b] at 25.00°C :

soly in :	methanol	ethanol	1-propanol	1-butanol	2-methyl-1-propanol
g/100 g sln	60.95	42.16	26.82	21.40	18.85
g/100 cm^{-3} sln	69.61	43.18	25.07	19.435	16.75
mol dm^{-3}	4.338	2.691	1.563	1.211	1.044
mol kg^{-1} [c]	14.671	6.851	3.445	2.559	2.183
satd sln density/g cm^{-3}	1.1420	1.0241	0.9349	0.9082	0.8887
pure solvent density/g cm^{-3}	0.78705	0.78515	0.8026	0.8059	0.7981

[a] In terms of the anhydrous salt. The solid phase was not exactly specified; presumably, it was the trihydrate.

[b] More correctly, mixtures of alcohol and water from the trihydrate, (compiler). The alcohol-water solvent compositions were not determined, but could be calculated if it was assumed that for each mole of $LiClO_4$ dissolved 3 moles of water went into solution.

[c] Compiler's calculations.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) *Alcohols*:

(A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]

(B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]

(C) 1-Propanol (*n-propyl alcohol*); C_3H_8O; [71-23-8]

(D) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3]

(E) 2-Methyl-1-propanol (*iso-butyl alcohol*); $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

AUXILIARY INFORMATION (continued)

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln. were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles, making sure that organic solvent was completely removed before the salt was dried to constant weight at 250°C in a current of air dried with P_2O_5. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate trihydrate was prepared as described in ref.1 . Alcohols were purified by refluxing with calcium and fractional distillation.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C.

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem.Soc.* 1922, *44*, 2816.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) Acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of lithium perchlorate trihydrate in acetone at 25.00 °C, the solid phase being $LiClO_4 \cdot 3H_2O$:

g/100g sln	g/100 cm^3 sln	g/100 g solvent	mol dm^{-3}	mol kg^{-1}	satd sln density / g cm^{-3}
49.04	53.77	96.23	5.054[b]	9.045[b]	1.0965

[a] In terms of the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles.

The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosion. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was prepared as described in ref. 1. Acetone refluxed with powdered KOH and purified by the bisulfite process. Its density was 0.7852 g cm^{-3} at 25 °C; b.p. 56.16-56.51 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) Ethyl acetate; $C_4H_8O_2$; [141-78-6]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] lithium perchlorate trihydrate in ethyl acetate at 25.00°C, the solid phase being $LiClO_4.3H_2O$:

mass %	g/100 cm^3 sln	g/100 g solvent	mol dm^{-3}	mol kg^{-1}	satd sln density / g cm^{-3}
26.35	27.41	35.78	1.7085	3.363[b]	1.0402

[a] In terms of the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles. The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosion. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was prepared as described in ref. 1. Ethyl acetate was purified by refluxing with P_2O_5 and fractional distillation. Its density at 25°C was 0.8945 g cm^{-3} and its b.p. was 77.14 - 77.16 °C.

ESTIMATED ERROR:

Precision in temp. was ± 0.01°C

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) 1,1'-oxybis-ethane (*diethyl ether*); $C_4H_{10}O$; [60-29-7]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of lithium perchlorate trihydrate in *diethyl ether*[b] at 25.00 °C , the solid phase being $LiClO_4 \cdot 3H_2O$:

g/100g sln	g/100 cm^3 sln	g/100 g solvent	mol dm^{-3}	mol kg^{-1}	satd sln density / g cm^{-3}
0.196	0.139	0.196	0.0131[b]	0.0184[b]	0.7091

[a] In terms of the anhydrous salt.

[b] Saturated with water from the trihydrate.

[c] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles.

The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosion.

Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was prepared as described in ref. 1. Ether was purified by refluxing with P_2O_5 and fractional distillation. The density of the fraction used was 0.70817 g cm^{-3} at 25 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$ [7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) N,N-dimethylformamide; C_3H_7NO; [68-12-2]

ORIGINAL MEASUREMENTS:

Keller, R.; Foster, J.N.; Hansen, F.F.; Muirhead, J.S.

NASA Contract. Rep. CR-1425 1969, Lewis Research Center, NASA, U.S.A.

VARIABLES:

Two temperatures: 298 K and 333 K.
Water content.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in N,N-dimethylformamide containing trace concentrations of water at 25 °C and 60 °C :
(the solid phase was the anhydrous salt)

H_2O content / mg dm^{-3}	$LiClO_4$ solubility / mol dm^{-3} 25 °C	 60 °C
45	4.4	4.8
1000	3.5	4.9

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Saturated solutions were prepared by adding an excess of solute to the solvent in flasks in a dry box, the flasks being then stoppered with glass stoppers. The neck of each flask was then enclosed in a polythene bag containing dry N_2. The flasks were then placed in a bath which was at a temperature well above the final sampling temperature for 1-2 days, the solutions being magnetically stirred. After that they were equilibrated to 25 °C for several days with occasional stirring. Samples of the supernatant liquid were analysed for Li by atomic absorption spectrophotometry.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was 99.9 % pure (Atomergic Chemicals Co.) and dried at 90-120 °C under vacuum. Dimethylformamide (Matheson, Coleman and Bell, spectropure), after pre-treatment with chromatographic grade molecular sieves for 6 hours, was distilled at 151 °C and at atmos. pressure. Final sample used contained 45 mg dm^{-3} H_2O and 35 mg dm^{-3} impurities.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$
[7791-03-9]

(2) Water; H_2O; [7732-18-5]

(3) Propylene carbonate; $C_4H_6O_3$;
[108-32-7]

ORIGINAL MEASUREMENTS:

Keller, R.; Foster, J.N.;
Hansen, F.F.; Muirhead, J.S.

NASA Contract. Rep. CR-1425
1969, Lewis Research Center,
NASA, U.S.A.

VARIABLES:

Two temperatures: 298 K and 333 K.
Water content.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate in propylene carbonate containing trace concentrations of water at 25 °C and 60 °C :
(the solid phase was the anhydrous salt)

H_2O content / mg dm^{-3}	$LiClO_4$ solubility / mol dm^{-3}	
	25 °C	60 °C
20	2.1	3.1
1000	3.1	3.1

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Saturated solutions were prepared by adding an excess of solute to the solvent in flasks in a dry box, the flasks being then stoppered with glass stoppers. The neck of each flask was then enclosed in a polythene bag containing dry N_2. The flasks were then placed in a bath which was at a temperature well above the final sampling temperature for 1-2 days, the solutions being magnetically stirred. After that they were equilibrated to 25 °C for several days with occasional stirring. Samples of the supernatant liquid were analysed for Li by atomic absorption spectrophotometry.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate was 99.9 % pure (Atomergic Chemicals Co.) and dried at 90-120 °C under vacuum. Propylene carbonate (Matheson, Coleman and Bell, spectro pure) was fractionally distilled in the presence of CaH_2 and dry N_2. The sample used contained 20 mg dm^{-3} H_2O and less than 35 mg dm^{-3} of organic impurities.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Acetamide; C_2H_5NO; [60-35-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Tarakanov, V.F.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1975, *144*, 92-4.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-CH_3CONH_2-H_2O at 25°C :

	Liquid phase composition						Solid[b]
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.50	-	9.223	-	5.640	-	A
3	36.55	14.60	10.40	7.48	7.033	5.060	A
6	37.98	49.72	18.97	44.74	29.02	68.43	A + B
8	35.43	53.99	18.15	49.83	31.48	86.39	B
11	32.96	59.42	17.82	57.86	40.66	132.0	B + C
15	24.43	66.59	12.38	60.76	25.57	125.5	C
17	20.35	74.35	10.97	72.17	36.09	237.5	C + D
20	10.35	81.53	5.045	71.58	11.98	170.0	D
22	-	84.24	-	61.98	-	90.49	D

[a] Values calculated by C.C. Ho;

[b] A = $LiClO_4.3H_2O$; B = $LiClO_4.2CH_3CONH_2$; C = $LiClO_4.4CH_3CONH_2$; D = CH_3CONH_2.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details were given.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

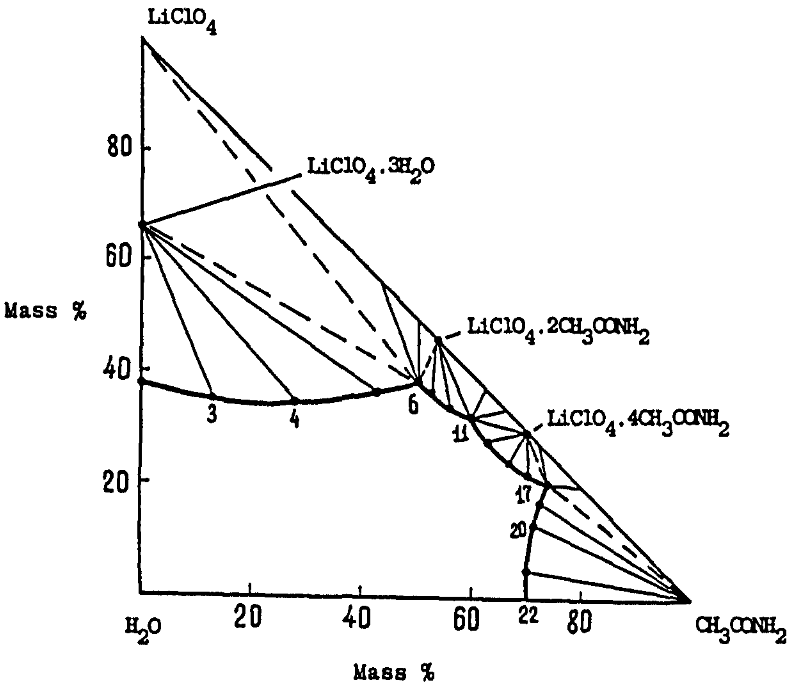
(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) Acetamide; C_2H_5NO; [60-35-5] (3) Water; H_2O; [7732-18-5]	Tarakanov, V.F. *Sb. Tr. Yarosl. Gos. Ped. Inst.* 1975, *144*, 92-4.

EXPERIMENTAL VALUES: (continued)

COMMENTS/ADDITIONAL DATA:

The solubility isotherm (see Figure below) shows four branches of crystallization: lithium perchlorate crystallizes as trihydrate; lithium perchlorate diacetamide; lithium perchlorate tetraacetamide; and acetamide. $LiClO_4.2CH_3CONH_2$ and $LiClO_4.4CH_3CONH_2$ are very hygroscopic. The compounds are formed through the interaction between Li^+ cations and acetamide molecules.



COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) N(1), *N*(1)-dimethylcarbamide (*dimethylurea*); $C_3H_8N_2O$; [1320-50-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, M.M.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1979, *178*, 58-63.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$C_3H_8N_2O$-H_2O at 25°C :

	Liquid phase composition						Solid phase
	mass %		mol %[a]		molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.46	-	9.209	-	5.630	-	$LiClO_4 \cdot 3H_2O$
2	37.01	1.63	9.222	0.490	5.669	0.301	"
3	34.78	12.49	9.627	4.175	6.200	2.688	"
4	35.61	17.09	10.61	6.149	7.076	4.101	"
5	36.79	22.93	12.17	9.157	8.585	6.461	"
6	25.40	47.19	10.40	23.33	8.710	19.54	$C_3H_8N_2O$
7	22.09	41.33	7.670	17.33	5.676	12.82	"
8	17.91	33.06	5.156	11.49	3.433	7.653	"
9	3.53	25.28	0.777	6.717	0.466	4.030	"
10	-	23.55	-	5.925	-	3.496	"

[a] Values calculated by C.C. Ho.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached in 2-3 days. ClO_4^- was determined gravimetrically by precipitating with nitron. (2) was determined by Kjeldahl's method. The densities and viscosities of the saturated solutions were determined.

SOURCE AND PURITY OF MATERIALS:

Nothing specified

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

(continued next page)

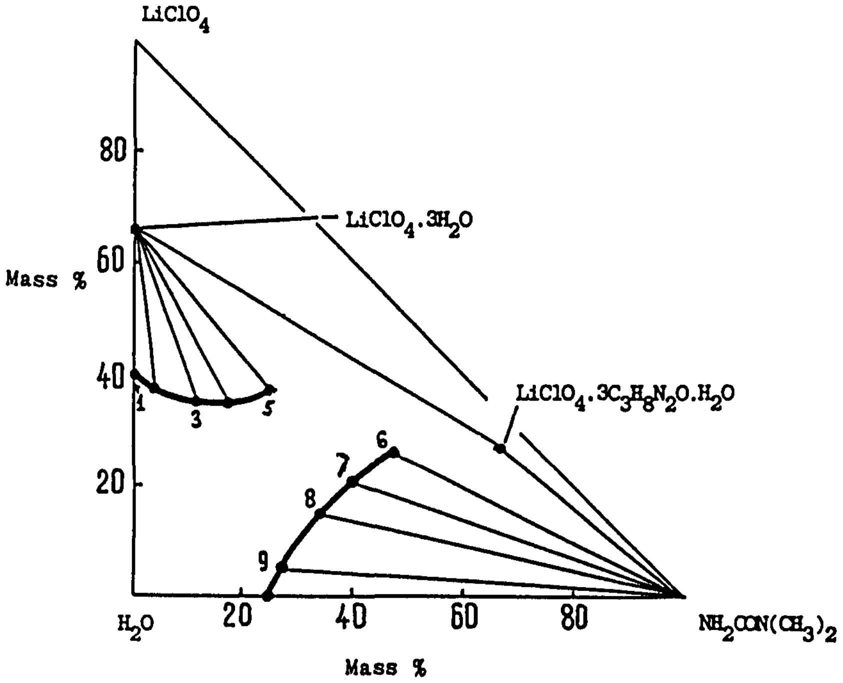
COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) N(1), N(1)-dimethylcarbamide (*dimethylurea*); $C_3H_8N_2O$; [1320-50-9] (3) Water; H_2O; [7732-18-5]	Bestuzheva, M.M. *Sb. Tr. Yarosl. Gos. Ped. Inst.* 1979, *178*, 58-63.

EXPERIMENTAL VALUES: (continued)

COMMENTS/ADDITIONAL DATA:

Addition of dimethylurea to lithium perchlorate causes some irregularity in the solubility: from 37.46% (point 1) to 34.78% (point 3). Further addition of dimethylurea increases the solubility of lithium perchlorate and this results in the complete dissolution of the solid phase. A new compound is presumably formed, i.e. $LiClO_4.3C_3H_8ON_2.H_2O$. The diagram below shows a probable region of formation of this compound.

The compound contains 29.9% $LiClO_4$; 64.58% $C_3H_8N_2O$ and 5.52% H_2O.



COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kosheleva, N.I.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1975, *144*, 107-11.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$C_6H_{12}N_4$-H_2O at 25°C :

	Liquid phase composition						Solid[b] phase
	mass %		mol %[a]		molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	-	46.50	-	10.05	-	6.200	A
2	4.60	46.70	1.40	10.82	0.888	6.840	A
3	6.24	48.10	2.00	11.69	1.285	7.514	A
4	6.48	45.10	1.98	10.48	1.258	6.644	C
5	9.45	41.35	2.85	9.470	1.805	5.995	C
6	12.23	37.26	3.610	8.346	2.276	5.262	C
7	15.96	33.85	4.721	7.599	2.989	4.811	C
8	18.64	35.92	5.932	8.675	3.856	5.639	D
9	18.60	34.54	5.785	8.152	3.731	5.258	D
10	20.53	27.82	5.922	6.090	3.736	3.842	D
11	21.75	24.62	6.090	5.232	3.812	3.275	D
12	25.25	20.06	6.947	4.189	4.340	2.616	D
13	26.45	17.06	7.091	3.471	4.401	2.154	D
14	30.22	13.26	8.079	2.690	5.026	1.674	D
15	32.82	10.38	8.726	2.094	5.431	1.304	D

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached in 1 day. ClO_4^- was determined gravimetrically by nitron precipitation. (2) was determined by Kjeldahl's method. The compositions of the solid phases were determined by chemical analyses and by Schreinemakers' method of residues. The densities and viscosities of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kosheleva, N.I.

Sb. Tr. Yarosl. Gos. Ped. Inst. <u>1975</u>, *144*, 107-11.

EXPERIMENTAL VALUES: (continued)

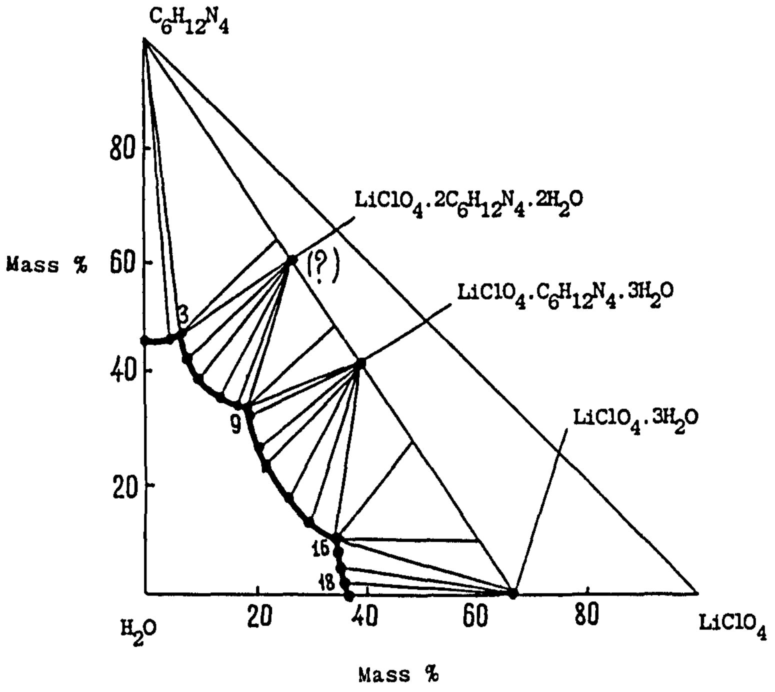
	Liquid phase composition						Solid[b]
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
16	33.26	10.32	8.886	2.093	5.541	1.305	B + D
17	33.75	6.95	8.671	1.355	5.350	0.836	B
18	36.55	3.11	9.247	0.597	5.694	0.368	B
19	37.55	-	9.241	-	5.652	-	B

[a] Values calculated by C.C. Ho;

[b] A = $C_6H_{12}N_4$; B = $LiClO_4.3H_2O$; C = $LiClO_4.2C_6H_{12}N_4.2H_2O$; D = $LiClO_4.C_6H_{12}N_4.3H_2O$.

COMMENTS/ADDITIONAL DATA:

The solubility isotherm (see Figure below) shows four branches of crystallization: the crystallization of hexamethylenetetramine (point 1-2); the crystallization of the compound $LiClO_4.2C_6H_{12}N_4.2H_2O$ which is congruently soluble (point 4 through 7); the crystallization of the double complex compound $LiClO_4.C_6H_{12}N_4.3H_2O$ (points 9 through 15); the branch from point 17 to point 19 indicates the crystallization of lithium perchlorate trihydrate. Hexamethylenetetramine is salted out.



COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Methyl acetate; $C_3H_6O_2$; [79-20-9]

(3) Propylene carbonate; $C_4H_6O_3$ [108-32-7]

ORIGINAL MEASUREMENTS:

Il'in, K.K.; Demakhin, A.G.

Zh. Neorg. Khim. 1989, *34*, 780-2; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1989, *34*, 436-8.

VARIABLES:

Temperature: 283.2 K - 323.2 K.
Composition.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-methyl acetate-propylene carbonate at various temperatures (the solid phase was the anhydrous salt over the whole temperature range studied for both the pure and mixed solvents):

	Liquid phase composition					
t / °C	mass %			mol %[a]		
	(1)	(2)	(3)	(1)	(2)	(3)
10.0	47.4	0.0	52.6	46.4	0.0	53.6
	48.0	10.4	41.6	45.2	14.1	40.8
	49.0	20.4	30.6	44.5	26.6	28.9
	49.9	30.1	20.0	43.8	37.9	18.3
	50.9	39.3	9.8	43.3	48.0	8.7
	52.5	47.5	0.0	43.5	56.5	0.0
20.0	47.8	0.0	52.2	46.8	0.0	53.2
	48.5	10.3	41.2	45.7	13.9	40.4
	49.4	20.2	30.4	44.9	26.4	28.8
	50.5	29.7	19.8	44.4	37.5	18.1
	51.5	38.8	9.7	43.9	47.5	8.6
	53.5	46.5	0.0	44.5	55.5	0.0

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Special vessels, reported in ref.(1) were used in the preparation of the satd solutions. The salt and the solvents were placed in the vessels under conditions which ensured that atmospheric moisture was excluded. The vessels were equilibrated in an U-10 ultrathermostat which was maintained to within ±0.1 K of the required temperature. Equilibrium was reached after continuous stirring for 7-8 h and was reached both from

SOURCE AND PURITY OF MATERIALS:

" Chemically pure " $LiClO_4$ was was dried in a vacuum at 160 °C for 3 h. "Chem. pure" propylene carbonate was vacuum-distilled and "pure" grade methyl acetate was purified as recommended in ref. (3). The solvents were dried using zeolites of type NaA. Water content in propylene carbonate was 0.015 mass % and in methyl acetate 0.014 mass %.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Methyl acetate; $C_3H_6O_2$; [79-20-9]

(3) Propylene carbonate; $C_4H_6O_3$ [108-32-7]

ORIGINAL MEASUREMENTS:

Il'in, K.K.; Demakhin, A.G.

Zh. Neorg. Khim. 1989, *34*, 780-2; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1989, *34*, 436-8.

EXPERIMENTAL VALUES: (continued)

t / °C	Liquid phase composition mass % (1)	(2)	(3)	mol %^{a} (1)	(2)	(3)
25.0	48.2	0.0	51.8	47.2	0.0	52.8
	48.4	5.2	46.4	46.4	7.2	46.4
	48.7	10.3	41.0	45.8	13.9	40.2
	49.1	15.3	35.6	45.4	20.3	34.3
	49.6	20.2	30.2	45.1	26.4	28.6
	50.7	29.6	19.7	44.6	37.4	18.0
	51.7	38.6	9.7	44.1	47.3	8.6
	53.5	46.5	0.0	44.5	55.5	0.0
30.0	48.4	0.0	51.6	47.4	0.0	52.6
	49.0	10.2	40.8	46.2	13.8	40.0
	50.0	20.0	30.0	45.5	26.1	28.4
	51.1	29.3	19.6	45.0	37.0	18.0
	52.1	38.3	9.6	44.5	47.0	8.5
	53.9	46.1	0.0	44.9	55.1	0.0

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: (continued)

supersaturated and unsaturated sln. $LiClO_4$ concentration was determined by gravimetric precipitation with nitron (2). Each reported soly value was the mean of 5 determinations. The compositions of solvent mixtures were checked by measuring their refractive indices and comparison with those previously measured for known mixtures of the solvents.

ESTIMATED ERROR:

"Relative error" in soly values did not exceed ± 0.5 %.

Temperature precision ± 0.1 K.

REFERENCES:

(1) Frontas'ev, V.P.; Sakharova, Yu G.; Sakharova, N.N. *Zh. Neorg. Khim.* 1965, *10*, 1816.

(2) Schumacher, J.C. *Perchlorates* (Russ. Transl.), Goskhimizdat, Moscow, 1963, 274.

(3) Keil, B. *Laboratorni Technika Organicke Chemie* (Russ. Transl.), Izd. Mir., Moscow, 1966.

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) Methyl acetate; $C_3H_6O_2$; [79-20-9] (3) Propylene carbonate; $C_4H_6O_3$ [108-32-7]	Il'in, K.K.; Demakhin, A.G. *Zh. Neorg. Khim.* 1989, *34*, 780-2; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1989, *34*, 436-8.

EXPERIMENTAL VALUES: (continued)

t / °C	Liquid phase composition mass % (1)	(2)	(3)	mol %[a] (1)	(2)	(3)
40.0	49.0	0.0	51.0	48.0	0.0	52.0
	49.5	10.1	40.4	46.7	13.7	39.7
	50.6	19.8	29.6	46.0	25.9	28.1
	51.7	29.0	19.3	45.6	36.7	17.7
	52.6	37.9	9.5	45.0	46.5	8.5
	54.3	45.7	0.0	45.3	54.7	0.0
50.0	49.5	0.0	50.5	48.5	0.0	51.5
	50.1	10.0	39.9	47.2	13.5	39.2
	51.3	19.5	29.2	46.7	25.5	27.7
	52.3	28.6	19.1	46.2	36.3	17.6
	53.2	37.4	9.4	45.6	46.0	8.4
	54.9	45.1	0.0	45.9	54.1	0.0

[a] Compiler's calculations.

COMMENTS AND/OR ADDITIONAL DATA

At all temperatures, the solubility of lithium perchlorate in methyl acetate is higher than that in propylene carbonate which is the more polar solvent. The solubility of the salt increases linearly with temperature and may be approximated by an equation of the form,

$\log s = A + B/T$, where s is the solubility of the salt in

mass %, T the absolute temperature, and A and B are empirical constants, "least squares best-fit" values of which are given below for pure methyl acetate, pure propylene carbonate and mixtures of the two solvents.

Solvent mass % of methyl acetate :	0.00	20.00	40.00	60.00	80.00	100.00
A :	1.8308	1.8329	1.8490	1.8606	1.8579	1.8752
-B / K :	44.113	43.152	45.357	46.165	42.840	43.765

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.; Bogomolova, V.V.; Gulyakova, N.I.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1969, *66*, 57-61.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$NaClO_4$-H_2O at 25°C :

	Liquid phase composition						Solid
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.62	-	9.266	-	5.669	-	$LiClO_4.3H_2O$
2	36.82	0.95	9.088	0.204	5.561	0.125	"
3	36.31	2.00	9.024	0.432	5.532	0.265	"
4	35.91	4.00	9.108	0.882	5.617	0.544	"
5	31.26	11.92	8.288	2.746	5.171	1.713	"
6	28.72	16.74	7.861	3.981	4.950	2.507	"
7	21.84	29.09	6.483	7.503	4.183	4.842	"
8	13.14	43.90	4.308	12.51	2.875	8.346	"
9	7.23	57.59	2.728	18.88	1.932	13.37	"
10	6.23	60.19	2.426	20.36	1.744	14.64	$LiClO_4.3H_2O$ + $NaClO_4.H_2O$
11	6.10	59.86	2.35	20.07	1.684	14.36	"
12	5.96	60.19	2.31	20.26	1.655	14.52	"
13	5.76	60.21	2.22	20.20	1.591	14.45	$NaClO_4.H_2O$
14	0.38	66.99	0.15	23.16	0.109	16.77	"
15	-	67.89	-	23.73	-	17.27	"

[a] Values calculated by C.C. Ho.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached after 6-8 days. Li^+ was determined by the periodate method; ClO_4^- by precipitating with nitron. The compositions of the solid phases were determined by Schreinemakers' method of residues. The densities, viscosities and refractive indexes of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.

Uch. zap. Yarosl. gos. ped. Inst. 1973, *120*, 43-6.

VARIABLES:

One temperature: 323 K

Composition

PREPARED BY:

R.A. Vasina

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$NaClO_4$-H_2O at 323 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
45.28	-	12.29	-	7.778	-	$LiClO_4.3H_2O$
40.63	7.37	11.47	1.81	7.344	1.158	"
39.05	10.60	11.30	2.67	7.290	1.719	"
31.58	22.06	9.73	5.91	6.403	3.886	"
25.78	31.62	8.46	9.01	5.688	6.062	"
21.43	40.55	7.62	12.53	5.298	8.711	"
17.01	49.98	6.66	17.01	4.844	12.366	"
13.45	56.91	5.65	20.78	4.265	15.681	"
13.29	57.72	5.66	21.37	4.309	16.261	$LiClO_4.3H_2O$ + $NaClO_4$
13.28	57.75	5.66	21.39	4.309	16.281	"
13.28	57.74	5.66	21.39	4.307	16.272	"
13.28	57.83	5.67	21.46	4.321	16.349	"
10.42	60.62	4.45	22.50	3.382	17.096	$NaClO_4$
9.75	61.83	4.22	23.23	3.225	17.768	"
5.44	66.87	2.40	25.59	1.847	19.723	"
3.26	70.07	1.47	27.47	1.149	21.458	$NaClO_4.H_2O$
-	73.75	-	29.25	-	22.946	"

[a] Compiler's calculation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Details of saturation were not given. The composition of solid phases was determined graphically by Schreinemaker's method of "residues".

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Potassium perchlorate; $KClO_4$; [7778-74-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Voronina, T.N.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1969, *66*, 132-7.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$KClO_4$-H_2O at 25°C :

	Liquid phase composition						Solid
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	-	2.05	-	0.2714	-	0.1511	$KClO_4$
2	2.29	1.27	0.400	0.170	0.223	0.0950	"
3	6.41	0.70	1.154	0.0968	0.649	0.0544	"
4	11.84	0.68	2.238	0.0987	1.272	0.0561	"
5	14.83	0.67	2.883	0.1000	1.650	0.0572	"
6	17.46	0.64	3.481	0.0980	2.004	0.0564	"
7	26.95	0.50	5.913	0.0842	3.492	0.0497	"
8	23.30	0.40	4.914	0.0648	2.870	0.0378	"
9	26.12	0.37	5.672	0.0617	3.340	0.0363	"
10	31.67	0.18	7.293	0.0318	4.368	0.0191	"
11	37.50	0.19	9.245	0.0360	5.657	0.0220	$KClO_4$ + $LiClO_4 \cdot 3H_2O$
12	37.48	0.197	9.239	0.0373	5.653	0.0228	"
13	37.49	0.19	9.242	0.0360	5.654	0.0220	"
14	37.52	0.19	9.252	0.0360	5.662	0.0220	"
15	37.70	-	9.295	-	5.688	-	$LiClO_4 \cdot 3H_2O$

[a] Values calculated by C.C. Ho.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached after 3-4 days. The salt concns were calculated using the data of chemical analysis. K^+ was determined gravimetrically by the tetraphenylborate method; Li^+ by the volumetric periodate method; ClO_4^- by difference. The compositions of the solid phases were determined by Schreinemakers' method of residues and then confirmed under a microscope. The densities, viscosities of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

Lithium and potassium perchlorates were reagent grade. They were further purified by recrystallization.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9] (3) Water; H_2O; [7732-18-5]	Karnaukhov, A.S.; Ganina, G.I. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1969, *66*, 101-6
VARIABLES: Temperature: 298 K Composition	PREPARED BY: N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system : NH_4ClO_4-$LiClO_4$-H_2O at 25°C

Point	Liquid phase composition mass % (1)	mass % (2)	mol %[a] (1)	mol %[a] (2)	molality[a]/mol kg^{-1} (1)	molality[a]/mol kg^{-1} (2)	Solid phase
1	-	19.96	-	3.683	-	2.123	NH_4ClO_4
2	1.39	18.82	0.284	3.481	0.164	2.008	"
3	2.59	18.22	0.532	3.390	0.307	1.958	"
4	5.72	15.23	1.176	2.836	0.680	1.640	"
5	8.54	12.64	1.759	2.358	1.018	1.365	"
6	12.24	9.36	2.530	1.752	1.467	1.016	"
7	16.41	7.34	3.467	1.404	2.023	0.819	"
8	20.82	5.89	4.536	1.162	2.670	0.684	"
9	25.98	4.49	5.896	0.923	3.512	0.550	"
10	32.68	3.61	7.928	0.793	4.821	0.482	"
11	35.95	3.24	9.033	0.737	5.557	0.453	NH_4ClO_4 + $LiClO_4.3H_2O$
12	35.74	2.93	8.922	0.662	5.478	0.407	"
13	35.79	2.95	8.942	0.667	5.491	0.410	"
14	35.61	2.94	8.877	0.664	5.447	0.407	"
15	35.76	2.97	8.934	0.672	5.486	0.413	"
16	35.43	2.94	8.812	0.662	5.404	0.406	"
17	36.18	1.99	8.975	0.447	5.500	0.274	$LiClO_4.3H_2O$
18	36.49	1.25	9.003	0.279	5.509	0.171	"
19	37.30	-	9.152	-	5.592	-	"

[a] Editors' calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal solubility. Details of saturation method were not given. NH_4^+ was determined by distilling off NH_3 into 4% H_3BO_3 solution and then titrating with 0.2 mol dm^{-3} H_2SO_4 ; ClO_4^- was determined by nitron precipitation ; Li^+ by difference. The compositions of the solid phases were determined by Schreinemakers' method of "residues". The densities, viscosities and electric conductivities of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

None.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Aravamudan, G.

Ind. J. Chem. 1964, *43*, 475-507.

VARIABLES:

One temperature: 303.15 K.

Composition.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-NH_4ClO_4-H_2O at 303.15 K :

Solution composition						Solid phase
mass %		mol %^{a}		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
38.87	-	9.72	-	5.977	-	$LiClO_4.3H_2O$
38.23	1.457	9.66	0.3334	5.958	0.2056	"
37.85	2.591	9.66	0.5986	5.973	0.3703	$LiClO_4.3H_2O$ + NH_4ClO_4
36.22	2.880	9.09	0.6545	5.590	0.4025	NH_4ClO_4
30.22	4.228	7.175	0.9090	4.333	0.5490	"
22.99	6.563	5.167	1.336	3.067	0.7929	"
17.24	9.046	3.742	1.778	2.198	1.045	"
15.42	10.20	3.324	1.991	1.949	1.117	"
10.50	13.31	2.222	2.551	1.295	1.487	"
4.96	17.55	1.037	3.321	0.602	1.928	"
-	22.00	-	4.146	-	2.401	"

^{a} Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Saturated solutions were variously prepared as follows:

(i) addition of $LiClO_4.3H_2O$ crystals to satd NH_4ClO_4 solutions at 30°C;

(ii) from admixture of water and crystals of both salts;

(iii) slow evaporation of solutions containing both salts at 30°C until slightly beyond the point of incipient crystallization.

They were then agitated continuously at 30.00°C until equilibrium was attained, generally after less than 24h. Saturated solutions were then separated from the solid phases, whose compositions were ascertained using Schreinemakers' method. Ammonium ion was analysed using the formalin method (ref.1) and lithium by weighing as sulphate after volatilization of ammonia and perchorate using sulphuric acid.

SOURCE AND PURITY OF MATERIALS:

$LiClO_4.3H_2O$ was prepared from dilute $HClO_4$ and Li_2CO_3 and NH_4ClO_4 from ammonia and $HClO_4$. No details of purity of starting materials were given.

ESTIMATED ERROR:

Temp. precision: ± 0.02 K.

REFERENCES:

1. Stockdale, D. *Analyst* 1959, *84*, 667.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Guseva, A.D.; Lepeshkov, I.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1969, *66*, 3-22

VARIABLES:

Temperature: 308 K

Composition

PREPARED BY:

I.S. Bodnya ; N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system : NH_4ClO_4-$LiClO_4$-H_2O at 35°C

Point	Liquid phase composition mass % (1)	mass % (2)	mol %[a] (1)	mol %[a] (2)	molality[a]/mol kg^{-1} (1)	molality[a]/mol kg^{-1} (2)	Solid phase
1	-	22.43	-	4.246	-	2.461	NH_4ClO_4
2	3.34	20.62	0.709	3.964	0.413	2.308	"
3	4.80	19.46	1.022	3.752	0.596	2.187	"
4	9.90	15.90	2.141	3.113	1.254	1.824	"
5	17.15	11.35	3.814	2.286	2.255	1.351	"
6	21.20	9.42	4.824	1.941	2.872	1.156	"
7	25.76	7.31	6.024	1.548	3.618	0.930	"
8	30.05	5.00	7.187	1.083	4.349	0.655	"
9	31.40	4.66	7.599	1.021	4.616	0.620	"
10	35.13	3.62	8.780	0.819	5.391	0.503	"
11	39.80	2.43	10.39	0.574	6.476	0.358	NH_4ClO_4 + $LiClO_4.3H_2O$
12	40.10	2.19	10.47	0.518	6.531	0.323	"
13	40.35	1.99	10.54	0.471	6.578	0.294	"
14	40.38	2.17	10.58	0.515	6.607	0.321	"
15	40.70	1.88	10.67	0.446	6.662	0.279	$LiClO_4.3H_2O$
16	40.80	0.97	10.58	0.228	6.586	0.142	"
17	41.09	-	10.56	-	6.556	-	"

[a] Editors' calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method. Details of saturation were not given. Li^+ was determined by precipitating as lithium zinc uranyl acetate; NH_4^+ by distillation of NH_3 ; ClO_4^- by difference.

SOURCE AND PURITY OF MATERIALS:

The chemically pure salts were further purified by recrystallization. The hydrate of lithium perchlorate was dehydrated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

None.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Thallium perchlorate; $TlClO_4$; [13453-40-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ivanov, S.A.; Smirnov, V.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1972, *103*, 33-5.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

N.A. Vasina

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$TlClO_4$-H_2O at 25°C :

	Liquid phase composition						Solid phase
	mass %		mol %[a]		molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	-	14.09	-	0.9631	-	0.5398	$TlClO_4$
2	9.35	5.26	1.814	0.357	1.029	0.203	"
4	18.67	3.33	3.886	0.243	2.250	0.141	"
5	28.17	1.99	6.383	0.158	3.791	0.0938	"
6	36.76	1.78	9.182	0.156	5.622	0.0953	"
7	37.14	1.70	9.310	0.149	5.708	0.0915	$TlClO_4$ + $LiClO_4.3H_2O$
9	36.92	1.58	9.215	0.138	5.643	0.0846	"
10	37.12	1.83	9.320	0.161	5.715	0.0987	$LiClO_4.3H_2O$
11	37.78	-	9.323	-	5.707	-	"

[a] Values calculated by C.C. Ho.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details were given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Calcium perchlorate; $Ca(ClO_4)_2$; [13477-36-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ivanov, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1971, *95*, 11-13

VARIABLES:

One temperature: 298 K

Composition.

PREPARED BY:

Kozyreva, N.A.

EXPERIMENTAL VALUES:

Solubility of the system $LiClO_4$-$Ca(ClO_4)_2$-H_2O at 25°C :

Liquid phase composition						Solid[b] phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
37.52	0.00	9.230	0.00	5.644	0.000	A
29.56	11.73	7.748	1.369	4.733	0.836	A
14.24	31.58	4.089	4.037	2.470	2.439	A
10.18	39.44	3.130	5.398	1,899	3.276	A
8.89	48.35	3.14	7.608	1.954	4.731	A + B
3.26	52.71	1.14	8.183	0.696	5.009	B
0.00	65.50	0.00	12.52	0.00	7.944	B

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[a] Compiler's calculations.

[b] A = $LiClO_4 \cdot 3H_2O$

B = $Ca(ClO_4)_2 \cdot 4H_2O$

The solid phases at the isothermal double saturation point are $Ca(ClO_4)_2 \cdot 4H_2O$ and $LiClO_4 \cdot 3H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method. Conditions of saturation were not given. The chemical, thermographic and X-ray powder analyses were employed.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Barium perchlorate; $Ba(ClO_4)_2$; [13465-95-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ganina, G.I.; Pisarenko O.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1976, *154*, 41-4.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system : $Ba(ClO_4)_2$-$LiClO_4$-H_2O at 25° C

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
37.34	-	9.166	-	5.601	-	$LiClO_4 \cdot 3H_2O$
29.90	15.77	8.405	1.403	5.173	0.863	"
19.52	33.43	6.339	3.435	3.900	2.113	"
14.71	42.96	5.286	4.885	3.270	3.018	"
11.49	51.21	4.634	6.534	2.895	4.083	"
6.16	58.24	2.623	7.847	1.626	4.865	$LiClO_4 \cdot 3H_2O$ + $Ba(ClO_4)_2 \cdot 3H_2O$
5.25	60.06	2.291	8.294	1.423	5.149	$Ba(ClO_4)_2 \cdot 3H_2O$
1.41	62.17	0.597	8.330	0.364	5.077	"
-	62.63	-	8.240	-	4.984	"

[a] Editors' calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE

The isothermal method was used. The densities and viscosities of the saturated solutions were measured. No description of the chemical analysis was given but literature references were cited [1,2].

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

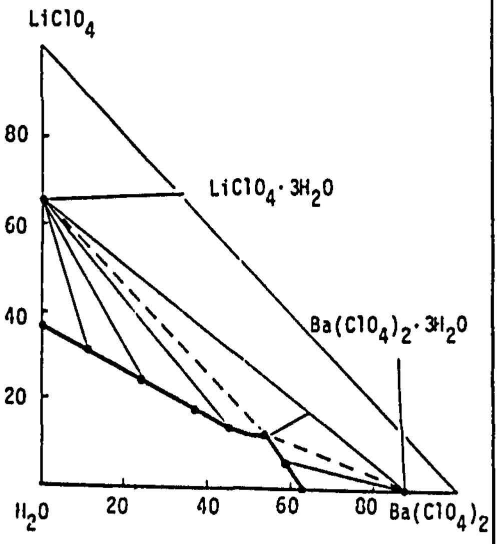
Not stated.

REFERENCES:

1. Hillebrand, W.F.; Lundell, G. G.E.F. *Appl. Inorg. Anal.*, New-York-London, Wiley, 1963.
2. Pribil, R. *Komplexone in der chemischen Analyse. Berlin, Deut. Verl. der Wissens.*, 1961.

COMMENTS AND/OR ADDITIONAL DATA:

The solubility isotherm (mass %) is shown below. The eutonic composition is 6.16 % $LiClO_4$, 58.24 % $Ba(ClO_4)_2$ and 35.60 % H_2O.



COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$;
[7791-03-9]

(2) Manganese perchlorate; $Mn(ClO_4)_2$;
[13770-16-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ganina, G.I.

Sb. Tr. Yarosl. Gos. Ped. Inst.
<u>1977</u>, *164*, 58-60.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Mn(ClO_4)_2$-H_2O at 25°C :

	Liquid phase composition						Solid[b]
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.34	-	9.166	-	5.601	-	A
2	34.81	4.23	8.777	0.447	5.367	0.273	A
3	30.87	9.07	7.928	0.976	4.831	0.595	A
4	26.43	13.00	6.784	1.399	4.101	0.8455	A
5	23.72	16.91	6.219	1.858	3.755	1.122	A
6	20.48	21.19	5.478	2.376	3.300	1.431	A
7	13.83	30.76	3.907	3.642	2.346	2.187	A
8	9.60	39.25	2.926	5.014	1.764	3.023	A
9	5.30	44.36	1.650	5.789	0.990	3.472	A
10	4.02	47.74	1.301	6.477	0.783	3.899	A
11	3.38	49.95	1.13	6.980	0.681	4.216	A + B
12	1.54	50.84	0.506	7.008	0.304	4.206	B
13	-	51.91	-	7.116	-	4.252	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Mn(ClO_4)_2.6H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. The compositions of liquid phases and residues were analysed for perchlorate ion (ref. 1) and manganese ion (ref. 2). Densities and viscosities of the solutions were measured.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

1. Hillebrand, W.F.; Lundell, G. E.F. *Applied Inorganic Analysis*, 2nd edi, New York, Wiley, <u>1963</u>.
2. Pribil, R. *Komplexone in der chemischen Analyse*, Berlin, <u>1961</u>.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Cobalt perchlorate; $Co(ClO_4)_2$; [13455-31-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.; Guseva, A.D.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1970, *79*, 32-5.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Co(ClO_4)_2$-H_2O at 25°C :

	Liquid phase composition						Solid[b] phase
	mass %		mol %[a]		molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.53	-	9.23	-	5.647	-	A
2	30.73	8.02	7.765	0.836	4.716	0.508	A
3	26.11	13.60	6.733	1.447	4.071	0.875	A
4	17.75	23.74	4.758	2.626	2.851	1.574	A
5	13.24	32.71	3.827	3.902	2.302	2.347	A
6	6.67	43.72	2.10	5.679	1.264	3.418	A
7	5.29	46.64	1.715	6.240	1.034	3.763	A + B
8	5.41	46.48	1.752	6.213	1.057	3.747	A + B
9	4.54	47.90	1.488	6.477	0.897	3.906	B
10	-	51.93	-	7.018	-	4.190	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Co(ClO_4)_2.6H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Co^{2+} was determined by complexometric titration; ClO_4^- by precipitating with nitron. The compositions of the true solid phases were determined by Schreinemakers' method of residues.

SOURCE AND PURITY OF MATERIALS:

Nothing stated.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Nickel perchlorate; $Ni(ClO_4)_2$; [13637-71-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.; Guseva, A.D.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 32-5.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Ni(ClO_4)_2$-H_2O at 25°C :

	Liquid phase composition						Solid[b] phase
	mass %		mol %[a]		molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.58	-	9.252	-	5.659	-	A
2	32.96	4.97	8.208	0.511	4.991	0.311	A
3	28.41	11.02	7.272	1.165	4.409	0.706	A
4	21.11	20.22	5.615	2.221	3.382	1.338	A
5	14.40	29.12	4.000	3.341	2.396	2.001	A
6	10.33	36.90	3.063	4.519	1.840	2.714	A
7	7.86	41.11	2.410	5.205	1.448	3.127	A
8	6.62	45.15	2.135	6.013	1.290	3.634	A + B
9	6.76	45.03	2.180	5.998	1.318	3.626	A + B
10	3.19	47.98	1.025	6.364	0.614	3.814	B
11	-	52.05	-	7.056	-	4.214	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Ni(ClO_4)_2.6H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Ni^{2+} was determined by complexometric titration. ClO_4^- by precipitating with nitron. The compositions of the true solid phases were determined by Schreinemakers' method of residues.

SOURCE AND PURITY OF MATERIALS:

Nickel perchlorate was synthesized from nickel carbonate by treating the latter with perchloric acid followed by recrystallization.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Copper perchlorate; $Cu(ClO_4)_2$; [13770-18-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kosheleva, N.I.; Pisarenko, O.N.

Sb. Nauch. Tr. Yarosl. Gos. Ped. Inst., 1975, *144*, 3-7.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Cu(ClO_4)_2$-H_2O at 25°C :

	Liquid phase composition						Solid[b]
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.58	-	9.252	-	5.659	-	A
2	34.37	4.18	8.615	0.425	5.257	0.259	A
3	29.60	6.60	7.236	0.654	4.361	0.394	A
4	23.10	12.10	5.625	1.194	3.351	0.7115	A
5	17.33	19.50	4.351	1.985	2.579	1.176	A
6	14.26	22.80	3.608	2.339	2.130	1.380	A
7	12.29	28.10	3.271	3.032	1.938	1.796	A
8	10.00	32.50	2.757	3.632	1.635	2.154	A
9	8.94	40.00	2.737	4.963	1.646	2.985	A
10	7.62	49.30	2.702	7.087	1.663	4.360	A + B
11	8.00	49.25	2.85	7.119	1.759	4.390	A + B
12	2.94	51.40	1.00	7.101	0.605	4.289	B
13	-	63.20	-	10.55	-	6.544	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Cu(ClO_4)_2.6H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium of the saturated solutions was reached in 2h. Cu^{2+} was determined spectrophotometrically; ClO_4^- gravimetrically by precipitating with nitron; Li^+ was determined by difference.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Cerium perchlorate; $Ce(ClO_4)_3$; [14017-47-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.; Rybina, T.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1976, *154*, 52-5.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

N.A. Vasina

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Ce(ClO_4)_3$-H_2O at 25°C :

	Liquid phase composition						Solid[b] phase
	mass %		mol %[a]		molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.34	-	9.17	-	5.601	-	A
2	30.69	5.04	7.459	0.297	4.488	0.179	A
3	22.57	17.80	5.955	1.139	3.558	0.681	A
4	17.24	24.94	4.727	1.659	2.803	0.984	A
5	9.44	39.50	2.945	2.990	1.738	1.764	A
6	6.63	47.42	2.290	3.974	1.356	2.354	A
7	4.06	59.38	1.732	6.147	1.044	3.704	A
8	3.35	64.05	1.585	7.351	0.966	4.481	A + B
9	3.16	64.14	1.492	7.347	0.908	4.473	A + B
10	-	64.78	-	7.026	-	4.195	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Ce(ClO_4)_3.9H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached after 1-2 days. ClO_4^- was determined gravimetrically by precipitating with nitron, Ce^{3+} by titrating with Trilon B using the indicator xylenol orange.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Gadolinium perchlorate; $Gd(ClO_4)_3$; [14017-52-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Rybina, T.V.; Druzhinina, G.V.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1978, *169*, 26-8.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Gd(ClO_4)_3$-H_2O at 25°C :

	Liquid phase composition						Solid
	mass %		mol %^{a}		molality^a/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.34	-	9.166	-	5.601	-	$LiClO_4.3H_2O$
2	26.16	11.73	6.611	0.6922	3.959	0.4145	"
3	15.10	27.36	4.179	1.768	2.467	1.044	"
4	10.74	35.03	3.167	2.412	1.862	1.418	"
5	6.07	44.45	1.967	3.363	1.153	1.972	"

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Samples of liquid phases and residues were taken one or two days after a second salt was added and then analysed. ClO_4^- was determined gravimetrically as nitron perchlorate (ref. 1). Gd^{3+} by complexometric titration with Trilon B in the presence of xylenol orange with urotropin buffer (ref. 2).

SOURCE AND PURITY OF MATERIALS:

Gadolinium perchlorate was prepared in the laboratory (ref. 3). Analysis revealed the gadolinium perchlorate and water contents to correspond to $Gd(ClO_4)_3.9H_2O$.

ESTIMATED ERROR:

Temperature: ± 0.1°C.
Solubility : Nothing specified.

REFERENCES:

1. Muller, G. *Praktikum der Quantitativen Chemischen Analyse*, Leipzig, 1951, 328.
2. Nikolayev (ed) *A Short Course of Radiochemistry*, Vysshaya shkola, Moscow 1969 (in Russian).
3. Paraguzova, T.V.; Druzhinina, G.V. *Sb. Tr. Yarosl. Gos. Ped. Inst.* 1977, *164*, 62.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Gadolinium perchlorate; $Gd(ClO_4)_3$; [14017-52-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Rybina, T.V.; Druzhinina, G.V.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1978, *169*, 26-8.

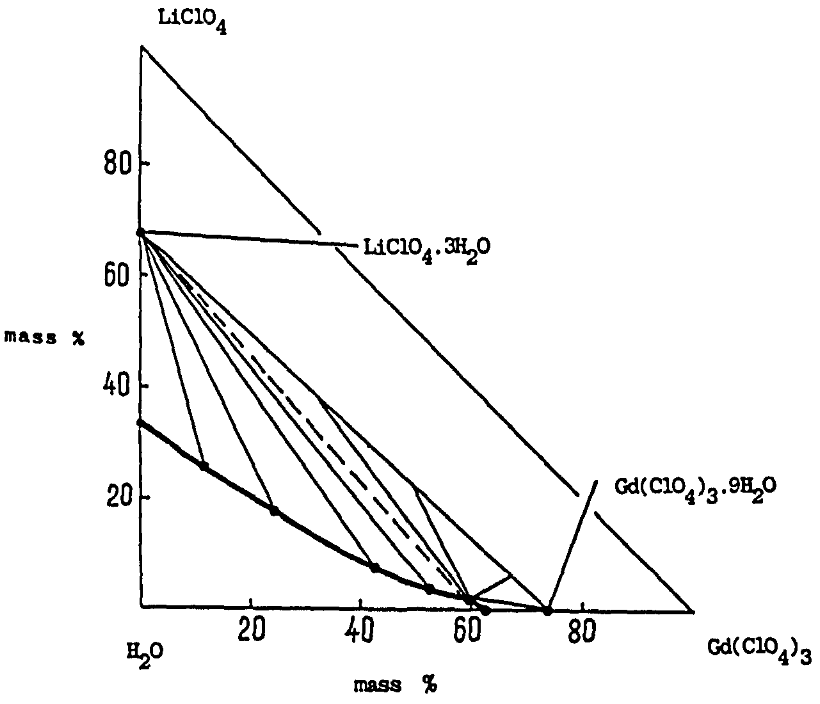
EXPERIMENTAL VALUES: (continued)

	Liquid phase composition						Solid phase
	mass %		mol %^{a}		molality^a/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
6	2.07	52.28	0.729	4.301	0.426	2.514	$LiClO_4.3H_2O$
7	2.09	55.27	0.783	4.837	0.461	2.845	"
8	0.89	61.18	0.372	5.973	0.221	3.540	$LiClO_4.3H_2O$ + $Gd(ClO_4)_3.9H_2O$
9	0.93	61.28	0.390	6.002	0.231	3.559	"
10	0.90	61.04	0.375	5.941	0.222	3.520	"
11	-	64.62	-	6.736	-	4.009	$Gd(ClO_4)_3.9H_2O$

^{a} Values calculated by C.C. Ho.

COMMENTS/ADDITIONAL DATA:

The solubility isotherm (see Figure below) shows a strong salting-out action of gadolinium perchlorate.



COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Terbium perchlorate; $Tb(ClO_4)_3$; [14014-09-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.

Sb. Nauch. Tr. Yarosl. Gos. Ped. Inst. 1975, *144*, 24-6.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Tb(ClO_4)_3$-H_2O at 25°C :

	Liquid phase composition						Solid[b]
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.66	-	9.280	-	5.678	-	A
2	24.17	18.87	6.623	1.203	3.988	0.7245	A
3	19.87	24.26	5.590	1.588	3.343	0.9496	A
4	18.16	28.62	5.355	1.964	3.207	1.176	A
5	11.82	38.20	3.742	2.814	2.223	1.671	A
6	4.61	50.70	1.645	4.208	0.970	2.481	A
7	3.09	56.48	1.212	5.153	0.718	3.055	A
8	2.10	60.25	0.881	5.878	0.524	3.500	A
9	3.19	62.87	1.462	6.702	0.883	4.051	A + B
10	3.42	62.53	1.561	6.641	0.944	4.016	A + B
11	3.05	62.54	1.38	6.590	0.833	3.975	A + B
12	1.63	63.73	0.737	6.709	0.442	4.023	B
13	-	64.21	-	6.602	-	3.923	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Tb(ClO_4)_3.9H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. ClO_4^- was determined gravimetrically as nitron perchlorate. Tb^{3+} was determined by complexometric titration with Trilon B in the presence of indicator xylenol orange with urotropin buffer.

SOURCE AND PURITY OF MATERIALS:

Terbium perchlorate was prepared by heating terbium nitrate and then dissolving the terbium oxide in 56% perchloric acid. The salt was recrystallized from distilled water and washed with chloroform. After desiccating over P_2O_5, the salt contained 72.52 mass % $Tb(ClO_4)_3$

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium nitrate; $LiNO_3$; [7790-69-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ganina, G.I.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. 1970, *15*, 2825-7; **Russ. J. Inorg. Chem.*, *(Engl.Transl.)* 1970, *15*, 1469-70.

Andronova, N.P.; Ganina, G.I.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1970, *78*, 55-8.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

C.Y. Chan, I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$LiNO_3$-H_2O at 25 °C :

Solution composition						Solid phase
mass %		mol %[a]		molality[a]/ mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
37.34	-	9.17	-	5.601	-	$LiClO_4 \cdot 3H_2O$
35.52	2.40	8.75	0.91	5.378	0.561	"
32.88	5.68	8.13	2.17	5.030	1.341	"
30.19	8.41	7.44	3.20	4.622	1.987	"
26.79	11.98	6.58	4.54	4.113	2.838	"
25.04	14.29	6.18	5.44	3.879	3.416	"
21.32	18.23	5.25	6.92	3.315	4.374	"
17.91	22.28	4.417	8.48	2.815	5.403	"
15.47	26.78	3.889	10.39	2.518	6.726	"
13.41	30.98	3.441	12.27	2.267	8.08	"
10.29	36.82	2.712	14.97	1.829	10.10	"
7.86	39.69	2.075	16.17	1.409	10.98	"
7.68	42.43	2.086	17.80	1.447	12.34	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Details of saturation method were not given. The composition and nature of the solid phases were determined using Schreinemakers' method, chemical analysis and X-ray and optical crystallography methods. Nitrate was determined using Devarda's method (no ref. given), lithium by lithium zinc uranyl acetate precipitation (ref.1), and perchlorate by difference.

SOURCE AND PURITY OF MATERIALS:

No information given.

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Grüttner, B. *Z. Analyt. Chem.* 1951, *133*, 40.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium nitrate; $LiNO_3$; [7790-69-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ganina, G.I.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. 1970, *15*, 2825-7; **Russ. J. Inorg. Chem.*, *(Engl.Transl.)* 1970, *15*, 1469-70.

Andronova, N.P.; Ganina, G.I.

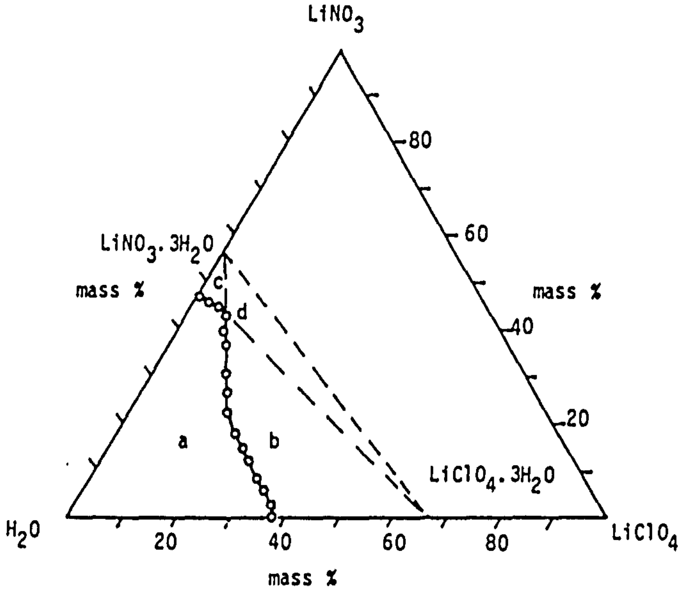
Sb. Tr. Yarosl. Gos. Ped. Inst. 1970, *78*, 55-8.

EXPERIMENTAL VALUES: (continued)

Solubility system $LiClO_4$-$LiNO_3$-H_2O at 25 °C :

Solution composition						Solid
mass %		mol %^{a}		molality^a/ mol kg^{-1}		phase
(1)	(2)	(1)	(2)	(1)	(2)	
7.66	42.35	2.080	17.75	1.440	12.29	$LiClO_4.3H_2O$ + $LiNO_3.3H_2O$
7.83	42.11	2.125	17.64	1.470	12.20	" "
7.55	42.78	2.058	17.99	1.429	12.49	" "
7.71	42.53	2.100	17.87	1.456	12.40	$LiNO_3.3H_2O$
4.51	44.61	1.206	18.42	0.833	12.72	"
2.76	45.52	0.729	18.56	0.502	12.77	"
-	46.99	-	18.81	-	12.86	"

COMMENTS AND/OR ADDITIONAL DATA



Isothermal phase diagram for the system $LiClO_4$-$LiNO_3$-H_2O at 25 °C :

region a —— unsaturated sln mixture.

" b —— mixed sln ($LiClO_4$ satd) + solid $LiClO_4.3H_2O$.

" c —— mixed sln ($LiNO_3$ satd) + solid $LiNO_3.3H_2O$:

" d —— mixed sln (both salts satd) + solid $LiClO_4.3H_2O$ + solid $LiNO_3.3H_2O$.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium nitrate; $LiNO_3$; [7790-69-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1973, *120*, 44-6.

VARIABLES:

One temperature: 323 K.

Composition.

PREPARED BY:

N.A. Vasina

EXPERIMENTAL VALUES:

Solubility system $LiNO_3$-$LiClO_4$-H_2O at 50°C :

	Liquid phase composition						Solid
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	45.27	-	12.29	-	7.775	-	$LiClO_4.3H_2O$
2	38.08	8.98	10.45	3.801	6.761	2.460	"
3	35.75	12.74	9.942	5.467	6.524	3.587	"
4	27.80	20.84	7.653	8.853	5.088	5.885	"
5	22.90	27.73	6.410	11.98	4.360	8.147	"
6	12.80	51.21	4.206	25.96	3.343	20.64	"
7	12.92	52.07	4.306	26.78	3.469	21.57	$LiClO_4.3H_2O$ + $LiNO_3$
8	12.70	52.30	4.232	26.89	3.411	21.67	"
9	13.03	52.17	4.357	26.92	3.519	21.74	"
10	11.33	53.32	3.747	27.21	3.013	21.88	$LiNO_3$
11	8.30	55.98	2.716	28.26	2.184	22.73	"
12	4.18	60.03	1.356	30.06	1.098	24.33	"
13	1.20	61.98	0.382	30.43	0.306	24.42	"
14	-	62.77	-	30.58	-	24.46	"

[a] Values calculated by C.C. Ho.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached in 6-8 days, and in the $LiNO_3$ crystallization field in 10 days. The solubility isotherm was constructed using data from chemical analysis. Analytical methods were not stated.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium chromate; Li_2CrO_4; [14307-35-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Ganina, G.I.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1969, *66*, 96-100.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system Li_2CrO_4-$LiClO_4$-H_2O at 25°C :

	Liquid phase composition						Solid[b]
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	37.34	-	9.166	-	5.601	-	A
2	36.24	1.81	8.980	0.367	5.499	0.225	A
3	35.42	3.34	8.859	0.684	5.436	0.420	A
4	32.72	6.74	8.268	1.395	5.080	0.857	A
5	29.62	2.38	6.838	0.450	4.094	0.269	A
6	24.82	14.71	6.300	3.059	3.858	1.873	A
7	16.99	22.01	4.298	4.562	2.618	2.778	A
8	12.50	27.00	3.190	5.644	1.942	3.436	A
9	7.54	32.79	1.949	6.945	1.188	4.231	A
10	4.81	37.32	1.275	8.106	0.781	4.966	A
11	2.75	40.97	0.746	9.104	0.459	5.605	A
12	1.99	42.32	0.544	9.484	0.336	5.851	A
13	1.45	45.90	0.414	10.74	0.259	6.713	A
14	1.56	47.17	0.455	11.27	0.286	7.084	A + B
15	1.56	47.17	0.455	11.27	0.286	7.084	A + B
16	1.56	47.17	0.455	11.27	0.286	7.084	A + B
17	1.56	47.17	0.455	11.27	0.286	7.084	A + B
18	0.91	48.15	0.27	11.56	0.168	7.278	B
19	-	48.88	-	11.71	-	7.363	B

[a] Values calculated by C.C. Ho; [b] A = $LiClO_4.3H_2O$; B = $Li_2CrO_4.2H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached after 5-6 days. The solutions and solid residues were analysed for the chromate ions and lithium ions. The compositions of the solid phases were determined by Schreinemakers' method of residues. The densities, viscosities and electric conductivities of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium chromate; Li_2CrO_4; [14307-35-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Guseva, A.D.;Lepeshkov, I.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1969, *66*, 3-22.

VARIABLES:

One temperature: 308 K.
Composition.

PREPARED BY:

N.A. Vasina

EXPERIMENTAL VALUES:

Solubility system Li_2CrO_4-$LiClO_4$-H_2O at 35°C :

	Liquid phase composition						Solid
	mass %		mol %[a]		molality[a]/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	41.09	-	10.56	-	6.556	-	$LiClO_4.3H_2O$
2	38.35	3.34	9.950	0.710	6.182	0.441	"
3	36.23	4.89	9.339	1.033	5.784	0.639	"
4	32.32	9.41	8.414	2.007	5.214	1.243	"
5	25.51	17.67	6.793	3.855	4.220	2.395	"
6	17.48	25.16	4.639	5.470	2.864	3.377	"
7	7.97	36.09	2.166	8.036	1.339	4.968	"
8	4.01	42.48	1.130	9.808	0.704	6.113	"
9	1.18	49.36	0.354	12.12	0.224	7.684	$LiClO_4.3H_2O$ + $Li_2CrO_4.2H_2O$
10	1.20	49.19	0.359	12.05	0.227	7.635	"
11	1.22	49.18	0.365	12.05	0.231	7.635	"
12	1.06	49.34	0.317	12.09	0.201	7.660	"
13	1.09	49.48	0.327	12.15	0.207	7.708	"
14	1.02	49.54	0.306	12.17	0.194	7.715	$Li_2CrO_4.2H_2O$
15	-	50.56	-	12.42	-	7.874	"

[a] Values calculated by C.C. Ho.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Details of saturation method were not given. Li^+ was determined by precipitating with lithium zinc uranyl acetate; CrO_4^{2-} by iodine titration; ClO_4^- by difference.

SOURCE AND PURITY OF MATERIALS:

Chemically pure salts were further purified by recrystallization. Hydrates of lithium salts were dehydrated.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$ [7791-03-9]
(2) Water; H_2O; [7732-18-5]
(3) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]
(4) Ethyl acetate; $C_4H_8O_2$; [141-78-6]

ORIGINAL MEASUREMENTS:

Smith, G.F.

J. Am. Chem. Soc. 1925, *47*, 762-9.

VARIABLES:

One temperature: 298.2 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of lithium perchlorate trihydrate in ethanol-ethyl acetate mixtures at 25.0 °C :

Volume %							
Ethanol (abs) :	0	5	10	20	30	40	50
Ethyl acetate :	100	95	90	80	70	60	50
mass %($LiClO_4.3H_2O$)[a]	26.35	-	31.05	33.59	35.10	36.51	37.96

Volume %						
Ethanol (abs) :	60	70	80	90	95	100
Ethyl acetate :	40	30	20	10	5	0
mass %($LiClO_4.3H_2O$)[a]	38.58	39.79	40.84	41.77	-	42.16

[a] Solute and solid phase were the trihydrate.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The experimental technique used was essentially the same as that reported in ref. 1 (see compilation). Duplicate measurements were made.

SOURCE AND PURITY OF MATERIALS:

Lithium perchlorate trihydrate was prepared in the same manner as that reported in ref. 1.

ESTIMATED ERROR:

Temperature ± 0.1 °C . Precision in soly determination not stated.

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1923, *45*, 286.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kosheleva, N.I

Sb. Tr. Yarosl. Gos. Ped. Inst. 1977, *164*, 5-7.

EXPERIMENTAL VALUES: (continued)

	Liquid phase composition						Solid[b]
	mass %			mol %[a]			phase
Point	(1)	(2)	(3)	(1)	(2)	(3)	
7	6.03	0.22	44.80	1.832	0.0319	10.33	A + B + C
8	10.21	0.35	15.84	2.234	0.0365	2.630	A + C + D
9	35.58	0.41	4.23	9.076	0.0499	0.819	A + D + E
10	3.63	46.76	1.56	1.168	7.170	0.381	F + A + E

	molality[a]/mol kg^{-1}			Solid[b]
Point	(1)	(2)	(3)	phase
1	-	0.091	6.338	A + B
2	1.285	-	7.514	B + C
3	3.667	-	5.458	C + D
4	5.541	-	1.305	D + E
5	0.461	3.924	-	E + F
6	-	3.046	0.154	F + B
7	1.158	0.0201	6.528	A + B + C
8	1.304	0.0213	1.535	A + C + D
9	5.594	0.0307	0.505	A + D + E
10	0.710	4.360	0.232	F + A + E

[a] Values calculated by C.C. Ho;

[b] A = $Mg(ClO_4)_2.2C_6H_{12}N_4.8H_2O$; B = $C_6H_{12}N_4$; C = $LiClO_4.2C_6H_{12}N_4.5H_2O$; D = $LiClO_4.C_6H_{12}N_4.3H_2O$; E = $LiClO_4.3H_2O$; F = $Mg(ClO_4)_2.6H_2O$.

COMMENTS/ADDITIONAL DATA:

The nodal points and monovariant lines of the solubility isotherm (see Figure) shows the crystallization fields of six solid phases: (1) $C_6H_{12}N_4$; (2) $LiClO_4.2C_6H_{12}N_4.5H_2O$; (3) $LiClO_4.C_6H_{12}N_4.3H_2O$; (4) $Mg(ClO_4)_2.2C_6H_{12}N_4.8H_2O$; (5) $Mg(ClO_4)_2.6H_2O$ and (6) $LiClO_4.3H_2O$.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kosheleva, N.I

Sb. Tr. Yarosl. Gos. Ped. Inst. 1977, *164*, 5-7.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Mg(ClO_4)_2$-$C_6H_{12}N_4$-H_2O at 25°C :

	Liquid phase composition						Solid[b]
		mass %			mol %[a]		phase
Point	(1)	(2)	(3)	(1)	(2)	(3)	
1	-	1.06	46.55	-	0.146	10.23	A + B
2	6.24	-	48.10	1.998	-	11.69	B + C
3	18.10	-	35.50	5.673	-	8.444	C + D
4	33.26	-	10.32	8.886	-	2.093	D + E
5	2.55	45.50	-	0.770	6.551	-	E + F
6	-	39.96	1.27	-	5.189	0.263	F + B

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Details not given.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

1. Karnaukhov, A.S.; Kosheleva, N.I. *Sb. Fiziko-khim. issled. ravnov. v rastvorakh.* 1975, *144*, 107.
2. Voronina, T.N.; Karnaukhov, A.S. *ibid*, 1970, *78*, 27-31
3. Karnaukhov, A.S.; Kosheleva, N.I. *ibid*, 1976, *154*, 62

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

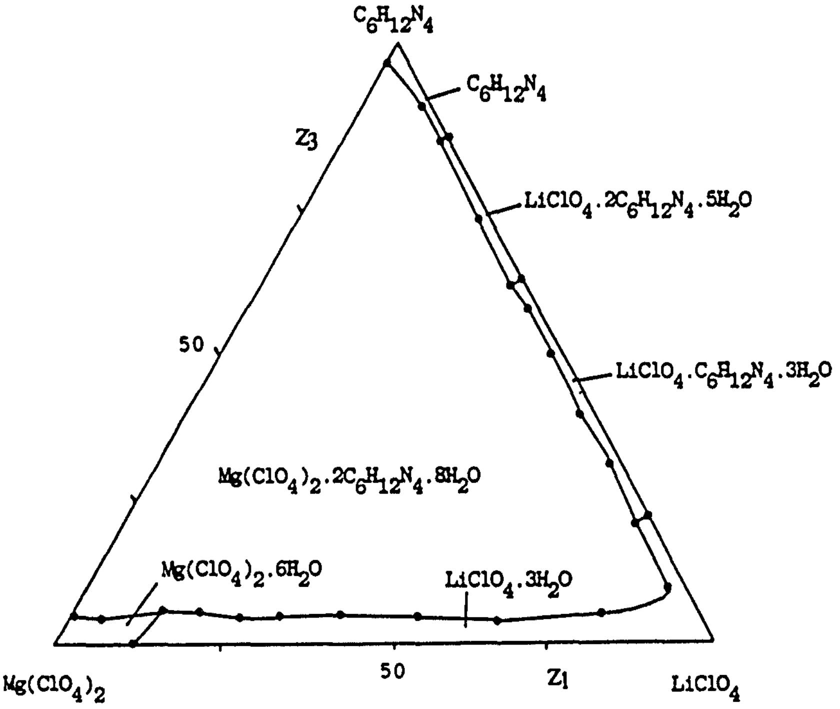
(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kosheleva, N.I

Sb. Tr. Yarosl. Gos. Ped. Inst. 1977, *164*, 5-7.

COMMENTS/ADDITIONAL DATA: (continued)



$Z_i = 100\, x_i/(x_1+x_2+x_3)$

Editors' note: Only 10 original data points were tabulated for the solubility system in this compilation but the above diagram appears to have been constructed from more data, the original reference source of which was not stated.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Copper perchlorate; $Cu(ClO_4)_2$; [13770-18-8]

(3) N(1), N(1)-dimethylcarbamide; $C_3H_8N_2O$; [1320-50-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, I.M.; Kinderov, A.P.; Bestuzheva, I.L.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1977, *164*, 5-7.

VARIABLES:

One temperature: 298 K.

Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $LiClO_4$-$Cu(ClO_4)_2$-$NH_2CON(CH_3)_2$-H_2O at 25°C :

	Liquid phase composition						Solid[b]
	mass %			mol %[a]			phase
Point	(1)	(2)	(3)	(1)	(2)	(3)	
1	7.81	49.27	-	2.777	7.102	-	A + B
2	-	58.65	3.88	-	9.520	1.876	A + C
3	-	19.17	19.69	-	1.979	6.056	C + D
4	25.40	-	47.19	10.40	-	23.33	D + E
5	36.79	-	22.93	12.17	-	9.157	E + B
6	7.80	48.16	2.21	2.816	7.047	0.963	A + B
7	5.91	45.47	6.05	2.088	6.512	2.581	A + B + C
8	5.90	41.60	11.28	2.109	6.027	4.868	C + B
9	8.15	36.42	14.41	2.884	5.225	6.158	C + B
10	8.67	32.53	18.37	3.066	4.663	7.843	C + B
11	10.18	27.22	22.73	3.583	3.884	9.660	C + B
12	12.21	22.68	23.26	4.116	3.099	9.468	B + C + D
13	13.12	18.52	26.52	4.377	2.505	10.68	B + D
14	15.58	13.97	28.61	5.144	1.870	11.41	B + D + E

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. The compositions of the liquid phases were determined by the content of the ions in solution. (3) was determined by Kjeldahl's method; Cu^{2+} by iodine titration; ClO_4^- gravimetrically with nitron; Li^+ by difference.

SOURCE AND PURITY OF MATERIALS:

No details were given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Copper perchlorate; $Cu(ClO_4)_2$; [13770-18-8]

(3) N(1), N(1)-dimethylcarbamide; $C_3H_8N_2O$; [1320-50-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, I.M.; Kinderov, A.P.; Bestuzheva, I.L.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1977, *164*, 5-7.

EXPERIMENTAL VALUES: (continued)

	Liquid phase composition						Solid[b]
	mass %			mol %[a]			phase
Point	(1)	(2)	(3)	(1)	(2)	(3)	
15	17.21	9.20	31.71	5.614	1.217	12.49	E + D
16	18.03	5.08	34.19	5.751	0.657	13.17	E + D
17	5.18	29.05	28.93	1.922	4.370	12.96	C + D
18	8.26	24.75	21.15	2.626	3.190	8.119	C + D
19	18.22	3.950	26.52	5.135	0.4512	9.024	B + E
20	20.82	7.290	27.16	6.492	0.9214	10.23	B + E
21	17.59	12.03	26.51	5.610	1.555	10.21	B + E
22	1.78	51.76	4.44	0.644	7.595	1.941	A + C
23	4.11	48.33	3.73	1.432	6.825	1.569	A + C

	molality[a]/mol kg^{-1}			Solid[b]
Point	(1)	(2)	(3)	phase
1	1.710	4.374	-	A + B
2	-	5.964	1.175	A + C
3	-	1.195	3.655	C + D
4	8.710	-	19.54	D + E
5	8.585	-	6.461	E + B
6	1.753	4.387	0.600	A + B
7	1.305	4.070	1.613	A + B + C
8	1.345	3.845	3.106	C + B
9	1.868	3.383	3.987	C + B
10	2.016	3.066	5.157	C + B
11	2.400	2.601	6.470	C + B
12	2.742	2.065	6.308	B + C + D
13	2.947	1.687	7.194	B + D
14	3.500	1.272	7.761	B + D + E
15	3.863	0.837	8.593	E + D
16	3.969	0.453	9.088	E + D
17	1.322	3.005	8.913	C + D
18	1.694	2.057	5.236	C + D

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COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Copper perchlorate; $Cu(ClO_4)_2$; [13770-18-8]

(3) N(1), N(1)-dimethylcarbamide; $C_3H_8N_2O$; [1320-50-9]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, I.M.; Kinderov, A.P.; Bestuzheva, I.L.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1977, *164*, 5-7.

EXPERIMENTAL VALUES: (continued)

Point	molality[a]/mol kg^{-1} (1)	(2)	(3)	Solid[b] phase
19	3.338	0.2933	5.866	B + E
20	4.375	0.6210	6.891	B + E
21	3.769	1.045	6.858	B + E
22	0.398	4.694	1.199	A + C
23	0.881	4.202	0.966	A + C

[a] Values calculated by C.C. Ho;

[b] A = $Cu(ClO_4)_2 \cdot 6H_2O$; B = $LiClO_4 \cdot 3H_2O$; C = $Cu(ClO_4)_2 \cdot 2NH_2CON(CH_3)_2 \cdot 4H_2O$; D = $NH_2CON(CH_3)_2$; E = $LiClO_4 \cdot 3NH_2CON(CH_3)_2 \cdot H_2O$;

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium chromate; Li_2CrO_4; [14307-35-8]

(3) Potassium perchlorate; $KClO_4$; [7778-74-7]

(4) Potassium chromate; K_2CrO_4; [7789-00-6]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Voronina, T.N.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. 1971, *16*, 871-3; **Russ. J. Inorg. Chem., (Engl. Transl.)* 1971, *16*, 466-7.

VARIABLES:

One temperature: 298 K.
Composition.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $2K^+, 2Li^+ \;||\; 2ClO_4^-, CrO_4^{2-}$ - H_2O at 25 °C :

Solution composition								Solid
mass %				solute ion mol % [a]				phase[b]
				$100x_s$(cation)		$100x_s$(anion)		
(1)	(2)	(3)	(4)	($2Li^+$)	($2K^+$)	($2ClO_4^-$)	(CrO_4^{2-})	
-	-	0.15	39.68	-	100.00	0.26	99.74	A + B
-	7.02	0.74	29.82	25.71	74.29	1.27	98.73	" "
-	22.46	2.10	19.02	62.08	37.89	2.72	97.28	" "
-	32.87	-	19.43	68.95	31.05	-	100.00	B + C
-	34.15	2.01	11.47	79.82	20.08	2.20	97.80	A + B + C
-	44.28	-	7.91	89.43	11.57	-	100.00	C + D
-	45.29	1.98	3.12	89.94	10.06	1.84	98.16	A + D + C
28.90	9.59	1.93	-	96.78	3.22	65.91	34.09	A + D
1.56	47.17	-	-	100.00	-	1.98	98.02	D + E
12.40	46.71	0.34	-	99.71	0.29	14.30	85.70	A + D + E
28.64	9.64	0.17	-	99.71	0.29	64.56	35.44	A + E
31.66	-	0.19	-	99.54	0.46	100.00	-	" "

[a] $x_s[2Li^+] = [n(Li^+)/\{n(Li^+) + n(K^+)\}] = \{1-x_s[2K^+]\}$
$x_s[2ClO_4^-] = [0.5n(ClO_4^-)/\{0.5n(ClO_4^-) + n(CrO_4^{2-})\}] = \{1-x_s[CrO_4^{2-}]\}$
n( ) = amount

[b] A = $KClO_4$; B = K_2CrO_4 ; C = $Li_2CrO_4.K_2CrO_4.H_2O$
D = $Li_2CrO_4.2H_2O$; E = $LiClO_4.3H_2O$

[c] Values in parentheses ( ) original values appear to be in error appear to be in error.

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COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]
(2) Lithium chromate; Li_2CrO_4; [14307-35-8]
(3) Potassium perchlorate; $KClO_4$; [7778-74-7]
(4) Potassium chromate; K_2CrO_4; [7789-00-6]
(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Voronina, T.N.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. 1971, *16*, 871-3; **Russ. J. Inorg. Chem.*, (*Engl. Transl.*) 1971, *16*, 466-7.

EXPERIMENTAL VALUES: (continued)

Solubility system $2K^+, 2Li^+ \parallel 2ClO_4^-, CrO_4^{2-} - H_2O$ at 25 °C :

Solution composition molality / mol kg^{-1}				Solid phase[b]
(1)	(2)	(3)	(4)	
-	-	0.018	3.396	A + B
-	0.866	0.086	2.460	" "
-	3.065	0.269	1.736	" "
-	5.306	-	2.098	B + C
-	5.021	0.277	1.128	A + B + C
-	7.131	-	0.852	C + D
-	7.029	0.288	0.324	A + D + C
4.559	1.239	0.234	-	A + D
0.286	7.084	-	-	D + E
2.874	8.870	0.061	-	A + D + E
4.374	1.206	0.020	-	A + E
4.367	-	0.020	-	A + E

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Details of method of saturation not given. K^+ was determined gravimetrically using sodium tetraphenylborate, Li^+ by the periodate method, CrO_4^{2-} iodometrically, and ClO_4^- by difference. For certain data, Li^+ was determined gravimetrically as lithium zinc uranyl acetate. Saturated solutions with compositions corresponding to the 'nodal' points of the quaternary reciprocal aqueous system were gradually treated with a third salt until a new solid phase appeared. With constant stirring, periods of equilibrium varied from 4 - 12 days. Solid phases were examined under a microscope.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium chromate; Li_2CrO_4; [14307-35-8]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ganina, G.I.; Karnaukhov, A.S.; Lepeshkov, I.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 151-6

VARIABLES:

Temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system : $2NH_4^+$, $2Li^+//2ClO_4^-$, CrO_4^{2-}-H_2O at 25°C

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	mol %[a] (1)	(2)	(3)	(4)	Solid phase
1	35.77	-	3.01	-	8.942	-	0.681	-	NH_4ClO_4 + $LiClO_4.3H_2O$
2	33.09	3.72	2.54	-	8.343	0.768	0.580	-	"
3	26.83	11.14	2.67	-	6.899	2.326	0.622	-	"
4	18.55	19.78	2.86	-	4.823	4.213	0.673	-	"
5	10.12	28.42	3.06	-	2.656	6.110	0.727	-	"
6	8.58	28.27	2.80	-	2.196	5.928	0.649	-	"
7	0.61	43.94	3.45	-	0.176	10.38	0.901	-	NH_4ClO_4 + $LiClO_4.3H_2O$ + $Li_2CrO_4.2H_2O$
8	1.56	47.17	-	-	0.455	11.27	-	-	$Li_2CrO_4.2H_2O$ + $LiClO_4.3H_2O$
9	-	47.81	1.37	2.27	-	11.92	0.377	0.483	$Li_2CrO_4.2H_2O$ + NH_4ClO_4
10	-	43.51	1.36	4.43	-	10.50	0.363	0.913	"
11	-	31.44	3.12	3.38	-	6.480	0.711	0.595	$Li_2CrO_4.2H_2O$ + NH_4ClO_4 + $(NH_4)_2CrO_4$
12	-	46.60	2.99	6.93	-	12.62	0.895	1.603	$Li_2CrO_4.2H_2O$ + $(NH_4)_2CrO_4.Li_2CrO_4.2H_2O$ + $(NH_4)_2CrO_4$
13	-	43.79	0.85	9.52	-	11.42	0.245	2.121	$(NH_4)_2CrO_4$ + $(NH_4)_2CrO_4.Li_2CrO_4.2H_2O$
14	-	43.14	0.52	10.51	-	11.26	0.150	2.343	"
15	-	42.08	-	11.27	-	10.85	-	2.481	"

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium chromate; Li_2CrO_4; [14307-35-8]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ganina, G.I.; Karnaukhov, A.S.; Lepeshkov, I.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 151-6

EXPERIMENTAL VALUES: (continued)

Solubility system : $2NH_4^+$, $2Li^+//2ClO_4^-$, CrO_4^{2-}-H_2O at 25°C (cont.)

Point	Liquid phase composition mass %				mol %[a]				Solid phase
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
16	-	46.86	-	7.95	-	12.35	1.789	-	$Li_2CrO_4.2H_2O$ + $(NH_4)_2CrO_4.Li_2CrO_4.2H_2O$
17	-	45.76	0.97	7.34	-	11.91	1.632	0.279	"
18	-	46.97	1.63	7.29	-	12.59	1.669	0.483	"
19	-	44.54	5.79	4.45	-	11.70	0.998	1.681	$(NH_4)_2CrO_4$ + NH_4ClO_4
21	-	25.64	9.70	1.50	-	5.201	0.260	2.175	"
23	-	14.32	12.05	0.90	-	2.591	0.139	2.410	"
24	-	11.98	12.27	1.02	-	2.120	0.154	2.400	$(NH_4)_2CrO_4$ + NH_4ClO_4 + $NH_4ClO_4.(NH_4)_2CrO_4$
25	-	7.48	12.70	1.54	-	1.274	0.224	2.391	NH_4ClO_4 + $NH_4ClO_4.(NH_4)_2CrO_4$
27	-	3.65	16.87	2.61	-	0.631	0.385	3.223	"
29	-	1.78	17.32	2.82	-	0.304	0.411	3.266	"
31	-	-	0.72	26.18	-	-	4.064	0.145	$(NH_4)_2CrO_4$ + $NH_4ClO_4.(NH_4)_2CrO_4$
33	-	2.99	0.78	19.24	-	0.520	2.856	0.150	"
35	-	8.61	6.90	6.16	-	1.469	0.897	1.301	"
37	-	11.04	11.64	1.66	-	1.934	0.248	2.254	"

[a] Editors' calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method. To the starting solutions corresponding to the non-variant points of the ternary systems a third salt was added until a new solid phase appeared. Details of the saturation method were not given. NH_4^+ was determined by distilling off ammonia unto 4 % boric acid solution and then titrating with 0.2 mol L^{-1} H_2SO_4; CrO_4^{2-} iodimetrically; Li^+ gravimetrically as lithium zinc uranyl acetate; ClO_4^- by difference. The crystals were examined under a microscope.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Lithium perchlorate; $LiClO_4$; [7791-03-9] (2) Lithium chromate; Li_2CrO_4; [14307-35-8] (3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9] (4) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9] (5) Water; H_2O; [7732-18-5]	Guseva, A.D.; Lepeshkov, I.N. *Uch. Zap. Yarosl. Gos. Ped. Inst.* <u>1969</u>, *66*, 3-22
VARIABLES:	**PREPARED BY:**
Temperature: 308 K Composition	N.A. Kozyreva

EXPERIMENTAL VALUES·

Solubility system: $2NH_4^+$, $2Li^+//2ClO_4^-$, $CrO_4^{2-}-H_2O$ at 35°C

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	mol %^{a} (1)	(2)	(3)	(4)	Solid phase
1	-	-	1.19	28.00	-	-	0.246	4.464	$NH_4ClO_4.(NH_4)_2CrO_4$
2	-	2.99	1.56	15.70	-	0.504	0.291	2.261	$NH_4ClO_4.(NH_4)_2CrO_4$ + $(NH_4)_2CrO_4$
3	-	5.24	2.41	12.87	-	0.885	0.450	1.857	"
4	-	6.08	3.25	10.58	-	1.020	0.603	1.516	"
5	-	8.89	6.38	6.49	-	1.518	1.204	0.947	"
6	-	11.70	9.64	2.40	-	2.038	1.856	0.357	"
7	-	13.38	10.94	1.73	-	2.389	2.159	0.264	$NH_4ClO_4.(NH_4)_2CrO_4$ + NH_4ClO_4 + $(NH_4)_2CrO_4$
8	-	10.48	12.11	1.85	-	1.838	2.348	0.277	$NH_4ClO_4.(NH_4)_2CrO_4$ + NH_4ClO_4
9	-	5.43	14.91	3.32	-	0.944	2.866	0.493	"
10	-	2.71	19.54	3.88	-	0.484	3.856	0.592	$NH_4ClO_4.(NH_4)_2CrO_4$ + NH_4ClO_4
11	-	-	20.45	3.62	-	-	3.945	0.539	$NH_4ClO_4.(NH_4)_2CrO_4$
12	-	16.66	8.73	2.04	-	3.022	1.751	0.316	$(NH_4)_2CrO_4$ + NH_4ClO_4
13	-	17.78	5.60	3.58	-	3.212	1.118	0.552	"
14	-	19.93	4.75	3.41	-	3.647	0.961	0.533	"

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Lithium chromate; Li_2CrO_4; [14307-35-8]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Guseva, A.D.; Lepeshkov, I.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1969, *66*, 3-22

EXPERIMENTAL VALUES: (continued)

Solubility system : $2NH_4^+$, $2Li^+//2ClO_4^-$, $CrO_4^{2-}-H_2O$ at 35°C (cont.)

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	mol % (1)	(2)	(3)	(4)	Solid phase
15	-	20.96	4.04	3.91	-	3.873	0.825	0.617	$(NH_4)_2CrO_4$ + NH_4ClO_4
16	-	22.27	2.67	5.20	-	4.176	0.553	0.833	$(NH_4)_2CrO_4$ + NH_4ClO_4 + $Li_2CrO_4.2H_2O$
17	-	27.52	0.46	5.74	-	5.388	0.099	0.960	$(NH_4)_2CrO_4$ + $Li_2CrO_4.2H_2O$
18	-	46.63	-	8.73	-	12.41	-	1.983	"
19	-	49.37	-	1.12	-	12.11	-	0.335	$Li_2CrO_4.2H_2O$ + $LiClO_4.3H_2O$
20	1.53	48.91	3.65	-	0.484	12.68	1.046	-	"
21	1.38	32.07	5.73	-	0.352	6.702	1.324	-	"
22	0.77	21.28	6.58	-	0.173	3.912	1.337	-	$Li_2CrO_4.2H_2O$ + NH_4ClO_4 + $LiClO_4.3H_2O$
23	4.45	18.17	6.32	-	1.001	3.347	1.287	-	$LiClO_4.3H_2O$ + NH_4ClO_4
24	9.51	14.07	5.86	-	2.147	2.602	1.198	-	"
25	15.64	9.39	5.41	-	3.562	1.752	1.116	-	"
26	17.78	6.76	4.49	-	3.982	1.240	0.911	-	"
27	21.93	3.21	3.97	-	4.908	0.589	0.805	-	"
28	40.26	-	2.13	-	10.53	-	0.504	-	"

METHOD/APPARATUS/PROCEDURE:

Isothermal method. Details of saturation method were not given. Li^+ was determined by precipitation as lithium uranyl acetate; NH_4^+ by distillation; CrO_4^{2-} iodimetrically; ClO_4^- by difference.

SOURCE AND PURITY OF MATERIALS:

The chemically pure salts were further purified by recrystallization. The hydrates of lithium salts were dehydrated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

None.

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Lithium chromate: Li_2CrO_4; [14307-35-8]

(4) Magnesium chromate; $MgCrO_4$; [13423-61-5]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Voronina. T.N.

Uch. Zap. Yasosl. Gos. Ped. Inst. 1970, *79,* 3-8.

VARIABLES:

One temperature: 298.2 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system : $Mg(ClO_4)_2$-$MgCrO_4$-$LiClO_4$-Li_2CrO_4-H_2O at 25.0°C

Liquid phase composition								Solid Phase[b]
mass %				mol %[a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
4.03	-	46.45	-	1.269	-	7.003	-	A + B
8.16	-	46.24	0.28	2.738	-	7.395	0.071	A + B
33.24	-	46.34	0.32	19.07	-	12.67	0.139	A + B
34.19	-	46.35	0.73	20.42	-	13.19	0.331	A + B + C
-	-	49.71	-	-	-	7.389	-	B + C
22.84	-	42.10	2.94	9.727	-	8.546	0.949	B + C
36.95	-	41.50	0.99	20.65	-	11.06	0.420	A + C
37.11	-	26.98	4.36	15.49	-	5.367	1.380	A + C
37.19	-	17.61	5.04	12.98	-	2.929	1.334	A + C
37.38	-	5.68	12.47	11.97	-	0.867	3.029	A + C
37.42	17.78	-	31.38	24.14	9.394	-	15.35	A + C
31.28	21.99	-	25.79	16.25	9.357	-	10.16	A + C
12.12	31.11	-	12.31	3.916	8.234	-	3.016	A + C

[a] Editors' calculations.

[b] A = $LiClO_4 \cdot 3H_2O$; B = $Mg(ClO_4)_2 \cdot 6H_2O$; C = $MgCrO_4 \cdot 5H_2O$.

AUXILIARY INFORMATION

METHOD/PROCEDURE/APPARATUS:

The isothermal method was used. Periods of equilibration were 4-6 days. CrO_4^{2-} was determined iodimetrically, Mg^{2+} by titration with EDTA, Li^+ as lithium zinc uranyl acetate, and ClO_4^- by difference.

SOURCE AND PURITY OF MATERIALS:

The salts were recrystallized.

ESTIMATED ERROR:

Temperature: ±0.1°C.

REFERENCES:

None.

(continued next page)

COMPONENTS:

(1) Lithium perchlorate; $LiClO_4$; [7791-03-9]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Lithium chromate: Li_2CrO_4; [14307-35-8]

(4) Magnesium chromate; $MgCrO_4$; [13423-61-5]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Voronina, T.N.

Uch. Zap. Yasosl. Gos. Ped. Inst. 1970, *79*, 3-8.

EXPERIMENTAL VALUES: (continued)

Solubility system : $Mg(ClO_4)_2$-$MgCrO_4$-$LiClO_4$-Li_2CrO_4-H_2O at 25.0°C (cont.)

Liquid phase composition								Solid Phase[b]
mass %				mol %[a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
2.45	34.40	-	0.88	0.614	7.062	-	0.167	A + C
1.83	44.27	-	4.79	0.552	10.93	-	1.095	A + C + D
-	44.52	-	4.83	-	10.75	-	1.080	C + D
2.75	46.80	-	1.76	0.833	11.62	-	0.404	A + D
1.56	47.17	-	-	0.455	11.27	-	-	A + D

[a] Editors' calculations.

[b] A = $LiClO_4 \cdot 3H_2O$; C = $MgCrO_4 \cdot 5H_2O$; D = $Li_2CrO_4 \cdot 2H_2O$.

COMPONENTS:	EVALUATOR:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Water; H_2O; [7732-18-5]	C.Y. Chan Department of Chemistry University of Malaya Kuala Lumpur, Malaysia

CRITICAL EVALUATION

I BINARY SYSTEMS

System $NaClO_4$-H_2O

The original values in mass % of the solubility of sodium perchlorate in water at various temperatures reported by different groups as well as the corresponding calculated mean values are given in Table 1. Original data listed which differed by more than twice the standard deviation of the initial mean at the temperature concerned were omitted in the computation of the final mean values. Twenty-six references to the solubility of $NaClO_4$ in water at 298 K were found. However, it should be noted that, as seen in Table 1, certain values have been obtained from more than one compilation reference source and in such cases, it is of the evaluator's opinion that the solubility determination had been carried out only once and that these reports had referred to the same result. Only Willard and Smith (6) indicated the precision of their solubility determination (± 0.05 %). None of the other groups gave any indication of the precision of their experimental results and insufficient information was available for obtaining fair estimates of the error limits of their data in the compilation. The solid phase in equilibrium with the saturated solution at temperatures below 328 K is the monohydrate, $NaClO_4.H_2O$, but at this temperature and above, the solid phase is the anhydrous salt.

Table 1. Solubility of sodium perchlorate in water at various temperatures

T/K	mass %	Solid Phase	Source
273	(60.14)[a]	$NaClO_4.H_2O$	Mikheeva and Titova (79)
"	62.54	"	Freeth (7)
"	62.87	"	Cornec and Dickely (10)
"	62.89	"	Karnaukhov and Makin (20)
Mean:	62.77		

[a] rejected in computation of the mean value

(continued)

CRITICAL EVALUATION (continued)

Table 1 (continued)

T/K	mass %	Solid Phase	Source
288	65.51	$NaClO_4 \cdot H_2O$	Freeth (7)
"	65.63	"	Cornec and Dickely (10)
"	64.63	"	Carlson (2)
Mean:	65.26		
293	66.84	$NaClO_4 \cdot H_2O$	Karnaukhov (21)
"	(67.48)[a]	"	Zaitseva and Lepeshkov (50)
"	67.58	"	Karnaukhov (17)
"	67.60	"	Freeth (7)
"	67.63	"	Cornec and Dickely (10)
"	67.64	"	Kudryakova and Karnaukhov (57)
"	67.65	"	Leboshchina and Kudryakova (85)
"	67.70	"	Molchanov (28)
298.15	67.70		Willard and Smith (6)
298	67.70	"	Chernykh, Ivanov and Alekseeva (51)
"	67.79	"	Lilich and Ovtrakht (27)
"	67.80	"	Lepeshkov and Druzhinina (34) Druzhinina and Paraguzova (82) Sal'nikova, Karnaukhov and Lepeshkov (65); Karnaukhov and Sal'nilova (55)
"	67.82	"	Karnaukhov and Makin (20)
"	67.84	"	Bestuzheva, Kinderov and Karnaukhov (87); Bestuzheva (88)
298.2	67.86	"	Karnaukhov and Kudryakova (32)
298	67.89	"	Karnaukhov and Tarakanov (56,64) Lepeshkov and Tarakanov (70)
"	67.89	"	Andronova (62); Andronova, Bogomolova and Gulyakova (40)
"	67.89	"	Smirnov, Ivanov and Chechneva (78)
"	67.92	"	Andronova (84)

(continued)

Table 1 (continued)

T/K	mass %	Solid Phase	Source
298	(68.84)[a]	$NaClO_4.H_2O$	Druzhinina (67)
Mean:	67.76		
303		"	Abdukarimova, Nogoev and Sulaimankulov (74)
"	68.71	"	Freeth (7)
"	68.25		Caven and Bryce (11)
Mean:	68.56		
308	69.8	$NaClO_4.H_2O$	Kudryakova and Kamaukhov (57) Kamaukhov and Guseva (31)
311	70.38	"	Comec and Dickely (10)
313	70.88	"	Freeth (7)
"	70.87	"	Karnaukov (17)
"	67.63	"	Ivanov (44)
Mean:	70.88		
323	(71.28)[a]	$NaClO_4.H_2O$	Carlson (2)
323	73.26	"	Comec and Dickely (10)
323	73.16	"	Freeth (7)
323	73.15	"	Zaitseva and Lepeshkov (50)
323	73.53	"	Andronova (62)
323	73.75	"	Andronova (75)
323	73.2	"	Molchanov (28)
323.2	73.2	"	Lepeshkov, Druzhinina and Troitskii (34); Druzhinina (30)
Mean:	73.32	std. dev. : 0.21	
323.95	73.3	$NaClO_4+NaClO_4.H_2O$	Freeth (7)
328	73.94	$NaClO_4$	Comec and Dickely (10)
333	74.30	"	Freeth (7)
"	74.2	"	Loseva (71)
Mean:	74.25		
335.8	74.33	$NaClO_4$	Molchanov (28)
348	75.00	"	Freeth (7)

(continued)

CRITICAL EVALUATION (continued)

Table 1 (continued)

T/K	mass %	Solid Phase	Source
348	75.01	$NaClO_4$	Comec and Dickely (10)
Mean	75.01		
363	76.27	"	Kudryakova and Lepeshkov (46)
"	75.85	"	Kudryakova and Karnaukhov (57)
"	75.85	"	Karnaukhov and Troitskii (33)
Mean:	75.99		
373 K	76.75	"	Comec and Dickely (10)
416	79.08	"	Carlson (2)

[a] rejected in computation of the mean value

Based on theoretical treatments described in ref. (76), (90) a semi-empirical equation on the form given by Equation (1) was used to fit the combined original data given in table 1, after conversion of the mass % data to mole fractions. Data were selectively rejected until all the values were fitted to within ± 2s of the calculated value at each selected temperature, s being the standard error defined by $s^2 = (x_{abs}-x_{calc})^2/(N-3)$, where N is the total number of data points.

$$F(x) = a_0 + a_1\,(T/K)^{-1} + a_2 \ln (T/K) \qquad (1)$$

where $F(x) = \ln\left(x^{v}(1-x)^{n}/(1+(v-1)x)^{(n+v)}\right)$, T = temperature, x = mole fraction, v = 2 for $NaClO_4$ (stoichiometric number for salt), the mole ratio water : salt is n = 1 when the solid phase is $NaClO_4.H_2O$ and n = 0 when the anhydrous salt is the solid phase.

a_0, a_1 and a_2 are the best-fit parameters, obtained using least-squares linear regression analysis. The results of the analysis are given in Table 2 for n = 1 and n = 0 in Eq. (1).

Table 2 Values of best-fit parameters with reference to Equation 1, pertaining to data in Table 1

Temperature : 273 K - 323 K

Solid phase : $NaClO_4.H_2O$

Correlation coefficient : 0.999 (37 data points)

Parameters	$a_0 = -31.828$	std. error in F(x) = 0.005
	$a_1 = 6.3_3\mathrm{x}10^2$	" " " a_1 = $1.7\mathrm{x}10^2$
	$a_2 = 4.55$	" " " a_2 = 0.57

(continued)

CRITICAL EVALUATION (continued)

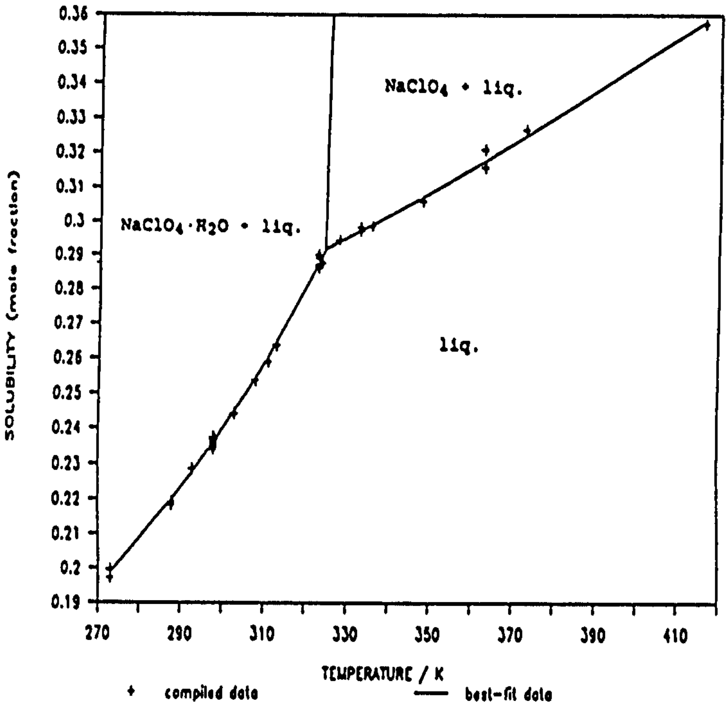
Table 2 (continued)

Temperature :	328 K - 416 K	
Solid phase :	$NaClO_4$	
Correlation coefficient :	0.996 (11 data points)	
Parameters	$a_0 = -17.854$	std. error in F(x) = 0.008
	$a_1 = 4.0_9 \times 10^2$	" " " $a_1 = 3.4 \times 10^2$
	$a_2 = 2.35_5$	" " " $a_2 = 0.94$

The average difference between calculated and observed values was 0.38 % of the observed solubility value.

Figure 1. Solubility-temperature plot for the $NaClO_4$-water system

Solid line represents smoothed data based on Equation 1.



The solubility-temperature plot is shown in Figure 1 and Table 3 lists recommended and tentative smoothed values of the solubility of sodium perchlorate in water, computed based on Equation 1 using the appropriate parameters at the selected temperatures. The recommended values are for the solubilities at 298.15 K and 323.15 K, where original data were

(continued)

CRITICAL EVALUATION: (continued)

reported by more than three independent groups at each of these temperatures.

Table 3. Smoothed data calculated for the solubility of $NaClO_4$ in water at selected temperatures.

t/°C	T/K	Solubility mol fraction	Solubility molality	Solid phase	Status
0	273.15	0.1987	13.77	$NaClO_4.H_2O$	tentative
5	278.15	0.2056	14.36	"	"
10	283.15	0.2126	14.99	"	"
15	288.15	0.2200	15.66	"	"
20	293.15	0.2278	16.38	"	"
25	298.15	0.2362	17.16	"	recommended
30	303.15	0.2451	18.02	"	tentative
35	308.15	0.2545	18.95	"	"
40	313.15	0.2647	19.98	"	"
45	318.15	0.2757	21.13	"	"
50	323.15	0.2876	22.41	"	recommended
51.8	324.95	0.2922	22.91	$NaClO_4.H_2O$ + $NaClO_4$	tentative
55	328.15	0.2942	23.14	$NaClO_4$	"
60	333.15	0.2975	23.50	"	"
65	338.15	0.3008	23.87	"	"
70	343.15	0.3041	24.26	"	"
75	348.15	0.3075	24.65	"	"
80	353.15	0.3109	25.04	"	"
85	358.15	0.3144	25.45	"	"
90	363.15	0.3179	25.87	"	"
95	368.15	0.3215	26.30	"	"
100	373.15	0.3251	26.74	"	"
105	378.15	0.3287	27.19	"	"
110	383.15	0.3324	27.64	"	"
115	388.15	0.3362	28.11	"	"

(continued)

CRITICAL EVALUATION (continued)

Table 3. (continued)

t/°C	T/K	Solubility mol fraction	 molality	Solid phase	Status
120	393.15	0.3400	28.59	$NaClO_4$	tentative
125	398.15	0.3438	29.08	"	"
130	403.15	0.3477	29.59	"	"
135	408.15	0.3516	30.10	"	"
140	413.15	0.3556	30.63	"	"
145	418.15	0.3596	31.17		

The peritectic transition from the monohydrate to anhydrous sodium perchlorate was determined to occur at 324.96 K and at this point the mole fraction of the salt in the solution at equilibrium is 0.2922, molality was 22.91 mol kg^{-1}, based on the evaluator's analysis. It should be noted that these values are slightly higher than the values of 0.2877 (mole fraction) and 22.42 mol kg^{-1} calculated from Freeth's data (7) at 323.95 K for the saturated solution in equilibrium with both the anhydrous salt and its monohydrate. The peritectic temperature reported by Cornec and Dickely (10) was 325.90 K.

Cornec and Dickely (10) also reported solubility data in mamount concentration units and saturated solution densities (see compilation) over the temperature range 273 K - 373 K while similar data were reported by Carlson (2) at 288 K, 323 K and 416 K. Carlson's solubility values of 8.79 mol dm^{-3} at 288 K and 10.08 mol dm^{-3} at 323 K are somewhat lower than Cornec and Dickely's values of 8.91 mol dm^{-3} and 10.46 mol dm^{-3} at the corresponding temperatures. There is better agreement between Willard and Smith's value (6) of 9.301 mol dm^{-3} at 298.15 K, Corned and Dickely's value of 9.33 mol dm^{-3} and the value of 9.309 mol dm^{-3} converted from the recommended molal solubility (Table 3) using Willard and Smith's value of 1.6821 g cm^{-3} for the saturated solution density (6) at the same temperature. Table 4 compares solubility values (in mol dm^{-3}) reported by Cornec and Dickely (10) and those calculated using the smoothed data given in Table 3 and Cornec and Dickely's saturated solution density values at various temperatures.

(continued)

CRITICAL EVALUATION (continued)

Table 4. Comparison of data for the solubility (in mol dm^{-3}) of $NaClO_4$ in water at selected temperatures

t/°C	T/K	Solubility / mol dm^{-3}	
		[calc. smoothed data]	[Cornec and Dickely (10)]
15	288.15	8.94	8.91
25	298.15	9.309	9.33
50	323.15	10.47	10.46
75	348.15	10.78	10.76
100	373.15	11.00	10.86

I.2. Solubility in D_2O

There is only one report of the solubility of sodium perchlorate in water-d_2, D_2O, over the temperature range 298-363 K, that of Selecki and Tyminski (60), (see relevant compilation).

I.3. Solubility of sodium perchlorate in other solvents

Data have been reported for the solubility of sodium perchlorate in each of the following solvents :

$T = 240\text{-}323$ K	ammonia (22)
$T = 272$ K	perchloric acid (39), hydrogen peroxide (91), hydrazine (59) ;
$T = 298$ K	methanol (6), ethanol (8), 1-propanol (6), 1-butanol (6), 2-methyl,1-propanol (6), sulfinylbis-methane (DMSO) (23,83), 1,2-ethanediol (14), 1,2-ethanediamine (14), 2-amino-ethanol (14), hydrazine (72), ethyl acetate;
$T = 308$ and 318 K	sulfinylbis-methane (DMSO) (23);
$T = 313$ K	tetrahydrothiophene 1-1 dioxide (sulfolane) (73) ;
$T = 373$ K	acetamide (60);
$T = 283\text{-}323$ K	2-butanone (methyl ethyl ketone) (69);
$T = 283\text{-}323$ K	acetone (48).

The only data compilations for the solubility of $NaClO_4$ in non-aqueous solvents that have a basis for comparison were those for solubility in acetone at 298 K. Willard and Smith (6) reported that the solubility of sodium perchlorate in acetone at 298.15 K was 4.228 mol kg^{-1} while Krumgal'z et al. (69) reported a value of 4.422 mol kg^{-1}, the solid phase being the

(continued)

anhydrous salt in both reports. Information on source and purity of materials as well as details of method were available in the former's report but not in the second.

II. TERNARY SYSTEMS

Solubility in mixed solvents

Systems $NaClO_4$ - organic solvent - H_2O

Data for such systems were reported in which the organic omponent was one of the following

$T = 298$ K	dimethylurea (88), thiocarbamide (64), acetamide (70), benzamide (87) and hexamethylenetetramine (65).
$T = 303$ K	carbamide (74), thiocarbamide (74).

No critical evaluation could be carried out for lack of relevant information.

Systems $NaClO_4$ - alcohol - ethyl acetate

The solubility at 298 K in mixed solvent ethyl acetate -alcohols (methanol, ethanol, 1-butanol has been determined by Smith (8).

Systems $NaClO_4$ - inorganic compound - water

The data concerning isothermal sections of the ternary systems involving a second salt are summarized in the following pages and some anomalies are mentioned but a critical evaluation of data could not be carried out because of insufficient information.

Systems involving the same anion

Systems $NaClO_4$-$MClO_4$-H_2O with $M = H, Li, K, Cs, NH_4, Tl$

$NaClO_4$-$HClO_4$-H_2O

At 298 K (51) the solid phases are $NaClO_4$, $NaClO_4 \cdot H_2O$ and $NaClO_4 \cdot HClO_4$.

$NaClO_4$-$LiClO_4$-H_2O

The results are presented in the critical analysis of $LiClO_4$.

$NaClO_4$-$KClO_4$-H_2O

$T = 273$ K (20), the observed solid phases are $NaClO_4$, $NaClO_4 \cdot H2O$, $KClO_4$ and $mNaClO_4 \cdot nKClO_4$. The data are scattered; furthermore, the double saturation point cannot involve $KClO_4$ and $NaClO_4$

$T = 298$ and 323 K (34, 30) the observed solid phases are $NaClO_4$, $NaClO_4 \cdot H2O$, $KClO_4$.

(continued)

$NaClO_4$-$CsClO_4$-H_2O (81)

At 298 K the solid phases in equilibrium with liquid are $NaClO_4 \cdot H_2O$, $CsClO_4$ and two double salts $3CsClO_4 \cdot NaClO_4$ and $CsClO_4 \cdot NaClO_4$.

At 348 K $3CsClO_4 \cdot NaClO_4$ is no longer observed.

$NaClO_4$-NH_4ClO_4-H_2O (57)

Two intermediate compounds are mentioned $C=n(NH_4ClO_4) \cdot m(NaClO_4 \cdot H_2O)$ and $D=n(NH_4ClO_4) \cdot m(NaClO_4)$; their stoichiometry is not known; their fields of existence are small and the phase diagram presents some anomalies so that the data must be considered very cautiously.

$T = 298$ K the observed solid phases are $NaClO_4 \cdot H_2O$, NH_4ClO_4 and C.

$T = 308$ K the solid phases are $NaClO_4 \cdot H_2O$, NH_4ClO_4, C and D.

$T = 363$ K three solid phases can crystallize $NaClO_4$, NH_4ClO_4 and D.

$NaClO_4$-$TlClO_4$-H_2O (78)

At 298 K the observed solid phases are $NaClO_4 \cdot H_2O$ and $TlClO_4$.

Systems $NaClO_4$-$M(ClO_4)_2$-H_2O with M = Mg, Ca, Sr, Ba, Zn, Ni

$NaClO_4$-$Mg(ClO_4)_2$-H_2O

$T = 298$ K (32) the observed solid phases are $NaClO_4 \cdot H_2O$ and $Mg(ClO_4)_2 \cdot 6H_2O$.

$T = 363$ K (46) the solid phases are $NaClO_4$ and $Mg(ClO_4)_2 \cdot 6H_2O$.

$NaClO_4$-$Ca(ClO_4)_2$-H_2O

$T = 298$ K (27) the observed solid phases are $NaClO_4 \cdot H_2O$ and $Ca(ClO_4)_2 \cdot 4H_2O$.

$T = 313$ K (44) the same phases can crystallize.

$NaClO_4$-$Sr(ClO_4)_2$-H_2O (67)

At 298 K the observed solid phases are $NaClO_4 \cdot H_2O$ and $Sr(ClO_4)_2 \cdot 4H_2O$.

$NaClO_4$-$Ba(ClO_4)_2$-H_2O (50)

$T = 298$ K the solid phases are $NaClO_4 \cdot H_2O$ and $Ba(ClO_4)_2 \cdot 3H_2O$.

$T = 323$ K two other salts can also crystallize according to the composition $NaClO_4$ and $Ba(ClO_4)_2 \cdot 2H_2O$.

$NaClO_4$-$Zn(ClO_4)_2$-H_2O (85)

At 298 K the observed solid phases are $NaClO_4 \cdot H_2O$ and $Zn(ClO_4)_2 \cdot 6H_2O$.

(continued)

CRITICAL EVALUATION (continued)

$NaClO_4$-$Ni(ClO_4)_2$-H_2O (56)

At 298 K the observed solid phases are $NaClO_4 \cdot H_2O$ and $Ni(ClO_4)_2 \cdot 6H_2O$.

Systems $NaClO_4$-$M(ClO_4)_3$-H_2O where M = Al, Ce, Tb

$NaClO_4$-$Al(ClO_4)_3$-H_2O (11)

At 303 K the solid phases are $NaClO_4 \cdot H_2O$, $Al(ClO_4)_3 \cdot nH_2O$.

$NaClO_4$-$Ce(ClO_4)_3$-H_2O (82)

At 298 K three solid phases are observed $NaClO_4$, $NaClO_4 \cdot H_2O$ and $Ce(ClO_4)_3 \cdot 9H_2O$.

$NaClO_4$-$Tb(ClO_4)_3$-H_2O (84)

At 298 K the solid phases $NaClO_4$, $NaClO_4 \cdot H_2O$ and $Tb(ClO_4)_3 \cdot 9H_2O$ can be observed.

Systems involving the same cation

$NaClO_4$-$NaCl$-H_2O

The solubilities have been measured between 273 and 373 K (10, 21, 32, 33, 71). At low temperatures the solid phases are $NaClO_4 \cdot H_2O$ and NaCl, at higher temperatures $NaClO_4$ and NaCl The nature of the solid perchlorate indicated on the 293 K data sheet (21) is erroneous.

$NaClO_4$-$NaNO_3$-H_2O (62)

Two isothermal sections have been investigated,the solid phases are $NaClO_4 \cdot H_2O$ and $NaNO_3$.

$NaClO_4$-$NaClO_3$-H_2O (71)

At 333 K the solubility curves of pure components, $NaClO_4$ and $NaClO_3$, are observed.

$NaClO_4$-Na_2SO_4-H_2O (7)

Two isothermal sections have been investigated. At 298 K three solid phases are observed, $NaClO_4 \cdot H_2O$, Na_2SO_4 and $Na_2SO_4 \cdot 10H_2O$. At 333 K the solid phases are the anhydrous salts $NaClO_4$ and Na_2SO_4.

$NaClO_4$-Na_2CrO_4-H_2O

The system has been investigated at three temperatures.
T = 298 K, Karnaukhov (31) mentions the existence of $NaClO_4 \cdot H_2O$ and $Na_2CrO_4 \cdot 4H_2O$ while Molchanov (28) indicates also a solubility field of Na_2CrO_4.

(continued)

T = 323 K (28, 30) the observed solid phases are $NaClO_4{\cdot}H_2O$, $Na_2CrO_4{\cdot}4H_2O$ and Na_2CrO_4.

T = 335 K (28) the dehydrated salts $NaClO_4$ and Na_2CrO_4 are observed.

$NaClO_4$-$Na_2Cr_2O_7$-H_2O (55)

At 298K the solid phases are $NaClO_4{\cdot}H_2O$ and $Na_2Cr_2O_7{\cdot}2H_2O$.

$NaClO_4$-Na_3PO_4-H_2O (66)

At 298 K the solid phases are $NaClO_4.H_2O$, $Na_3PO_4.12H_2O$ and a solid solution is observed.

Systems $NaClO_4$-inorganic compound-NH_3

$NaClO_4$-$NaCl$-NH_3 (22)

In the range 240-323 K the solid phases are the pure components $NaClO_4$ and NaCl.

$NaClO_4$-NH_4ClO_4-NH_3 (22)

The system has been investigated between 240 and 323 K . The solid phases are the pure components $NaClO_4$ and NH_4ClO_4.

III QUATERNARY SYSTEMS

Simple quaternary systems

$NaClO_4$-Water-alcohols-ethyl acetate (8)

The solubility of $NaClO_4{\cdot}H_2O$ in alcohol-methyl acetate mixtures has been determined at 298 K . The investigated alcohols were methanol, ethanol (abs. and 93 %), 1-butanol. The solid phase was $NaClO_4.H_2O$.

$NaClO_4$-NH_4ClO_4-Hexamethylenetetramine-Water (77)

At 298 K eight solubility fields were found corresponding to:

NH_4ClO_4, $NaClO_4{\cdot}H_2O$, $C_6H_{12}N_4$, $NH_4ClO_4{\cdot}C_6H_{12}N_4$, $NH_4ClO_4{\cdot}2C_6H_{12}N_4$, $NaClO_4{\cdot}C_6H_{12}N_4$, $n(NH_4ClO_4){\cdot}m(NaClO_4)$ and $5(NaClO_4){\cdot}2(C_6H_{12}N_4){\cdot}3H_2O$.

$NaClO_4$-$Cu(ClO_4)_2$-Benzamide-Water (87)

The system was investigated at 298 K. Three solid phases were observed, $NaClO_4{\cdot}H_2O$, $C_6H_5CONH_2$ and $Cu(ClO_4)_2$.

(continued)

CRITICAL EVALUATION (continued)

$NaClO_4$-$Ni(ClO_4)_2$-Urea-Water (86)

At 298 K seven solubility fields were found corresponding to $NaClO_4 \cdot H_2O$, $Ni(ClO_4)_2 \cdot 6H_2O$, CH_4N_2O, $NaClO_4 \cdot 2CH_4N_2O$, $2NaClO_4 \cdot 3CH_4N_2O$, $Ni(ClO_4)_2 \cdot 4CH_4N_2O \cdot 2H_2O$ and $Ni(ClO_4)_2 \cdot 6CH_4N_2O$.

$NaClO_4$-$NaClO_3$-NaCl-Water (41-43)

The isothermal section was investigated at two temperatures. At 313 K three compounds are observed $NaClO_4 \cdot H_2O$, $NaClO_3$, NaCl. At 333 K a solubility field of $NaClO_4$ is also observed

Reciprocal quaternary systems

The data concerning the reciprocal quaternary systems must be considered very cautiously , due to the incoherence of several data and to the erroneous attribution of the crystallization fields of some solid phases.

Na^+, K^+ // ClO_4^-, Cl^- - H_2O (33)

The isothermal section 363 K was investigated. According to the composition five solid phases can crystallize : NaCl, KCl, Na ClO_4, $KClO_4$ and a double salt $mKCl \cdot nKClO_4$.

Na^+, K^+ // ClO_4^-, CrO_4^{2-} - H_2O (30)

At 323 K five salts are observed in the diagram Na $ClO_4 \cdot H_2O$, $KClO_4$, K_2CrO_4, Na_2CrO_4 and a double salt $3K_2CrO_4 \cdot Na_2CrO_4$.

Na^+, Cs^+ // ClO_4^-, Cl^- - H_2O (81)

The isothermal section was investigated at two temperatures. At 298 K the components CsCl, NaCl, $CsClO_4$, a solid solution $Cs_{1-x}Na_xCl$ and two double salts $3CsClO_4 \cdot NaClO_4$, $CsClO_4 \cdot NaClO_4$ have a crystallization field. At 348 K $NaClO_4 \cdot H_2O$ and $3CsClO_4 \cdot NaClO_4$ are no longer observed and there is a solubility range for anhydrous $NaClO_4$.

Na^+, NH_4^+ // ClO_4^-, Cl^- - H_2O (54,63)

The system has been investigated by the same authors at three temperatures. The observed solid phases are indicated in the following table by x:

(continued)

CRITICAL EVALUATION (continued)

System Na^+, NH_4^+ // ClO_4^-, Cl^- - H_2O

observed solid phases

T / K	(I)	(II)	(III)	(IV)	(V)	(VI)
298	x	x	x		x	x
308	x	x	x		x	x
363	x	x	x	x		x

(I) = NH_4Cl, (II) = NH_4ClO_4, (III)= NaCl, (IV) = $NaClO_4$, (V) = $NaClO_4 \cdot H_2O$
(VI) = $mNH_4ClO_4 \cdot nNaClO_4 \cdot H_2O$

Na^+, NH_4^+ // ClO_4^-, SO_4^{2-} - H_2O (7)

Two isothermal sections of the diagram have been investigated. The observed solid phases are indicated in the following table by x:

System Na^+, NH_4^+ // ClO_4^-, SO_4^{2-} - H_2O

observed solid phases

T / K	A	B	C	D	E	F	G
298	x	x	x	x	x	x	
333	x	x			x		x

A=NH_4ClO_4, B=$(NH_4)_2SO_4$, C=$Na_2SO_4 \cdot (NH_4)_2SO_4 \cdot 10H_2O$, D=$Na_2SO_4 \cdot 10H_2O$
E=Na_2SO_4, F=$NaClO_4 \cdot H_2O$, G=$NaClO_4$

Na^+, NH_4^+ // ClO_4^-, CrO_4^{2-} - H_2O (35, 52)

Two sets of data are found in literature, at 298 and 308 K. The isothermal sections are very similar. At 298 K the solid phases shown in the corner closest to of $NaClO_4$ are Na_2CrO_4, $NaClO_4 \cdot H_2O$ and a mixture represented by $n(NH_4ClO_4) \cdot m(NaClO_4 \cdot H_2O)$. At 303 K the solubility surface of anhydrous $NaClO_4$ is no longer observed. This difference is surprising since the increase of temparature ought to favor the dehydration of $NaClO_4 \cdot H_2O$.

Na^+, NH_4^+ // ClO_4^-, $Cr_2O_7^{2-}$ - H_2O (58)

The crystallization fields of mixtures are not clearly represented on the phase diagram. Furthermore, in the last column of the compilation sheet the double saturation lines are problably D+F and A+F instead of D+E and A+E.

(continued)

CRITICAL EVALUATION (continued)

$Na^+, Mg^{2+} // ClO_4^-, Cl^- - H_2O$ *(46)*

At 363 K the diagram shows four solubility ranges corresponding to NaCl, $NaClO_4$, $Mg(ClO_4)_2 \cdot 6H_2O$ and $MgCl_2 \cdot 6H_2O$

$Na^+, Ba^{2+} / ClO_4^-, Cl^- - H_2O$ *(50, 61)*

The assessment of phases in the last column of the data sheets is not correct. For example, at 298 K $Ba(ClO_4)_2$ crystallizes from aqueous solution as a dihydrate and it is not possible to pass continuously from an hydrated salt to an anhydrous solid solution, as shown on the diagram.

$Na^+, Ni^{2+} // ClO_4^-, NO_3^- - H_2O$ *(68)*

At 363 K the diagram shows four solubility ranges corresponding to $NaNO_3$, $NaClO_4 \cdot H_2O$, $Ni(ClO_4)_2 \cdot 6H_2O$ and $Ni(NO_3)_2 \cdot 6H_2O$

$Na^+, Zn^{2+} // ClO_4^-, SO_4^{2-} - H_2O$ *(89)*

$ZnSO_4 \cdot H_2O$ mentioned in the data sheet is not observed on the phase diagram

$Na^+, NH_4^+ // ClO_4^-, Cl^- - NH_3$ *(22)*

At 240 and 323 K only the pure components are observed.

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(continued)

CRITICAL EVALUATION ((continued)

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64 Karnaukhov, A.S.; Tarakanov, V.F. *Uch. Zap. Yarosl. Gos. Ped. Inst.*, 1971, *95*, 109

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68 Karnaukhov, A.S.; Tarakanov, V.F. *Uch. Zap. Yarosl. Gos. Ped. Inst.*, 1972, *103*, 3

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70 Lepeshkov, I.N.; Tarakanov, V.F. *Uch. Zap. Yarosl. Gos. Ped. Inst.*, 1972, *103*, 78

71 Loseva, G.K. *Tr. Novocherkassk. Politekhn. Inst.* 1972,*266*, 78

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79 Mikheeva, V. I.; Titova, K. V. *Zh. Neorg. Khim.*, 1974, *19*, 2900; **Russ. J. Inorg.Chem. (Engl. Transl.)*, 1974, *19*, 1586

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81 Shklovskaya, R.M.; Arkhipov, S.M.; Kusina, V.A.; Kirgintsev, A.N. *Zh. Neorg. Khim.*, 1974, *19*, 846; **Russ. J. Inorg. Chem. (Engl. Transl.)*, 1974, *19*, 462

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(continued)

CRITICAL EVALUATION (continued)

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86 Tarakanov, V.F. *Uch. Zap. Yarosl. Gos. Ped. Inst.*, 1976, *154*, 35

87 Bestuzheva, I. M.; Kinderov, A.P.; Karnaukhov, A.S.. *Sb. Tr. Yarosl. Gos. Ped. Inst.*, 1978, *169*, 37

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89 Karnaukhov, A.S.; Leboschina, V.I. *Tr. Yarosl. Gos. Ped. Inst.*, 1979, *178*, 24

90 Counioux, J.J.; Tenu, R. *J. Chim. Phys.* 1981, *78*, 815

91 Titova, K. V.; Kolmakova, E. I.; Rosolovskii, V. Ya. *Zh. Neorg. Khim.*, 1986, *31*, 3213; **Russ. J. Inorg. Chem. (Engl. Transl.)*, 1986, *31*, 1846

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of sodium perchlorate in water at 25.00°C :

mass %	g/100 cm^{-3} sln	mol %	mol dm^{-3}	mol kg^{-1} m_1	satd sln. density/g cm^{-3}
67.70	113.88	23.57[b]	9.301 [b]	17.118[b]	1.6821

[a] The solid phase was mixture of the anhydrous salt and that crystallized from the sat. sln (probably $NaClO_4.H_2O$).

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles. The salt was dried to const. wt. at 250 °C in a current of air dried with P_2O_5. Duplicate soly determinations were made, those analyses in which chloride was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Anhyd. $NaClO_4$ was prepared from pure sodium carbonate and slight excess of purified $HClO_4$ (ref.1) by crystallization above 50 °C (ref. 2). After centrifugal separation, the solid was dried in a current of dry air at 250 °C.

ESTIMATED ERROR:

Precision in temp. was ± 0.01 °C
Precision in solubility data was ± 0.05 %.

REFERENCES:

1. Willard, H.H.; *J. Am. Chem. Soc.* 1912, *34*, 1480.
2. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]
(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:
Freeth, F.A.

Rec. Trav. Chim. Pays-Bas 1924, *43*, 475-507.

VARIABLES:
Temperature: 241 - 348 K.
Composition.

PREPARED BY:
C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-H_2O at various temperatures :

	Solubility of $NaClO_4$			Solid
t/ °C	mass %	mol % [a]	molality[a]/ mol kg^{-1}	phase
75	75.0	30.62	24.50	$NaClO_4$
60	74.3	29.84	23.61	"
50.8	73.3	28.77	22.42	$NaClO_4$ + $NaClO_4 \cdot H_2O$
50	73.16	28.63	22.26	$NaClO_4 \cdot H_2O$
40	70.88	26.37	19.88	"
30	68.71	24.42	17.94	"
15	65.51	21.84	15.51	"
0	62.54	19.72	13.64	"
-0.3	10	1.6	0.91	ice
-6.8	20	3.5	2.0	"
-11.1	30	5.9	3.5	"
-17.8	40	8.9	5.5	"
-22	45	10.7	6.7	"
-32	56	15.8	10.4	$NaClO_4 \cdot H_2O$ + ice

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The saturation apparatus was similar to that used by Van't Hoff (ref.1) and samples of clear satd sln were taken using a weight-pipette. Na^+ was determined as Na_2SO_4 by addition of pure sulphuric acid to the sln in silica basins and evaporating at a low red heat. All analyses were carried out in duplicate.
Solid phase compositions were determined using Schreinemakers' method. Gas-heated thermostats were used and thermometers were checked against N.P.L. Standards.

SOURCE AND PURITY OF MATERIALS:

$NaClO_4$ was prepared from very pure ammonium perchlorate (% purity not stated) and an aqueous sln of pure NaOH. Source and other details not given.

ESTIMATED ERROR:

No estimation.

REFERENCES:

1. Van't Hoff, J.H. *Zur Bildung der Ozeanischen Salzablagerungen Wieweg, Braunschweig* 1905, *1*; 1902, *2*.

(continued next page)

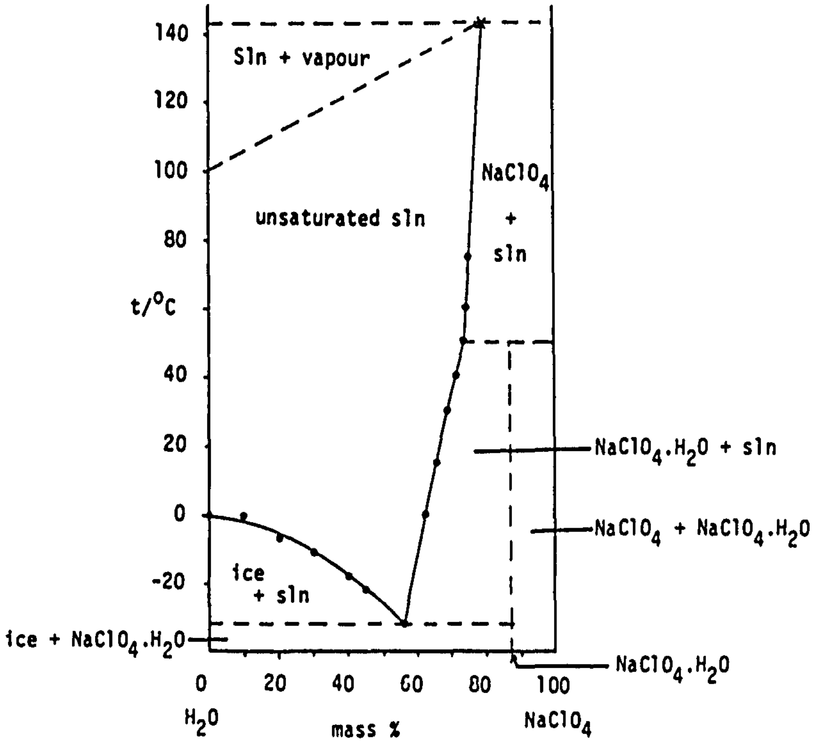
COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Water; H_2O; [7732-18-5]	Freeth, F.A. *Recl. Trav. Chim. Pays-Bas* <u>1924</u>, *43*, 475-507.

EXPERIMENTAL VALUES:(continued)

<u>COMMENTS AND/OR ADDITION DATA</u>:

The temperature-composition phase diagram for the system $NaClO_4$-H_2O (Pressure = 101325 Pa) is given below.

x - ref. B. Carlson



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cornec, E.; Dickely, J.

Bul. Soc. Chim. (France) 1927, *41*, 1017-27.

VARIABLES:

Temperature: 273 - 373 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in water at various temperatures :

	Solubility of $NaClO_4$				density/	Solid
t/ °C	g dm^{-3}	mass %	mol % [a]	mol dm^{-3}	g cm^{-3}	phase
100	1330	76.75	32.69	10.86	1.758	$NaClO_4$
75	1318	75.01	30.63	10.76	1.757	"
55	1298	73.94	29.45	10.60	1.756	"
50	1281	73.26	28.73	10.46	1.749	$NaClO_4.H_2O$
38	1206	70.38	25.90	9.85	1.713	"
25	1142	67.63	23.67	9.33	1.683	"
15	1091	65.63	21.93	8.91	1.663	"
0	-	62.87	19.94	-	-	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method given. The saturated solutions were evaporated in a water-bath and the solids dried in an oven at 110 °C, cooled and weighed in stoppered flasks.

Transition temperature detn: A mixture (about 40g) of hydrated sodium perchlorate with a small amount of water was put in a wide test-tube placed inside a wider tube, and the whole apparatus was placed in a thermostated oven set at a few degrees under the transition temperature. Then some crystals of the salt were added. The transition temperature which remained steady to ± 0.03 °C for at least 20 min. was measured using a Baudin thermometer.

SOURCE AND PURITY OF MATERIALS: Commercial sodium perchlorate was purified by several recrystallizations before use.

ESTIMATED ERROR: Not stated.

REFERENCES:

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Water; H_2O; [7732-18-5]	Cornec, E.; Dickely, J. *Bul. Soc. Chim. (France)* 1927, *41*, 1017-27.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA

The transition temperature for the transformation $NaClO_4 \cdot H_2O = NaClO_4$ was measured as 52.75 °C.

Compositions of super-saturated aqueous $NaClO_4$ solutions (solid phase was the anhydrous salt) are as follows :

t / °C	mass % (1)	mol % (1) [a]
38	72.83	28.28
25	72.21	27.66
15	71.68	27.14

[a] Compiler's calculations.

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Water; H_2O; [7732-18-5]	Carlson, B. *Festkrift* ed. Klason, P., (Norstedt, Stockholm, 1910), 262-3.

VARIABLES:	PREPARED BY:
Temperature: 288 K, 323 K and 416 K.	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-H_2O at various temperatures :

	Solubility of $NaClO_4$				density/	Solid
t/ °C	g dm^{-3}	mass %	mol % [a]	mol dm^{-3}	g cm^{-3}	phase
15	1076	64.63	21.19	8.79	1.666	$NaClO_4 \cdot H_2O$
50	1234	71.28	26.75	10.08	1.731	"
143	1414	79.08	35.74	11.55	1.789	$NaClO_4$

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
No details given.	Not stated.

ESTIMATED ERROR:	REFERENCES:
Not stated.	

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$ [7601-89-0] (2) Water-d_2; D_2O; [7789-20-0]	Selecki, A.; Tyminski, B.; Mariankowska, B. *J. Chem. Eng. Data* 1970, *15*, 130-4.
VARIABLES:	**PREPARED BY:**
One temperature: 298 - 363 K.	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of $NaClO_4$ in D_2O at various temperatures :

t/ °C	mol %	molality/ mol kg^{-1} [a]	Refractive Index
25	23.38 ± 0.04	15.24	1.3892
30	25.1 ± 0.1	16.7	1.3896
45	27.2 ± 0.2	18.7	1.3903
60	29.4 ± 0.2	20.8	1.3903
75	30.1 ± 0.3	21.5	1.3883
90	30.8 ± 0.2	22.2	1.3862

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method of saturation not given. Solubility was determined by plotting refractive indexes of standard and equilibrated solutions versus concentrations at each temperature, the saturation point being the concentration at which a break occurred in the curve, followed by observation of constant values of the refractive index. Refractive index measurements were made using a RL refractometer (PZO, Warsaw).

Accuracy of measurements was difficult to estimate because of indeterminate errors arising from solvent evaporation from the refractometer prisms.

SOURCE AND PURITY OF MATERIALS:

Heavy water, purity 99.8 mol %, was of Russian manufacture.

The salt was analytical grade and was used without further purification.

ESTIMATED ERROR:

Errors as tabulated were maximum deviations from mean values.

Temperature precision not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) *Alcohols*:

- (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]
- (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]
- (C) 1-Propanol (*n-propyl alcohol*); C_3H_8O; [71-23-8]
- (D) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3]
- (E) 2-Methyl-1-propanol (*iso-butyl alcohol*); $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of sodium perchlorate in various alcohols at 25.00°C, the solid phase being the anhydrous salt :

soly in :	methanol	ethanol	1-propanol	1-butanol	2-methyl-1-propanol
mass %	33.93	12.82	4.66	1.83	0.76
g/100 cm^{-3} sln	35.833	11.134	3.871	1.495	0.6264
mol %[a]	11.85	5.243	2.34	1.12	0.47
mol dm^{-3} [a]	2.927	0.9093	0.3162	0.1221	0.05116
mol kg^{-1} [a]	4.194	1.201	0.399	0.152	0.064

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the

SOURCE AND PURITY OF MATERIALS:

Anhydrous (1) was prepared by neutralizing pure sodium carbonate with a slight excess of a dilute sln of purified $HClO_4$ and crystallization above 50 °C. After centrifugal separation, the solid was dried at 250 °C (ref.1) in a current of dry air.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) *Alcohols*:

- (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]
- (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]
- (C) 1-Propanol (*n-propyl alcohol*); C_3H_8O; [71-23-8]
- (D) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3]
- (E) 2-Methyl-1-propanol (*iso-butyl alcohol*); $C_4H_{10}O$; [78-83-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

EXPERIMENTAL VALUES: (continued)

	methanol	ethanol	1-propanol	1-butanol	2-methyl-1-propanol
satd sln density/g cm^{-3}	1.0561	0.8685	0.8308	0.8167	0.8031
pure solvent density/g cm^{-3}	0.78705	0.78515	0.8026	0.8059	0.7981

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: (continued)

solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles, making sure that organic solvent was completely removed before the salt was dried to constant weight at 250°C in a current of air dried with P_2O_5. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Alcohols were purified by refluxing with calcium and fractional distillation.

ESTIMATED ERROR:

Precision in temp. was ± 0.01°C.

REFERENCES:

1. Willard, H.H.; Smith, G.F. *J. Am. Chem.Soc.* 1922, *44*, 2816.

COMPONENTS :

(1) Sodium Perchlorate ; $NaClO_4$: [7601-89-0]

(2) a) 1,2-ethanediol (ethylene-glycol) ; $C_2H_6O_2$; [107-21-1]
    b) 2-amino-ethanol *(monoethanolamine)* ; C_2H_7NO ; [141-43-5]

ORIGINAL MEASUREMENTS :

Isbin, H.S. ; Kobe, K.A.
J. Am. Chem. Soc. 1945, *67*, 464

VARIABLES

one temperature 298 K

PREPARED BY :

C.C. Ho

EXPERIMENTAL VALUES :

Solvent	g salt/100g solvent[a]	molality[b]/mol kg^{-1}
1,2-ethanediol	75.5	6.166
2-amino-ethanol	90.8	7.416

[a] Solid phase at equilibrium not specified
[b] Compiler's calculation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solvent and excess solid phase were sealed in soft-glass test-tubes and rotated for at least 7 days in a water thermostat at 25°C. Analyses of a series of tubes were made at regular intervals until values became consistent. All analyses were made on a weight basis by use of weighing pipets. The perchlorate was first reduced to the halide by fusing with sodium carbonate in a platinum crucible and determined with both the standard gravimetric detn of halide and the volumetric method, using dichlorofluorescein as indicator. The presence of (2) did not affect the accuracy of the detns. The solid phase was analysed by drying the excess solute on filter paper, weighing, titrating with HNO_3 to the methyl orange end-point and determining the halide with $AgNO_3$ to the dichlorofluorescein end-point.

SOURCE AND PURITY OF MATERIALS:

(1) was purified by recrystallization from water above 50°C and dehydrated at 250°C. (2) was technical grade chemical and purified by careful fractionation (ref. 1).

ESTIMATED ERROR:

Temperature: ± 0.08°C.
Solubility : Insufficient information for reliable estimates.

REFERENCES :

1. Reitmeier, R.E. ; Sivertz, V. ; Tartar, H.V. *J. Am. Chem. Soc.* 1940, *62*, 1943-4

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) 1,2-ethanediamine (*ethylenediamine*); $C_2H_8N_2$; [107-15-3]

ORIGINAL MEASUREMENTS:

Isbin, H.S.; Kobe, K.A.

J. Am. Chem. Soc. 1945, *67*, 464-5

VARIABLES:

One temperature: 298 K

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility of (1) in (2) at 25°C :

g salt/100g solvent[a]	molality[b]/mol kg^{-1}
30.1	2.458

[a] Solid phase at equilibrium is the solvate $NaClO_4.3C_2H_8N_2$.

[b] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solvent and excess solid phase were sealed in soft-glass test-tubes and rotated for at least 7 days in a water thermostat at 25°C. Analyses of a series of tubes were made at regular intervals until values were obtained which were within 0.5%. All analyses were made on a weight basis by use of weighing pipets. The perchlorate was first reduced to the halide by fusing with sodium carbonate in a platinum crucible and determined with both the standard gravimetric detn of halide and the volumetric method, using dichlorofluorescein as indicator. The presence of (2) after being neutralised with HNO_3, did not affect the accuracy of the detns. The solid phase was analysed by drying the excess solute on filter paper, weighing, titrating with HNO_3 to the methyl orange end-point and determining the halide with $AgNO_3$ to the dichlorofluorescein end-point.

SOURCE AND PURITY OF MATERIALS:

(1) was purified by recrystallization from water above 50°C and dehydrated at 250°C. (2) was dehydrated and purified by the method given in ref. 1.

ESTIMATED ERROR:

Temperature: ± 0.08°C.

Solubility : insufficient information for reliable estimates.

REFERENCES:

1. Putnam, G.L.; Kobe, K.A. *Trans. Electrochem. Soc.* 1938, *74*, 609-24.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$ [7601-89-0]

(2) Acetone; C_3H_6O; [67-64-1]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of sodium perchlorate in acetone at 25.00°C :

mass %	g/100 cm^{-3} sln	mol %	mol dm^{-3}	mol kg^{-1}	satd sln density/g cm^{-3}
34.10	36.596	19.71[b]	2.9889[b]	4.226[b]	1.0732

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles.

The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosions. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Sodium perchlorate was prepared by neutralizing pure Na_2CO_3 with a slight excess of a dilute sln of purified $HClO_4$ (ref. 1) and crystallization above 50 °C.

After centrifugal separation, the solid was dried in a current of dry air at 250 °C (ref.2).

Acetone was purified using the bisulfite process and refluxing with powdered potassium hydroxide.

Density of (2) at 25°C was 0.7852 g cm^{-3}; b.p. 56.16 - 56.51 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H. *J. Am. Chem. Soc.* 1912, *34*, 1480.
2. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$
[7601-89-0]

(2) Ethyl acetate; $C_4H_8O_2$;
[141-78-6]

ORIGINAL MEASUREMENTS:

Willard, H.H.; Smith, G.F.

J. Am. Chem. Soc. 1923, *45*, 286-96.

VARIABLES:

One temperature: 298.15 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility[a] of sodium perchlorate in ethyl acetate at 25.00°C :

mass %	g/100 cm^{-3} sln	mol %	mol dm^{-3}	mol kg^{-1}	satd sln density/g cm^{-3}
8.80	8.425	6.49[b]	0.6881[b]	0.788[b]	0.9574

[a] The solid phase was the anhydrous salt.

[b] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A satd sln of the salt was prepared at a temperature slightly above 25°C and sealed together with about 1 g of the anhydrous salt in a solubility tube, capacity 18-20 cm^3. This tube was then rotated end-over-end in the thermostat bath at 25.00°C for 24-48h and stood vertically to allow the solids to settle. Samples of the clear satd sln were then analysed for solute content by an evaporation-to-dryness method using Pt crucibles.
The salt was dried to constant wt. at 250°C in a current of air dried with P_2O_5, after ensuring that organic solvent was removed completely enough to avoid any danger of explosions. Duplicate soly determinations were made, those analyses in which chloride (from thermal decomposition) was found present being rejected.

SOURCE AND PURITY OF MATERIALS:

Sodium perchlorate was prepared by neutralizing pure Na_2CO_3 with purified $HClO_4$ (ref.1). The anhydrous salt was obtained by crystallization above 50°C and after centrifugal separation, dried in in a current of dry air at 250°C (ref.2). Ethyl acetate was purified by re-fluxing with P_2O_5 and fractional distillation. Its density at 25°C was 0.8945 g cm^{-3} ; and b.p. 77.14 - 77.16 °C.

ESTIMATED ERROR:

Precision in temp. was ±0.01°C .

REFERENCES:

1. Willard, H.H.; *J. Am. Chem. Soc.* 1912, *34*, 1480.
2. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1922, *44*, 2816.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) 2-butanone (*methyl ethyl ketone*); C_4H_8O; [78-93-3]

ORIGINAL MEASUREMENTS:

Krumgal'z, B.S.; Smirnova, V.A.; Gerzhvert, Yu. I.

Zh. Neorg. Khim. 1972, *17*, 1778-80; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1972, *17*, 924.

VARIABLES:

One temperature: 283-323 K

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility of (1) in (2) at various temperatures:

t/°C	Liquid phase composition[a] molality/mol kg^{-1}
10	1,944
20	1.836
25	1.790
30	1.749
40	1.682
50	1.630

[a] Solid phase at equilibrium was $NaClO_4$ over the temperature range investigated.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The method and apparatus were as described in ref. 1.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

1. Krumgal'z, B.S.; Gerzhvert, Yu. I; Nikitina, I.P.; Derevskaya, V.I.; Fedotova, G.F.; Traber, D.G. *Zh. Prikl. Khim.* 1969, *42*, 1414.

COMPONENTS: (1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Acetone; C_3H_6O; [67-64-1]	ORIGINAL MEASUREMENTS: Krumgal'z, B.S.; Smirnova, V.A.; Gerzhvert, Yu. I. *Zh. Neorg. Khim.* 1972, *17*, 1778-80; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1972, *17*, 924.
VARIABLES: One temperature: 283-323 K	PREPARED BY: C.C. Ho

EXPERIMENTAL VALUES:

Solubility of (1) in acetone at various temperatures:

$t/^{\circ}C$	Liquid phase composition[a] molality/mol kg^{-1}
10	4.242
20	4.346
25	4.422
30	4.508
40	4.604
50	4.666

[a] Solid phase at equilibrium was $NaClO_4$ over the temperature range investigated.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The method and apparatus were as described in ref. 1.

SOURCE AND PURITY OF MATERIALS:

No details given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

1. Krumgal'z, B.S.; Gerzhvert, Yu. I; Nikitina, I.P.; Derevskaya, V.I.; Fedotova, G.F.; Traber, D.G. *Zh. Prikl. Khim.* 1969, *42*, 1414.

COMPONENTS: (1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Acetamide; C_2H_5NO; [60-35-5]	**ORIGINAL MEASUREMENTS:** Paul, R.C.; Dev, R. *Res. Bulletin Panjab Univ.* 1969, *20*, 139-48.
VARIABLES: One temperature: 373 K.	**PREPARED BY:** C.C. Ho

EXPERIMENTAL VALUES:

Solubility of (1) in (2) at 100°C :

g salt/100g solvent	molality[a]/mol kg^{-1}
12.46	1.018

[a] Compiler's calculations.

COMMENTS/ADDITIONAL DATA:

The solubility of sodium perchlorate in molten acetamide is strikingly similar to that in water. A fairly high dielectric constant of acetamide is responsible for the ionization of the salt dissolved in it. The ions formed are assumed to be similar to those obtained in aqueous solution.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Solubility was determined by preparing the saturated solution in molten acetamide. The tubes containing the solvent and the solute were sealed and shaken continuously for several hours in a bath at 100°C. The cation and anion estimated using standard methods. No details were given.

SOURCE AND PURITY OF MATERIALS:

(1) and (2) were purified as described in ref. 1 and 2.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

1. Paul, R.C.; Dev, R. *Ind. J. Chem.* 1965, *3*, 315.
2. Paul, R.C.; Dev, R. *Ind. J. Chem.* 1967, *5*, 267.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sulfinylbis-methane (*dimethyl sulphoxide, DMSO*); C_2H_6OS; [67-68-5]

ORIGINAL MEASUREMENTS:

Kenttamaa, J.

Suomen Chemist 1960, *33*, 179-82.

VARIABLES:

Temperature: 298, 308 and 318 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in DMSO at various temperatures :

(Solid phase was the anhydrous salt.)

t / °C	mol/100 g(2)	mol kg^{-1}
25	0.18	1.8
35	0.17	1.7
45	0.21	2.1

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The soly measurements and the preparation of solvates was carried out in glass-stoppered flasks immersed in a thermostat at an initial temperature of 50 °C. The flasks were shaken from time to time to mix the contents. About 2 weeks were allowed for the attainment of equilibrium, after which the temperature was lowered to 45, 35, or 25 °C as required. After one more week of equilibration, the solutions were analysed. After the soly measurements at 25 °C, the solids in the flasks were filtered and washed with pure DMSO. Excess DMSO was removed from the solids in a vacuum of about 0.05 torr and trapped in a U-tube immersed in a dry ice-acetone mixture, care being taken to isolate the solvates from atmospheric moisture. The solutions were analysed for sodium by flame photometry, using a Beckman 4100 flame photometer. All analyses were carried out in duplicate or triplicate to an accuracy of about ± 5 %. The solvates were also analysed using flame photometry and ion exchange methods (no details).

SOURCE AND PURITY OF MATERIALS:

DMSO of "practical quality" was purified by repeated recrystallization. The melting point of the final product was 18.5 °C. The salt was dried in a heating cabinet for a few days at a temperature high enough to remove any moisture. No details of salt purity.

ESTIMATED ERROR:

Soly precision: about ± 5 % .

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Tetrahydrothiophene 1,1-dioxide (*sulfolane*); $C_4H_8O_2S$; [126-33-0]

ORIGINAL MEASUREMENTS:

Starkovich, J.A.; Janghorbani, M.

J. Inorg. Nucl. Chem. 1972, *34*, 789-91.

VARIABLES:

One temperature: 313 K

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

The solubility of (1) in sulfolane at 40°C was 0.981 mol dm^{-3}.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A small amount of (1) sufficient to saturate 3 cm^3 of the solvent was placed in 5 cm^3 glass ampoules and (2) added. The ampoules were sealed and placed in a water bath maintained at 40.0 ± 0.5°C. The soln was allowed to equilibrate for 250-300h with periodic shaking. At the end of the equilibration period, the ampoules were opened and a 1 cm^3 aliquot of each supernatant soln was transferred in the open atmosphere to a clean 1/2 dram polyvial. The 1/2 dram polyvials were sealed and placed inside 2 dram polyvials for activation. Solubility was determined by subjecting the perchlorate sample to neutron irradiation and subsequently measuring the amount of induced ^{38}Cl activity. Samples were activated twice for 30 min. each time at thermal neutron fluxes of 2.8×10^{10} and 5.6×10^{9} neutrons cm^{-2} s^{-1} in the Oregon State University Triga reactor. A set of 3 NH_4Cl standards was used to obtain a calibration plot of ^{38}Cl activity vs. perchlorate concentration. After each

SOURCE AND PURITY OF MATERIALS:

Sulfolane (Shell Chem.) was twice distilled below 100°C in vacuo. The solvent prepared in this way was found to contain <0.02% by wt water as determined by a Fisher titration (ref. 1). The salt used was of reagent grade quality or purified according to published procedures (ref. 2).

ESTIMATED ERROR:

Temperature: ± 0.5°C.

Solubility : relative standard deviations range between 2 and 6% which is what may be expected from INNA techniques without elaborate sample handling.

REFERENCES:

1. Mitchell, J.; Smith, D.M. *Aquametry*, Interscience, N.Y., 1948, 65-78.
2. Mann, C.K. *Electroanalytical Chemistry*, Marcel Dekker, N.Y., 1969, 132-4.

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Tetrahydrothiophene 1,1-dioxide (*sulfolane*); $C_4H_8O_2S$; [126-33-0]	Starkovich, J.A.; Janghorbani, M. *J. Inorg. Nucl. Chem.* 1972, *34*, 789-91.

METHOD/APPARATUS/PROCEDURE: (continued)

activation the 1/2 dram polyvials were placed in new 2 dram polyvials and counted with a 3 in x 3 in NaI(Tl) well detector coupled to a 400 channel analyzer. The 1.64 and 2.16 MeV photopeak areas of 37-min ^{38}Cl were corrected for Compton scattering and decay and both peaks were used generally for analysis. Where interferences were noted, only one γ-ray was used. The number of perchlorate ions per formula unit was taken into consideration in calculating the salt solubilities.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$ [13454-84-7]

(2) Hydrazine; N_2H_4; [302-01-2]

ORIGINAL MEASUREMENTS:

Rosolovskii, V.Ya.; Sakk, Zh.G.

Zh. Neorg. Khim. 1970, *15*, 2262-4; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1970, *15*, 1169-70.

VARIABLES:

One temperature: 273.2 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in hydrazine at 0.0 °C was reported as 74.3 g(1)/100 g(2). The corresponding mol % and molality values are 16.3 % and 6.07 mol kg^{-1}, respectively (calculated by compiler). The solid phase was reported to be $NaClO_4 \cdot N_2H_4$ [22475-89-4].

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

A sln of sodium perchlorate in hydrazine with the solid phase present was stirred for 2 h continuously in a thermostat at 0 °C. The liquid and solid phases were separated and analysed for ClO_4^- by precipitation as nitron perchlorate. Hydrazine in both phases was analysed by titration with satd iodine solution in the presence of excess sodium bicarbonate.

SOURCE AND PURITY OF MATERIALS:

Sodium perchlorate was obtained by reacting 70 % $HClO_4$ aq. sln with sodium carbonate and recrystallized twice. It was dried to constant wt. in a vacuum at 200 - 250 °C . Hydrazine was 99.5 - 98.8 % pure.

ESTIMATED ERROR:

Temperature precision: ± 0.1 °C. Insufficient details for soly error estimation.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$ [13454-84-7]

(2) Hydrazine; N_2H_4; [302-01-2]

ORIGINAL MEASUREMENTS:

Sakk, Zh.G.; Rosolovskii, V.Ya.

Zh. Neorg. Khim. 1972, *17*, 1783-4;
**Russ. J. Inorg. Chem. (Engl. Transl.)* 1972, *17*, 927-8.

VARIABLES:

One temperature: 298.2 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in hydrazine at 25.0 °C was reported as 85.1 g(1)/100 g(2). The corresponding mol % and molality values are 18.22 % and 6.95 mol kg^{-1}, respectively (calculated by compiler).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

4-6 g of the salt and 8-11 cm^3 of hydrazine were thermostated at 25°C for 7-8h with continuous stirring in a vessel isolated from atmospheric moisture. Samples for analysis were removed by withdrawing solution and part of the solid phase into another vessel fitted with a porosity no. 4 filter at reduced pressure. After separating the phases, the solution was analysed for hydrazine using the procedure given in ref. 1.
Replicate solubility determinations were carried out.

SOURCE AND PURITY OF MATERIALS:

The methods of purification of the perchlorate and of the preparation of anhydrous hydrazine were as described in ref. 1.
Salt purity was about 99.5-99.9 %.

ESTIMATED ERROR:

Absolute error in soly value was 0.4 %.
Precision in temp. was ±0.1 °C .

REFERENCES:

1. Rosolovskii, V.Ya.; Sakk, Zh.G. *Zh. Neorg. Khim.* 1970, *15*, 2262.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Perchloric acid; $HClO_4$; [7601-90-3]

ORIGINAL MEASUREMENTS:

Rosolovskii, V.Ya.; Kristov, N.V.; Lemesheva, D.G.

Zh. Neorg. Khim. 1968, *13*, 1115-8; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1968, *13*, 582-4.

VARIABLES:

Temperature: 273 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in anhydrous perchloric acid at 0 °C, the solid phase being the anhydrous salt :

mass % (1)	g(1)/100 g(2)	mol %[a]	molality[a]/mol kg^{-1}
0.624	0.628	0.512	0.0513

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Mixtures of 5-6 g of the salt with 10-12 g of the acid were kept in a thermostat at 0 °C (melting ice) for 10-15 h with continuous stirring in tubes isolated from atmospheric moisture. After equilibrium has been reached, the solid and liquid phases were separated on a glass filter. Perchlorate was determined gravimetrically as nitron perchlorate. The purity of the acid before and after saturation was determined by acid-base titration. Concentration of the salt in the satd sln was determined by first diluting a weighed sampple of the sln (5-8 g) in water and then evaporating to dryness. The dry residue was then dissolved in concentrated sulphuric acid, evaporated to dryness and the resulting sulfate heated to constant weight at 600 °C. Triplicate determinations were made.

SOURCE AND PURITY OF MATERIALS:

$NaClO_4$ was prepared by dissolving Na_2CO_3 in 70 % $HClO_4$, recrystalling twice from water, and drying to constant weight under vacuum at 200-250 °C. Analysis : Na 18.81 %, ClO_4 81.45 %.

Anhydrous $HClO_4$ was distilled from a mixture of oleum and perchloric acid dihydrate at 100 °C under vacuum (ref. 1). Acid purity was 99.79 ± 0.01 % (w/w).

ESTIMATED ERROR:

Precision in soly value : ± 0.3 %.

Temperature precision not stated.

REFERENCES:

(1) Rosolovskii, Y. Ya. *Khimiya Bezvodnoi Khlornoi Kisloty*, (Moscow, 1966).

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Hydrogen peroxide; H_2O_2; [7722-84-1]

ORIGINAL MEASUREMENTS:

Titova, K.V.; Kolmakova, E.I.; Rosolovskii, V.Ya.

Zh. Neorg. Khim. 1986, *31*, 3213-5; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1986, *31*, 1846-7.

VARIABLES:

One temperature: 273 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

The solubility[a] of sodium perchlorate in hydrogen peroxide at 0 °C :

g(1)/ 100 g(2)	mass %	mol %	molality/ mol kg^{-1}
42.12	29.64	10.48	3.440

[a] Mass%, mol% and molality values calculated by compiler.

The solid phase was an unstable solvate.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method was given. Solubility equilibrium was established in 1-1.5 h. The concentration of the solutions did not change noticeably during the next 3h but after that slow decomposition of peroxide began. The concentration of perchlorate in the satd solution was determined from the mass of the solid residue left after removal of the solvent from a sample of the solution under vacuum.

SOURCE AND PURITY OF MATERIALS:

Sources not given.

The H_2O_2 was 99.8% ± 0.2% pure.

No information on purity of salt.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Ammonia; NH_3; [7664-41-7]

ORIGINAL MEASUREMENTS:

Marshall, P.R.; Hunt, H.

J. Chem. Eng. Data 1959, *4*, 217-22.

VARIABLES:

Temperature: 240 - 323 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of $NaClO_4$ in NH_3 at various temperatures, the solid phase being the anhydrous salt :

t/ °C	g(1)/ 100g(2)	mol %^{a}	molality/ mol kg^{-1}
-33	278.3	27.91	22.7
0	304.3	29.74	24.8
25	318.3	30.69	26.0
50	328.0	31.33	26.75

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility determinations were carried out using a specially constructed apparatus (diagram given in original paper), involving a gas line connected to the saturation cell. The cell consisted of two compartments separated by a sintered glass partition, the larger one of which was connected to the gas line in such a way that the cell could be inverted, with either one of the compartments vertically above the other. Weighed amts of the salt were sealed in the smaller compartment of the cell which was then connected to the gas line via the larger compartment. Excess of dry ammonia was condensed in the cell until the salt had completely dissolved at the set temperature. Coolants used were dry ice and CCl_4. The cell was thermostated in a liquid NH_3 bath for -33 °C determinations, in an ice + water bath for 0 °C, and in a water bath for the other temperatures. Ammonia was bled from the solution until salt crystals were formed, and the cell inverted so that the solution filtered through the partition into the larger compartment. After filtration the ammonia in the solution was all removed by condensation into a reservoir in the apparatus and determined quantitatively by absorption in std. HCl sln and back-titrated with std. base. The cell was then opened and the solids removed for analysis.

SOURCE AND PURITY OF MATERIALS:

Not stated. Ammonia was dried with sodium.

ESTIMATED ERROR: Reproducibility (3 detn) is within ± 2 % of the mean value in most cases.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Carbamide (*urea*); CH_4N_2O; [57-13-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Abdukarimova, F.M.; Nogoev, K; Sulaimankulov, K.

Zh. Neorg. Khim. 1973, *18*, 3102-6; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1973, *18*, 1651-3.

VARIABLES:

One temperature: 303 K

Composition

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$CO(NH_2)_2$-H_2O at 30°C:

Liquid phase composition						Solid
mass %		mol %		molality[a]/mol kg^{-1}		phase[b]
(1)	(2)	(1)	(2)	(1)	(2)	
-	57.50	-	28.87	-	22.53	A
7.86	54.09	1.91 (2.09)[c]	28.61 (29.27)	1.687	23.67	A
14.00	51.61	3.80 (3.97)	29.74 (29.81)	3.325	24.99	A
17.91	50.64	5.16 (5.35)	30.98 (30.83)	4.651	26.81	A
24.04	49.10	7.60 (7.84)	32.79 (32.64)	7.310	30.44	A
31.49	49.60	11.71 (12.06)	38.96 (38.73)	13.60	43.68	A
37.50	52.29	17.63 (17.56)	50.00 (49.93)	30.00	85.28	A
37.57	52.46	17.80 (17.70)	50.82 (50.38)	30.78	87.62	A + B
37.77	51.96	17.75 (17.69)	49.47 (49.62)	30.04	84.25	B
39.13	43.81	16.07 (16.01)	36.62 (36.55)	18.73	42.76	B
42.44	37.48	16.61 (16.62)	30.00 (29.93)	17.26	31.08	B
46.52	31.19	17.80 (17.78)	24.38 (24.31)	17.05	23.30	B

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details were given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Carbamide (*urea*); CH_4N_2O; [57-13-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Abdukarimova, F.M.; Nogoev, K; Sulaimankulov, K.

Zh. Neorg. Khim. 1973, *18*, 3102-6; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1973, *18*, 1651-3.

EXPERIMENTAL VALUES: (continued)

Liquid phase composition						Solid
mass %		mol %		molality[a]/mol kg^{-1}		phase[b]
(1)	(2)	(1)	(2)	(1)	(2)	
52.43	25.72	20.61 (20.69)[c]	20.76 (20.70)	19.60	19.60	B
62.40	19.02	37.62 (27.43)	23.50 (17.05)	27.43	17.05	B
62.76	19.34	28.30 (28.04)	16.90 (17.61)	28.64	17.99	B + C
62.35	19.28	27.40 (27.53)	17.30 (17.35)	27.72	17.48	B + C
62.55	19.36	28.00 (27.80)	16.87 (17.54)	28.24	17.82	C
64.26	9.96	24.83 (24.74)	7.86 (7.82)	20.36	6.43	C
66.12	3.83	23.88 (23.77)	2.83 (2.81)	17.97	2.12	C
68.71	-	24.4	-	17.94	-	C

[a] Compiler's calculations.

[b] A = $CO(NH_2)_2$;
B = $NaClO_4.2CO(NH_2)_2$;
C = $NaClO_4.H_2O$.

[c] Values in brackets are compiler's calculations.

COMMENTS/ADDITIONAL DATA

The solubility curve of the ternary system (see Figure) shows that in addition to the initial components, an anhydrous compound with sodium perchlorate:urea ratio of 1:2 crystallises out. The branch of the curve which belongs to this compound occupies a large part of the diagram and extends in the range 19.02- 51.96% urea and 37.77-62.40% sodium perchlorate. The straight line rays which run from this branch of the solubility curve meet at a single point of the diagram corresponding to a solid phase with the composition $NaClO_4.2CO(NH_2)_2$.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Carbamide (urea); CH_4N_2O; [57-13-6]

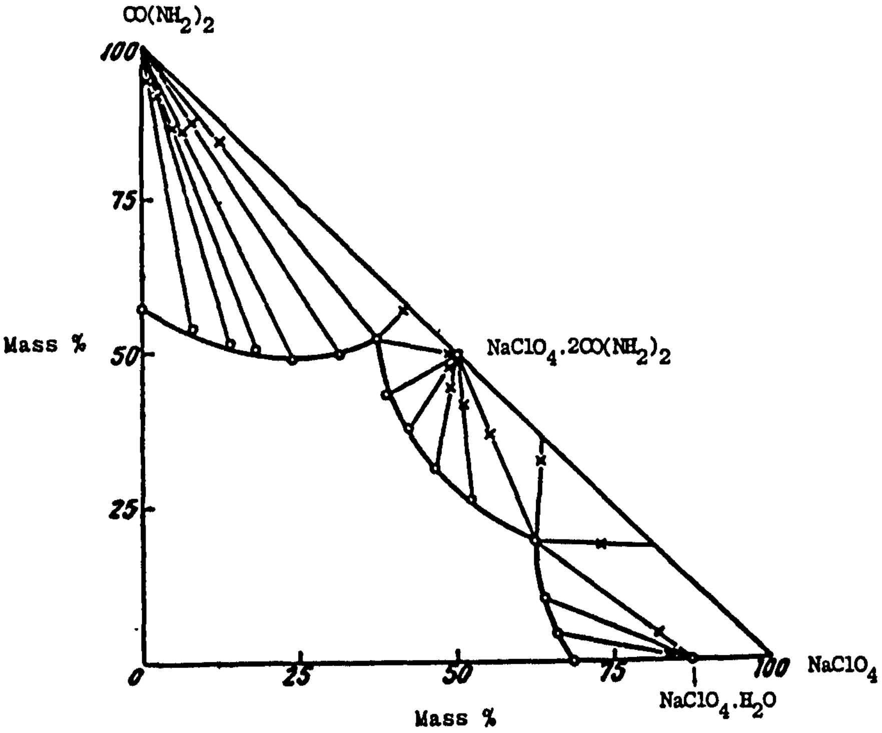
(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Abdukarimova, F.M.; Nogoev, K; Sulaimankulov, K.

Zh. Neorg. Khim. 1973, *18*, 3102-6; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1973, *18*, 1651-3.

EXPERIMENTAL VALUES: (continued)



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Thiocarbamide (*thiourea*); CH_4N_2S; [62-56-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Abdukarimova, F.M.; Nogoev, K; Sulaimankulov, K.

Zh. Neorg. Khim. 1973, *18*, 3102-6; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1973, *18*, 1651-3.

VARIABLES:

One temperature: 303 K

Composition

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$CS(NH_2)_2$-H_2O at 30°C:

Liquid phase composition						Solid phase
mass %		mol %		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	18.20	-	5.27 (5.00)^b	-	2.923	$CS(NH_2)_2$
12.67	16.35	2.42 (2.43)	5.31 (5.04)	1.458	3.026	"
23.52	12.03	4.87 (4.89)	4.24 (4.02)	2.981	2.452	"
33.78	9.06	7.71 (7.73)	3.51 (3.34)	4.827	2.082	"
47.89	8.01	13.24 (13.28)	3.76 (3.57)	8.869	2.386	"
60.56	5.07	19.97 (20.03)	2.83 (2.70)	14.39	1.938	"
67.02	3.60	24.54 (24.60)	2.25 (2.13)	18.63	1.610	"
67.50	3.51	25.06 (24.98)	2.21 (2.09)	19.02	1.591	$CS(NH_2)_2$ + $NaClO_4.H_2O$
68.06	2.80	25.11 (25.15)	1.76 (1.66)	19.08	1.262	$NaClO_4.H_2O$
68.45	1.23	24.73 (24.76)	0.75 (0.72)	18.44	0.533	"
68.71	-	24.40 (24.42)	-	17.94	-	"

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details were given.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Thiocarbamide (*thiourea*); CH_4N_2S; [62-56-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Abdukarimova, F.M.; Nogoev, K; Sulaimankulov, K.

Zh. Neorg. Khim. 1973, *18*, 3102-6; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1973, *18*, 1651-3.

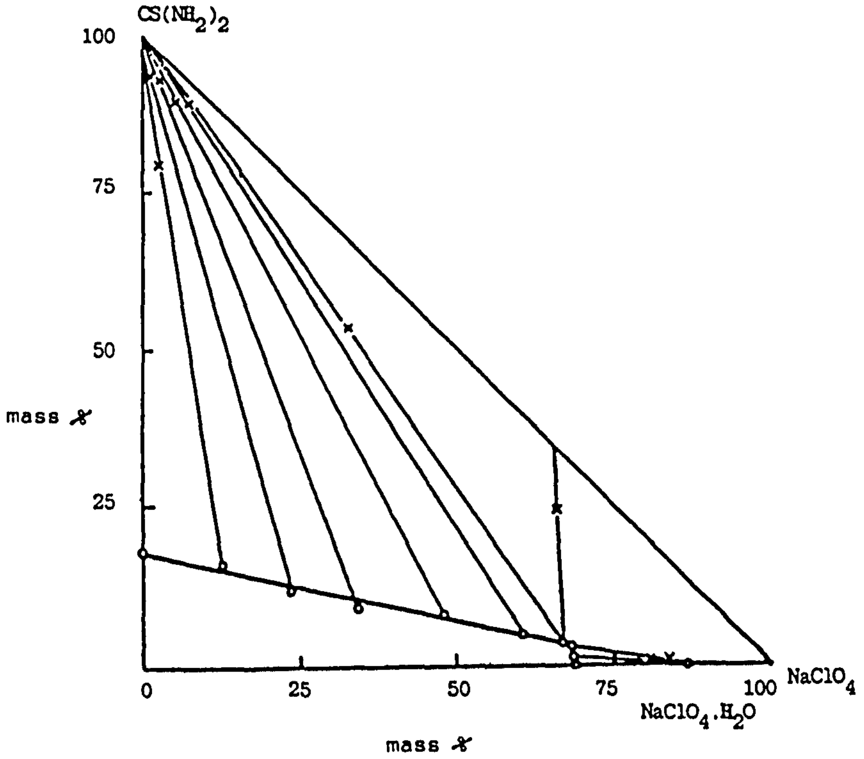
EXPERIMENTAL VALUES: (continued)

[a] Compiler's calculations.

[b] Values in brackets are compiler's calculations. The original values appeared to be in error.

COMMENTS/ADDITIONAL DATA

The solubility isotherm of the ternary system (see Figure) consists of two branches: one corresponding to $CS(NH_2)_2$ as solid phase in equilibrium and the other to $NaClO_4.H_2O$ as solid phase. The composition of the eutonic solution, where crystals of thiourea and sodium perchlorate monohydrate are in equilibrium, is characterized by the following mean composition of initial substances: 3.51% thiourea and 67.50% sodium perchlorate.



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Thiocarbamide; $CS(NH_2)_2$; [62-56-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Tarakanov, V.F.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1971, *95*, 109-12.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$CS(NH_2)_2$-H_2O at 298 K:

Liquid phase composition						Solid phase
mass %		mol %		molality/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
0.00	14.70	0.00	3.92	0.000	2.264	$CS(NH_2)_2$
21.79	11.44	4.41	3.72	2.665	2.251	"
47.93	8.20	13.34	3.67	8.923	2.455	"
61.20	4.48	20.29	2.39	14.564	1.715	"
64.79	3.84	22.80	2.17	16.868	1.608	$CS(NH_2)_2$ + $NaClO_4.H_2O$
67.89	0.00	23.73	0.00	17.268	0.000	$NaClO_4.H_2O$

Solution composition at the isothermal double saturation point (solid phases $NaClO_4.H_2O$ and $CS(NH_2)_2$):

64.79 mass % $NaClO_4$, 3.84 mass % $CS(NH_2)_2$, and 31.37 mass % H_2O.

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method. Details of saturation technique are not given. The composition of solid phases was determined by Schreinemakers' method of "residues". Thiocarbamide was determined by the Kjeldahl method; ClO_4^- gravimetrically, by nitron precipitation.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Acetamide; C_2H_5NO; [60-35-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Tarakanov, V.F.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1972, *103*, 78-82.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-CH_3CONH_2-H_2O at 298 K:

Liquid phase composition				Solid phase
mass %		mol %		
(1)	(2)	(1)	(2)	
67.89	-	23.73	-	$NaClO_4 \cdot H_2O$
62.10	9.70	22.68	7.34	"
58.21	20.56	23.75	17.39	"
54.07	31.00	24.60	29.23	"
48.22	45.14	25.80	50.06	$NaClO_4$
46.03	50.59	26.47	60.31	"
32.90	65.10	18.13	74.37	CH_3CONH_2
23.75	65.16	10.14	57.67	"
11.00	68.35	3.75	48.35	"
-	71.24	-	43.03	"

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The soly was studied by the method of isothermal recrystallization. Addition of sodium perchlorate monohydrate to the saturated solution of acetamide resulted in dissolution of the solid phase. To avoid this, dried acetamide was taken or anhydrous sodium perchlorate was added. Acetamide was determined by the Kjeldahl method; perchlorate ion by the gravimetric method with nitron. The density, viscosity and electric conductivity of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Sulfinylbis-methane (*dimethyl sulphoxide, DMSO*); C_2H_6OS; [67-68-5] (3) Water; H_2O; [7732-18-5]	Ferroni, G.; Villetard, M. *Ann. Chim.* 1975, *10*, 33-5.
VARIABLES:	**PREPARED BY:**
Temperature: 298.2 K . Composition.	C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in mixtures of water and DMSO at 25.0 °C, the solid phase being $NaClO_4.H_2O$:

Solvent composition	Solubility	
mol ratio, $DMSO:H_2O$	$g/100\ cm^3$	$mol\ dm^{-3}$
2:1	23.27	1.90
1:1	25.59	2.09
1:2	34.53	2.82
1:5	60.12	4.91
1:10	82.12	6.71
pure DMSO	22.41	1.83
pure H_2O	181.22	14.8

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method. Excess of the salt was allowed to saturate in 50 cm^3 of solvent for 8 days at 25 °C. The saturated slns were first eluted through acidic cation exchange resins and the eluants analysed by potentiometric titration (glass electrode used) with NaOH sln.

SOURCE AND PURITY OF MATERIALS:

Anhydrous $NaClO_4$ was obtained by heating the monohydrate (Merck product) gradually, then by fusing to remove water of crystallization and further dried at 120 °C. Analytical grade DMSO was further purified (ref. 1) before use.

ESTIMATED ERROR:

Temperature precision: ± 0.1 °C.
Precision in soly detn not stated.

REFERENCES:

1. Butler, J.N. *J. Electroanalytical. Chem.* 1967, *14*, 89.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Dimethylurea; $C_3H_8ON_2$; [1320-50-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, M.M.

Sb. Tr.Yarosl. Gos. Ped. Inst. 1979, *178*, 67-9.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$C_3H_8ON_2$-H_2O at 298 K:

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
67.84	-	23.69	-	17.228	-	A
67.24	1.89	24.04	0.94	17.790	0.695	"
65.27	3.81	23.25	1.89	17.240	1.398	A + B
65.19	3.85	23.20	1.90	17.197	1.411	"
65.04	4.16	23.22	2.06	17.247	1.533	B
55.99	6.89	17.62	3.01	12.319	2.107	"
49.50	10.50	14.73	4.34	10.107	2.979	"
43.29	14.38	12.33	5.69	8.352	3.855	"
39.43	16.51	10.90	6.34	7.309	4.253	"
37.05	23.56	10.98	9.70	7.682	6.788	"
37.07	23.50	10.98	9.67	7.678	6.764	B + C
37.01	23.42	10.93	9.61	7.639	6.717	C
28.08	22.83	7.14	8.06	4.672	5.278	"
24.31	22.60	5.84	7.54	3.740	4.831	"
16.64	22.42	3.60	6.74	2.230	4.175	"
12.94	22.30	2.67	6.40	1.632	3.908	"
9.90	21.71	1.96	5.98	1.182	3.603	C
5.43	22.16	1.03	5.83	0.612	3.473	"
-	23.55	-	5.92	-	3.496	"

---

[a] Compiler's calculations.

[b] A = $NaClO_4 \cdot H_2O$; B = $NaClO_4 \cdot 2C_3H_8ON_2 \cdot H_2O$; C = $C_3H_8ON_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal recrystallization was used. Periods of equilibration vary from 2 to 3 days. Perchlorate ion was determined gravimetrically with nitron, dimethylurea by Kjeldahl's method. The density and viscosity of saturated solutions were determined.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sal'nikova, L.N.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. 1971, *16*, 2840-4; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1971, *16*, 1511-3.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$C_6H_{12}N_4$-H_2O at 25°C:

Liquid phase composition							Solid[c]
mass %		mol %[a]		molality[a]/mol kg^{-1}		density[b]	phase
(1)	(2)	(1)	(2)	(1)	(2)		
-	46.52	-	10.05	-	6.205	1.1126	A
2.29	46.20	0.583	10.28	0.363	6.398	1.1250	A
6.83	45.18	1.834	10.60	1.162	6.716	1.1480	A
9.95	44.10	2.758	10.68	1.769	6.846	1.1832	A
16.35	43.46	4.993	11.59	3.323	7.714	1.3217	A + B
19.67	39.78	5.960	10.53	3.962	6.998	1.2510	B
21.43	38.70	6.569	10.36	4.390	6.924	-	B
22.94	37.02	7.007	9.88	4.679	6.595	1.2764	B
30.34	28.53	9.062	7.443	6.025	4.948	1.3241	B
36.63	23.97	11.26	6.435	7.593	4.340	-	B
38.44	21.86	11.74	5.83	7.908	3.928	1.3810	B
43.99	17.75	13.77	4.85	9.390	3.309	-	B
47.71	15.74	15.40	4.44	10.66	3.072	1.8382	B
52.72	13.50	17.93	4.01	12.75	2.851	-	B
54.47	13.67	19.25	4.22	13.96	3.061	2.2410	B + C
56.28	12.04	19.95	3.73	14.51	2.711	1.6005	C
59.50	9.37	21.31	2.93	15.61	2.147	1.5907	C

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was reached after 20 days. The solid phases were analysed for ClO_4^- ion (determined as nitron perchlorate) and $C_6H_{12}N_4$, by acid hydrolysis followed by distillation of the ammonia into saturated boric acid soln and titration with H_2SO_4. The density was measured pyknometrically in benzene.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sal'nikova, L.N.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. <u>1971</u>, *16*, 2840-4; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) <u>1971</u>, *16*, 1511-3.

EXPERIMENTAL VALUES: (continued)

Liquid phase composition							Solid[c]
mass %		mol %[a]		molality[a]/mol kg^{-1}		density[b]	phase
(1)	(2)	(1)	(2)	(1)	(2)		
61.72	7.97	22.47	2.53	16.63	1.876	1.6127	C
64.95	5.55	24.03	1.79	17.98	1.342	-	C
67.11	5.44	25.97	1.84	19.97	1.414	1.7310	C + D
67.02	4.27	25.21	1.40	19.07	1.061	-	D
66.86	3.50	24.64	1.13	18.42	0.842	-	D
67.80	-	23.65	-	17.20	-	1.6840	D

[a] Compiler's calculation. [b] in 10^3 kg m^{-3}

[c] A = $C_6H_{12}N_4$; B = $NaClO_4 \cdot C_6H_{12}N_4$; C = $5NaClO_4 \cdot 2C_6H_{12}N_4 \cdot 3H_2O$; D = $NaClO_4 \cdot H_2O$.

COMMENTS/ADDITIONAL DATA:

The solubility isotherm of the system has four crystallization branches (see Figure). The first and fourth correspond to the crystallization in the solid phase of the initial subtances. The second (the longest) branch corresponds to the crystallization of congruently soluble $NaClO_4 \cdot C_6H_{12}N_4$, the composition of which was confirmed by chemical and thermographic analyses:

Found % : $NaClO_4$ 46.45%; $C_6H_{12}N_4$ 53.32%

Calculated % : $NaClO_4$ 46.62%; $C_6H_{12}N_4$ 53.38%

The compound was isolated as elongated crystals and its density is 1.703×10^3 kg m^{-3}.

When the concn of sodium perchlorate was increased a complex with the formula $5NaClO_4 \cdot 2C_6H_{12}N_4 \cdot 3H_2O$ was formed. The composition of this compound was confirmed similarly:

Found % : $NaClO_4$ 64.69%; $C_6H_{12}N_4$ 29.49%; H_2O 5.81%

Calculated % : $NaClO_4$ 64.67%; $C_6H_{12}N_4$ 29.62%; H_2O 5.71%

The compound crystallized out as rectangular plates and its density is 1.8639×10^3 kg m^{-3}.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Hexamethylenetetramine; $C_6H_{12}N_4$; [100-97-0]

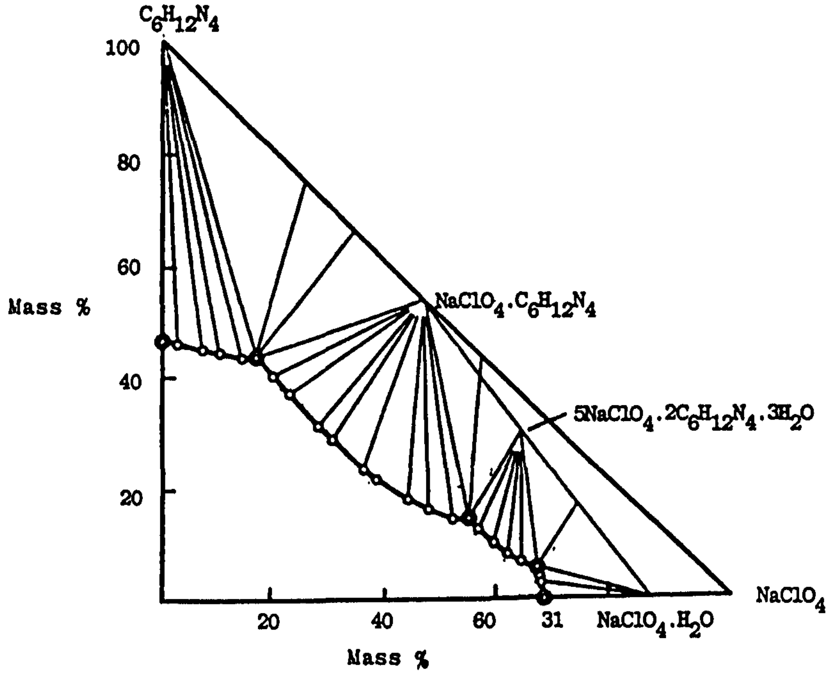
(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Sal'nikova, L.N.; Karnaukhov, A.S.; Lepeshkov, I.N.

Zh. Neorg. Khim. 1971, *16*, 2840-4; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1971, *16*, 1511-3.

COMMENTS/ADDITIONAL DATA: (continued)



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Benzamide; C_7H_7NO; [55-21-0]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, M.M.; Kinderov, A.B.; Karnaukhov, A.S.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1978, *169*, 37-41.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$C_6H_5CONH_2$-H_2O at 298 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	1.57	-	0.24	-	0.132	$C_6H_5CONH_2$
4.36	1.42	0.67	0.22	0.378	0.124	"
12.66	1.40	2.12	0.24	1.203	0.134	"
21.30	1.63	3.90	0.30	2.257	0.175	"
30.42	1.60	6.16	0.33	3.655	0.194	"
45.07	1.57	11.01	0.39	6.898	0.243	"
57.70	1.88	17.26	0.57	11.659	0.384	"
64.61	1.87	21.95	0.64	15.742	0.461	$NaClO_4.H_2O$ + $C_6H_5CONH_2$
65.12	1.84	22.34	0.64	16.097	0.460	"
66.28	1.32	23.03	0.46	16.708	0.336	$NaClO_4.H_2O$
67.84	-	23.69	-	17.228	-	"

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Periods of equilibration varied from 2 to 3 days in the system and from 4 to 6 days at the eutonic points. Benzamide was determined by the Kjeldahl method (ref. 1); ClO_4^- ion by nitron precipitation (ref. 2). The density and viscosity of saturated solutions were measured. The maximum density and viscosity values occurred at the eutonic composition.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Hillebrand, W. F.; Lundell G.E.F. *Applied Inorganic Analysis*, 2nd edit.Wiley, N.Y.-London 1961
2. Loebich, O.L. *Anal. Chem.*, 1926, *68*, 34.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Perchloric acid; $HClO_4$; [7601-90-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Chernykh, L.V.; Ivanov, V.V.; Alekseeva, E.A.

Zh. Neorg. Khim. 1970, *15*, 1922-27; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1970, *15*, 987-9.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$HClO_4$-H_2O at 25°C:

Liquid phase composition						Solid^b phase
mass %		mol %^{a}		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
67.70	-	23.57	-	17.12	-	A
58.26	7.62	19.46	3.102	13.95	2.223	A
49.45	14.63	15.88	5.726	11.24	4.054	A
32.30	28.81	9.737	10.59	6.783	7.374	A
28.47	32.80	8.584	12.05	6.004	8.430	A
25.26	35.33	7.514	12.81	5.235	8.924	A
23.86	36.47	7.061	13.15	4.912	9.151	A + B

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

(1) was analysed on columns of KU-2 ion exchange resin and gravimetrically. The solubility was found by isothermal saturation at 25°C. Equilibrium was reached in 6-8h. In analyses of specimens of liquid and solid phases, the H^+ ion concn was determined by titration with borax solution and the sum of Na^+ and H^+ cations was determined on columns of Ku-2 ion-exchange resin, then the concn of Na^+ ion in the specimen was found by difference. Solid phase composition was found by Schreinemakers' method.

SOURCE AND PURITY OF MATERIALS:

Chémically pure grade 57% $HClO_4$, anhydrous $HClO_4$, and repeatedly recrystallized $NaClO_4$ were used. The anhydrous acid was made by the recommended method (ref. 1). The $HClO_4$ solutions were tested for Cl^- ion, the anhydrous acid for sulfur oxides and chloride oxides.

ESTIMATED ERROR:

Temperature: ± 0.05°C

Solubility : nothing specified.

REFERENCES:

1. Brauer, G. *Handbuch der Praparativen anorganischen chemie* (Transl. into Russ.), Inostr. Lit. Moscow, 1956.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Perchloric acid; $HClO_4$; [7601-90-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Chernykh, L.V.; Ivanov, V.V.; Alekseeva, E.A.

Zh. Neorg. Khim. 1970, *15*, 1922-27; **Russ. J. Inorg. Chem.* (*Engl. Transl.*) 1970, *15*, 987-9.

EXPERIMENTAL VALUES: (continued)

Liquid phase composition						Solid^b
mass %		mol %^{a}		molality^a/mol kg^{-1}		phase
(1)	(2)	(1)	(2)	(1)	(2)	
23.12	37.15	6.832	13.38	4.753	9.308	B
19.40	40.88	5.720	14.69	3.989	10.25	B
16.60	43.42	4.865	15.51	3.391	10.81	B
13.56	46.29	3.955	16.46	2.758	11.48	B
10.45	50.06	3.075	17.95	2.161	12.62	B
4.60	58.13	1.399	21.55	1.008	15.53	B
3.00	63.26	0.970	24.92	0.7262	18.66	B
2.33	66.45	0.788	27.41	0.6095	21.19	B
2.03	69.01	0.717	29.72	0.5725	23.72	B
1.78	69.30	0.622	29.85	0.4967	23.84	B
1.53	74.46	0.599	35.52	0.5204	30.87	B
1.57	76.34	0.641	38.02	0.5805	34.40	B
1.09	78.63	0.464	40.82	0.4390	38.60	C
1.40	78.51	0.599	40.96	0.5691	38.90	C
1.02	84.10	0.498	50.09	0.5599	56.26	C
1.00	91.60	0.614	68.52	1.104	123.22	C
1.26	93.80	0.845	76.65	2.083	189.01	C

[a] Compiler's claculations. [b] A = $NaClO_4.H_2O$; B = $NaClO_4$; C = $NaClO_4.HClO_4$.

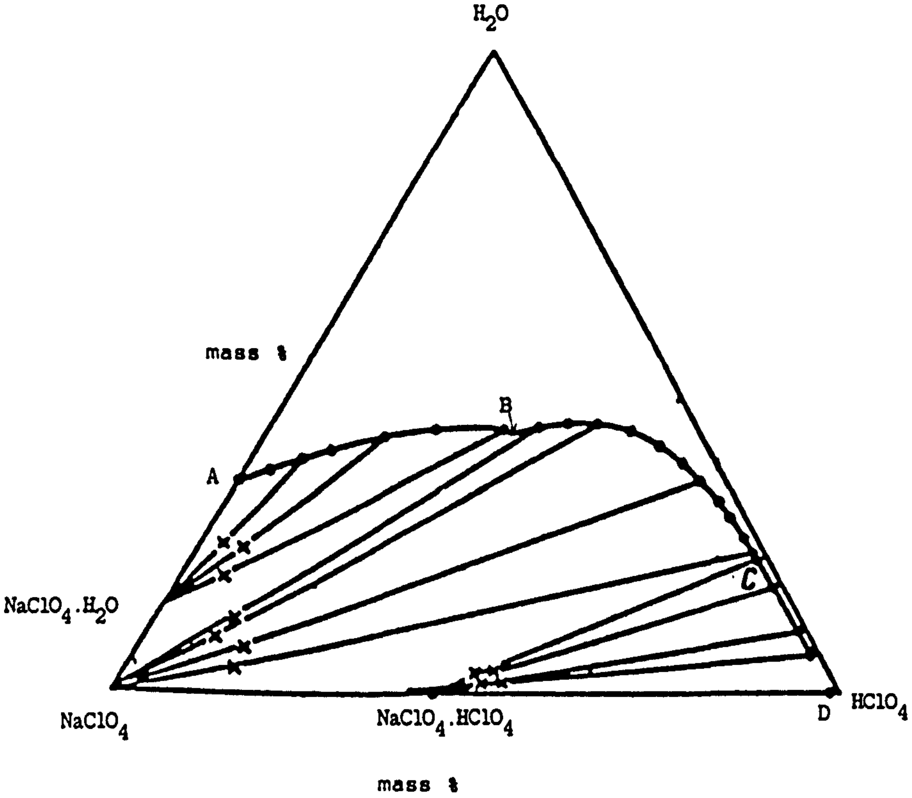
COMMENTS/ADDITIONAL DATA:

The solubility isotherm of the ternary system (see Figure) does not have a branch with a salt solubility minimum but there is a monotonic decrease in the solubility of $NaClO_4$. Evidently the Na^+ ion does not compete with the H_3O^+ as a salting-out agent and this part is played by the acid throughout the whole region. The isotherm has two eutonic points (B and C). Point B corresponds to the change of the solid phase from the crystal hydrate $NaClO_4.H_2O$ to the anhydrous salt and point C to the change from $NaClO_4$ to the compound $NaClO_4.HClO_4$. It was found that the solubility of $NaClO_4$ in the anhydrous acid is 0.624% (point D).

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Perchloric acid; $HClO_4$; [7601-90-3] (3) Water; H_2O; [7732-18-5]	Chernykh, L.V.; Ivanov, V.V.; Alekseeva, E.A. *Zh. Neorg. Khim.* 1970, *15*, 1922-27; **Russ. J. Inorg. Chem. (Engl. Transl.)* 1970, *15*, 987-9.

COMMENTS/ADDITIONAL DATA: (continued)



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Potassium perchlorate; $KClO_4$; [7778-74-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Makin, A.V.

Zh. Neorg. Khim. 1957, 2, 910-4.
**Russ. J. Inorg. Chem.*, (*Engl. Transl.*) 1957, 2, 311-6.

VARIABLES:

Temperature: 273K and 298K
Composition.

PREPARED BY:

C.C. Ho

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$KClO_4$-H_2O at 0°C:

	Liquid Phase composition						Solid
	mass %		mol x^a		Molality^a/mol kg^{-1}		phase
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	-	0.75	-	0.098	-	0.0545	$KClO_4$
2	5.15	0.63	0.797	0.0862	0.446	0.0483	"
3	6.94	0.55	1.091	0.0764	0.613	0.0429	"
4	9.23	0.45	1.480	0.0638	0.835	0.0360	"
5	11.71	0.49	1.923	0.0711	1.089	0.0403	"
6	11.85	0.48	1.949	0.0698	1.104	0.0395	"
7	19.54	0.51	3.468	0.0800	1.996	0.0460	"
8	21.56	0.50	3.908	0.0801	2.259	0.0463	"
9	31.82	0.49	6.463	0.0880	3.839	0.0522	"
10	36.58	0.45	7.868	0.0855	4.744	0.0516	"
11	41.24	0.46	9.418	0.0928	5.777	0.0569	"
12	50.00	0.51	12.93	0.117	8.251	0.0744	"
13	55.37	0.52	15.57	0.129	10.25	0.0851	$KClO_4 + NaClO_4{}^b$
14	55.32	0.51	15.54	0.127	10.23	0.0833	"
15	55.35	0.51	15.56	0.127	10.24	0.0834	"
16	55.32	0.54	15.55	0.134	10.24	0.0883	"

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Equilibrium was attained after 5-6 days at 25°C, but after 10-12 days at 0°C. ClO_4^- was determined gravimetrically by precipitation from a satd sln of rubidium chloride, filtered, washed with 96% alcohol and dried to constant weight at 105°C. Potassium was determined by the gravimetric method of cobalt nitrate in the form of $K_2NaCo(NO_3)_6 \cdot H_2O$. Na^+ was determined by the zinc-uranyl-acetate gravimetric method.

SOURCE AND PURITY OF MATERIALS:

Chemically pure sodium perchlorate was purified by two recrystallizations. $KClO_4$ was obtained from 30% $HClO_4$ and chemically pure KCl. The salt obtained was twice recrystallized. Purities of salts obtained varied within the limits from 99.54-99.76%.

ESTIMATED ERROR:

Nothing specified.

REFERENCES: (continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Potassium perchlorate; $KClO_4$; [7778-74-7] (3) Water; H_2O; [7732-18-5]	Karnaukhov, A.S.; Makin, A.V. *Zh. Neorg. Khim.* 1957, *2*, 910-4. **Russ. J. Inorg. Chem.*, (*Engl. Transl.*) 1957, *2*, 311-6.

EXPERIMENTAL VALUES: (continued)

Solubility system $NaClO_4$-$KClO_4$-H_2O at 0°C:

	Liquid Phase composition						Solid phase
	mass %		mol %[a]		Molality[a]/mol kg^{-1}		
Ponit	(1)	(2)	(1)	(2)	(1)	(2)	
17	58.23	0.42	17.15	0.109	11.50	0.0733	$nKClO_4 \cdot mNaClO_4$
18	60.15	0.28	18.26	0.0751	12.42	0.0511	"
19	61.46	0.16	19.06	0.0438	13.08	0.0301	"
20	62.89	-	19.96	-	13.84	-	$NaClO_4 \cdot H_2O$

[a] Compiler's calculations.

[b] (evaluator's remark) the solid phase is not $NaClO_4$

Solubility system $NaClO_4$-$KClO_4$-H_2O at 25°C:

	Liquid Phase composition						Solid phase
	mass %		mol %[a]		Molality[a]/mol kg^{-1}		
Point	(1)	(2)	(1)	(2)	(1)	(2)	
1	-	2.30	-	0.305	-	0.170	$KClO_4$
2	2.38	2.18	0.364	0.295	0.204	0.165	"
3	4.11	2.21	0.639	0.304	0.358	0.170	"
4	6.52	2.03	1.035	0.285	0.582	0.160	"
5	10.00	1.36	1.630	0.196	0.921	0.111	"
6	11.95	1.34	1.984	0.197	1.126	0.112	"
7	16.74	1.60	2.921	0.247	1.674	0.141	"
8	18.39	1.60	3.263	0.251	1.877	0.144	"
9	26.06	1.62	5.021	0.276	2.943	0.162	"
10	32.38	1.45	6.699	0.265	3.997	0.158	"
11	40.82	1.30	9.376	0.264	5.760	0.162	"
12	49.94	1.26	13.05	0.291	8.358	0.186	"
13	58.37	1.33	17.51	0.352	11.83	0.238	"
14	63.26	1.34	20.74	0.388	14.59	0.273	"
15	66.32	0.47	22.68	0.142	16.31	0.102	$NaClO_4 \cdot H_2O$
16	67.82	-	23.67	-	17.21	-	"

[a] Compiler's calculations.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Potassium perchlorate; $KClO_4$; [7778-74-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

a. Lepeshkov, I.N.; Druzhinina, G.V.; Troitskii, E.N.
Yarosl. kn. Izd. 1966, 37-45

b. Druzhinina, G.V.
Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, 59, 73-82

VARIABLES:

Temperatures: 298.2 and 323.2 K
Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$KClO_4$-H_2O at 298.2 K:

Liquid phase composition						Solid phase
mass %		mol %^{a}		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	2.00	-	0.26	-	0.147	$KClO_4$
3.00	1.28	0.46	0.17	0.256	0.097	"
6.50	0.64	1.02	0.09	0.572	0.050	"
11.87	0.46	1.95	0.07	1.106	0.038	"
17.38	0.39	3.01	0.06	1.726	0.034	"
22.36	0.37	4.08	0.06	2.363	0.035	"
26.20	0.36	4.98	0.06	2.914	0.035	"
32.70	0.35	6.70	0.06	3.989	0.038	"
38.45	0.32	8.45	0.06	5.129	0.038	"
46.00	0.33	11.19	0.07	7.000	0.044	"
52.39	0.29	14.00	0.07	9.042	0.044	"
58.51	0.26	17.26	0.07	11.590	0.046	"
63.50	0.22	20.47	0.06	14.295	0.044	"
67.63	0.21	23.61	0.06	17.175	0.047	$KClO_4$ + $NaClO_4.H_2O$
67.62	0.20	23.60	0.06	17.162	0.045	"
67.64	0.22	23.63	0.07	17.188	0.049	"
67.63	0.21	23.61	0.06	17.175	0.047	"
67.61	0.20	23.59	0.06	17.154	0.045	"
67.80	-	23.65	-	17.197	-	$NaClO_4.H_2O$

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Equilibrium of saturated solns was reached in 4 or 5 days for 298K and in 2 or 3 days for 323K. Sodium ion was determined gravimetrically with zinc uranyl acetate; potassium by precipitating with sodium tetraphenylacetate.

SOURCE AND PURITY OF MATERIALS:

The salts were purified by double recrystallization.

ESTIMATED ERROR:

Temperature: ± 0.1 K

REFERENCES:

None.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Potassium perchlorate; $KClO_4$; [7778-74-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS;

a. Lepeshkov, I.N.; Druzhinina, G.V.; Troitskii, E.N.
Yarosl. kn. Izd. 1966, 37-45

b. Druzhinina, G.V.
Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 73-82

EXPERIMENTAL VALUES: (continued)

Solubility system $KClO_4$-$NaClO_4$-H_2O at 323.2 K:

Liquid phase composition						Solid phase
mass %		mol %		molality/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	4.93	-	0.67	-	0.374	$KClO_4$
3.11	3.60	0.49	0.50	0.272	0.279	"
7.47	2.38	1.20	0.34	0.677	0.191	"
12.31	2.02	2.06	0.30	1.174	0.170	"
17.23	1.79	3.03	0.28	1.738	0.160	"
26.20	1.18	5.03	0.20	2.947	0.117	"
30.73	0.99	6.20	0.18	3.676	0.105	"
36.50	0.87	7.88	0.17	4.760	0.100	"
40.53	0.65	9.19	0.13	5.628	0.080	"
45.28	0.62	10.95	0.13	6.836	0.083	"
51.43	0.64	13.61	0.15	8.764	0.096	"
56.91	0.61	16.44	0.16	10.942	0.104	"
60.61	0.62	18.67	0.17	12.768	0.115	"
67.00	0.60	23.29	0.18	16.889	0.134	"
71.05	0.62	26.90	0.21	20.483	0.158	"
72.52	0.61	28.36	0.21	22.043	0.164	$KClO_4$ + $NaClO_4 \cdot H_2O$
72.65	0.59	28.49	0.20	22.173	0.159	"
72.70	0.60	28.54	0.21	22.238	0.162	"
72.54	0.61	28.38	0.21	22.065	0.164	"
72.81	0.60	28.66	0.21	22.364	0.163	"
73.20	-	28.67	-	22.308	-	$NaClO_4 \cdot H_2O$

[a] Compiler's calculation.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Cesium perchlorate; $CsClO_4$; [13454-84-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shklovskaya, R.M.; Arkhipov, S.M.; Kuzina, V.A.; Kirgintsev, A.N.

Zh. Neorg. Khim. 1974, *19*, 846-9;
**Russ. J. Inorg. Chem.* (Engl. Transl.) 1974, *19*, 462-3.

EXPERIMENTAL VALUES: (continued)

Solubility system $NaClO_4$-$CsClO_4$-H_2O at 348.2 K:

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	11.667	-	1.0137	-	0.5684	A
10.950	5.046	1.8733	0.4549	1.0646	0.2585	"
25.725	3.816	5.0779	0,3969	2.9819	0.2331	"
38.600	3.517	8.8970	0.4272	5.4464	0.2615	"
51.497	3.417	14.3158	0.5006	9.3286	0.3262	"
55.502	3.413	16.4923	0.5344	11.033	0.3575	"
55.976	3.447	16.781	0.5445	11.267	0.3656	A + C
56.450	3.381	17.042	0.5379	11.478	0.3622	C
57.883	2.921	17.766	0.4724	12.061	0.3207	"
59.875	2.580	18.923	0.4297	13.025	0.2957	"
67.044	1.278	23.689	0.2380	17.285	0.1736	"
74.080	0.808	30.215	0.1737	24.093	0.1385	"
74.175	0.544	30.118	0.1164	23.963	0.0926	C + E
74.876	-	30.483	-	24.341	-	E

[a] Compiler's calculation.

[b] A = $CsClO_4$; B = $3CsClO_4.NaClO_4$; C = $CsClO_4.NaClO_4$
D = $NaClO_4.H_2O$; E = $NaClO_4$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: (continued)

ed gravimetrically with nitron (ref. 1); Cs^+ by precipitation as the tetraphenylborate (ref. 2). The solid phases were identified by the method of residues and by x-ray diffraction.

ESTIMATED ERROR:

Temperature: ± 0.1 °C.

REFERENCES:

1. Loebich, O. *Z. Analyt. Chem.* 1926, *68*, 34.
2. Yanson, E.Yu.; Levin'sh, A.F. *Uspekhi. Khim.* 1953, *28*, 980.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Cesium perchlorate; $CsClO_4$; [13454-84-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shklovskaya, R.M.; Arkhipov, S.M.; Kuzina, V.A.; Kirgintsev, A.N.

Zh. Neorg. Khim. __1974__, *19*, 846-9; **Russ. J. Inorg. Chem.* (Engl. Transl.) __1974__, *19*, 462-3.

VARIABLES:

Temperature: 298.2 K and 348.2 K.

Composition.

PREPARED BY:

W.L. Ng

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$CsClO_4$-H_2O at 298.2 K:

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	1.96	-	0.1548	-	0.086	A
6.262	0.598	0.9791	0.0493	0.549	0.0276	"
13.230	0.440	2.2043	0.0386	1.252	0.0219	"
20.042	0.379	3.5719	0.0356	2.057	0.0205	"
32.377	0.468	6.6205	0.0504	3.938	0.0300	"
37.010	0.502	8.0113	0.0573	4.837	0.0346	"
39.359	0.528	8.7817	0.0621	5.348	0.0378	"
43.492	0.562	10.257	0.0698	6.349	0.0432	"
43.540	0.563	10.275	0.0700	6.362	0.0433	A + B
43.588	0.565	10.294	0.0703	6.374	0.0435	B
44.504	0.565	10.643	0.0712	6.617	0.0443	"
44.957	0.565	10.820	0.0717	6.740	0.0446	"
46.587	0.556	11.471	0.0721	7.198	0.0453	"
47.114	0.556	11.689	0.0727	7.353	0.0457	"
47.138	0.552	11.698	0.0722	7.356	0.0454	B + C
47.162	0.548	11.707	0.0717	7.366	0.0451	C
48.919	0.488	12.447	0.0654	7.897	0.0415	"
54.996	0.385	15.343	0.0566	10.067	0.0371	"
57.436	0.383	16.681	0.0586	11.121	0.0391	"
58.746	0.292	17.417	0.0456	11.713	0.0307	"
60.413	0.237	18.420	0.0381	12.539	0.0259	"
62.117	0.201	19.514	0.0333	13.463	0.0230	"
67.246	0.168	23.284	0.0307	16.854	0.0222	"
68.388	0.128	24.214	0.0239	17.741	0.0175	C + D
68.464	0.129	24.279	0.0241	17.804	0.0177	C + D
68.516	-	24.254	-	17.774	-	D

[a] Compiler's calculation.

[b] A = $CsClO_4$; B = $3CsClO_4.NaClO_4$; C = $CsClO_4.NaClO_4$
D = $NaClO_4.H_2O$; E = $NaClO_4$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

In the isothermal method used, the mixtures were equilibrated in a thermostated bath for 30 days. In the analysis of the solid and liquid phases, ClO_4^- was determin-

SOURCE AND PURITY OF MATERIALS:

"Chemically pure" grade salts were recrystallized twice from doubly-distilled water.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kudryakova, S.A.; Karnaukhov, A.S.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 36-42.

VARIABLES:

Temperature: 298.2, 308.2, 363.2 K.

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-NH_4ClO_4-H_2O at 298.2 K:

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	18.60	-	3.39	-	1.945	A
4.77	16.28	0.85	3.04	0.493	1.755	"
8.20	15.58	1.51	2.99	0.879	1.740	"
13.37	13.58	2.55	2.70	1.495	1.582	"
19.07	10.82	3.76	2.22	2.221	1.314	"
23.90	9.47	4.91	2.03	2.930	1.210	"
28.18	7.76	5.97	1.71	3.593	1.031	"
35.71	6.36	8.19	1.52	5.035	0.934	"
39.47	5.62	9.43	1.40	5.871	0.871	"
45.06	4.87	11.54	1.30	7.350	0.828	"
49.59	4.40	13.52	1.25	8.803	0.814	"
52.62	3.82	14.92	1.13	9.866	0.746	"
61.89	2.75	20.29	0.94	14.295	0.662	"
61.92	2.70	20.29	0.92	14.294	0.650	A + B
63.33	2.59	21.28	0.91	15.177	0.647	B
64.73	2.11	22.15	0.75	15.943	0.542	"
66.52	1.63	23.37	0.60	17.058	0.436	B + C
66.82	1.49	23.55	0.55	17.221	0.400	"
66.58	1.70	23.45	0.62	17.143	0.456	C
67.27	0.68	23.54	0.25	17.142	0.181	"
67.64	-	23.52	-	17.071	-	"

[a] Compiler's calculation.

[b] A = NH_4ClO_4 ; B = $n(NH_4ClO_4).m(NaClO_4.H_2O)$; C = $NaClO_4.H_2O$;
D = $NaClO_4$; E = $n(NH_4ClO_4).m(NaClO_4)$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Equilibrium in the system in the region of solid solutions was reached in 30 days. Sodium ion was determined gravimetrically as sodium zinc uranyl acetate; ammonium ion by the volumet-

SOURCE AND PURITY OF MATERIALS:

The salts were purified by two recrystallizations and then ground to fine powder.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kudryakova, S.A.; Karnaukhov, A.S.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 36-42.

EXPERIMENTAL VALUES: (continued)

Solubility system $NaClO_4$-NH_4ClO_4-H_2O at 308.2 K:

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	22.43	-	4.25	-	2.461	A
3.16	21.67	0.59	4.21	0.343	2.454	"
6.03	20.13	1.14	3.97	0.667	2.320	"
8.34	18.50	1.59	3.67	0.931	2.152	"
15.88	15.63	3.19	3.27	1.894	1.942	"
20.90	13.33	4.34	2.88	2.595	1.725	"
23.64	12.08	5.00	2.66	3.004	1.600	"
26.05	11.46	5.63	2.58	3.405	1.561	"
28.46	10.78	6.29	2.48	3.826	1.510	"
34.11	8.41	7.87	2.02	4.847	1.245	"
36.20	7.88	8.53	1.93	5.287	1.199	"
43.57	5.89	11.08	1.56	7.041	0.992	"
50.05	5.36	13.95	1.56	9.167	1.023	"
56.18	4.71	17.19	1.50	11.732	1.025	"
60.60	4.38	19.99	1.51	14.133	1.065	"
60.75	4.50	20.14	1.55	14.278	1.102	A + B
64.45	3.12	22.37	1.13	16.231	0.819	B
66.74	2.23	23.84	0.83	17.566	0.612	"
67.64	2.33	24.67	0.89	18.396	0.660	B + C
67.58	2.27	24.59	0.86	18.307	0.641	C
67.68	2.35	24.72	0.89	18.444	0.667	"
69.20	0.85	25.29	0.32	18.871	0.242	"
69.80	-	25.38	-	18.877	-	"

[a] Compiler's calculation.

[b] A = NH_4ClO_4 ; B = $n(NH_4ClO_4).m(NaClO_4.H_2O)$; C = $NaClO_4.H_2O$;
D = $NaClO_4$; E = $n(NH_4ClO_4).m(NaClO_4)$

AUXILIARY INFORMATION

METHOD: (continued)

ric Formalin method; perchlorate ion by difference and occasionally by nitron precipitation. Solid solutions were studied by the differential thermal, microphotographic and X-ray powder analytical methods.

ESTIMATED ERROR:

Temperature: ± 0.1 K

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kudryakova, S.A.; Karnaukhov, A.S.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 36-42.

EXPERIMENTAL VALUES: (continued)

Solubility system $NaClO_4$-NH_4ClO_4-H_2O at 363.2 K:

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	43.37	-	10.51	-	6.518	A
4.18	40.45	0.99	9.97	0.617	6.218	"
9.82	35.37	2.34	8.79	1.463	5.493	"
14.14	32.86	3.46	8.38	2.179	5.277	"
20.69	27.65	5.16	7.19	3.271	4.556	"
25.40	24.80	6.52	6.63	4.166	4.239	"
30.75	21.80	8.18	6.04	5.293	3.910	"
37.50	18.40	10.52	5.38	6.945	3.551	"
40.85	16.93	11.83	5.11	7.902	3.413	"
43.60	14.93	12.79	4.56	8.587	3.064	"
46.76	13.20	14.06	4.14	9.538	2.806	"
51.38	11.20	16.19	3.68	11.214	2.548	"
58.76	9.20	20.54	3.35	14.978	2.444	"
67.99	6.14	27.17	2.56	21.465	2.020	"
68.28	6.43	27.66	2.71	22.051	2.164	A + E
70.85	5.27	29.69	2.30	24.232	1.878	E
71.94	4.56	30.43	2.01	25.002	1.652	"
73.67	3.67	31.82	1.65	26.553	1.379	E + D
73.78	3.56	31.87	1.60	26.592	1.337	"
73.58	3.65	31.70	1.64	26.392	1.364	D
74.40	2.40	31.72	1.07	26.191	0.880	"
75.20	0.86	31.49	0.38	25.655	0.306	"
75.85	-	31.61	-	25.652	-	"

[a] Compiler's calculation.

[b] A = NH_4ClO_4 ; B = $n(NH_4ClO_4).m(NaClO_4.H_2O)$; C = $NaClO_4.H_2O$;
D = $NaClO_4$; E = $n(NH_4ClO_4).m(NaClO_4)$

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Thallium perchlorate; $TlClO_4$; [13453-40-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Smirnov, V.N.; Ivanov, S.A.; Chechneva, I.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1973, *120*, 13-5.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$TlClO_4$-H_2O at 298 K:

Liquid phase composition						Solid phase
mass %		mol %^{a}		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	14.27	-	0.98	-	0.548	$TlClO_4$
14.62	6.43	2.64	0.47	1.512	0.268	"
35.51	4.65	8.00	0.42	4.847	0.256	"
53.13	2.81	15.02	0.32	9.849	0.210	"
66.41	2.38	23.76	0.34	17.379	0.251	$NaClO_4 \cdot H_2O$ + $TlClO_4$
66.35	2.41	23.73	0.35	17.346	0.254	$NaClO_4 \cdot H_2O$
67.89	-	23.73	-	17.268	-	"

^{a} Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Equilibrium was attained in 5-7 days. Thallium ion was determined by bromate method; perchlorate ion gravimetrically by precipitation with nitron and sodium ion by difference.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 119-36.

VARIABLES:

One temperature: 298.2 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system : $NaClO_4$-$Mg(ClO_4)_2$-H_2O at 25°C

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	49.80	-	7.413	-	4.444	$Mg(ClO_4)_2 \cdot 6H_2O$
2.95	47.88	0.812	7.228	0.490	4.363	"
9.12	43.76	2.581	6.793	1.581	4.161	"
15.13	40.51	4.465	6.558	2.786	4.091	"
20.26	37.75	6.208	6.345	3.941	4.028	"
25.57	34.59	8.109	6.018	5.242	3.890	"
26.73	33.75	8.517	5.899	5.524	3.826	"
28.05	33.13	9.047	5.861	5.901	3.823	"
27.80	33.13	8.924	5.834	5.811	3.799	$NaClO_4 \cdot H_2O$ + $Mg(ClO_4)_2 \cdot 6H_2O$
27.85	33.18	8.958	5.854	5.837	3.815	"
28.08	33.43	9.116	5.954	5.958	3.891	"
28.00	33.56	9.101	5.984	5.949	3.911	"
28.12	33.60	9.168	6.009	6.000	3.932	"
28.20	33.73	9.232	6.058	6.050	3.969	"
28.30	33.73	9.283	6.069	6.087	3.980	$NaClO_4 \cdot H_2O$
31.48	30.27	10.22	5.390	6.722	3.545	"
35.49	27.04	11.64	4.863	7.736	3.233	"
40.48	22.77	13.37	4.126	8.996	2.776	"
45.59	18.61	15.24	3.413	10.40	2.329	"
50.27	14.72	16.97	2.725	11.73	1.884	"
54.38	11.01	18.39	2.043	12.83	1.425	"

[a] Editors' calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Periods of equilibration varied from 20 to 70 h. Mg^{2+} was determined by complexometric titration, Na^+ gravimetrically as sodium zinc uranyl acetate, and ClO_4^- gravimetrically by nitron precipitation.

SOURCE AND PURITY OF MATERIALS:

The salts were recrystallized twice. Purity: 95.58-99.75%.

ESTIMATED ERROR:

Temperature: ±0.1°C.

REFERENCES:

None.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 119-36.

EXPERIMENTAL VALUES: (continued)

Solubility system : $NaClO_4$-$Mg(ClO_4)_2$-H_2O at 25°C (continued)

[Solid phase : $NaClO_4 \cdot H_2O$]

Liquid phase composition

mass %		mol %^{a}		molality^a/mol kg^{-1}	
(1)	(2)	(1)	(2)	(1)	(2)
57.58	8.35	19.60	1.559	13.80	1.098
60.37	6.12	20.71	1.152	14.71	0.818
64.51	2.38	22.18	0.449	15.91	0.322
67.86	-	23.70	-	17.24	-

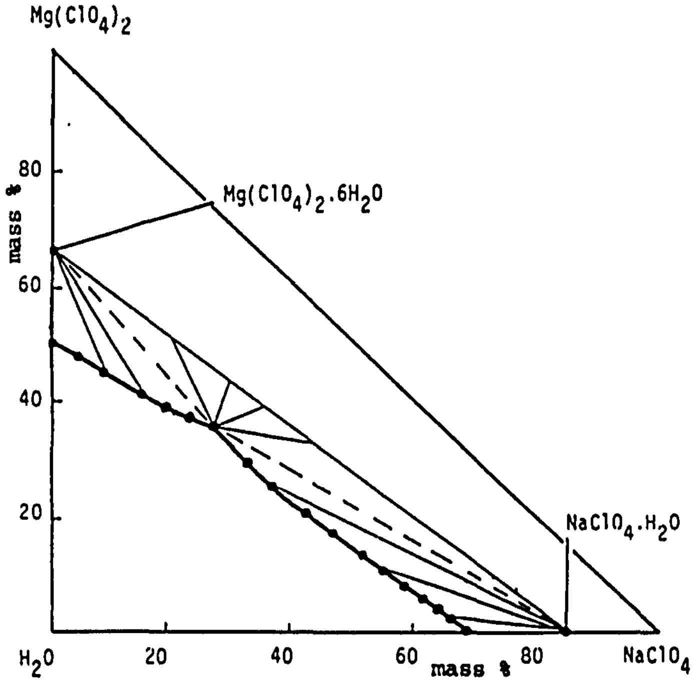
^{a} Editors' calculations.

COMMENTS AND/OR ADDITIONAL DATA:

The solubility isotherm (mass%) is shown below.

Solution composition at the isothermal double saturation point (solid phases $NaClO_4 \cdot H_2O$ and $Mg(ClO_4)_2 \cdot 6H_2O$):

28.05 mass % $NaClO_4$, 33.43 mass % $Mg(ClO_4)_2$, and 38.52 mass % H_2O.



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kudryakova, S.A.; Lepeshkov, I.N.

Sb. Tr. Yarosl. Gos. Ped. Inst., 1969, *66*, 40-50.

VARIABLES:

One temperature: 363 K

Composition

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility System : $NaClO_4$-$Mg(ClO_4)_2$-H_2O at 90°C

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	55.57	-	9.167	-	5.603	$Mg(ClO_4)_2.6H_2O$
4.40	52.15	1.340	8.713	0.827	5.377	"
8.07	49.67	2.502	8.448	1.560	5.266	"
14.54	45.18	4.644	7.916	2.948	5.025	"
19.87	42.03	6.582	7.638	4.259	4.942	"
24.22	39.21	8.230	7.309	5.409	4.804	"
28.63	36.39	9.999	6.972	6.685	4.661	"
34.01	33.10	12.34	6.586	8.445	4.509	"
34.08	32.87	12.32	6.516	8.422	4.456	$NaClO_4$ + $Mg(ClO_4)_2.6H_2O$
34.27	32.75	12.40	6.500	8.487	4.449	"
34.57	32.56	12.53	6.475	8.590	4.438	"
35.10	31.89	12.67	6.317	8.684	4.328	"
34.57	32.18	12.43	6.345	8.491	4.336	"
34.60	32.28	12.47	6.383	8.532	4.367	$NaClO_4$
37.58	29.81	13.64	5.934	9.412	4.095	"
41.69	26.57	15.33	5.359	10.73	3.750	"
45.56	23.78	17.06	4.886	12.14	3.475	"
49.37	20.81	18.74	4.333	13.62	3.126	"
55.45	15.49	21.21	3.250	15.58	2.388	"
61.75	11.03	24.43	2.393	18.53	1.815	"
69.13	5.45	28.23	1.221	22.21	0.961	"
74.51	1.33	31.12	0.305	25.19	0.247	"
76.27	-	32.11	-	26.25	-	"

[a] Editors's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Mg^{2+} was determined volumetrically by titration with Trilon B ; Na^+ gravimetrically by precipitation with zinc uranyl acetate; and ClO_4^- gravimetrically by nitron precipitation. The densities and relative viscosities of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

Not given.

ESTIMATED ERROR:

Not given.

REFERENCES:

None.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Calcium perchlorate; $Ca(ClO_4)_2$; [13477-36-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lilich, L.S.; Ovtrakht, N.V.

Vestn. LGU, Ser. Fiz. Khim. 1965, *10*, 115-9.

VARIABLES:

One temperature: 298 K

Composition.

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility of the system $NaClO_4$-$Ca(ClO_4)_2$-H_2O at 25°C:

Liquid phase composition						Solid
mass %		mol %[a]		molality[a]/mol kg^{-1}		phase[b]
(1)	(2)	(1)	(2)	(1)	(2)	
-	65.40	-	12.47	-	7.909	$Ca(ClO_4)_2 \cdot 4H_2O$
1.92	64.14	0.72	12.38	0.462	7.908	"
3.28	62.91	1.24	12.15	0.792	7.786	"
5.61	61.76	2.17	12.22	1.404	7.920	"
5.82	61.47	2.24	12.13	1.453	7.864	"
5.84	61.47	2.25	12.14	1.459	7.868	"
6.01	61.26	2.31	12.08	1.500	7.832	"
6.45	61.16	2.50	12.15	1.626	7.901	$NaClO_4$
6.77	60.30	2.59	11.82	1.679	7.662	"
9.15	57.59	3.46	11.15	2.247	7.245	"
13.50	51.48	4.858	9.491	3.148	6.151	"
13.77	51.17	4.948	9.421	3.208	6.107	"
15.71	48.36	5.518	8.703	3.571	5.632	$NaClO_4 \cdot H_2O$
17.16	46.73	5.989	8.356	3.881	5.415	"
17.32	46.90	6.087	8.445	3.954	5.485	"
18.16	45.72	6.326	8.160	4.106	5.297	"
23.13	39.56	7.789	6.825	5.063	4.437	"
35.68	27.02	11.77	4.568	7.813	3.031	"
44.94	18.59	14.86	3.150	10.06	2.133	"
53.88	11.15	18.13	1.922	12.58	1.334	"
67.79	-	23.64	-	17.19	-	"

[a] Compiler's calculations.

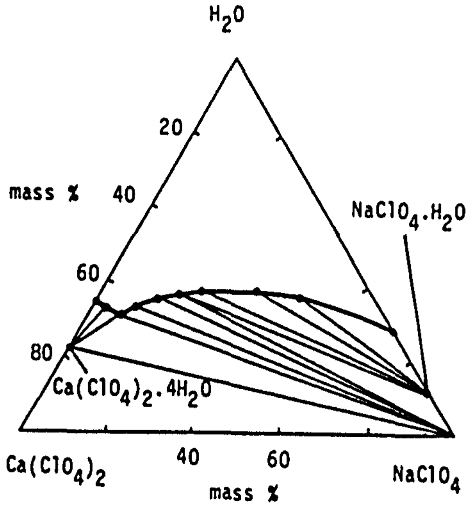
AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal. Equilibrium attained in 3-4h. ClO_4^- was determined by an ion-exchange method using a KU-2 resin; Ca^{2+} by complexometric titration. The composition of the solid phase was determined by Schreinemakers' method of "residues".

SOURCE AND PURITY OF MATERIALS:

Not stated.



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Calcium perchlorate; $Ca(ClO_4)_2$; [13477-36-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Ivanov, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. **1969**, *66*, 82-95.

VARIABLES:

One temperature: 313 K

Composition.

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility of the system $NaClO_4$-$Ca(ClO_4)_2$-H_2O at 40°C:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	68.40	-	14.03	-	9.057	$Ca(ClO_4)_2.4H_2O$
2.50	67.00	1.02	14.06	0.669	9.192	"
6.00	64.98	2.54	14.08	1.689	9.370	"
6.40	65.08	2.74	14.28	1.833	9.548	$Ca(ClO_4)_2.4H_2O$ + $NaClO_4$
6.23	65.14	2.66	14.25	1.777	9.516	" "
5.90	64.90	2.48	13.99	1.650	9.300	" "
6.10	65.30	2.61	14.30	1.742	9.554	" "
6.15	65.20	2.63	14.26	1.753	9.523	$NaClO_4$
10.30	59.80	4.219	12.55	2.813	8.369	"
13.20	55.90	5.241	11.37	3.489	7.570	"
15.20	50.04	5.486	9.253	3.571	6.024	"
20.17	45.70	7.320	8.497	4.827	5.603	"
23.04	42.20	8.202	7.697	5.413	5.080	"
29.82	35.00	10.40	6.251	6.923	4.163	"
36.05	31.71	13.28	5.986	9.132	4.116	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method. Periods of equilibrium varied from 3-5 days. The solid phases were studied thermographically. The densities, viscosities and refractive indexes of saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Calcium perchlorate; $Ca(ClO_4)_2$; [13477-36-6] (3) Water; H_2O; [7732-18-5]	Ivanov, S.A. *Uch. Zap. Yarosl. Gos. Ped. Inst.* <u>1969</u>, *66*, 82-95.

EXPERIMENTAL VALUES: (continued)

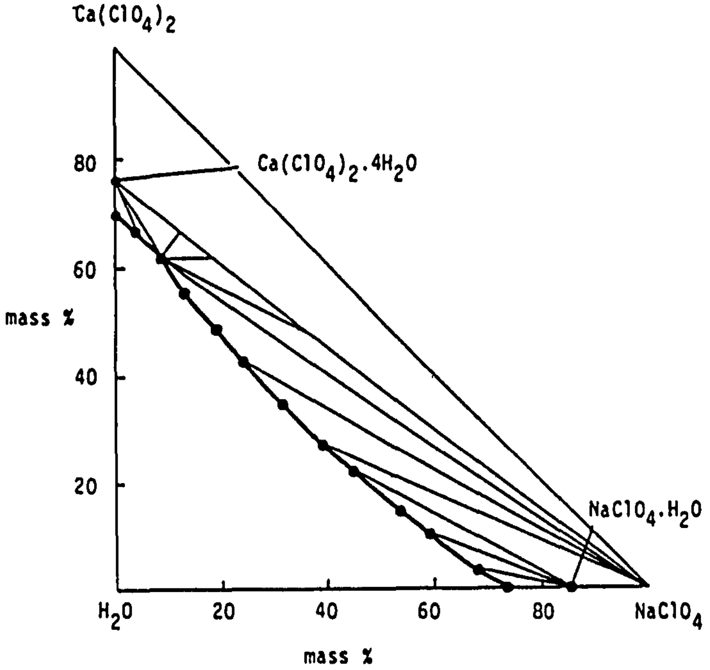
Solubility of the system $NaClO_4$-$Ca(ClO_4)_2$-H_2O at 40°C:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
40.60	26.70	14.68	4.947	10.14	3.417	$NaClO_4.H_2O$
47.10	19.80	16.69	3.595	11.62	2.503	"
53.70	14.05	19.17	2.570	13.60	1.823	"
59.40	8.90	21.26	1.63	15.30	1.175	"
66.07	4.14	24.41	0.78	18.11	0.582	"
70.87	-	26.36	-	19.87	-	"

[a] Compiler's calculations.

<u>COMMENTS/ADDITIONAL DATA</u>:

The isotherm shows the branches of crystallization of $Ca(ClO_4)_2.4H_2O$, $NaClO_4$ and $NaClO_4.H_2O$.



Solution composition at the isothermal double saturation point (solid phases $NaClO_4$ and $Ca(ClO_4)_2.4H_2O$):

6.18 mass % $NaClO_4$, 65.10 mass % $Ca(ClO_4)_2$, and 28.77 mass % H_2O.

COMPONENTS: (1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Strontium perchlorate; $Sr(ClO_4)_2$; [13450-97-0] (3) Water; H_2O; [7732-18-5]	ORIGINAL MEASUREMENTS: Druzhinina, G.V. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1972, *103*, 39-41.
VARIABLES: One temperature, 298 K. Composition.	PREPARED BY: I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility System $NaClO_4$-$Sr(ClO_4)_2$-H_2O at 25°C:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
68.84	-	24.53	-	18.04	-	$NaClO_4.H_2O$
55.51	12.80	20.09	1.979	14.31	1.410	"
40.04	28.45	15.03	4.564	10.38	3.151	"
23.80	47.06	9.836	8.311	6.671	5.636	"
12.30	58.39	5.202	10.55	3.427	6.953	"
5.81	69.39	2.848	14.54	1.913	9.765	" + $Sr(ClO_4)_2.4H_2O$
-	75.01	-	15.88	-	10.48	$Sr(ClO_4)_2.4H_2O$

[a] Compiler's calculations.

COMMENTS / ADDITIONAL DATA

The solubility isotherm consists of two branches, corresponding to solid phases $Sr(ClO_4)_2.4H_2O$ and $NaClO_4.H_2O$. Average solution composition at the isothermal double saturation point:

5.81 mass % $NaClO_4$, 69.39 mass % $Sr(ClO_4)_2$, and 24.80 mass % H_2O

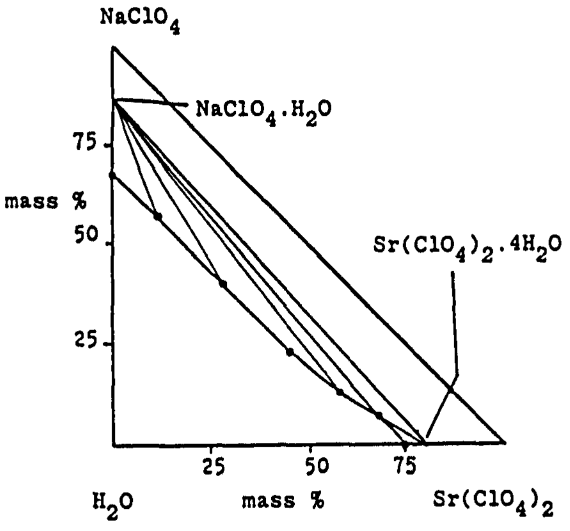
AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
No details.

SOURCE AND PURITY OF MATERIALS:
Not stated.

ESTIMATED ERROR: Not stated.

REFERENCES: None.



COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Barium perchlorate; $Ba(ClO_4)_2$; [13465-95-7]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Zaitseva, S.N.; Lepeshkov, I.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1969, *66*, 113-21.

VARIABLES:

Temperature/K: 298 and 323

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system : $Ba(ClO_4)_2$-$NaClO_4$-H_2O

Liquid phase composition						Solid phase[b]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
At 25°C						
-	66.89	-	9.767	-	6.008	A
0.96	66.34	0.388	9.766	0.240	6.034	A
6.74	60.85	2.705	8.893	1.698	5.584	A
19.68	50.08	8.084	7.491	5.315	4.925	A
29.40	42.20	12.36	6.462	8.455	4.419	A
35.95	36.59	15.24	5.648	10.69	3.963	A
39.89	33.00	16.89	5.088	12.02	3.620	A + B
40.67	32.19	17.17	4.949	12.24	3.527	A + B
40.67	32.73	17.43	5.107	12.49	3.659	A + B
41.32	32.90	18.08	5.243	13.09	3.795	A + B
41.30	32.02	17.63	4.977	12.64	3.569	A + B
41.30	32.33	17.78	5.068	12.79	3.646	B
42.22	29.15	17.06	4.290	12.04	3.028	B
47.04	23.69	18.48	3.388	13.13	2.407	B
56.45	12.92	20.96	1.747	15.05	1.254	B
61.46	4.45	20.85	0.550	14.73	0.388	B
67.48	-	23.39	-	16.95	-	B
At 50°C						
-	72.52	-	12.39	-	7.849	A
0.13	71.65	0.060	11.97	0.038	7.551	A
4.50	68.27	2.099	11.59	1.350	7.456	A
8.20	65.63	3.905	11.38	2.559	7.458	A
14.69	59.31	6.897	10.14	4.614	6.784	A
21.67	53.17	10.22	9.132	7.034	6.285	A
28.32	48.04	13.72	8.472	9.784	6.044	A

[a] Editors' calculations ; [b] A = $Ba(ClO_4)_2 \cdot 3H_2O$; B = $NaClO_4 \cdot H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used [1]. The densities and viscosities of the saturated solutions were measured.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Karnaukhov, A.S. *Izv. SFKhA AN SSSR*, 1954, *25*, 335.

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Barium perchlorate; $Ba(ClO_4)_2$; [13465-95-7] (3) Water; H_2O; [7732-18-5]	Zaitseva, S.N.; Lepeshkov, I.N. *Uch. Zap. Yarosl. Gos. Ped. Inst.* <u>1969</u>, *66*, 113-21.

EXPERIMENTAL VALUES: (continued)

Solubility system : $Ba(ClO_4)_2$-$NaClO_4$-H_2O at 50°C (continued)

Liquid phase composition						Solid phase[a]
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
30.39	46.21	14.73	8.158	10.61	5.873	B
34.05	43.02	16.56	7.621	12.13	5.580	B
34.67	42.89	17.10	7.701	12.62	5.684	B
35.35	42.74	17.69	7.789	13.18	5.802	B
35.85	41.87	17.70	7.528	13.14	5.589	B + C
35.83	40.90	17.15	7.130	12.58	5.227	B + C
35.40	41.71	17.17	7.367	12.63	5.419	B + C
35.14	41.84	16.99	7.366	12.47	5.405	B + C
36.68	41.76	18.49	7.664	13.90	5.761	C
37.43	40.19	18.33	7.168	13.66	5.341	C
43.50	33.34	20.42	5.699	15.34	4.281	C
47.97	28.00	21.66	4.603	16.30	3.465	C
51.46	22.79	21.92	3.535	16.32	2.632	C
61.01	13.31	25.38	2.016	19.40	1.541	C
64.15	10.01	26.35	1.497	20.28	1.152	D
68.79	4.14	27.05	0.593	20.76	0.456	D
71.50	2.23	28.50	0.324	22.23	0.252	D
73.15	-	28.62	-	22.25	-	D

[a] Editors' calculations.

[b] B = $Ba(ClO_4)_2.2H_2O$; C = $NaClO_4$; D = $NaClO_4.H_2O$.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Zinc perchlorate; $Zn(ClO_4)_2$; [13637-61-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Leboshchina, V.I.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1976, *154*, 68-71.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$Zn(ClO_4)_2$-H_2O at 298 K:

Liquid phase composition						Solid phase
mass %		mol %^{a}		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	53.17	-	7.18	-	4.296	$Zn(ClO_4)_2 \cdot 6H_2O$
5.02	47.60	1.44	6.32	0.865	3.801	"
11.68	43.00	3.44	5.87	2.105	3.590	"
20.29	38.71	6.40	5.66	4.042	3.573	"
23.64	35.20	7.39	5.10	4.691	3.236	$Zn(ClO_4)_2 \cdot 6H_2O + NaClO_4 \cdot H_2O$
29.38	30.71	9.33	4.52	6.012	2.912	$NaClO_4 \cdot H_2O$
36.14	26.38	11.92	4.03	7.875	2.663	"
39.58	23.00	13.00	3.50	8.639	2.326	"
51.70	12.48	17.18	1.92	11.788	1.318	"
63.35	3.87	22.00	0.62	15.784	0.447	"
67.65	-	23.53	-	17.079	-	"

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Equilibrium was reached in 3 or 4 days. Zn^{2+} was determined by complexometric titration with the indicator eriochrome black T at pH 9.7; ClO_4^- gravimetrically as nitron perchlorate.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Nickel perchlorate; $Ni(ClO_4)_2$; [13637-71-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Tarakanov, V.F.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 28-31.

VARIABLES:

One temperature: 298.2 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$Ni(ClO_4)_2$-H_2O at 298.2 K:

Liquid phase composition						Solid phase
mass %		mol %		molality/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
-	52.42	-	7.15	-	4.277	$Ni(ClO_4)_2.6H_2O$
5.08	47.63	1.46	6.48	0.877	3.910	"
6.50	46.58	1.87	6.37	1.131	3.854	"
9.33	44.58	2.71	6.16	1.653	3.755	"
12.32	41.81	3.58	5.78	2.194	3.538	"
17.04	38.81	5.08	5.50	3.152	3.412	"
20.59	36.53	6.25	5.27	3.922	3.307	"
24.94	33.31	7.69	4.88	4.879	3.097	"
31.66	28.94	10.11	4.39	6.563	2.851	$Ni(ClO_4)_2.6H_2O$ + $NaClO_4.H_2O$
30.73	29.42	9.74	4.43	6.298	2.866	"
30.44	29.56	9.62	4.44	6.215	2.869	"
30.38	29.76	9.63	4.48	6.225	2.898	$NaClO_4.H_2O$
32.61	27.59	10.31	4.15	6.692	2.691	"
44.72	17.43	14.41	2.67	9.650	1.788	"
51.52	11.88	16.84	1.85	11.497	1.260	"
64.71	1.98	22.16	0.32	15.866	0.231	"
67.89	-	23.73	-	17.268	-	"

[a] Compiler's calculations.

Solution composition at the isothermal double saturation point (solid phases $NaClO_4.H_2O$ and $Ni(ClO_4)_2).6H_2O$:

30.80 mass %, 29.42 mass % $Ni(ClO_4)_2$, and 39.78 mass % H_2O.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. The time of equilibration varied from 4 to 5 days. Ni^{2+} was determined by titrating with Trilon B; ClO_4^- gravimetrically, by nitron precipitation. The composition of the true solid phase was determined by Schreinemakers' method of "residues".

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Temperature: ±0.1 K

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Aluminium perchlorate; $Al(ClO_4)_3$; [14452-39-2]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Caven, R.M.; Bryce, G.

J. Chem. Soc. 1934, 514-7.

VARIABLES:

One temperature: 303.2 K

Composition

PREPARED BY:

K.H. Khoo

EXPERIMENTAL VALUES:

Solubility system : $NaClO_4-Al(ClO_4)_3-H_2O$ at 30.2°C

Liquid phase composition g/100 g(3) (1)	g/100 g(3) (2)	molality[a]/mol kg^{-1} (1)	molality[a]/mol kg^{-1} (2)	Solid phase
215.0	-	17.6	-	$NaClO_4.H_2O$
135.4	27.76	11.1	0.85	"
116.6	37.30	9.52	1.15	"
100.7	45.59	8.22	1.40	"
50.64	72.46	4.14	2.23	"
43.84	76.26	3.58	2.34	$NaClO_4.H_2O+Al(ClO_4)_3.nH_2O$
30.02	83.37	2.45	2.58	$Al(ClO_4)_3.nH_2O$
-	110.1	-	3.38	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The isothermal method was used. Aluminium was determined as the oxide. Sodium was determined in the presence of aluminium as sodium magnesium uranyl acetate. The method of analysis of the solid phase was not mentioned.

SOURCE AND PURITY OF MATERIALS:

Nothing specified.

ESTIMATED ERROR:

Temperature: ±0.1°C

REFERENCES:

None.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Cerium perchlorate; $Ce(ClO_4)_3$; [14017-47-1]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.; Paraguzova, T.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1975, *144*, 76-85.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $Ce(ClO_4)_3$-$NaClO_4$-H_2O at 298 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
67.80	-	23.65	-	17.197	-	$NaClO_4.H_2O$
60.56	6.12	20.97	0.59	14.844	0.419	"
47.28	16.30	15.79	1.52	10.603	1.021	"
31.98	28.99	10.47	2.65	6.692	1.694	"
19.56	42.34	6.74	4.07	4.193	2.535	"
12.15	51.33	4.42	5.22	2.717	3.206	"
11.04	52.41	4.03	5.34	2.467	3.270	"
8.31	56.48	3.16	5.99	1.928	3.659	"
7.78	58.17	3.05	6.36	1.866	3.896	"
6.38	60.94	2.60	6.93	1.594	4.253	$Ce(ClO_4)_3.9H_2O$ + $NaClO_4$
6.07	60.60	2.43	6.78	1.487	4.147	"
2.32	63.01	0.91	6.89	0.547	4.145	$Ce(ClO_4)_3.9H_2O$
-	64.33	-	6.90	-	4.113	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. ClO_4^- was determined gravimetrically as nitron perchlorate; Ce^{3+} trilonometrically with the indicator xylenol orange. The composition of solid phases was determined graphically by Schreinemakers' method. The heating curves were recorded using Kurnakov's pyrometer to confirm the character of solid phases. I.R. spectra were studied using a IKS-14A spectrophotometer.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Terbium perchlorate; $Tb(ClO_4)_3$; [14014-09-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1976, *154*, 25-7.

VARIABLES:

One temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$Tb(ClO_4)_3$-H_2O at 298 K :

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
67.92	-	23.75	-	17.292	-	$NaClO_4.H_2O$
51.42	13.84	17.66	1.27	12.089	0.871	"
33.27	30.59	11.59	2.85	7.519	1.851	"
18.52	45.37	6.71	4.40	4.189	2.748	"
17.75	47.57	6.67	4.79	4.180	3.000	"
16.36	49.46	6.25	5.06	3.909	3.165	"
13.85	51.90	5.32	5.33	3.303	3.314	$NaClO_4$
12.50	53.98	4.91	5.67	3.046	3.522	"
11.81	55.40	4.73	5.95	2.942	3.695	"
7.99	59.31	3.25	6.45	1.996	3.967	"
6.96	61.34	2.91	6.88	1.793	4.232	"
6.68	63.39	2.94	7.48	1.823	4.632	$NaClO_4$ + $Tb(ClO_4)_3.9H_2O$
3.53	63.70	1.45	7.01	0.880	4.251	$Tb(ClO_4)_3.9H_2O$
-	64.30	-	6.63	-	3.939	"

[a] Compiler's calculation

Average solution composition at the isothermal double saturation point (solid phases $NaClO_4$ and $Tb(ClO_4)_3.9H_2O$):
6.68 mass % $NaClO_4$, 63.39 mass % $Tb(ClO_4)_3$, and 29.93 mass % H_2O.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details given. The solid phases were studied under a microscope and by differential thermal analysis.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chloride; $NaCl$; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cornec, E.; Dickeley, J.

Bul. Soc. Chim. France 1927, *41*, 1017-27.

VARIABLES:

Temperature/K: 273-373

Composition

PREPARED BY:

K.H. Khoo

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate monohydrate at various temperatures (t)

t/°C	0	15	25	38	50
g(2)/100 g(3)	169	191	211	238	274
molality[a]/ mol kg^{-1}	13.80	15.60	17.23	19.44	22.38

Solubility of anhydrous sodium perchlorate at various temperatures (t)

t/°C	15	25	38	55	75	100
g(2)/100 g(3)	256	260	268	284	300	330
molality[a]/ mol kg^{-1}	20.91	21.23	21.89	23.19	24.50	26.95

Solubility of sodium perchlorate in aqueous sodium chloride

(i) At 0°C

g(2)/100 g(3)	0	6.70	10.21	17.15	25.44
g(1)/100 g(3)	169.4	158.0	123.5	80.2	39.3
Solid phase[b]	A	A+B	B	B	B

(ii) At 100°C

g(2)/100 g(3)	0	3.87	4.93	8.11	17.75
g(1)/100 g(3)	330.1	324.9	237.1	157.1	83.3
Solid phase[b]	C	C+B	B	B	B

(iii) At other temperatures

Temperature/°C	25	38	50	55	75
g(2)/100 g(3)	207.7	235.0	271.5	278.3	296.7
g(1)/100 g(3)	4.27	3.57	3.03	2.97	3.32
Solid phase[b]	A+B	A+B	A+B	C+B	C+B

[a] Compiler's calculations.

[b] A = $NaClO_4 \cdot H_2O$; B = $NaCl$; C = $NaClO_4$

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Cornec, E.; Dickely, J.

Bul.· Soc. Chim. (France) 1927, *41*, 1017-27.

VARIABLES:

Temperature: 273 - 373 K

Composition.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $NaCl-NaClO_4-H_2O$ at various temperatures :

	Liquid phase composition						Sln density	Solid
t/ °C	mass%		mol % [a]		mol kg^{-1} [a]		g cm^{-3}	phase
	(2)	(1)	(2)	(1)	(2)	(1)		
100	-	76.75	-	32.69	-	26.96	1.758	$NaClO_4$
"	0.88	75.79	0.78	32.09	0.65	26.53	1.757	$NaClO_4$ + NaCl
"	1.44	69.32	1.11	25.57	0.84	19.36	1.664	NaCl
"	3.06	59.23	1.99	18.40	1.39	12.83	1.532	"
"	8.81	41.44	4.64	10.41	3.03	6.80	1.367	"
75	0.83	74.15	0.71	30.15	0.57	24.21	1.757	$NaClO_4$ + NaCl
55	0.78	73.00	0.65	28.87	0.51	22.74	1.755	" "
50	0.81	72.46	0.66	28.32	0.52	22.14	1.749	$NaCl+NaClO_4.H_2O$
38	1.05	69.41	0.81	25.48	0.61	19.19	1.713	" "
25	1.37	66.58	1.00	23.18	0.73	16.97	1.683	" "
0	-	62.87	-	19.94	-	13.83	-	$NaClO_4.H_2O$
0	2.53	59.69	1.65	18.55	1.15	12.90	-	$NaCl+NaClO_4.H_2O$
0	4.37	52.82	2.59	14.97	1.746	10.08	-	NaCl
0	8.63	40.65	4.48	10.08	2.911	6.55	-	"
0	15.44	23.86	6.90	5.09	4.352	3.210	-	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method given. The saturated solutions were evaporated in a water-bath and the solids dried at 110 °C in an oven, cooled and weighed in stoppered flasks.

SOURCE AND PURITY OF MATERIALS:

Commercial sodium perchlorate was purified by several recrystallizations before use.

ESTIMATED ERROR:

Not stated.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.

Izv. Vyssh. Uch. Zap. Khim. i. Khim. Tekhnolog. 1958, *3*, 34-9.

VARIABLES:

One temperature: 293 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-NaCl-H_2O at 293 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
-	66.84	-	22.87	-	16.463	$NaClO_4$ [b]
0.82	66.30	0.59	22.75	0.427	16.469	"
1.62	65.55	1.16	22.44	0.844	16.307	"
1.78	64.80	1.26	21.92	0.911	15.836	"
1.83	64.26	1.28	21.52	0.923	15.477	$NaClO_4$ [b] + NaCl
1.77	64.23	1.24	21.48	0.891	15.429	"
1.85	64.11	1.29	21.42	0.930	15.382	NaCl
3.97	53.43	2.37	15.21	1.595	10.244	"
10.64	38.19	5.46	9.35	3.558	6.096	"
13.53	31.86	6.57	7.39	4.239	4.765	"
14.83	25.12	6.69	5.41	4.226	3.417	"
21.68	10.32	8.77	1.99	5.455	1.239	"
22.46	8.18	8.93	1.55	5.541	0.963	"
23.59	5.39	9.19	1.00	5.684	0.620	"
26.50	-	10.00	-	6.169	-	"

[a] Compiler's calculation.

[b] probably $NaClO_4 \cdot H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method (ref. 1) was used. Equilibrium of the saturated solutions was reached in 2 days. Na^+ was determined gravimetrically as sodium zinc uranyl acetate; Cl^- by Mohr's method and in the transition points, gravimetrically as silver chloride.

SOURCE AND PURITY OF MATERIALS:

Chemically pure salts were further purified by double recrystallization. Analysis gave 99.41 % to 99.63 % purity.

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Karnaukhov, A.S. *Zh. Neorg. khim.* 1957, *2*, 915.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 119-36.

VARIABLES:

One temperature: 298.2 K

Composition

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-NaCl-H_2O at 298.2 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
26.45	-	9.98	-	6.153	-	NaCl
24.33	4.27	9.43	0.79	5.831	0.488	"
21.09	11.39	8.59	2.21	5.345	1.378	"
18.32	17.50	7.80	3.56	4.884	2.227	"
14.73	25.49	6.67	5.51	4.216	3.482	"
11.20	33.18	5.40	7.63	3.446	4.872	"
8.49	40.41	4.39	9.97	2.843	6.459	"
5.19	49.88	2.97	13.62	1.977	9.067	"
1.31	66.34	0.95	22.96	0.693	16.749	"
1.33	66.29	0.96	22.93	0.703	16.720	NaCl + $NaClO_4.H_2O$
1.35	66.18	0.98	22.85	0.711	16.646	"
1.38	66.11	1.00	22.80	0.726	16.608	"
1.36	66.11	0.98	22.79	0.715	16.598	"
1.41	65.69	1.01	22.48	0.733	16.307	"
1.41	65.92	1.02	22.66	0.738	16.479	"
1.42	66.03	1.03	22.75	0.746	16.568	$NaClO_4.H_2O$
0.91	66.66	0.66	23.07	0.480	16.788	"
-	67.84	-	23.69	-	17.228	"

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[a] Compiler's calculation.

COMMENTS AND/OR ADDITIONAL DATA:

Solution composition at the isothermal double saturation point (solid phases $NaClO_4.H_2O$ and NaCl):

1.36 mass % NaCl, 66.09 mass % $NaClO_4$, and 32.55 mass % H_2O.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Equilibrium was reached in 20-70 hours. Na^+ was determined gravimetrically as sodium zinc uranyl acetate; Cl^- mercurimetrically; ClO_4^- gravimetrically by nitron precipitation.

SOURCE AND PURITY OF MATERIALS:

The initial salts were recrystallized twice. Purity of the salts varied from 95.58 to 99.75%.

ESTIMATED ERROR:

Temperature: ± 0.1 K

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chloride; $NaCl$; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loseva, G.K.

Tr. Novocherkassk. Politekhn. Inst. 1972, *266*, 78-81

VARIABLES:

One temperature: 333 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility, system $NaClO_4$-$NaCl$-H_2O

liquid phase composition						solid phase
mass %		mol %^{a}		molality^a/mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
13.70	20.40	2.72	8.47	1.698	5.297	$NaCl$
31.70	12.40	7.24	5.94	4.632	3.796	"
41.30	8.50	10.32	4.45	6.719	2.897	"
49.50	5.60	13.51	3.20	9.004	2.134	"
55.70	3.70	16.41	2.28	11.205	1.559	"
66.00	2.40	23.09	1.76	17.058	1.300	"
66.80	1.60	23.45	1.18	17.265	0.866	"
69.60	1.20	25.72	0.93	19.467	0.703	"
71.70	0.99	27.64	0.80	21.442	0.620	"
72.80	0.79	28.67	0.65	22.513	0.512	$NaCl + NaClO_4$
74.20	-	29.73	-	23.489	-	$NaClO_4$

^{a} Compiler's calculation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. The composition of the liquid phase was determined by chemical analysis. The composition of the solid phase was determined using Schreinemaker's method.

SOURCE AND PURITY OF MATERIALS:

The reagents were purified by recrystallization ; final components were 99.6-99.6 % pure.

ESTIMATED ERROR:

not stated

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chloride; NaCl; [7647-14-5]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS

Karnaukhov, A.S., Troitskii, E.N.

Uch Zap. Yarosl Gos. Ped. Inst. 1966, *59*, 8-21.

VARIABLES:

One temperature: 363 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$NaCl$-H_2O at 363 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
27.80	-	10.61	-	6.588	-	NaCl
25.11	5.05	9.88	0.95	6.152	0.591	"
22.95	8.72	9.23	1.67	5.747	1.042	"
18.97	18.96	8.27	3.95	5.229	2.495	"
14.80	23.85	6.57	5.05	4.128	3.175	"
12.10	29.94	5.64	6.66	3.572	4.219	"
9.12	38.03	4.59	9.13	2.953	5.877	"
6.80	45.20	3.69	11.72	2.424	7.691	"
6.00	47.99	3.37	12.86	2.231	8.519	"
5.53	49.97	3.18	13.73	2.126	9.171	"
4.60	52.62	2.73	14.91	1.840	10.046	"
3.78	55.77	2.34	16.47	1.599	11.260	"
3.15	58.64	2.03	18.05	1.411	12.534	"
1.85	63.20	1.27	20.75	0.906	14.769	"
0.90	68.09	0.67	24.25	0.497	17.933	"
0.87	67.34	0.64	23.61	0.468	17.300	NaCl + $NaClO_4$
0.88	66.93	0.64	23.28	0.468	16.981	"
0.85	67.31	0.62	23.58	0.457	17.266	"
0.86	68.06	0.64	24.21	0.473	17.885	"
0.87	67.17	0.64	23.47	0.466	17.165	"
0.90	66.42	0.65	22.87	0.471	16.599	"
0.89	66.95	0.65	23.30	0.474	17.002	$NaClO_4$
-	75.85	-	31.61	-	25.652	"

[a] Compiler's calculation.

Average solution composition at the isothermal double saturation point (solid phases $NaClO_4$ and NaCl):

0.87 mass % NaCl, 67.21 mass % $NaClO_4$, and 31.92 mass% H_2O.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE

Isothermal method was used. Conditions of saturation were not given. Na^+ was determined gravimetrically as sodium zinc uranyl acetate; ClO_4^- gravimetrically by precipitating with nitron; Cl^- mercurimetrically.

SOURCE AND PURITY OF MATERIALS.

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1971, *95*, 142-6.

VARIABLES:

Temperature: 298 and 323 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaNO_3$-$NaClO_4$-H_2O at 298 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
47.82	-	16.27	-	10.782	-	$NaNO_3$
42.88	8.12	15.33	2.02	10.296	1.353	"
33.68	20.38	12.73	5.35	8.626	3.623	"
29.47	24.85	11.24	6.58	7.590	4.443	"
25.82	35.56	11.10	10.61	7.866	7.520	"
19.37	47.52	9.29	15.82	6.883	11.722	"
15.50	55.50	8.12	20.19	6.288	15.630	"
11.59	59.19	6.08	21.56	4.667	16.544	$NaNO_3$ + $NaClO_4.H_2O$
11.53	59.28	6.06	21.61	4.647	16.586	"
7.84	62.32	4.09	22.55	3.091	17.057	$NaClO_4.H_2O$
4.98	64.13	2.55	22.80	1.897	16.956	"
-	67.89	-	23.73	-	17.268	"

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Saturation conditions were not given. The composition of solid phases was determined graphically by Schreinemakers' method of "residues". The solutions and solid "residues" were analysed for the nitrate ion by Devarda's method. The perchlorate ion was precipitated with nitron.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium nitrate; $NaNO_3$; [7631-99-4]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Andronova, N.P.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1971, *95*, 142-6.

EXPERIMENTAL VALUES: (continued)

Solubility system $NaNO_3$-$NaClO_4$-H_2O at 323 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
53.27	-	19.46	-	13.412	-	$NaNO_3$
48.42	6.50	18.23	1.70	12.637	1.178	"
41.70	18.30	17.15	5.23	12.265	3.737	"
33.41	31.78	15.21	10.04	11.292	7.456	"
24.40	43.67	11.88	14.76	8.991	11.170	"
18.14	57.23	10.42	22.82	8.665	18.977	"
16.98	59.07	9.93	23.98	8.341	20.144	$NaNO_3$ + $NaClO_4$
16.98	59.07	9.93	23.98	8.341	20.144	"
14.81	60.82	8.61	24.55	7.150	20.383	$NaClO_4$
10.05	65.17	5.84	26.27	4.772	21.479	"
5.70	69.20	3.31	27.90	2.672	22.517	"
3.37	70.84	1.93	28.23	1.537	22.434	$NaClO_4.H_2O$
-	73.53	-	29.01	-	22.687	"

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[a] Compiler's calculation.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium sulfate; Na_2SO_4; [7757-82-6]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Freeth, F.A.

Rec. Trav. Chim. Pays-Bas 1924, 43, 475

VARIABLES:

Two temperatures: 298 K and 333 K.
Composition.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-Na_2SO_4-H_2O at 25 °C :

Liquid phase composition						Solid
mass %		mol % [a]		molality[a]/ mol kg^{-1}		phase
(1)	(2)	(1)	(2)	(1)	(2)	
67.60	-	23.49	-	17.04	-	$NaClO_4.H_2O$
67.67	0.26	23.67	0.08	17.23	0.06	$NaClO_4.H_2O + Na_2SO_4$
53.58	1.24	14.81	0.296	9.69	0.193	Na_2SO_4
41.68	4.28	10.10	0.894	6.30	0.558	"
31.27	9.07	7.034	1.759	4.281	1.070	$Na_2SO_4 + Na_2SO_4.10H_2O$
31.21	9.07	7.015	1.757	4.268	1.069	" "
18.72	12.56	3.761	2.180	2.225	1.287	$Na_2SO_4.10H_2O$
5.79	18.15	1.075	2.906	0.622	1.671	"
-	21.71	-	3.398	-	1.952	"

[a] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The saturation apparatus was similar to that used by Van't Hoff (ref.1) and samples of clear satd sln were taken using a weight-pipette. Na^+ was determined as Na_2SO_4 by addition of pure sulphuric acid to the sln in silica basins and evaporating at a low red heat. Sulfate was determined gravimetrically as $BaSO_4$.
Solid phase compositions were determined using Schreinemakers' method. Gas-heated thermostats were used and thermometers were checked against N.P.L. Standards. All analyses were carried out in duplicates.

SOURCE AND PURITY OF MATERIALS:

$NaClO_4$ was prepared from very pure ammonium perchlorate (% purity not stated) and an aqueous sln of pure NaOH. Source and other details not given. $NaSO_4$ was recrystallized from the reagent grade salt.

ESTIMATED ERROR:

No estimation.

REFERENCES:

1. Van't Hoff, J.H. *Zur Bildung der Ozeanischen Salzablagerungen Wieweg, Braunschweig* 1905, *1*; 1902, *2*.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chlorate; $NaClO_3$; [7775-09-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Loseva, G.K.

Tr. Novocherkassk. Politekhn. Inst. 1972, *266*, 78-81.

VARIABLES:

One temperature: 333 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$NaClO_3$-H_2O at 333 K:

Liquid phase composition						Solid phase
mass %		mol %		molality/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
51.40	9.20	17.59	2.74	12.256	1.907	$NaClO_3$
40.10	23.00	14.42	7.19	10.210	5.091	"
30.90	35.90	11.96	12.08	8.744	8.831	"
23.40	47.70	9.93	17.60	7.607	13.480	"
20.10	55.10	9.37	22.33	7.614	18.146	"
16.80	59.90	8.13	25.21	6.774	20.996	"
15.30	62.70	7.66	27.28	6.534	23.277	$NaClO_3$ + $NaClO_4$
14.80	62.90	7.35	27.17	6.235	23.037	$NaClO_4$
14.10	63.50	6.99	27.38	5.914	23.153	"
7.90	68.30	3.80	28.56	3.118	23.438	"

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. The composition of the liquid phase was determined by chemical analysis. The composition of the solid phase was determined by Schreinemakers' method. The viscosity, density and electrical conductivity were measured. X-ray powder analysis and optical crystallography methods were used.

SOURCE AND PURITY OF MATERIALS:

The reagents were purified by recrystallization until the content of the main substance was 99.6-99 % pure.

ESTIMATED ERROR:

Not given.

REFERENCES:

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Sodium sulfate; Na_2SO_4; [7757-82-6] (3) Water; H_2O; [7732-18-5]	Freeth, F.A. *Rec. Trav. Chim. Pays-Bas* 1924, 43, 475

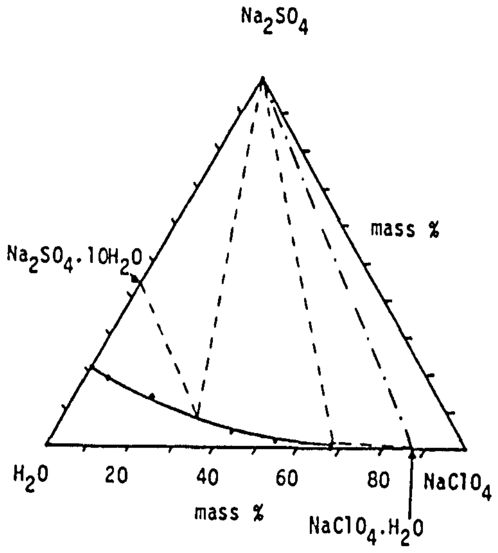
EXPERIMENTAL VALUES:(continued)

Solubility system $NaClO_4$-Na_2SO_4-H_2O at 60 °C :

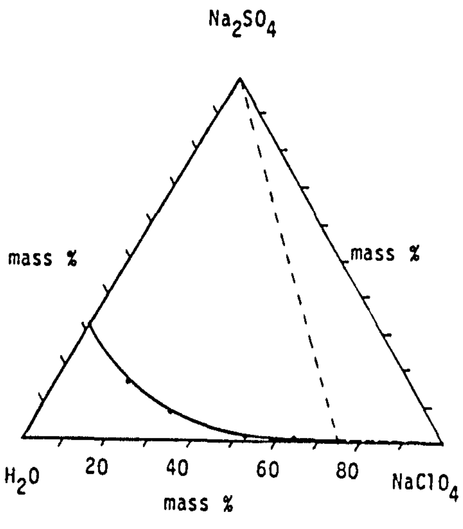
Liquid phase composition						Solid phase
mass %		mol % [a]		molality[a]/ mol kg^{-1}		
(1)	(2)	(1)	(2)	(1)	(2)	
74.30	-	29.84	-	23.61	-	$NaClO_4$
74.40	0.290	30.16	0.101	24.01	0.081	$NaClO_4$ + Na_2SO_4
64.65	0.370	21.36	0.105	15.095	0.074	Na_2SO_4
52.47	1.11	14.22	0.259	9.232	0.168	"
31.55	6.95	6.93	1.315	4.181	0.796	"
17.70	14.90	3.622	2.629	2.145	1.556	"
-	31.2	-	5.44	-	3.19	"

[a] Compiler's calculations.

COMMENTS AND/OR ADDITIONAL DATA The solubility isotherms for the system at 25 °C and 60 °C are reproduced below.



at 25 °C



at 60 °C

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium perchlorate; $NaClO_4$; [7601-89-0] (2) Sodium chromate; Na_2CrO_4; [7775-11-3] (3) Water; H_2O; [7732-18-5]	Karnaukhov, A.S.; Guseva, A.D. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1966, *59*, 96-103
VARIABLES: One temperature: 298 K Composition	PREPARED BY: N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-Na_2CrO_4-H_2O at 308 K:

Liquid phase composition						Solid phase
mass %		mol %		molality/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
47.63	0.00	9.19	0.00	5.615	0.000	$Na_2CrO_4.4H_2O$
45.69	2.82	8.92	0.73	5.478	0.447	"
40.63	10.20	8.19	2.72	5.101	1.694	"
38.07	13.39	7.73	3.60	4.842	2.253	"
33.14	20.35	6.93	5.63	4.399	3.573	"
30.60	24.04	6.51	6.76	4.165	4.328	"
27.84	28.22	6.05	8.11	3.912	5.245	"
24.81	33.26	5.57	9.87	3.653	6.478	"
20.43	39.60	4.73	12.12	3.156	8.092	"
15.82	46.45	3.80	14.75	2.589	10.055	"
13.80	49.77	3.39	16.17	2.339	11.158	"
12.02	53.15	3.04	17.78	2.131	12.463	"
10.44	56.41	2.72	19.48	1.944	13.898	"
9.38	59.27	2.54	21.21	1.847	15.441	"
8.63	61.62	2.41	22.79	1.791	16.916	$Na_2CrO_4.4H_2O$ + $NaClO_4.H_2O$
8.61	61.48	2.40	22.66	1.777	16.788	"
8.62	61.52	2.40	22.70	1.782	16.827	"
8.60	61.68	2.41	22.83	1.786	16.950	"
8.61	61.63	2.41	22.79	1.786	16.914	"
5.63	64.32	1.56	23.58	1.157	17.481	$NaClO_4.H_2O$
2.40	67.01	0.66	24.22	0.484	17.891	"
0.00	69.80	0.00	25.38	0.000	18.877	"

[a] Compiler's calculation.

Solution composition at the isothermal double saturation point (solid phases $NaClO_4.H_2O$ and $Na_2CrO_4.4H_2O$): 61.58 mass % $NaClO_4$, 8.61 mass % Na_2CrO_4, and 29.81 mass % H_2O.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:	SOURCE AND PURITY OF MATERIALS:
Isothermal method was used. Equilibrium was reached in 2-3 days. Na^+ was determined gravimetrically as zinc uranyl acetate; CrO_4^{-2} iodimetrically; ClO_4^- by difference.	The initial salts (reagent grade) were purified by recrystallization.
	ESTIMATED ERROR: Not stated.
	REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chromate; Na_2CrO_4; [7775-11-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 73-82.

VARIABLES:

One temperature: 323 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility in the system $NaClO_4$-Na_2CrO_4-H_2O at 323K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
50.76	-	10.29	-	6.364	-	$Na_2CrO_4 \cdot 4H_2O$
49.38	2.51	10.18	0.68	6.337	0.426	"
48.19	4.58	10.06	1.27	6.299	0.792	"
46.11	8.73	9.94	2.49	6.303	1.579	"
41.94	12.71	8.99	3.60	5.709	2.289	"
38.84	17.05	8.48	4.92	5.436	3.157	"
35.40	21.83	7.89	6.43	5.110	4.169	"
31.91	26.44	7.23	7.92	4.730	5.185	"
27.05	33.55	6.35	10.43	4.238	6.955	"
23.02	40.88	5.73	13.46	3.937	9.249	"
19.47	47.02	5.08	16.24	3.587	11.460	Na_2CrO_4
15.69	51.35	4.13	17.88	2.939	12.724	"
12.95	56.15	3.55	20.35	2.587	14.841	"
10.82	58.98	3.00	21.65	2.212	15.950	"
9.69	61.16	2.75	22.94	2.052	17.136	"
7.71	64.58	2.25	24.96	1.718	19.034	Na_2CrO_4
6.41	67.19	1.93	26.72	1.499	20.786	"
6.38	67.23	1.92	26.74	1.493	20.806	$Na_2CrO_4 + NaClO_4 \cdot H_2O$
6.42	67.28	1.93	26.82	1.507	20.893	"
6.37	67.20	1.91	26.70	1.488	20.766	"
6.40	67.21	1.92	26.73	1.497	20.800	$NaClO_4 \cdot H_2O$
2.40	70.73	0.71	27.72	0.551	21.499	"
-	78.20	-	34.55	-	29.297	"

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility was studied by the method of isothermal recrystallization from supersaturated solutions. Conditions of saturation are not stated. Na^+ was determined as sodium zinc uranyl acetate and by flame photometry CrO_4^{-2} iodimetrically and ClO_4^- by difference.

SOURCE AND PURITY OF MATERIALS:

Chemically pure grade (1) and (2) were purified by recrystallization and dehydrated.

ESTIMATED ERROR:

Not stated.

REFERENCES: None.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium chromate; Na_2CrO_4; [7775-11-3]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Molchanov, S.N.

Tr. po Kimii i Khim. Tekhnolog. 1965, *3(14)*, 27-9.

VARIABLES:

Temperature: 298, 323, 335.8 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-Na_2CrO_4-H_2O:

Liquid phase composition

At 298 K

mass %		mol %^{a}		molality^a/mol kg^{-1}		Solid phase
(2)	(1)	(2)	(1)	(2)	(1)	
45.78	-	8.58	-	5.213	-	$Na_2CrO_4.4H_2O$
7.82	53.91	1.85	16.85	1.261	11.505	Na_2CrO_4
6.18	60.71	1.61	20.90	1.152	14.975	$Na_2CrO_4 + NaClO_4.H_2O$
-	67.70	-	23.57	-	17.118	$NaClO_4.H_2O$

At 323 K

mass %		mol %^{a}		molality^a/mol kg^{-1}		Solid phase
(2)	(1)	(2)	(1)	(2)	(1)	
50.76	-	10.29	-	6.364	-	$Na_2CrO_4.4H_2O$
15.98	52.15	4.30	18.57	3.096	13.364	Na_2CrO_4
6.39	67.82	1.95	27.35	1.530	21.477	$Na_2CrO_4 + NaClO_4.H_2O$
-	73.20	-	28.67	-	22.308	$NaClO_4.H_2O$

At 335.8 K

mass %		mol %		molality/mol kg^{-1}		Solid phase
(2)	(1)	(2)	(1)	(2)	(1)	
55.01	-	11.97	-	7.549	-	Na_2CrO_4
4.55	73.13	1.51	32.04	1.259	26.759	$Na_2CrO_4 + NaClO_4$
-	74.33	-	29.88	-	23.649	$NaClO_4$

[a] Compiler's calculation.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Periods of equilibrium varied from several hours at 62.8°C to 15-25 days at 25°C. Na^+ was determined as sodium zinc uranyl acetate; CrO_4^{2-} iodimetrically. Solid phase was analysed microscopically, the decomposition curves were recorded with Kurnakov's pyrometer.

SOURCE AND PURITY OF MATERIALS:

(1) was reagent grade and (2) was pure (no details). The salts were twice recrystallized. Analysis gave: (1) 99.78 %;
(2) 99.92 - 100.00 %.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium dichromate; $Na_2Cr_2O_7$; [10558-01-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Sal'nikova, L.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *78*, 65-70.

VARIABLES:

One temperature: 298.2 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$Na_2Cr_2O_7$-H_2O at 298.2 K:

Liquid phase composition						Solid phase
mass %		mol %		molality/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
65.16	-	11.40	-	7.139	-	$Na_2Cr_2O_7 \cdot 2H_2O$
64.06	1.78	11.35	0.67	7.158	0.426	"
62.68	4.69	11.45	1.83	7.332	1.174	"
53.26	15.50	9.85	6.13	6.508	4.052	"
45.63	27.95	9.32	12.21	6.592	8.640	"
36.16	36.87	7.13	15.55	5.118	11.165	"
33.37	40.80	6.72	17.59	4.931	12.901	"
31.89	42.90	6.50	18.72	4.829	13.898	"
32.02	42.98	6.57	18.86	4.889	14.041	$Na_2Cr_2O_7 \cdot 2H_2O$ + $NaClO_4 \cdot H_2O$
23.23	49.04	4.37	19.75	3.198	14.444	$NaClO_4 \cdot H_2O$
18.04	53.26	3.28	20.74	2.399	15.156	"
12.74	57.94	2.26	22.02	1.659	16.139	"
4.15	59.90	0.63	19.56	0.441	13.608	"
0.87	67.14	0.14	23.56	0.104	17.141	"
-	67.80	-	23.65	-	17.197	"

[a] Compiler's calculation

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Equilibrium was reached in 4-6 days. Na^+ was determined with zinc uranyl acetate. $Cr_2O_7^{2-}$ iodimetrically; ClO_4^- by difference. Solid compositions were determined by Schreinemakers' method.

SOURCE AND PURITY OF MATERIALS:

Not stated

ESTIMATED ERROR:

Temperature: ± 0.1 K

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium phosphate; Na_3PO_4; [7601-54-9]

(3) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Babayan, G.G.; Darbinyan, G.M.

Arm. Khim. Zh. ,1972, *25*, 482-7.

VARIABLES:

One temperature: 293 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-Na_3PO_4-H_2O at 293 K:

Liquid phase composition						Solid phase
mass %		mol %[a]		molality[a]/mol kg^{-1}		
(2)	(1)	(2)	(1)	(2)	(1)	
0.39	58.40	0.09	17.24	0.058	11.574	$NaClO_4.H_2O$
0.40	52.80	0.08	14.23	0.052	9.214	solid solutions[b]
0.47	47.70	0.09	11.92	0.055	7.516	"
2.14	41.60	0.38	9.78	0.232	6.039	"
1.80	41.35	0.31	9.64	0.193	5.940	"
2.54	35.87	0.42	7.86	0.252	4.757	"
2.90	34.70	0.47	7.53	0.283	4.542	"
3.20	26.00	0.47	5.10	0.276	2.999	$Na_3PO_4.12H_2O$
4.80	21.80	0.68	4.16	0.399	2.426	"
12.46	9.80	1.70	1.79	0.978	1.030	"
18.42	4.48	2.54	0.83	1.457	0.475	"
14.46	8.20	1.98	1.51	1.140	0.866	"
23.90	1.60	3.39	0.30	1.957	0.175	"

[a] Compiler's calculation.

[b] Composition not known.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Isothermal method was used. Periods of equilibration were 5-7 days. Phosphate ion was detrmined by precipitating with ammonium molybdate in acidic solution; perchlorate ion gravimetrically. The composition of the solid phase was determined by Schreinemakers' method of residues . The composition of the solid phase was confirmed by thermographic, optical crystallographic and X-ray diffraction methods.

SOURCE AND PURITY OF MATERIALS:

The original salts were reagent grade and were chemically pure.

ESTIMATED ERROR:

Not stated.

REFERENCES:

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium Chloride; [7647-14-5]

(3) Ammonia; NH_3; [7664-41-7]

ORIGINAL MEASUREMENTS:

Marshall, P.R.; Hunt, H.

J. Chem. Eng. Data 1959, *4*, 217-22.

VARIABLES:

Temperature: 240 - 323 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $NaCl-NaClO_4-H_2O$ at various temperatures, the solid phase being a mixture of the anhydrous salts :

t/ °C	g / 100g(3)		molality/ mol kg^{-1}		mol % (compiler)	
	(2)	(1)	(2)	(1)	(2)	(1)
-33	1.88	236	0.322	19.25	0.411	24.61
0	0.20	298.4	0.0343	24.4	0.041	29.32
25	0.222	299	0.038	24.4	0.046	29.36
50	-	310.0	-	25.3	-	30.13

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility determinations were carried out using a specially constructed apparatus (diagram given in original paper), involving a gas line connected to the saturation cell. The cell consisted of two compartments separated by a sintered glass partition, the larger one of which was connected to the gas line in such a way that the cell could be inverted, with either one of the compartments vertically above the other. Weighed amts of the salts were sealed in the smaller compartment of the cell which was then connected to the gas line via the larger compartment. Excess of dry ammonia was condensed in the cell until the salts had all dissolved at the set temperature. The coolants used were dry ice and CCl_4. The cell was thermostated in a liquid NH_3 bath for -33 °C determinations, in an ice + water bath for 0 °C, and in a water bath for the other temperatures. Ammonia was bled from the solution until salt crystals were formed, and the cell inverted so that the solution filtered through the partition into the larger compartment. After filtration the ammonia in the solution was all removed by condensation into a reservoir in the apparatus and determined quantitatively by absorption in std. HCl sln and back-titrated with std. base. The cell was then opened and the solids removed for analysis. Chloride was determined by titration with $AgNO_3$ using dichlorofluorescein as indicator.

SOURCE AND PURITY OF MATERIALS:

Not stated. Ammonia was dried with sodium.

ESTIMATED ERROR: Reproducibility (3 detn) is within ± 2 % of the mean value in most cases.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-07]

(2) Ammonium perchlorate; NH_4ClO_4 [7790-98-9]

(3) Ammonia; NH_3; [7664-41-7]

ORIGINAL MEASUREMENTS:

Marshall, P.R.; Hunt, H.

J. Chem. Eng. Data 1959, *4*, 217-22.

VARIABLES:

Temperature: 240 - 323 K.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-NH_4ClO_4-NH_3 at various temperatures, the solid phase being a mixture of the anhydrous salts :

t/ °C	g / 100g(3)		molality/ mol kg^{-1}		mol % (compiler)	
	(1)	(2)	(1)	(2)	(1)	(2)
-33	210.3	42.5	17.1	3.6	21.60	4.55
0	241.7	45.7	19.75	3.89	23.97	4.72
25	267.0	47.0	21.8	4.00	25.80	4.73
50	292.2	49.6	23.8	4.22	27.49	4.86

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility determinations were carried out using a specially constructed apparatus (diagram given in original paper), involving a gas line connected to the saturation cell. The cell consisted of two compartments separated by a sintered glass partition, the larger one of which was connected to the gas line in such a way that the cell could be inverted, with either one of the compartments vertically above the other. Weighed amts of the salts were sealed in the smaller compartment of the cell which was then connected to the gas line via the larger compartment. Excess of dry ammonia was condensed in the cell until the salts had all dissolved at the set temperature. The coolants used were dry ice and CCl_4. The cell was thermostated in a liquid NH_3 bath for -33 °C determinations, in an ice + water bath for 0 °C, and in a water bath for the other temperatures. Ammonia was bled from the solution until salt crystals were formed, and the cell inverted so that the solution filtered through the partition into the larger compartment. After filtration the ammonia in the solution was all removed by condensation into a reservoir in the apparatus and determined quantitatively by absorption in std. HCl sln and back-titrated with std. base. The cell was then opened and the solids removed for analysis. Ammonium ion was determined by a standard Kjeldahl procedure.

SOURCE AND PURITY OF MATERIALS:

Not stated. Ammonia was dried with sodium.

ESTIMATED ERROR: Reproducibility (3 detn) is within ± 2 % of the mean value in most cases.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$ [7601-89-0]

(2) Water; H_2O; [7732-18-5]

(3) *Alcohols*:

  (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]

  (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]

  (C) 1-Butanol (*n-butyl alcohol*): $C_4H_{10}O$; [71-36-3]

(4) Ethyl acetate; $C_4H_8O_2$; [141-78-6]

ORIGINAL MEASUREMENTS:

Smith, G.F.

J. Am. Chem. Soc. 1925, *47*, 762-9.

VARIABLES:

One temperature: 298.2 K

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility of sodium perchlorate in alcohol-ethyl acetate mixtures at 25.0 °C :

			Volume %				
Alcohol :	0	5	10	20	30	40	50
Ethyl acetate :	100	95	90	80	70	60	50
Alcohol used			mass %($NaClO_4$)^b				
methanol	8.80	-	19.39	23.37	25.85	27.81	29.38
ethanol (abs.)	"	13.83	16.05	18.55	19.66	20.08	20.07
ethanol (93 %)	"	14.12	16.92	20.00	21.75	22.79	23.30
1-butanol	"	-	12.34	13.16	-	12.82	11.99
1-butanol^a	"	11.97	13.00	14.32	14.75	14.71	13.98
			mass %($NaClO_4.H_2O$)^c				
ethanol (abs.)	26.32	-	29.32	31.16	32.44	33.26	33.63

(continued next page)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The experimental technique used was essentially the same as that reported in ref.2 (see compilation). Duplicate measurements were made.

SOURCE AND PURITY OF MATERIALS:

Sodium perchlorate monohydrate was prepared by recrystallization of the salt from its aqueous sln below 50 °C, filtered centrifugally and dried at room temp. in contact with excess of the anhydrous salt. The anhydrous salt was prepared in the same manner

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$ [7601-89-0]

(2) Water; H_2O; [7732-18-5]

(3) *Alcohols*:

- (A) Methanol (*methyl alcohol*); CH_4O; [67-56-1]
- (B) Ethanol (*ethyl alcohol*); C_2H_6O; [64-17-5]
- (C) 1-Butanol (*n-butyl alcohol*); $C_4H_{10}O$; [71-36-3]

(4) Ethyl acetate; $C_4H_8O_2$; [141-78-6]

ORIGINAL MEASUREMENTS:

Smith, G.F.

J. Am. Chem. Soc. 1925, *47*, 762-9.

EXPERIMENTAL VALUES: (continued)

Solubility of sodium perchlorate in alcohol-ethyl acetate mixtures at 25.0 °C :

	Volume %					
Alcohol :	60	70	80	90	95	100
Ethyl acetate :	40	30	20	10	5	0
Alcohol used	mass %($NaClO_4$)[b]					
methanol	30.50	31.61	32.56	33.44	-	34.33
ethanol (abs.)	19.67	18.78	17.53	15.82	14.80	12.83
ethanol (93 %)	23.39	22.73	21.92	20.96	21.31	20.60
1-butanol	10.54	-	6.70	4.35	-	2.19
1-butanol[a]	13.09	11.66	9.85	7.87	6.97	4.27
	mass %($NaClO_4 \cdot H_2O$)[c]					
ethanol (abs.)	33.61	33.20	32.56	31.56	31.10	29.80

[a] Same quality as that reported in ref. 1.

[b] Solute and solid phase were the anhydrous salt.

[c] Solute and solid phase were the monohydrate.

AUXILIARY INFORMATION

SOURCE AND PURITY OF MATERIALS: (continued)

as that reported in ref.2. Analysis yielded 12.87 % water of crystallization for the hydrate prepared, compared to the theoretical value of 12.82 % for the monohydrate. Ethyl acetate and 1-butanol were prepared as reported in ref.2. Technical methyl alcohol was dried over solid KOH and distilled before used (2). 93 % ethanol was dehydrated with lime to 99.6 % before being made anhydrous by reaction with a slight excess of Ca metal. B.p. of the ethanol thus obtained was 78.29 - 78.31 °C.

ESTIMATED ERROR: Precision in soly not stated. Temperature ± 0.1 °C.

REFERENCES:

1. Smith, G.F. *J. Am. Chem. Soc.* 1923, *45*, 2072.
2. Willard, H.H.; Smith, G.F. *J. Am. Chem. Soc.* 1923, *45*, 286.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Hexamethylenetetramine; $C_6H_{12}N_4$ [100-97-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Sal'nikova, L.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1973, *120*, 120-5.

VARIABLES:

Temperature: 298 K

Composition

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-NH_4ClO_4-$C_6H_{12}O_4$-water at 25 °C :

Liquid phase composition									
mass %			mol % [a]			molality[a]/ mol kg^{-1}			Solid
(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	phase[b]
-	22.66	22.78	-	5.700	4.802	-	3.535	2.978	A + B
-	6.96	43.27	-	1.892	9.86	-	1.190	6.202	B + C
-	6.07	46.12	-	1.703	10.84	-	1.081	6.881	C + D
16.35	-	43.46	4.99	-	11.59	3.323	-	7.714	D + E
54.47	-	13.67	19.25	-	4.220	13.96	-	3.061	E + F
67.11	-	5.44	25.97	-	1.839	19.97	-	1.414	F + G
66.82	1.62	-	23.61	0.597	-	17.29	0.437	-	G + H
61.92	2.70	-	20.29	0.922	-	14.29	0.650	-	A + H
9.25	4.09	41.94	2.61	1.204	10.35	1.689	0.778	6.690	B + C + D
14.15	3.71	41.12	4.25	1.162	10.79	2.817	0.770	7.151	B + D + E
42.39	3.23	15.95	13.21	1.049	4.34	9.009	0.715	2.961	A + B + E
50.87	3.58	12.79	17.64	1.294	3.87	12.682	0.930	2.785	A + E + F
61.38	2.21	5.45	22.01	0.826	1.707	16.192	0.608	1.256	A + F + G
65.18	1.95	2.58	23.67	0.738	0.818	17.575	0.548	0.608	A + G + H

[a] Compiler's calculations.

[b] A = NH_4ClO_4; B = $NH_4ClO_4 \cdot C_6H_{12}N_4$; C = $NH_4ClO_4 \cdot 2C_6H_{12}N_4$;
D = $C_6H_{12}N_4$; E = $NaClO_4 \cdot C_6H_{12}N_4$; F = $5(NaClO_4) \cdot 2(C_6H_{12}N_4) \cdot 3H_2O$;
G = $NaClO_4 \cdot H_2O$; H = $n(NH_4ClO_4) \cdot m(NaClO_4)$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method of "invariant points" used; to the satd slns corresponding to the eutonic and transition points of the ternary systems, relevant salt or hexamethylenetetramine was added until a new solid phase appeared. Periods of equilibration varied from 2 weeks to 1 month.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(3) Hexamethylenetetramine; $C_6H_{12}N_4$ [100-97-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

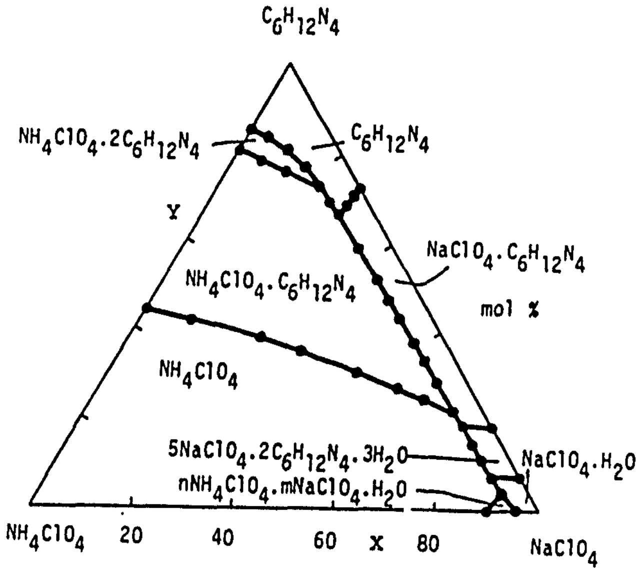
Lepeshkov, I.N.; Sal'nikova, L.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1973, *120*, 120-5.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA

The diagram given below, in which solute mol % values are plotted, shows eight crystallization fields: NH_4ClO_4; $NH_4ClO_4 \cdot C_6H_{12}N_4$; $NH_4ClO_4 \cdot 2C_6H_{12}N_4$; $C_6H_{12}N_4$; $NaClO_4 \cdot C_6H_{12}N_4$; $5(NaClO_4) \cdot 2(C_6H_{12}N_4) \cdot 3H_2O$; $NaClO_4 \cdot H_2O$; and solid solutions represented by $n(NH_4ClO_4) \cdot m(NaClO_4)$.



$X=100x_1/(x_1+x_2+x_3)$ $Y=100x_3/(x_1+x_2+x_3)$

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Copper perchlorate; $Cu(ClO_4)_2$; [13770-18-8]

(3) Benzamide; C_7H_7NO; [55-21-0]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Bestuzheva, M.M.; Kinderov, A.P.; Karnaukhov, A.S.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1978, *169*, 47-51.

VARIABLES:

Temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$Cu(ClO_4)_2$-$C_6H_5CONH_2$-water at 25 °C :

Liquid phase composition									
mass %			mol % [a]			molality[a]/mol kg^{-1}			Solid
(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	phase[b]
17.68	45.62	-	6.13	7.380	-	3.935	4.736	-	A + B
66.71	-	1.33	23.38	-	0.471	17.05	-	0.344	A + C
-	47.35	4.93	-	6.286	1.42	-	3.781	0.853	C + B
62.73	5.20	9.85	27.74	1.073	4.40	23.06	0.892	3.659	A + C
49.63	15.99	0.74	17.32	2.604	0.26	12.05	1.811	0.182	A + C
35.71	27.41	0.55	12.07	4.321	0.19	8.03	2.875	0.125	A + C
27.57	36.07	0.89	9.63	5.876	0.31	6.35	3.875	0.207	A + C
18.12	43.83	0.76	6.19	6.984	0.26	3.97	4.479	0.168	A + B + C
6.00	50.65	0.95	1.88	7.413	0.30	1.156	4.552	0.185	B + C
8.17	48.50	0.72	2.54	7.046	0.23	1.566	4.337	0.139	B + C
10.24	47.28	0.65	3.23	6.953	0.21	1.999	4.307	0.128	B + C
12.76	45.51	0.82	4.08	6.786	0.26	2.547	4.239	0.165	B + C
16.61	43.85	0.77	5.51	6.789	0.26	3.499	4.310	0.164	B + C

[a] Compiler's calculations.

[b] A = $NaClO_4\cdot H_2O$; B = $Cu(ClO_4)2\cdot 5H_2O$; C = $C_6H_5CONH_2$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Details of saturation method not given. Benzamide was determined by the Kjeldahl method; Cu^{2+} iodimetrically; ClO_4^- by nitron pptn.; Na^+ by difference.

SOURCE AND PURITY OF MATERIALS:

Not stated.

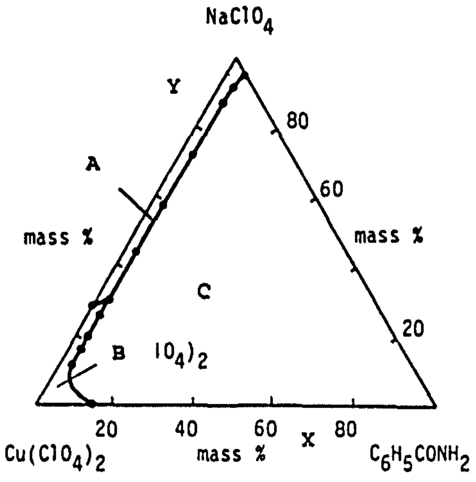
ESTIMATED ERROR:

Not stated.

The eutonic composition (mass %):
18.12 % $NaClO_4$, 43.83 % $Cu(ClO_4)_2$, 0.76 % $C_6H_5CONH_2$ and 37.29 % H_2O.

COMMENTS AND/OR ADDITIONAL DATA:

The diagram below shows three crystallization fields: $NaClO_4.H_2O$, $C_6H_5CONH_2$, and $Cu(ClO_4)_2.5H_2O$.



$X=100x_1/(x_1+x_2+x_3)$ $Y=100x_3/(x_1+x_2+x_3)$

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Nickel perchlorate; $Ni(ClO_4)_2$; [13637-71-3]

(3) Carbamide (*urea*); CH_4N_2O; [57-13-6]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Tarakanov, V.F.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1976, *154*, 35-7.

VARIABLES:

Temperature: 298 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$Ni(ClO_4)_2$-$CO(NH_2)_2$-water at 25 °C :

	Liquid phase composition									
	mass %			mol % [a]			molality[a]/mol kg^{-1}			Solid phase[b]
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	
I	-	51.12	7.58	-	7.582	4.82	-	4.805	3.06	E + F
II	22.66	34.18	6.55	7.526	5.396	4.44	5.055	3.624	2.98	D + E + F
III	62.41	2.37	6.20	22.83	0.412	4.62	17.56	0.317	3.56	D + F + G
IV	31.09	29.42	-	9.92	4.461	-	6.43	2.892	-	D + E
V	-	33.99	29.13	-	4.953	18.21	-	3.578	13.15	F + G
VI	-	20.30	55.63	-	3.366	39.57	-	3.274	38.48	A + G
VII	33.57	1.84	49.47	14.10	0.367	42.37	18.13	0.472	54.48	A + C + G
VIII	46.43	0.86	31.75	18.28	0.161	25.48	18.09	0.159	25.22	B + C + G
IX	59.42	0.99	20.18	25.51	0.202	17.66	25.00	0.198	17.31	B + D + G
X	34.85	-	50.06	14.55	-	42.62	18.86	-	55.24	A + B
XI	46.81	-	32.88	18.58	-	26.61	18.82	-	26.96	B + C
XII	59.69	-	19.71	24.88	-	16.75	23.67	-	15.93	C + D

[a] Compiler's calculations.

[b] A = $CO(NH_2)_2$; B = $NaClO_4 \cdot 2CO(NH_2)_2$; C = $2NaClO_4 \cdot 3CO(NH_2)_2$; D = $NaClO_4 \cdot H_2O$; E = $Ni(ClO_4)_2 \cdot 6H_2O$; F = $Ni(ClO_4)_2 \cdot 4CO(NH_2)_2 \cdot 2H_2O$; G = $Ni(ClO_4)_2 \cdot 6CO(NH_2)_2$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details, but reference given (ref. 1).

SOURCE AND PURITY OF MATERIALS:

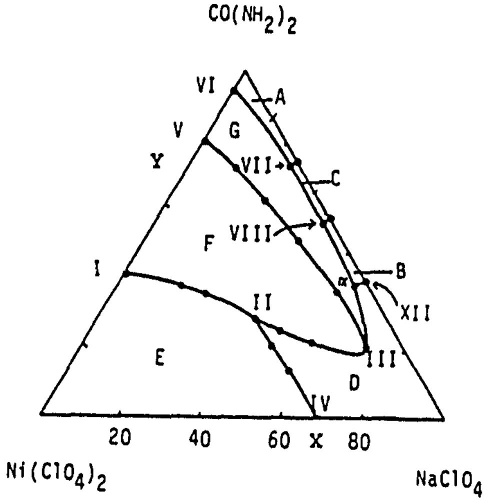
Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Karnaukhov, A.S.; Goryunov, Yu.A.; Tarakanov, V.F. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1970, *79*, 131.



$X = 100x_1/(x_1+x_2+x_3)$ $Y = 100x_3/(x_1+x_2+x_3)$

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium Chlorate; $NaClO_3$; [7775-09-9]

(3) Sodium chloride; NaCl; [7647-14-5]

(4) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

1. Il'in, K.G.; Loseva, G.K.; Semchenko, D.P. *Tr. Novoch. Politekhn. Inst.* 1969, *197*, 37-44.
2. Loseva, K.G.; Semchenko, D.P.; Il'in, K.G. *Tr. Novoch. Politekhn. Inst.* 1969, *197*, 45-49.
3. Loseva, G.K. *Tr. Novoch. Politekhn. Inst.* 1969, *197*, 78-81.

VARIABLES:

Temperature: 313.2 K and 333.2 K.

Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $NaClO_4$-$NaClO_3$-NaCl-water at 40.0 °C :

Liquid phase composition

mass %			mol %[a]			molality[a]/mol kg^{-1}			Solid phase[b]
(3)	(2)	(1)	(3)	(2)	(1)	(3)	(2)	(1)	
11.80	34.70	0.00	5.77	9.32	0.00	3.77	6.09	0.00	A + B
10.60	33.00	4.60	5.33	9.11	1.10	3.50	5.99	0.73	A + B
9.90	31.80	7.20	5.04	8.88	1.75	3.31	5.85	1.15	A + B
9.20	30.80	10.90	4.83	8.87	2.73	3.21	5.89	1.81	A + B
8.80	29.80	12.40	4.63	8.61	3.11	3.07	5.71	2.07	A + B
8.00	29.70	13.90	4.26	8.68	3.53	2.83	5.77	2.35	A + B
7.00	27.40	18.90	3.83	8.24	4.94	2.56	5.51	3.31	A + B
6.20	26.30	22.30	3.48	8.12	5.98	2.35	5.47	4.03	A + B
5.90	20.20	23.70	3.09	5.80	5.92	2.01	3.78	3.86	A + B
5.70	25.00	27.60	3.40	8.18	7.85	2.34	5.63	5.41	A + B
4.80	23.50	30.80	2.91	7.82	8.91	2.01	5.40	6.15	A + B
3.90	18.80	32.70	2.23	5.91	8.94	1.50	3.96	5.99	A + B
3.10	18.00	40.70	1.98	6.32	12.43	1.39	4.43	8.70	A + B
2.50	17.10	43.90	1.65	6.21	13.85	1.17	4.40	9.82	A + B
2.10	15.30	48.60	1.46	5.83	16.11	1.06	4.23	11.67	A + B
1.70	14.20	51.20	1.21	5.54	17.37	0.88	4.05	12.71	A + B
1.60	13.70	51.20	1.12	5.29	17.18	0.82	3.84	12.48	A + B
1.70	13.20	51.40	1.19	5.08	17.18	0.86	3.68	12.46	A + B
1.50	14.10	53.30	1.11	5.71	18.77	0.83	4.26	14.00	A + B
1.30	12.80	55.40	0.97	5.26	19.78	0.73	3.94	14.83	A + B
1.20	12.20	55.50	0.89	4.95	19.58	0.66	3.69	14.57	A + B
1.00	11.70	58.40	0.77	4.98	21.60	0.59	3.80	16.50	A + B + C
2.00	0.00	63.70	1.39	0.00	21.16	1.00	0.00	15.17	A + C
2.00	3.10	63.40	1.47	1.25	22.23	1.09	0.92	16.44	A + C
1.40	3.50	62.40	1.01	1.38	21.40	0.73	1.01	15.59	A + C
1.30	4.70	61.60	0.94	1.86	21.25	0.69	1.36	15.53	A + C
1.20	7.30	61.00	0.90	3.01	21.85	0.67	2.25	16.33	A + C
1.10	11.40	58.80	0.86	4.87	21.84	0.66	3.73	16.73	A + B + C
0.00	11.40	59.80	0.00	4.88	22.26	0.00	3.72	16.96	B + C
0.90	11.10	59.20	0.70	4.74	21.96	0.53	3.62	16.79	B + C
1.00	11.50	59.00	0.78	4.94	22.01	0.60	3.79	16.91	A + B + C
1.00	11.20	58.30	0.77	4.71	21.29	0.58	3.57	16.14	A + B + C

[a] Compiler's calculations.

[b] A = NaCl; B = $NaClO_3$; C = $NaClO_4.H_2O$.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]
(2) Sodium Chlorate; $NaClO_3$; [7775-09-9]
(3) Sodium chloride; $NaCl$; [7647-14-5]
(4) Water; $H2O$; [7732-18-5]

ORIGINAL MEASUREMENTS:

1. Il'in, K.G.; Loseva,G.K.; Semchenko, D.P. *Tr. Novoch. Politekhn. Inst.* 1969, *197*, 37-44.
2. Loseva, K.G.; Semchenko, D.P.; Il'in, K.G. *Tr. Novoch. Politekhn. Inst.* 1969, *197*, 45-49.
3. Loseva, G.K. *Tr. Novoch. Politekhn. Inst.* 1969, *197*, 78-81.

EXPERIMENTAL VALUES: (continued)

Solubility system $NaClO_4$-$NaClO_3$-NaCl-water at 60.0 °C :

Liquid phase composition

mass %			mol x^a			molality^a/mol kg^{-1}			Solid phase^b
(3)	(2)	(1)	(3)	(2)	(1)	(3)	(2)	(1)	
6.30	45.80	4.80	3.63	14.49	1.32	2.50	9.98	0.91	A + B
5.00	41.00	12.90	2.99	13.48	3.69	2.08	9.37	2.56	A + B
4.10	36.40	21.40	2.60	12.66	6.47	1.84	8.98	4.59	A + B
3.20	32.90	27.70	2.11	11.89	8.70	1.51	8.54	6.25	A + B
2.80	30.40	32.30	1.91	11.37	10.50	1.39	8.28	7.65	A + B
2.30	27.50	37.60	1.63	10.70	12.72	1.21	7.93	9.42	A + B
2.00	25.80	40.10	1.43	10.16	13.73	1.07	7.55	10.20	A + B
1.80	24.00	42.60	1.31	9.56	14.75	0.97	7.14	11.01	A + B
1.40	21.60	48.50	1.09	9.20	17.96	0.84	7.12	13.90	A + B
1.20	19.40	52.20	0.96	8.52	19.93	0.75	6.70	15.67	A + B
1.10	18.40	53.70	0.89	8.16	20.71	0.70	6.45	16.36	A + B
1.00	18.30	55.10	0.83	8.35	21.84	0.67	6.72	17.58	A + B
0.90	17.00	57.60	0.77	7.96	23.46	0.63	6.52	19.20	A + B
0.80	16.00	59.60	0.70	7.67	24.83	0.58	6.37	20.63	A + B
0.70	15.30	61.50	0.63	7.54	26.34	0.53	6.39	22.32	A + B + D
0.80	3.80	69.80	0.67	1.75	27.94	0.53	1.39	22.27	A + D
0.70	13.10	65.20	0.65	6.71	29.05	0.57	5.86	25.36	A + D

[a] Compiler's calculations.

[b] A = NaCl; B = $NaClO_3$; C = $NaClO_4.H_2O$; D = $NaClO_4$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Saturation details not given.

Satd. slns. reached equilibrium in 24 h at 40 °C. ClO_3^- was determined by titration with $KMnO_4$ std. sln. in the presence of Mohr's salt; perchlorate determined chromatographically (no details). The composition of the solid phase was determined by Schreinemakers' method and optical crystallography and X-ray powder analysis were employed.

SOURCE AND PURITY OF MATERIALS:

Chemically pure and reagent grade salts were recrystallized twice; 99.6 - 99.9 % pure.

ESTIMATED ERROR:

± 0.1 °C in temperature.

COMMENTS: The eutonic composition at 40 °C (mass %): 1.05% NaCl, 11.68% $NaClO_3$ and 58.40% $NaClO_4$.

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Potassium chloride; KCl; [7447-40-7]

(4) Potassium perchlorate; $KClO_4$; [7778-74-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Troitskii, E.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. __1966__, *59*, 8-21.

VARIABLES:

Temperature: 363 K.

Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system Na^+, K^+ || ClO_4^-, Cl^- - water at 90 °C :

Liquid phase composition								Solid
mass %				molality^a / mol kg^{-1}				phase^b
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
0.84	72.75	-	2.71	0.606	25.07	-	0.825	A + B + C
0.83	72.71	-	2.70	0.598	24.99	-	0.820	A + B + C
0.79	72.70	-	2.69	0.567	24.93	-	0.815	A + B + C
0.84	72.75	-	1.56	0.578	23.91	-	0.453	A + B
6.13	47.83	-	2.32	2.399	8.94	-	0.383	A + C
10.20	36.38	-	2.55	3.431	5.841	-	0.362	A + C
12.52	30.41	-	2.74	3.943	4.571	-	0.364	A + C
17.04	19.28	-	3.01	4.806	2.595	-	0.358	A + C
19.73	14.91	-	3.53	5.460	1.969	-	0.412	A + C
23.22	5.70	-	4.48	5.966	0.699	-	0.485	A + C
23.32	-	5.55	4.47	5.986	-	1.117	0.484	A + C
22.02	-	7.82	3.91	5.687	-	1.583	0.426	A + C
20.96	-	10.55	1.96	5.391	-	2.127	0.213	A + C
16.89	-	13.47	0.84	4.201	-	2.626	0.088	A + C
15.71	-	19.96	1.19	4.257	-	4.240	0.136	A + C + D
15.97	-	20.05	1.21	4.353	-	4.284	0.139	A + C + D
15.82	-	20.04	1.20	4.301	-	4.271	0.138	A + C + D
12.23	-	23.27	1.53	3.323	-	4.957	0.175	C + D
8.42	-	26.39	1.67	2.268	-	5.573	0.190	C + D
4.57	-	30.15	1.72	1.230	-	6.362	0.195	C + D
-	73.83	-	2.36	-	25.33	-	0.715	C + B
0.88	67.17	-	-	0.471	17.17	-	-	A + B
16.90	-	20.80	-	4.642	-	4.478	-	A + E
-	-	34.11	2.42	-	-	7.208	0.275	C + E

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method of invariant points used; to a satd eutonic sln of a ternary system a third salt was added until a new solid phase appeared. K^+ was determined by the tetraphenylborate gravimetric method; Na^+ gravimetric-

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Temperature: ± 0.05 °C.

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Potassium chloride; KCl; [7447-40-7]

(4) Potassium perchlorate; $KClO_4$; [7778-74-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Troitskii, E.N.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 8-21.

EXPERIMENTAL VALUES: (continued)

				ion mol % [a]				Solid phase[b]
mol % [a]				Cation		Anion		
(1)	(2)	(3)	(4)	Na^+	K^+	Cl^-	ClO_4^-	
0.74	30.57	-	1.006	96.89	3.11	2.29	97.71	A + B + C
0.73	30.51	-	1.001	96.89	3.11	2.26	97.74	A + B + C
0.69	30.47	-	0.996	96.90	3.10	2.16	97.84	A + B + C
0.72	29.72	-	0.563	98.18	1.82	2.32	97.68	A + B
3.57	13.29	-	0.570	96.73	3.27	20.48	79.52	A + C
5.27	8.97	-	0.555	96.24	3.76	35.61	64.39	A + C
6.12	7.10	-	0.565	95.90	4.10	44.41	55.59	A + C
7.60	4.10	-	0.566	95.39	4.61	61.94	38.06	A + C
8.62	3.11	-	0.650	94.75	5.25	69.63	30.37	A + C
9.52	1.12	-	0.775	93.21	6.79	83.43	16.57	A + C
9.49	-	1.77	0.767	78.90	21.10	93.62	6.38	A + C
9.00	-	2.50	0.674	73.89	26.11	94.47	5.53	A + C
8.52	-	3.36	0.336	69.73	30.27	97.25	2.75	A + C
6.73	-	4.21	0.141	60.75	39.25	98.73	1.27	A + C
6.64	-	6.61	0.212	49.31	50.69	98.42	1.58	A + C + D
6.77	-	6.66	0.216	49.60	50.40	98.41	1.59	A + C + D
6.70	-	6.65	0.214	49.38	50.62	98.42	1.58	A + C + D
5.20	-	7.75	0.274	39.30	60.70	97.93	2.07	C + D
3.57	-	8.77	0.299	28.24	71.76	97.64	2.36	C + D
1.94	-	10.1	0.309	15.80	84.20	97.49	2.51	C + D
-	31.06	-	0.877	97.25	2.75	-	100.00	B + C
0.64	23.47	-	-	100.00	-	2.67	97.33	A + B
7.18	-	6.93	-	50.90	49.10	100.00	-	A + E
-	-	11.44	0.437	-	100.00	96.32	3.68	C + E

[a] Compiler's calculations.

[b] A = NaCl; B = $NaClO_4$; C = $KClO_4$; D = m(KCl).n($KClO_4$)
E = KCl

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

ally as sodium uranyl acetate; perclorate gravimetrically with nitron and chloride mercurimetrically. Optical crystallographic and differential thermal analyses of the solid phases were carried out.

REFERENCES:

COMPONENTS:

(1) Sodium chromate; Na_2CrO_4; [7775-11-3]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Potassium chromate; K_2CrO_4; [7789-00-6]

(4) Potassium perchlorate; $KClO_4$; [7778-74-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1966, *59*, 73-82.

VARIABLES:

Temperature: 323 K.
Composition.

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $2Na^+, 2K^+ \parallel 2ClO_4^-, CrO_4^{2-}$ - water at 50 °C :

Point	Liquid phase composition								Solid
	mass %				molality[a] / mol kg^{-1}				phase[b]
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
I	-	-	40.95	0.55	-	-	3.605	0.068	A + B
	2.59	-	37.66	0.46	0.270	-	3.271	0.056	A + B
II	6.04	-	37.32	-	0.658	-	3.393	-	B + C
III	5.78	-	35.28	0.49	0.611	-	3.108	0.061	A + B + C
	7.64	-	34.63	0.44	0.823	-	3.113	0.055	A + C
	15.56	-	28.35	0.58	1.731	-	2.630	0.075	A + C
	20.86	-	20.36	0.49	2.209	-	1.799	0.061	A + C
	27.62	-	13.40	0.52	2.917	-	1.180	0.064	A + C
	37.73	-	8.52	0.53	4.377	-	0.824	0.072	A + C
IV	44.35	-	5.87	-	5.500	-	0.607	-	C + D
V	49.92	-	2.61	1.06	6.641	-	0.290	0.165	A + C + D

(continued next page)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

This solubility study involved isothermal recrystallization and crystallization from supersaturated solutions. Details of saturation were not given. Sodium was determined gravimetrically as sodium zinc uranyl acetate and by flame photometry; potassium as potassium tetraphenylborate; chromate iodimetrically and perchlorate by difference.

SOURCE AND PURITY OF MATERIALS:

The chemically "pure" salts were purified by recrystallization. The hydrates of sodium salts were dehydrated (no details given).

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium chromate; Na_2CrO_4; [7775-11-3]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Potassium chromate; K_2CrO_4; [7789-00-6]

(4) Potassium perchlorate; $KClO_4$ [7778-74-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Druzhinina, G.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. <u>1966</u>, *59*, 73-82.

EXPERIMENTAL VALUES: (continued)

Solubility system $2Na^+, 2K^+ \,||\, 2ClO_4^-, CrO_4^{2-}$ - water at 50 °C :

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	molality[a] / mol kg^{-1} (1)	(2)	(3)	(4)	Solid phase[b]
	48.06	2.61	-	0.49	6.075	0.436	-	0.072	A + D
	48.15	5.14	-	0.33	6.409	0.905	-	0.051	A + D
	42.59	13.42	-	0.33	6.023	2.510	-	0.055	A + D
	39.58	18.21	-	0.25	5.824	3.544	-	0.043	A + D
	29.42	31.06	-	0.36	4.638	6.478	-	0.066	A + D
	24.82	39.03	-	0.29	4.273	8.889	-	0.058	A + D
VI	19.69	47.82	-	0.27	3.773	12.12	-	0.060	A + D + E
VII	19.47	47.02	-	-	3.587	11.46	-	-	D + E
	15.58	51.64	-	0.31	2.962	12.99	-	0.069	A + E
	10.93	58.54	-	0.32	2.234	15.83	-	0.076	A + E
	7.87	64.06	-	0.40	1.756	18.91	-	0.104	A + E
VIII	6.70	65.60	-	0.49	1.520	19.69	-	0.130	A + E + F
IX	6.41	67.19	-	-	1.499	20.79	-	-	E + F
	3.28	69.14	-	0.51	0.748	20.86	-	0.136	A + F
X	-	72.65	-	0.61	-	22.19	-	0.165	A + F

Point	Liquid phase composition mol %[a] (1)	(2)	(3)	(4)	ion mol %[a] Cation $2Na^+$	$2K^+$	Anion CrO_4^{2-}	$2ClO_4^-$	Solid phase[b]
I	-	-	6.09	0.115	-	100.00	99.07	0.93	A + B
	0.46	-	5.53	0.095	7.56	92.44	99.22	0.78	A + B
II	1.11	-	5.70	-	16.25	83.75	100.00	-	B + C
III	1.03	-	5.24	0.102	16.29	83.71	99.19	0.81	A + B + C
	1.38	-	5.23	0.093	20.77	79.23	99.30	0.70	A + C
	2.89	-	4.39	0.126	39.35	60.65	99.14	0.86	A + C
	3.71	-	3.02	0.102	54.71	45.29	99.25	0.75	A + C
	4.89	-	1.98	0.108	70.64	29.36	99.22	0.78	A + C
	7.20	-	1.36	0.118	83.57	16.43	99.31	0.69	A + C
IV	8.93	-	0.99	-	90.06	9.94	100.00	-	C + D
V	10.61	-	0.46	0.263	94.70	5.30	98.82	1.18	A + C + D
	9.78	0.70	-	0.117	99.43	0.57	95.98	4.02	A + D
	10.19	1.44	-	0.082	99.63	0.37	93.06	6.94	A + D
	9.40	3.92	-	0.085	99.63	0.37	82.44	17.56	A + D
	8.97	5.46	-	0.066	99.72	0.28	76.45	23.55	A + D
	6.95	9.71	-	0.099	99.58	0.42	58.64	41.36	A + D
	6.22	12.93	-	0.085	99.67	0.33	48.85	51.15	A + D

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium chromate; Na_2CrO_4; [7775-11-3] (2) Sodium perchlorate; $NaClO_4$; [7601-89-0] (3) Potassium chromate; K_2CrO_4; [7789-00-6] (4) Potassium perchlorate; $KClO_4$ [7778-74-7] (5) Water; H_2O; [7732-18-5]	Druzhinina, G.V. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1966, *59*, 73-82.

EXPERIMENTAL VALUES: (continued)

	mol % [a]				ion mol % [a]				Solid phase[b]
					Cation		Anion		
Point	(1)	(2)	(3)	(4)	$2Na^+$	$2K^+$	CrO_4^{2-}	$2ClO_4^-$	
VI	5.28	16.96	-	0.085	99.69	0.31	38.25	61.75	A + D + E
VII	5.08	16.24	-	-	100.00	-	38.50	61.50	D + E
	4.14	18.16	-	0.096	99.64	0.36	31.21	68.79	A + E
	3.03	21.49	-	0.104	99.62	0.38	21.93	78.07	A + E
	2.30	24.79	-	0.137	99.54	0.46	15.59	84.41	A + E
VIII	1.98	25.62	-	0.169	99.43	0.57	13.30	86.70	A + E + F
IX	1.93	26.72	-	-	100.00	-	12.61	87.39	E + F
	0.97	27.00	-	0.176	99.40	0.60	6.65	93.35	A + F
X	-	28.50	-	0.211	99.26	0.74	-	100.00	A + F

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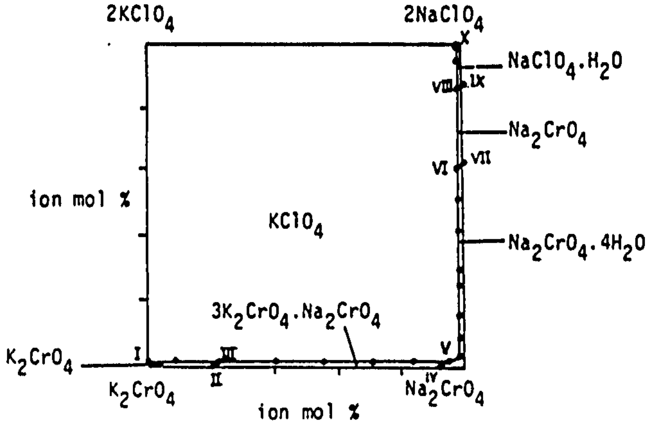
[a] Compiler's calculations

[b] A = $KClO_4$; B = K_2CrO_4; C = $Na_2CrO_4 . 3K_2CrO_4$; D = $Na_2CrO_4 . 4H_2O$; E = Na_2CrO_4; F = $NaClO_4 . H_2O$.

COMMENTS / ADDITIONAL DATA

The Janecke diagram given below shows six crystallization fields : $KClO_4$; $NaClO_4 . H_2O$; Na_2CrO_4; $Na_2CrO_4 . 4H_2O$, $Na_2CrO_4 . 3K_2CrO_4$ and K_2CrO_4. Points I, II, VII, IX and X correspond to the average compositions of the liquid phases of the isothermal double saturation points of the ternary systems, e.g. point II in the system K_2CrO_4-Na_2CrO_4-H_2O and point VII in the system $NaClO_4$-Na_2CrO_4-H_2O. Compositions of triple saturation points III, V, VI, VIII are given in the preceding tables. Potassium perchlorate was nearly completely salted out from solution by all the other salts of the system. The equilibrium of the exchange reaction $2NaClO_4 + K_2CrO_4 = 2KClO_4 + Na_2CrO_4$ was shifted to the right.



COMPONENTS:

(1) Sodium chloride; $NaCl$; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Cesium chloride; $CsCl$; [7647-17-8]

(4) Cesium perchlorate; $CsClO_4$; [13454-84-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shklovskaya, R.M.; Arkhipov, S.M.; Kuzina, V.A.

Zh. Neorg. Khim. 1974, *19*, 3128-33; **Russ. J. Inorg. Chem.* Engl. Transl.) 1974, *19*, 1711-4.

VARIABLES:

Temperature: 298.2 K and 348.2 K.
Composition.

PREPARED BY:

W.L. Ng

EXPERIMENTAL VALUES:

Solubility system $Na^+, Cs^+ \parallel Cl^-, ClO_4^-$, water at 25.0 °C :

Liquid phase composition								Solid phase[b]
mass %				mol %[a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
-	-	64.794	0.494	-	-	16.633	0.0919	A + B
0.316	-	62.528	0.321	0.2232	-	15.329	0.0570	B + C
1.373	-	60.770	0.267	0.9503	-	14.601	0.0465	B + C
3.838	-	56.644	0.260	2.5430	-	13.029	0.0433	B + C
4.042	-	56.311	0.258	2.6691	-	12.908	0.0429	B + C
5.823	-	51.593	0.274	3.6155	-	11.120	0.0428	B + C
8.160	-	46.492	0.342	4.7891	-	9.472	0.0505	B + C
10.753	-	44.893	-	6.3170	-	9.155	-	B + C
10.034	-	41.502	0.220	5.5436	-	7.959	0.0306	C + D
12.652	-	34.262	0.272	6.4569	-	6.070	0.0349	B + C + D

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of saturation method were given. A thermostat maintained the temperature constant to within ± 0.1°C. Equilibrium was attained after 2-3 weeks at 25°C and 7-15 days at 75°C. Cs^+ was analysed by precipitation with sodium tetraphenylborate (ref. 1); Cl^- by argentometric method (ref. 2); ClO_4^- by precipitation with nitron (ref.3) for concentrations higher than 1.5%, otherwise by photometry involving the use of

SOURCE AND PURITY OF MATERIALS:

The salts were at least 99.5 % pure.

ESTIMATED ERROR:

Temperature: ± 0.1°C.
Solubility : not stated.

REFERENCES:

1. Yanson, E.Yu.; Ievin'sh, A.F. *Uspekhi Khim.* 1953, *28*, 980.
2. Hillebrand, W. F.; Lundell G.E.F.; Bright, H.A. ; Hoffman, J.I. *Applied Inorganic Analysis*, Goskhimizdat, Moscow, 1964, 745

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Cesium chloride; CsCl; [7647-17-8]

(4) Cesium perchlorate; $CsClO_4$; [13454-84-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shklovskaya, R.M.; Arkhipov, S.M.; Kuzina, V.A.

Zh. Neorg. Khim. 1974, *19*, 3128-33; **Russ. J. Inorg. Chem.* Engl. Transl.) 1974, *19*, 1711-4.

EXPERIMENTAL VALUES: (continued)

Solubility system $Na^+, Cs^+ \| Cl^-, ClO_4^-$, water at 25.0 °C : (continued)

Liquid phase composition								Solid phase[b]
				ion mol %[a]				
molality[a] / mol kg^{-1}				cation		anion		
(1)	(2)	(3)	(4)	Na^+	Cs^+	Cl^-	ClO_4^-	
-	-	11.087	0.0612	-	100.00	99.45	0.55	A + B
0.147	-	10.083	0.0375	1.43	98.57	99.63	0.37	B + C
0.625	-	9.602	0.0306	6.09	93.91	99.70	0.30	B + C
1.673	-	8.570	0.0285	16.29	83.71	99.72	0.28	B + C
1.756	-	8.492	0.0282	17.09	82.91	99.73	0.27	B + C
2.355	-	7.243	0.0279	24.46	75.54	99.71	0.29	B + C
3.102	-	6.136	0.0327	33.46	66.54	99.65	0.35	B + C
4.148	-	6.012	-	40.83	59.17	100.00	-	B + C
3.559	-	5.110	0.0196	40.96	59.04	99.77	0.23	C + D
4.099	-	3.853	0.0222	51.40	48.60	99.72	0.28	B + C + D
4.845	-	1.990	0.0203	70.67	29.33	99.70	0.30	B + D
5.042	-	1.495	0.0191	76.91	23.09	99.71	0.29	B + D
5.333	-	0.781	0.0238	86.89	13.11	99.61	0.39	B + D
5.553	-	0.307	0.0424	94.08	5.92	99.28	0.72	B + D
5.672	-	-	0.1396	97.60	2.40	97.60	2.40	B + D
5.968	0.495	-	0.0449	99.31	0.69	91.71	8.29	B + D
5.491	1.073	-	0.0283	99.57	0.43	83.30	16.70	B + D
4.710	1.776	-	0.0204	99.69	0.31	72.39	27.61	B + D
3.927	3.245	-	0.0343	99.52	0.48	54.49	45.51	B + D + E
1.898	4.985	-	0.0380	99.45	0.55	27.42	72.58	B + E
1.051	5.516	-	0.0419	99.37	0.63	15.91	84.09	B + E
-	6.362	-	0.0433	99.32	0.68	-	100.00	B + E
-	7.360	-	0.0454	99.39	0.61	-	100.00	E + F
0.243	6.109	-	0.0372	99.42	0.58	3.80	96.20	E + F
1.113	4.813	-	0.0261	99.56	0.44	18.69	81.31	E + F
1.478	4.758	-	0.0223	99.64	0.36	23.61	76.39	E + F
3.500	4.964	-	0.0280	99.67	0.33	41.22	58.78	D + E + F
2.797	6.847	-	0.0261	99.73	0.27	28.93	71.07	D + F
2.555	7.405	-	0.0210	99.79	0.21	25.60	74.40	D + F
1.745	9.544	-	0.0214	99.81	0.19	15.43	84.57	D + F
1.195	12.445	-	0.0233	99.83	0.17	8.75	91.25	D + F
0.678	16.725	-	0.0352	99.80	0.20	3.89	96.11	D + F + G
0.278	17.720	-	0.0379	99.79	0.21	1.54	98.46	F + G
-	18.019	-	0.0180	99.90	0.10	-	100.00	F + G
0.675	15.187	-	-	100.00	-	4.25	95.75	D + G

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COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Cesium chloride; CsCl; [7647-17-8]

(4) Cesium perchlorate; $CsClO_4$; [13454-84-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Shklovskaya, R.M.; Arkhipov, S.M.; Kuzina, V.A.

Zh. Neorg. Khim. 1974, *19*, 3128-33; **Russ. J. Inorg. Chem.* Engl. Transl.) 1974, *19*, 1711-4.

EXPERIMENTAL VALUES: (continued)

Solubility system $Na^+,Cs^+ \parallel Cl^-,ClO_4^-$, water at 25.0 °C : (continued)

Liquid phase composition								Solid
mass %				mol %[a]				phase[b]
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
17.448	-	20.646	0.290	7.7694	-	3.191	0.0325	B + D
19.001	-	16.230	0.286	8.1238	-	2.409	0.0308	B + D
21.515	-	9.075	0.381	8.6512	-	1.267	0.0385	B + D
23.412	-	3.731	0.710	9.0417	-	0.500	0.0690	B + D
24.305	-	-	2.378	9.2503	-	-	0.2276	B + D
24.567	4.266	-	0.734	9.6237	0.798	-	0.0723	B + D
21.997	9.003	-	0.451	8.8418	1.727	-	0.0456	B + D
18.381	14.522	-	0.316	7.5944	2.864	-	0.0328	B + D
14.037	24.306	-	0.488	6.2610	5.175	-	0.0547	B + D + E
6.411	35.277	-	0.511	3.040	7.984	-	0.0609	B + E
3.518	38.667	-	0.558	1.693	8.879	-	0.0675	B + E
-	43.540	-	0.563	-	10.275	-	0.0700	B + E
-	47.138	-	0.552	-	11.698	-	0.0722	E + F
0.801	42.240	-	0.488	0.392	9.870	-	0.0601	E + F
3.916	35.492	-	0.365	1.810	7.831	-	0.0424	E + F
5.158	34.801	-	0.309	2.392	7.704	-	0.0360	E + F
11.247	33.415	-	0.358	5.469	7.756	-	0.0438	D + E + F
8.142	41.754	-	0.302	4.292	10.506	-	0.0400	D + F
7.246	43.994	-	0.237	3.902	11.307	-	0.0321	D + F
4.483	51.352	-	0.219	2.612	14.283	-	0.0321	D + F
2.688	58.628	-	0.208	1.728	17.991	-	0.0336	D + F
1.280	66.152	-	0.264	0.929	22.928	-	0.0482	D + F + G
0.508	67.914	-	0.276	0.378	24.094	-	0.0516	F + G
-	68.722	-	0.130	-	24.501	-	0.0244	F + G
1.360	64.144	-	-	0.945	21.279	-	-	D + G

[a] Compiler's calculations.

[b] A = CsCl; B = $CsClO_4$; C = $Cs_{1-x}Na_xCl$; D = NaCl;
E = $3CsClO_4.NaClO_4$; F = $CsClO_4.NaClO_4$; G = $NaClO_4.H_2O$; H = $NaClO_4$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Brilliant Green and benzene (refs. 4,5); Na^+ by difference. Solid phases were identified by Schreinmakers' method and by x-ray diffraction.

REFERENCES:

3. Loebich, O. *Z. Analyt. Chem.* 1926, *68*, 34.
4. Golonitskaia, V.A. ; Petrashen, V.I. *Zh. Anal.Khim.* 1962, *17*, 848

5. Golonitskaia, V.A. ; Petrashen, V.I. *Zh. Tr. Novoch. Politekhn. Inst.* 1964, *141*, 65.

(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium chloride; NaCl; [7647-14-5] (2) Sodium perchlorate; $NaClO_4$; [7601-89-0] (3) Cesium chloride; CsCl; [7647-17-8] (4) Cesium perchlorate; $CsClO_4$; [13454-84-7] (5) Water; H_2O; [7732-18-5]	Shklovskaya, R.M.; Arkhipov, S.M.; Kuzina, V.A. *Zh. Neorg. Khim.* 1974, *19*, 3128-33; **Russ. J. Inorg. Chem.* Engl. Transl.) 1974, *19*, 1711-4.

EXPERIMENTAL VALUES: (continued)

Solubility system $Na^+,Cs^+ \| Cl^-,ClO_4^-$, water at 75.0 °C :

Liquid phase composition								Solid
mass %				mol %[a]				phase[b]
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
-	-	67.717	2.518	-	-	19.476	0.5247	A + B
6.157	-	59.744	-	4.477	-	15.081	-	C + D
6.787	-	57.734	1.402	4.928	-	14.551	0.2560	B + C + D
24.021	-	-	8.446	9.795	-	-	0.8663	B + D
5.706	44.779	-	3.346	3.211	12.028	-	0.4736	B + D + F
-	55.976	-	3.397	-	16.765	-	0.5361	B + F
-	74.185	-	0.539	-	30.125	-	0.1153	F + H
0.889	73.798	-	0.56	0.763	30.219	-	0.1200	D + H + F
0.881	75.116	-	-	0.769	31.286	-	-	D + H

Liquid phase composition								Solid
				ion mol %[a]				phase[b]
molality[a] / mol kg^{-1}				cation		anion		
(1)	(2)	(3)	(4)	Na^+	Cs^+	Cl^-	ClO_4^-	
-	-	13.513	0.364	-	100.00	97.38	2.62	A + B
3.090	-	10.407	-	22.89	77.11	100.00	0.00	C + D
3.408	-	10.063	0.177	24.97	75.03	98.70	1.30	B + C + D
6.086	-	-	0.538	91.87	8.13	91.87	8.13	B + D
2.115	7.921	-	0.312	96.99	3.01	20.44	79.56	B + D + F
-	11.253	-	0.360	96.90	3.10	-	100.00	B + F
-	23.971	-	0.092	99.62	0.38	-	100.00	H + F
0.614	24.346	-	0.097	99.61	0.39	2.45	97.55	D + H + F
0.628	25.559	-	-	100.00	-	2.40	97.60	D + H

[a] Compiler's calculations.

[b] A = CsCl; B = $CsClO_4$; C = $Cs_{1-x}Na_xCl$; D = NaCl;
E = $3CsClO_4.NaClO_4$; F = $CsClO_4.NaClO_4$; G = $NaClO_4.H_2O$; H = $NaClO_4$

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 43-52.

EXPERIMENTAL VALUES: (continued)

Solubility system Na^+, NH_4^+ || ClO_4^-, Cl^- - water at 25 °C :

Liquid phase composition								Solid
mol % [a]				ion mol % [a]				phase[b]
(1)	(2)	(3)	(4)	Na^+	NH_4^+	Cl^-	ClO_4^-	
0.808	-	10.74	1.123	6.38	93.62	91.13	8.87	A + B
1.609	-	10.09	0.859	12.81	87.19	93.16	6.84	A + B
2.205	-	9.75	0.813	17.27	82.73	93.64	6.36	A + B
2.415	-	10.02	0.749	18.32	81.68	94.32	5.68	A + B
4.052	-	8.39	0.658	30.94	69.06	94.98	5.02	A + B
6.066	-	7.35	0.919	42.33	57.67	93.59	6.41	A + B
6.561	-	7.02	0.965	45.12	54.88	93.37	6.63	A + B
6.759	-	6.64	1.018	46.89	53.11	92.94	7.06	A + B + C
6.740	-	6.63	0.975	46.98	53.02	93.20	6.80	A + B + C
6.725	-	6.62	0.962	47.01	52.99	93.28	6.72	A + B + C
7.524	-	5.02	1.315	54.29	45.71	90.51	9.49	B + C
8.111	-	3.68	1.302	61.97	38.03	90.06	9.94	B + C
9.511	-	0.207	2.664	76.82	23.18	78.49	21.51	B + C
7.832	2.60	-	1.783	85.41	14.59	64.11	35.89	B + C
6.856	4.42	-	1.495	88.30	11.70	53.68	46.32	B + C
5.938	5.49	-	1.247	90.16	9.84	46.84	53.16	B + C
5.767	5.82	-	1.228	90.42	9.58	45.00	55.00	B + C
4.295	9.92	-	1.310	91.56	8.44	27.66	72.34	B + C
3.049	12.35	-	1.109	93.28	6.72	18.47	81.53	B + C
2.137	15.09	-	0.948	94.78	5.22	11.76	88.24	B + C
1.983	17.05	-	1.002	95.00	5.00	9.89	90.11	B + C + D
1.649	17.79	-	1.000	95.11	4.89	8.07	91.93	B + D + E
1.625	18.25	-	1.032	95.06	4.94	7.77	92.23	B + D + E
1.593	18.72	-	1.070	95.00	5.00	7.45	92.55	B + D + E
0.270	18.72	-	0.879	95.57	4.43	1.36	98.64	B + E
0.906	19.63	-	0.952	95.57	4.43	4.22	95.78	B + E
6.37	-	7.061	0.337	46.27	53.73	97.55	2.45	A + C
6.75	-	6.673	0.948	46.97	53.03	93.40	6.60	A + C

[a] Compiler's calculations.

[b] A = NH_4Cl; B = NH_4ClO_4; C = NaCl; D = $NaClO_4.H_2O$; E = $n(NH_4ClO_4).m(NaClO_4.H_2O)$

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COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 43-52.

VARIABLES:

Temperature: 298 K and 308 K.
Composition.

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system Na^+, NH_4^+ || ClO_4^-, Cl^- - water at 25 °C :

Liquid phase composition								Solid phase[b]
mass %				molality[a] / mol kg^{-1}				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
2.03	-	24.68	5.67	0.514	-	6.823	0.714	A + B
4.07	-	23.37	4.37	1.021	-	6.407	0.545	A + B
5.56	-	22.51	4.12	1.403	-	6.206	0.517	A + B
6.06	-	23.01	3.78	1.544	-	6.406	0.479	A + B
10.17	-	19.27	3.32	2.588	-	5.358	0.420	A + B
14.78	-	16.38	4.50	3.931	-	4.759	0.595	A + B
15.90	-	15.56	4.70	4.262	-	4.556	0.627	A + B
16.38	-	14.72	4.96	4.383	-	4.304	0.660	A + B + C
16.37	-	14.74	4.76	4.368	-	4.297	0.632	A + B + C
16.35	-	14.73	4.70	4.356	-	4.288	0.623	A + B + C
18.21	-	11.12	6.40	4.848	-	3.235	0.848	B + C
19.84	-	8.23	6.40	5.180	-	2.348	0.831	B + C
22.61	-	0.45	12.73	6.025	-	0.131	1.687	B + C
17.83	12.41	-	8.16	4.953	1.645	-	1.127	B + C
14.90	20.13	-	6.53	4.363	2.813	-	0.951	B + C
12.67	24.55	-	5.35	3.775	3.491	-	0.793	B + C
12.19	25.78	-	5.22	3.672	3.706	-	0.782	B + C
7.99	38.67	-	4.90	2.822	6.520	-	0.861	B + C
5.36	45.48	-	3.92	2.027	8.211	-	0.738	B + C
3.51	51.93	-	3.13	1.450	10.237	-	0.643	B + C
3.08	55.50	-	3.13	1.376	11.838	-	0.696	B + C + D
2.52	56.94	-	3.07	1.151	12.411	-	0.697	B + D + E
2.45	57.65	-	3.13	1.140	12.805	-	0.725	B + D + E
2.37	58.37	-	3.20	1.125	13.220	-	0.755	B + D + E
0.41	59.46	-	2.68	0.187	12.967	-	0.609	B + E
1.33	60.34	-	2.81	0.641	13.874	-	0.673	B + E
15.89	-	16.12	1.69	4.101	-	4.545	0.217	A + C
16.40	-	14.84	4.63	4.376	-	4.326	0.614	A + C

(continued next page)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of method given.

SOURCE AND PURITY OF MATERIALS.

Not stated.

ESTIMATED ERROR:

Not stated.

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 43-52.

EXPERIMENTAL VALUES: (continued)

Solubility system Na^+, NH_4^+ || ClO_4^-, Cl^- - water at 35 °C :

Liquid phase composition								Solid
mass %				molality[a] / mol kg^{-1}				phase[b]
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
1.10	68.64	-	-	0.622	18.53	-	-	C + D
1.30	64.55	-	1.95	0.691	16.373	-	0.515	C + D
2.83	55.66	-	3.98	1.290	12.113	-	0.903	B + C + D
-	60.75	-	4.50	-	14.278	-	1.102	B + E
-	67.66	-	2.29	-	18.389	-	0.649	D + E
1.17	59.35	-	3.98	0.564	13.654	-	0.954	B + D + E
5.60	45.80	-	5.22	2.209	8.623	-	1.024	B + C
8.50	37.44	-	6.46	3.055	6.424	-	1.155	B + C
14.06	22.17	-	8.36	4.342	3.268	-	1.284	B + C
20.99	1.74	-	13.51	5.633	0.223	-	1.803	B + C
20.86	-	3.33	10.90	5.499	-	0.959	1.429	B + C
19.13	-	6.93	8.75	5.021	-	1.987	1.142	B + C
17.63	-	11.12	6.92	4.689	-	3.232	0.916	B + C
14.88	-	17.26	5.35	4.073	-	5.162	0.728	A + B + C
15.24	-	17.75	2.87	4.066	-	5.173	0.381	A + C
15.20	-	18.15	-	3.902	-	5.091	-	A + C
12.77	-	19.50	6.61	3.575	-	5.964	0.920	A + B
10.88	-	20.49	6.95	3.018	-	6.210	0.959	A + B
8.42	-	21.58	6.46	2.267	-	6.349	0.865	A + B
4.24	-	24.48	8.02	1.147	-	7.234	1.079	A + B
-	-	28.11	7.12	-	-	8.113	0.936	A + B

Liquid phase composition								Solid
mol % [a]				ion mol % [a]				phase[b]
(1)	(2)	(3)	(4)	Na^+	NH_4^+	Cl^-	ClO_4^-	
0.833	24.82	-	-	100.0	-	3.3	96.8	C + D
0.945	22.40	-	0.705	97.1	2.9	3.9	96.1	C + D
1.85	17.35	-	1.293	93.7	6.3	9.0	91.0	B + C + D
-	20.14	-	1.555	92.8	7.2	-	100.0	B + E
-	24.67	-	0.870	96.6	3.4	-	100.0	D + E
0.798	19.32	-	1.350	93.7	6.3	3.7	96.3	B + D + E
3.279	12.80	-	1.520	91.4	8.6	18.6	81.4	B + C
4.620	9.71	-	1.746	89.1	10.9	28.7	71.3	B + C
6.742	5.07	-	1.994	85.6	14.4	48.8	51.2	B + C
8.917	0.353	-	2.855	76.5	23.6	73.5	26.5	B + C
8.674	-	1.51	2.255	69.7	30.3	81.9	18.1	B + C
7.888	-	3.12	1.795	61.6	38.4	86.0	14.0	B + C
7.288	-	5.02	1.423	53.1	46.9	89.6	10.4	B + C
6.221	-	7.88	1.113	40.9	59.1	92.7	7.3	A + B + C
6.242	-	7.94	0.585	42.3	57.7	96.0	4.0	A + C
6.050	-	7.89	-	43.4	56.6	100.0	-	A + C
5.419	-	9.04	1.395	34.2	65.8	91.2	8.8	A + B
4.594	-	9.45	1.460	29.6	70.4	90.6	9.4	A + B
3.489	-	9.77	1.331	23.9	76.1	90.9	9.1	A + B
1.765	-	11.15	1.661	12.1	87.9	88.6	11.4	A + B
-	-	12.57	1.449	-	100.0	89.7	10.3	A + B

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COMPONENTS:

(1) Sodium chloride; $NaCl$; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *79*, 43-52.

EXPERIMENTAL VALUES: (continued)

[a] Compiler's calculations.

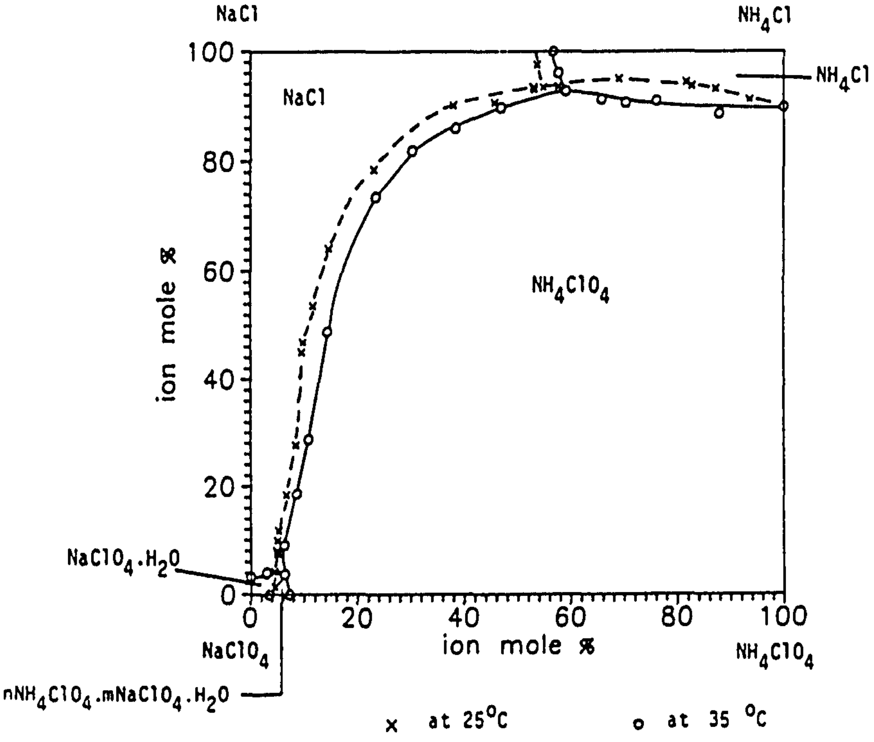
[b] A = NH_4Cl; B = NH_4ClO_4; C = $NaCl$; D = $NaClO_4.H_2O$; E = $n(NH_4ClO_4).m(NaClO_4.H_2O)$

COMMENTS AND/OR ADDITIONAL DATA

The phase diagrams shown below for both temperatures for this system show five crystallization fields: $NaClO_4.H_2O$; $NaCl$; NH_4Cl; NH_4ClO_4; and solid solutions of the type represented by $n(NH_4ClO_4).m(NaClO_4.H_2O)$. Increase in temperature causes a slight increase in the NaCl and NH_4Cl crystallization fields and a decrease in the $NaClO_4.H_2O$ and NH_4ClO_4 crystallization fields. The equilibrium of the reaction

$$NaClO_4 + NH_4Cl = NaCl + NH_4ClO_4$$

is shifted in the direction of formation of ammonium perchlorate.



COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium chloride; NaCl; [7647-14-5] (2) Sodium perchlorate; $NaClO_4$; [7601-89-0] (3) Ammonium chloride; NH_4Cl; [12125-02-9] (4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9] (5) Water; H_2O; [7732-18-5]	Karnaukhov, A.S.; Kudryakova, S.A. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1971, *95*, 3-7.
VARIABLES:	PREPARED BY:
Temperature: 363 K Composition	N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system Na^+, NH_4^+ || ClO_4^-, Cl^- - water at 90 °C :

	Liquid phase composition								Solid
Point	mass %				molality[a] / mol kg^{-1}				phase[b]
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
1	0.56	-	33.54	17.36	0.197	-	12.92	3.044	A + B
2	2.14	-	31.93	17.50	0.756	-	12.33	3.076	A + B
3	5.24	-	28.89	17.48	1.85	-	11.16	3.075	A + B
4	7.50	-	27.46	17.36	2.69	-	10.77	3.099	A + B
5	8.67	-	26.63	16.45	3.07	-	10.32	2.902	A + B + C
6	8.83	-	26.75	15.60	3.09	-	10.24	2.720	A + B + C
7	9.33	-	26.43	15.80	3.30	-	10.20	2.776	A + B + C
8	9.33	-	25.77	17.82	3.39	-	10.23	3.222	A + B + C
9	10.58	-	23.66	13.21	3.44	-	8.42	2.140	A + C
10	12.23	-	17.10	19.98	4.13	-	6.31	3.355	A + C
11	16.61	-	6.72	23.30	5.33	-	2.35	3.716	A + C
12	17.75	-	4.48	24.54	5.71	-	1.57	3.924	A + C
13	23.47	4.05	-	34.92	10.69	0.881	-	7.913	A + C
14	17.45	11.40	-	26.89	6.75	2.104	-	5.171	A + C
15	9.10	28.60	-	18.80	3.58	5.370	-	3.678	A + C
16	6.03	38.93	-	15.04	2.58	7.949	-	3.200	A + C
17	4.61	43.99	-	13.06	2.06	9.371	-	2.899	A + C
18	1.20	69.03	-	3.72	0.79	21.64	-	1.215	A + C + D
19	0.97	71.48	-	4.44	0.72	25.26	-	1.635	A + E
20	1.11	70.34	-	4.10	0.78	23.50	-	1.427	A + D + E
21	1.17	70.52	-	4.44	0.84	24.13	-	1.583	A + D + E
22	11.62	-	30.35	4.27	3.70	-	10.55	0.676	B + C
I	-	-	34.12	17.46	-	-	13.17	3.069	A + B
II	12.70	-	31.50	-	3.89	-	10.55	-	B + C
III	0.87	67.31	-	-	0.47	17.28	-	-	C + D
IV	-	78.28	-	3.63	-	35.34	-	1.708	D + E
V	-	68.13	-	6.28	-	21.74	-	2.089	A + E
VI	9.16	-	24.16	16.42	3.12	-	8.99	2.781	A + B + C
VII	1.20	69.03	-	3.72	0.79	21.64	-	1.215	A + C + D
VIII	1.11	70.34	-	4.20	0.78	23.60	-	1.468	A + D + E

[a] Compiler's calculations.

[b] A = NH_4ClO_4; B = NH_4Cl; C = NaCl;
D = $NaClO_4$; E = $n(NH_4ClO_4).m(NaClO_4)$.
Points I-VIII are nodal points of this quaternary aqueous reciprocal system.

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1971, *95*, 3-7.

EXPERIMENTAL VALUES: (continued)

Solubility system Na^+, NH_4^+ || ClO_4^-, Cl^- - water at 90 °C :

Point	Liquid phase composition mol %[a] (1)	(2)	(3)	(4)	ion mol %[a] Na^+	NH_4^+	Cl^-	ClO_4^-	Solid phase[b]
1	0.275	-	18.02	4.247	1.22	98.78	81.16	18.84	A + B
2	1.055	-	17.20	4.292	4.68	95.32	80.96	19.04	A + B
3	2.588	-	15.59	4.294	11.52	88.48	80.89	19.11	A + B
4	3.735	-	14.94	4.300	16.26	83.74	81.28	18.72	A + B
5	4.282	-	14.37	4.041	18.87	81.13	82.19	17.81	A + B + C
6	4.324	-	14.31	3.800	19.27	80.73	83.06	16.94	A + B + C
7	4.591	-	14.21	3.868	20.25	79.75	82.94	17.06	A + B + C
8	4.687	-	14.14	4.453	20.13	79.87	80.88	19.12	A + B + C
9	4.956	-	12.11	3.078	24.60	75.40	84.72	15.28	A + C
10	5.957	-	9.10	4.841	29.94	70.06	75.67	24.33	A + C
11	7.960	-	3.52	5.554	46.73	53.27	67.39	32.61	A + C
12	8.553	-	2.36	5.882	50.93	49.07	64.97	35.03	A + C
13	14.257	1.174	-	10.552	59.39	40.61	54.87	45.13	A + C
14	9.703	3.026	-	7.437	63.12	36.88	48.11	51.89	A + C
15	5.253	7.881	-	5.399	70.87	29.13	28.35	71.65	A + C
16	3.726	11.481	-	4.622	76.69	23.31	18.79	81.21	A + C
17	2.946	13.418	-	4.152	79.76	20.24	14.36	85.64	A + C
18	0.996	27.342	-	1.54	94.86	5.14	3.33	96.67	A + C + D
19	0.864	30.390	-	1.97	94.08	5.92	2.60	97.40	A + E
20	0.957	28.933	-	1.76	94.45	5.55	3.02	96.98	A + D + E
21	1.022	29.404	-	1.93	94.04	5.96	3.16	96.84	A + D + E
22	5.251	-	14.98	0.960	24.77	75.23	95.47	4.53	B + C
I	-	-	18.36	4.278	-	100.00	81.10	18.90	A + B
II	5.567	-	15.09	-	26.95	73.05	100.00	-	B + C
III	0.639	23.585	-	-	100.00	-	2.64	97.36	C + D
IV	-	38.183	-	1.845	95.39	4.61	-	100.00	D + E
V	-	27.406	-	2.633	91.24	8.76	-	100.00	A + E
VI	4.430	-	12.77	3.950	20.95	79.05	81.32	18.68	A + B + C
VII	0.996	27.342	-	1.536	94.86	5.14	3.33	96.67	A + C + D
VIII	0.959	29.002	-	1.805	94.32	5.68	3.02	96.98	A + D + E

[a] Compiler's calculations.

[b] A = NH_4ClO_4; B = NH_4Cl; C = NaCl;
D = $NaClO_4$; E = $n(NH_4ClO_4).m(NaClO_4)$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

No details of method given. Na^+ was determined by precipitating as sodium uranyl acetate; Cl^- was determined mercurimetrically; ClO_4^- gravimetrically by precipitation with nitron; and NH_4^+ by the volumetric formalin method (ref. 1).

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Kudryakova, S.A.

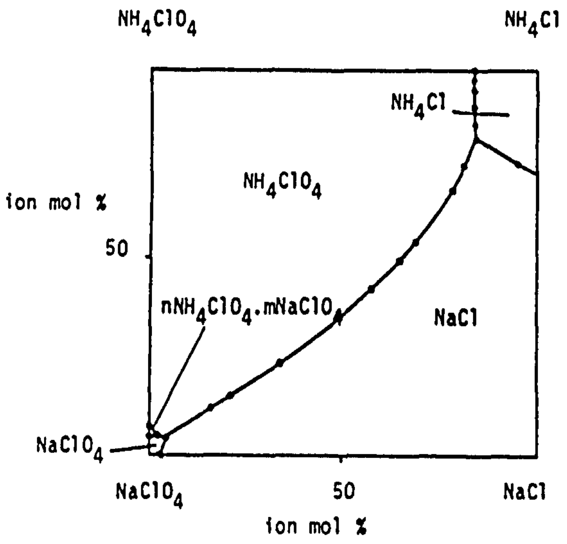
Uch. Zap. Yarosl. Gos. Ped. Inst. 1971, *95*, 3-7.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA

The solubility diagram given below shows five crystallization fields: NaCl, $NaClO_4$, NH_4Cl, NH_4ClO_4 and solid solutions represented by $n(NH_4ClO_4).m(NaClO_4)$.

Three triple points were found that corresponded to equilibria with the following combination of solid phases: (point VI) NaCl + NH_4Cl + NH_4ClO_4, (point VII) $NaClO_4$ + NaCl + NH_4ClO_4, and (point VIII) $NaClO_4$ + NH_4ClO_4 + $n(NH_4ClO_4).m(NaClO_4)$.



AUXILIARY INFORMATION

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Karnaukhov, A.S.; Kudryakova, S.A. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1970, *79*, 32.

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium sulfate; Na_2SO_4; [7757-82-6]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium sulfate; $(NH_4)_2SO_4$; [7783-20-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Freeth, F.A.

Rec. Trav. Chim. Pays-Bas 1924, 43, 475-507

VARIABLES:

Two temperatures: 298 K and 333 K. Composition.

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $2NH_4^+$, $2Na^+$ || $2ClO_4^-$, SO_4^{2-} - H_2O at 25 °C :

Liquid phase composition								Solid
mass %				mol % [a]				phase[b]
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
-	-	3.00	41.70	-	-	0.749	9.253	A + B
-	3.47	2.71	39.55	-	0.727	0.687	8.910	A + B
-	6.87	2.66	37.38	-	1.465	0.686	8.570	A + B + C
-	8.20	-	38.70	-	1.750	-	8.880	B + C
-	6.83	2.28	37.69	-	1.455	0.587	8.628	A + C
-	9.82	2.84	30.70	-	1.993	0.697	6.696	A + C
-	14.69	3.48	22.47	-	2.874	0.823	4.726	A + C
-	20.39	4.30	15.08	-	3.946	1.006	3.137	A + C
-	21.81	4.07	14.10	-	4.234	0.955	2.942	A + C
-	24.38	4.36	11.59	-	4.756	1.028	2.431	A + D + C
-	25.76	-	14.10	-	5.001	-	2.943	D + C
-	24.97	1.60	13.15	-	4.836	0.375	2.738	D + C
-	9.84	3.85	28.90	-	1.975	0.934	6.236	A
-	23.22	7.80	6.56	-	4.366	1.773	1.326	A + D
-	22.45	13.47	-	-	4.127	2.994	-	A + D
12.71	15.79	9.41	-	2.774	2.971	2.141	-	A + D
24.38	10.79	6.73	-	5.597	2.135	1.610	-	A + D
31.21	9.07	-	-	7.015	1.757	-	-	D + E
31.62	6.91	5.74	-	7.487	1.410	1.416	-	A + E
-	25.94	6.09	7.83	-	5.028	1.427	1.632	D + E
67.67	0.26	-	-	23.673	0.078	-	-	E + F
67.42	-	1.51	-	24.065	-	0.562	-	A + F
66.79	0.21	1.50	-	23.632	0.064	0.553	-	A + E + F

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The saturation apparatus was similar to that used by Van't Hoff (ref.1) and samples of clear satd sln were taken using a weight-pipette. Na^+ was determined as Na_2SO_4 by addition of pure sulphuric acid to the sln in

SOURCE AND PURITY OF MATERIALS:

$NaClO_4$ was prepared from very pure ammonium perchlorate (% purity not stated) and an aqueous sln of pure NaOH. Source and other details not given. Na_2SO_4 was recrystallized from the reagent grade salt.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium sulfate; Na_2SO_4; [7757-82-6]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium sulfate; $(NH_4)_2SO_4$; [7783-20-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Freeth, F.A.

Rec. Trav. Chim. Pays-Bas 1924, *43*, 475-507

EXPERIMENTAL VALUES: (continued)

Solubility system $2NH_4^+$, $2Na^+$ || $2ClO_4^-$, SO_4^{2-} - H_2O at 25 °C :

Liquid phase composition								Solid
molality[a]/ mol kg^{-1}				ion mol % [a]				phase[b]
(1)	(2)	(3)	(4)	$2Na^+$	$2NH_4^+$	$2ClO_4^-$	SO_4^{2-}	
-	-	0.462	5.707	-	100.00	3.89	96.11	A + B
-	0.450	0.425	5.515	7.29	92.71	3.44	96.56	A + B
-	0.911	0.426	5.328	14.12	85.88	3.30	96.70	A + B + C
-	1.087	-	5.516	16.47	83.53	-	100.00	B + C
-	0.904	0.365	5.361	14.02	85.98	2.83	97.17	A + C
-	1.221	0.427	4.102	22.05	77.95	3.85	96.15	A + C
-	1.742	0.499	2.865	35.88	64.12	5.14	94.86	A + C
-	2.383	0.608	1.895	52.02	47.98	6.63	93.37	A + C
-	2.558	0.577	1.778	55.32	44.68	6.24	93.76	A + C
-	2.876	0.622	1.470	61.76	38.24	6.68	93.32	A + D + C
-	3.016	-	1.774	62.96	37.04	-	100.00	D + C
-	2.916	0.226	1.651	62.31	37.69	2.41	97.59	D + C
-	1.207	0.571	3.810	22.76	77.24	5.38	94.62	A
-	2.619	1.064	0.795	66.37	33.63	13.48	86.52	A + D
-	2.466	1.789	-	73.38	26.62	26.62	73.38	A + D
1.672	1.790	1.290	-	80.28	19.72	45.27	54.73	A + D
3.427	1.307	0.986	-	85.97	14.03	62.79	37.21	A + D
4.268	1.069	-	-	100.00	-	66.62	33.38	D + E
4.634	0.873	0.877	-	87.92	12.08	75.94	24.06	A + E
-	3.037	0.862	0.985	68.19	31.81	9.68	90.32	D + E
17.23	0.057	-	-	100.00	-	99.34	0.66	E + F
17.72	-	0.414	-	97.72	2.28	100.00	-	A + F
17.32	0.047	0.405	-	97.73	2.27	99.47	0.53	A + E + F

[a] Compiler's calculations.

[b] A = NH_4ClO_4 B = $(NH_4)_2SO_4$ C = $Na_2SO_4.(NH_4)_2SO_4.4H_2O$

D = $Na_2SO_4.10H_2O$ E = Na_2SO_4 F = $NaClO_4.H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: (continued)

silica basins and evaporating at a low red heat. Sulfate was determined gravimetrically as $BaSO_4$. To determine ammonia content, the slns were distilled with excess NaOH and the ammonia distillate absorbed in excess of standard acid solution, followed by back-titration of the acid. All analyses were duplicated. Solid phase compositions were determined using Schreinemakers' method. Gas-heated thermostats were used and thermometers were checked against N.P.L. Standards.

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium sulfate; Na_2SO_4; [7757-82-6]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium sulfate; $(NH_4)_2SO_4$; [7783-20-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Freeth, F.A.

Rec. Trav. Chim. Pays-Bas 1924, 43, 475-507

EXPERIMENTAL VALUES: (continued)

Solubility system $2NH_4^+, 2Na^+ \| 2ClO_4^-, SO_4^{2-} - H_2O$ at 60 °C :

Liquid phase composition								Solid phase[b]
mass %				mol % [a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
-	-	8.21	40.92	-	-	2.181	9.667	A + B
-	5.06	6.79	38.68	-	1.137	1.845	9.346	A + B
-	8.62	6.27	37.07	-	1.982	1.743	9.164	A + B
-	14.51	5.12	34.66	-	3.468	1.480	8.906	A + B + E
-	14.66	4.95	34.65	-	3.503	1.430	8.899	A + B + E
-	15.27	2.77	35.26	-	3.595	0.788	8.924	B + E
-	16.33	-	36.91	-	3.845	-	9.342	B + E
-	17.27	9.86	21.33	-	3.767	2.600	5.001	A + E
-	18.35	16.25	10.51	-	3.806	4.075	2.344	A + E
-	18.60	25.30	-	-	3.784	6.223	-	A + E
10.42	12.52	21.42	-	2.47	2.559	5.294	-	A + E
26.77	4.61	15.36	-	6.55	0.972	3.916	-	A + E
34.87	2.79	12.88	-	9.01	0.622	3.470	-	A + E
44.02	1.44	9.04	-	12.10	0.341	2.589	-	A + E
56.69	0.730	7.11	-	18.54	0.206	2.423	-	A + E
61.24	0.370	5.00	-	20.85	0.109	1.774	-	A + E
72.98	0.240	1.86	-	29.85	0.085	0.793	-	A + E + G
72.86	-	1.87	-	29.55	-	0.790	-	A + G
74.40	0.290	-	-	30.16	0.101	-	-	E + G

Liquid phase composition								Solid phase[b]
molality[a]/ mol kg^{-1}				ion mol % [a]				
(1)	(2)	(3)	(4)	$2Na^+$	$2NH_4^+$	$2ClO_4^-$	SO_4^{2-}	
-	-	1.374	6.088	-	100.00	10.14	89.86	A + B
-	0.720	1.168	5.917	9.97	90.03	8.09	91.91	A + B
-	1.263	1.111	5.840	16.50	83.50	7.25	92.75	A + B
-	2.235	0.953	5.738	26.45	73.55	5.64	94.36	A + B + E
-	2.256	0.921	5.733	26.70	73.30	5.45	94.55	A + B + E
-	2.302	0.505	5.714	27.84	72.16	3.05	96.95	B + E
-	2.459	-	5.974	29.16	70.84	-	100.00	B + E
-	2.359	1.628	3.132	37.41	62.59	12.91	87.09	A + E
-	2.354	2.520	1.449	46.49	53.51	24.89	75.11	A + E
-	2.334	3.838	-	54.88	45.12	45.12	54.88	A + E
1.530	1.584	3.277	-	58.91	41.09	60.27	39.73	A + E
4.105	0.609	2.455	-	68.44	31.56	84.33	15.67	A + E
5.758	0.397	2.216	-	74.72	25.28	90.94	9.06	A + E
7.902	0.223	1.691	-	83.15	16.85	95.56	4.44	A + E
13.05	0.145	1.706	-	88.66	11.34	98.07	1.93	A + E
14.98	0.078	1.275	-	92.23	7.77	99.05	0.95	A + E
23.92	0.068	0.635	-	97.43	2.57	99.45	0.55	A + E + G
23.55	-	0.630	-	97.39	2.61	100.00	-	A + G
24.01	0.081	-	-	100.00	-	99.33	0.67	E + G

(continued next page)

COMPONENTS:

(1) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(2) Sodium sulfate; Na_2SO_4; [7757-82-6]

(3) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(4) Ammonium sulfate; $(NH_4)_2SO_4$; [7783-20-2]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Freeth, F.A.

Rec. Trav. Chim. Pays-Bas 1924, *43*, 475-507

EXPERIMENTAL VALUES: (continued)

[a] Compiler's calculations.

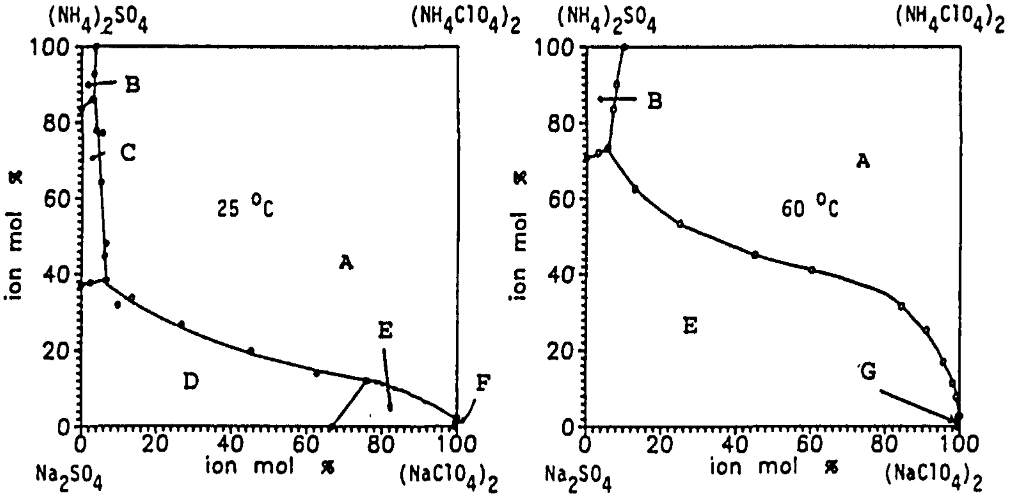
[b] A = NH_4ClO_4 B = $(NH_4)_2SO_4$ C = $Na_2SO_4 \cdot (NH_4)_2SO_4 \cdot 4H_2O$

D = $Na_2SO_4 \cdot 10H_2O$ E = Na_2SO_4 F = $NaClO_4 \cdot H_2O$.

G = $NaClO_4$

COMMENTS AND/OR ADDITIONAL DATA:

The Janecke diagrams for the system $2NH_4^+, 2Na^+ \,||\, 2ClO_4^-, SO_4^{2-} - H_2O$ at 25 °C and 60 °C are shown below.



AUXILLIARY INFORMATION

ESTIMATED ERROR:

Not stated.

REFERENCES:

1. Van't Hoff, J.H. *Zur Bildung der Ozeanischen Salzablagerungen Wieweg, Braunschweig* 1905, *1*; 1902, *2*.

COMPONENTS:

(1) Sodium chromate; Na_2CrO_4; [7775-11-3]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Karnaukhov, A.S.; Molchanov, S.M.

Tr. po Khimii i Khim. Tekhnologii 1966, *2*, 215-18.

VARIABLES:

Temperature: 298 K.
Composition.

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $2Na^+, 2NH_4^+ \,||\, 2ClO_4^-, CrO_4^{2-}$ - water at 25 °C :

	Liquid phase composition								Solid
Point	mass %				molality^a / mol kg^{-1}				phase^b
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
I	-	-	3.85	17.56	-	-	0.322	1.902	A + B
II	-	-	25.50	1.08	-	-	2.284	0.125	B + C
III	16.22	0.39	-	13.16	1.426	0.045	-	1.593	A + B + C
IV	16.19	-	21.61	-	1.607	-	2.285	-	C + D
V	44.95	-	1.50	-	5.182	-	0.184	-	D + E
VI	31.23	2.13	-	8.14	3.296	0.297	-	1.184	A + C + D
VII	38.71	8.15	-	2.93	4.760	1.326	-	0.497	A + D + E
VIII	7.82	53.91	-	-	1.262	11.505	-	-	E + F
IX	6.18	60.70	-	-	1.152	14.968	-	-	F + G
X	9.94	52.72	-	2.08	1.740	12.211	-	0.502	A + E + F
XI	6.99	58.68	-	1.63	1.320	14.656	-	0.424	A + G + H
XII	3.77	61.88	-	1.63	0.711	15.446	-	0.424	F + G + H
XIII	-	66.35	-	1.92	-	17.078	-	0.515	G + H
XIV	-	61.92	-	2.56	-	14.237	-	0.613	A + H

[a] Compiler's calculations.

[b] A = NH_4ClO_4; B = $NH_4ClO_4 \cdot (NH_4)_2CrO_4$; C = $(NH_4)_2CrO_4$;
D = $NaNH_4CrO_4 \cdot 2H_2O$; E = $Na_2CrO_4 \cdot 4H_2O$; F = Na_2CrO_4;
G = $NaClO_4 \cdot H_2O$; H = $nNH_4ClO_4 \cdot mNaClO_4$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method of "invariant points" used. Periods of equilibration varied from 3 to 10 days. Na^+ was determined gravimetrically as $NaZn(UO_2)_3(C_2H_3O_2)_9$; NH_4^+ by the "formalin method"; chromate iodimetrically and perchlorate by difference.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium chromate; Na_2CrO_4; [7775-11-3]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Karnaukhov, A.S.; Molchanov, S.M.

Tr. po Khimii i Khim. Tekhnologii 1966, *2*, 215-18.

EXPERIMENTAL VALUES: (continued)

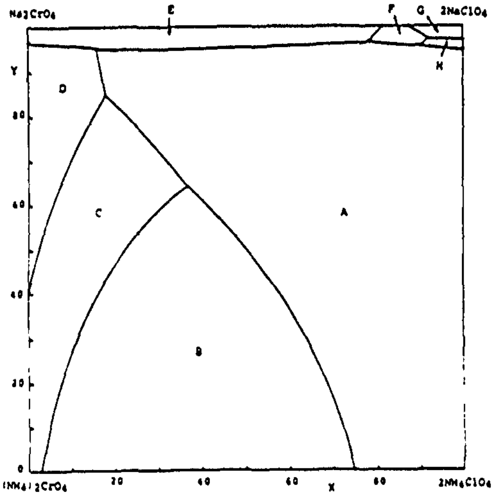
	Liquid phase composition								Solid
Point	mol % a				ion mol %[a]				phase[b]
	(1)	(2)	(3)	(4)	$2Na^+$	$2NH_4^+$	CrO_4^{2-}	$2ClO_4^-$	
I	-	-	0.56	3.294	-	100.00	25.31	74.69	A + B
II	-	-	3.94	0.216	-	100.00	97.33	2.67	B + C
III	2.43	0.08	-	2.720	64.51	35.49	63.50	36.50	A + B + C
IV	2.71	-	3.85	-	41.29	58.71	100.00	-	C + D
V	8.51	-	0.30	-	96.57	3.43	100.00	-	D + E
VI	5.47	0.49	-	1.965	85.33	14.67	81.65	18.35	A + C + D
VII	7.67	2.14	-	0.800	95.62	4.38	83.93	16.07	A + D + E
VIII	1.85	16.85	-	-	100.00	-	17.99	82.01	E + F
IX	1.61	20.90	-	-	100.00	-	13.34	86.66	F + G
X	2.49	17.45	-	0.718	96.90	3.10	21.49	78.51	A + E + F
XI	1.84	20.38	-	0.590	97.61	2.39	14.90	85.10	A + F + H
XII	0.99	21.43	-	0.588	97.55	2.45	8.23	91.77	F + G + H
XIII	-	23.36	-	0.705	97.07	2.93	-	100.00	G + H
XIV	-	20.24	-	0.872	95.87	4.13	-	100.00	A + H

[a] Compiler's calculations.

[b] A = NH_4ClO_4; B = $NH_4ClO_4 \cdot (NH_4)_2CrO_4$; C = $(NH_4)_2CrO_4$; D = $NaNH_4CrO_4 \cdot 2H_2O$; E = $Na_2CrO_4 \cdot 4H_2O$; F = Na_2CrO_4; G = $NaClO_4 \cdot H_2O$; H = $nNH_4ClO_4 \cdot mNaClO_4$.

COMMENTS AND/OR ADDITIONAL DATA

The phase diagram given below shows eight crystallization fields: (a) NH_4ClO_4; (b) $NH_4ClO_4 \cdot (NH_4)_2CrO_4$; (c) $(NH_4)_2CrO_4$; (d) $NaNH_4CrO_4 \cdot 2H_2O$; (e) $Na_2CrO_4 \cdot 4H_2O$; (f) Na_2CrO_4; (g) $NaClO_4 \cdot H_2O$; (h) solid solutions represented by $nNH_4ClO_4 \cdot mNaClO_4$



$X = 100X_{ClO_4}/(X_{ClO_4}+2X_{CrO_4})$

$Y = 100X_{NH_4}/(X_{NH_4}+X_{Na})$

COMPONENTS:

(1) Sodium chromate; Na_2CrO_4; [7775-11-3]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Guseva, A.D.; Druzhinina, G.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *78*, 32-8.

VARIABLES:

Temperature: 308 K.

Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $2Na^+$, $2NH_4^+$ || $2ClO_4^-$, CrO_4^{2-} - water at 35 °C :

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	molality[a] / mol kg^{-1} (1)	(2)	(3)	(4)	Solid phase[b]
I	-	-	3.62	20.45	-	-	0.314	2.292	A + B
	3.84	-	1.11	18.04	0.308	-	0.095	1.994	A + B
	10.53	-	0.71	22.40	0.980	-	0.070	2.873	A + B
II	17.05	-	0.83	14.42	1.555	-	0.081	1.813	A + B + C
	24.10	-	1.76	12.11	2.399	-	0.187	1.662	B + C
III	31.24	-	2.88	7.30	3.292	-	0.323	1.061	B + C + D
	-	-	28.00	1.19	-	-	2.600	0.143	A + C
	2.61	-	25.64	1.11	0.228	-	2.387	0.134	A + C
	4.79	-	17.71	2.40	0.394	-	1.551	0.272	A + C
	11.27	-	4.82	13.87	0.993	-	0.453	1.686	A + C
	15.36	-	3.83	14.59	1.432	-	0.380	1.875	A + C
V	20.36	-	20.45	-	2.124	-	2.272	-	C + D
	26.35	-	11.37	2.93	2.741	-	1.260	0.420	C + D
VI	45.92	-	2.18	-	5.462	-	0.276	-	D + E
	44.66	3.25	-	4.04	5.738	0.552	-	0.716	D + E
VII	36.66	12.67	-	2.57	4.705	2.151	-	0.455	B + D + E
	25.43	26.79	-	4.82	3.655	5.093	-	0.955	B + E
	16.16	36.32	-	4.95	2.344	6.968	-	0.990	B + E
VIII	14.19	40.90	-	5.67	2.233	8.513	-	1.230	B + E + F
	8.38	47.67	-	4.04	1.296	9.755	-	0.862	B + F
IX	-	60.75	-	4.50	-	14.278	-	1.102	B + F
X	11.52	47.24	-	3.91	1.905	10.335	-	0.891	E + F + G
XI	8.63	61.62	-	-	1.791	16.916	-	-	E + G
XII	-	67.64	-	2.33	-	18.396	-	0.660	F + G

[a] Compiler's calculations.

[b] A = $NH_4ClO_4 \cdot (NH_4)_2CrO_4$; B = NH_4ClO_4; C = $(NH_4)_2CrO_4$;
D = $NaNH_4CrO_4 \cdot 2H_2O$; E = $Na_2CrO_4 \cdot 4H_2O$;
F = $n(NH_4ClO_4) \cdot m(NaClO_4 \cdot H_2O)$; G = $NaClO_4 \cdot H_2O$

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: Method of "invariant points" used. Details of method not given. Na^+ was analysed gravimetrically as sodium zinc uranyl acetate; NH_4^+ by distillation and titrimetry; CrO_4^{2-} iodimetrically and ClO_4^- by difference.

(continued next page)

COMPONENTS:

(1) Sodium chromate; Na_2CrO_4; [7775-11-3]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Guseva, A.D.; Druzhinina, G.V.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *78*, 32-8.

EXPERIMENTAL VALUES: (continued)

	Liquid phase composition								Solid
Point	mol % a				ion mol %[a]				phase[b]
	(1)	(2)	(3)	(4)	$2Na^+$	$2NH_4^+$	CrO_4^{2-}	$2ClO_4^-$	
I	-	-	0.539	3.945	-	100.00	21.48	78.52	A + B
	0.532	-	0.164	3.443	22.00	78.00	28.77	71.23	A + B
	1.648	-	0.118	4.834	39.40	60.60	42.23	57.77	A + B
II	2.637	-	0.137	3.075	61.17	38.83	64.34	35.66	A + B + C
	4.014	-	0.312	2.781	70.22	29.78	75.68	24.32	B + C
III	5.471	-	0.537	1.762	79.41	20.59	87.21	12.79	B + C + D
	-	-	4.464	0.246	-	100.00	97.32	2.68	A + C
	0.392	-	4.097	0.230	8.51	91.49	97.51	2.49	A + C
	0.682	-	2.686	0.471	18.93	81.07	93.46	6.54	A + C
	1.694	-	0.772	2.874	43.41	56.59	63.18	36.82	A + C
	2.419	-	0.642	3.168	52.07	47.93	65.90	34.10	A + C
V	3.545	-	3.793	-	48.31	51.69	100.00	-	C + D
	4.574	-	2.102	0.701	65.09	34.91	95.01	4.99	C + D
VI	8.92	-	0.451	-	95.19	4.81	100.00	-	D + E
	9.18	0.884	-	1.145	94.38	5.62	90.05	9.95	D + E
VII	7.49	3.425	-	0.724	96.22	3.78	78.31	21.69	B + D + E
	5.60	7.81	-	1.464	92.85	7.15	54.72	45.28	B + E
	3.56	10.59	-	1.504	92.17	7.83	37.07	62.93	B + E
VIII	3.31	12.62	-	1.822	91.34	8.66	31.43	68.57	B + E + F
	1.92	14.47	-	1.278	93.48	6.52	19.63	80.37	B + F
IX	-	20.14	-	1.555	92.83	7.17	-	100.00	B + F
X	2.78	15.06	-	1.299	94.07	5.93	25.34	74.66	E + F + G
XI	2.41	22.79	-	-	100.00	-	17.47	82.53	E + G
XII	-	24.67	-	0.886	96.53	3.47	-	100.00	F + G

[a] Compiler's calculations.

[b] A = $NH_4ClO_4 \cdot (NH_4)_2CrO_4$; B = NH_4ClO_4; C = $(NH_4)_2CrO_4$;
D = $NaNH_4CrO_4 \cdot 2H_2O$; E = $Na_2CrO_4 \cdot 4H_2O$;
F = $n(NH_4ClO_4) \cdot m(NaClO_4 \cdot H_2O)$; G = $NaClO_4 \cdot H_2O$.

AUXILIARY INFORMATION

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

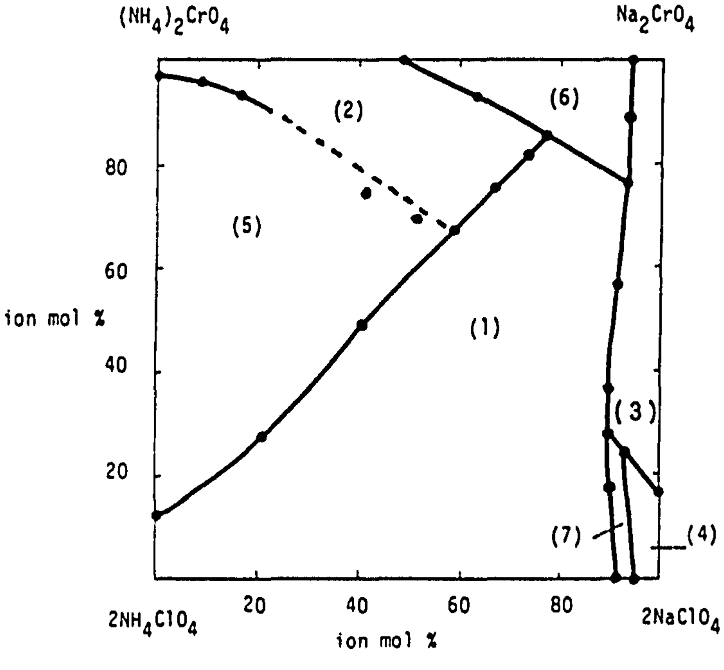
COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium chromate; Na_2CrO_4; [7775-11-3] (2) Sodium perchlorate; $NaClO_4$; [7601-89-0] (3) Ammonium chromate; $(NH_4)_2CrO_4$; [7788-98-9] (4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9] (5) Water; H_2O; [7732-18-5]	Guseva, A.D.; Druzhinina, G.V. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1970, *78*, 32-8.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA

The phase diagram given below for this aqueous reciprocal salts solubility system at 308 K shows seven crystallization fields:

(1) NH_4ClO_4
(2) $(NH_4)_2CrO_4$
(3) $Na_2CrO_4.4H_2O$
(4) $NaClO_4.H_2O$
(5) $NH_4ClO_4.(NH_4)_2CrO_4$
(6) $NaNH_4CrO_4.2H_2O$
(7) solid solutions formed by sodium and ammonium perchlorates.



COMPONENTS:

(1) Sodium dichromate; $Na_2Cr_2O_7$; [10588-01-9]
(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]
(3) Ammonium dichromate; $(NH_4)_2Cr_2O_7$; [7789-09-5]
(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]
(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Sal'nikova, L.N.

Uch. Zap. Yarosl. Gos. Ped. 1970, *79*, 11-5.

VARIABLES:

Temperature: 298 K.
Composition.

PREPARED BY:

N.A. Kozyreva

EXPERIMENTAL VALUES:

Solubility system $2Na^+$, $2NH_4^+$ || $2ClO_4^-$, $Cr_2O_7^{2-}$ - water at 25 °C :

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	molality[a] / mol kg^{-1} (1)	(2)	(3)	(4)	Solid phase[b,c]
P	3.26	64.57	-	2.59	0.421	17.83	-	0.745	A + B + C
	5.08	61.58	-	2.39	0.627	16.25	-	0.657	A + B
	7.06	61.10	-	2.57	0.921	17.05	-	0.747	A + B
	10.47	53.22	-	2.83	1.194	12.98	-	0.719	A + B
	17.62	48.43	-	3.08	2.179	12.81	-	0.849	A + B
	22.44	37.16	-	3.46	2.319	8.22	-	0.797	A + B
	24.87	44.26	-	3.26	3.438	13.09	-	1.005	A + B
Q	32.29	38.50	-	2.72	4.653	11.87	-	0.874	A + B + D
	29.66	39.82	-	3.51	4.192	12.04	-	1.106	A + D
	39.06	28.47	-	4.15	5.265	8.21	-	1.247	A + D
R	44.27	24.07	-	5.08	6.358	7.40	-	1.627	A + D + F
	45.17	21.52	-	5.41	6.180	6.30	-	1.650	D + E
	52.98	14.22	-	7.20	7.900	4.54	-	2.394	D + E
	55.30	11.77	-	9.31	8.937	4.07	-	3.355	D + E
	56.77	8.81	-	7.10	7.932	2.63	-	2.212	D + E
	62.29	3.25	-	7.29	8.751	0.98	-	2.284	D + E
	64.70	-	3.42	3.51	8.706	-	0.478	1.053	D + F
	2.10	-	20.78	12.96	0.125	-	1.285	1.719	A + E
	5.00	-	18.70	12.75	0.300	-	1.167	1.708	A + E
	17.07	-	10.88	15.05	1.143	-	0.757	2.247	A + E
	35.23	-	0.89	16.61	2.845	-	0.075	2.991	A + E
	39.13	7.08	-	11.07	3.496	1.35	-	2.206	A + E
	38.08	7.83	-	9.96	3.294	1.45	-	1.921	A + E
	38.67	12.41	-	8.08	3.614	2.48	-	1.684	A + E
	39.17	14.11	-	7.68	3.830	2.95	-	1.674	A + E

[a] Compiler's calculations.
[c] See critical Evaluation
[b] A = NH_4ClO_4; B = $NaClO_4.H_2O$; C = $nNH_4ClO_4.mNaClO_4.H_2O$; D = $Na_2Cr_2O_7.2H_2O$; E = $n(NH_4)_2Cr_2O_7.mNH_4ClO_4$; F = $(NH_4)_2Cr_2O_7$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method of "invariant points" used; the third salt is added to the saturated sln. corresponding to the eutonic composition of the ternary

SOURCE AND PURITY OF MATERIALS:

Not stated.

(continued next page)

COMPONENTS:

(1) Sodium dichromate; $Na_2Cr_2O_7$; [10588-01-9]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium dichromate; $(NH_4)_2Cr_2O_7$; [7789-09-5]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Sal'nikova, L.N.

Uch. Zap. Yarosl. Gos. Ped. 1970, *79*, 11-5.

EXPERIMENTAL VALUES: (continued)

	Liquid phase composition								Solid phase[b,c]
Point	mol % a				ion mol %[a]				
	(1)	(2)	(3)	(4)	$2Na^+$	$2NH_4^+$	$Cr_2O_7^{2-}$	$2ClO_4^-$	
P	0.565	23.93	-	1.00	96.2	3.8	4.3	95.7	A + B + C
	0.858	22.25	-	0.90	96.4	3.6	6.9	93.1	A + B
	1.240	22.97	-	1.01	96.2	3.8	9.4	90.6	A + B
	1.696	18.44	-	1.02	95.5	4.5	14.8	85.2	A + B
	3.054	17.96	-	1.19	95.3	4.7	24.2	75.8	A + B
	3.469	12.29	-	1.19	94.2	5.8	34.0	66.0	A + B
	4.707	17.92	-	1.38	95.2	4.8	32.8	67.2	A + B
Q	6.382	16.28	-	1.20	96.0	4.0	42.2	57.8	A + B + D
	5.754	16.53	-	1.52	94.9	5.1	38.9	61.1	A + D
	7.497	11.69	-	1.78	93.8	6.2	52.7	47.3	A + D
R	8.969	10.43	-	2.29	92.5	7.5	58.5	41.5	A + D + F
	8.875	9.05	-	2.37	91.9	8.1	60.9	39.1	D + E
	11.231	6.45	-	3.40	89.5	10.5	69.5	30.5	D + E
	12.435	5.66	-	4.67	86.7	13.3	70.7	29.3	D + E
	11.616	3.86	-	3.24	89.3	10.7	76.6	23.4	D + E
	12.961	1.45	-	3.38	89.0	11.0	84.3	15.7	D + E
	13.241	0.00	0.727	1.60	89.7	10.3	94.6	5.4	D + F
	0.213	-	2.19	2.93	5.5	94.5	62.1	37.9	A + E
	0.512	-	1.99	2.91	12.9	87.1	63.2	36.8	A + E
	1.916	-	1.27	3.77	37.8	62.2	62.8	37.2	A + E
	4.632	-	0.122	4.87	64.4	35.6	66.1	33.9	A + E
	5.589	2.16	-	3.53	79.1	20.9	66.3	33.7	A + E
	5.298	2.33	-	3.09	80.7	19.3	66.2	33.8	A + E
	5.711	3.92	-	2.66	85.2	14.8	63.4	36.6	A + E
	5.988	4.61	-	2.62	86.4	13.6	62.3	37.7	A + E

[a] Compiler's calculations.

[c] See critical Evaluation

[b] A = NH_4ClO_4; B = $NaClO_4 . H_2O$; C = $nNH_4ClO_4 . mNaClO_4 . H_2O$;
D = $Na_2Cr_2O_7 . 2H_2O$; E = $n(NH_4)_2Cr_2O_7 . mNH_4ClO_4$; F = $(NH_4)_2Cr_2O_7$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE: (continued)

system until a new solid phase appeared. Sodium was determined by precipitation as sodium zinc uranyl acetate; ammonium ion by distillation of ammonia into satd. boric acid sln. and titrating with 0.05 mol L^{-1} H_2SO_4; dichromate iodimetrically and perchlorate by difference. Solid phases were analysed chemically and examined under a microscope.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium dichromate; $Na_2Cr_2O_7$; [10588-01-9]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Ammonium dichromate; $(NH_4)_2Cr_2O_7$; [7789-09-5]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Lepeshkov, I.N.; Sal'nikova, L.N.

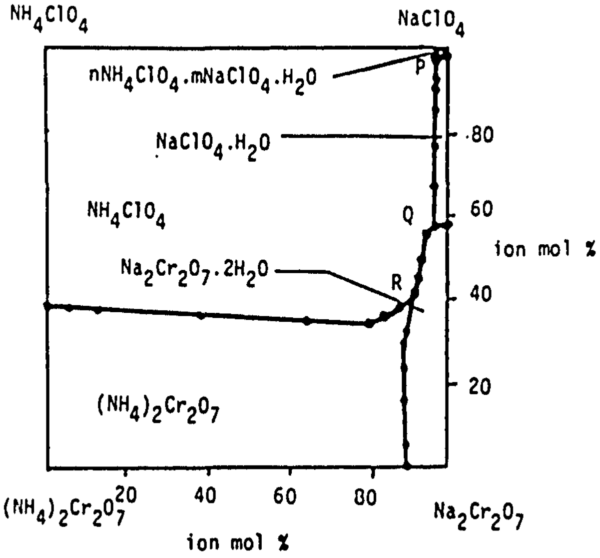
Uch. Zap. Yarosl. Gos. Ped. 1970, *79*, 11-5.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA

The phase diagram given below shows five crystallization fields: NH_4ClO_4; $NaClO_4.H_2O$; $Na_2Cr_2O_7.2H_2O$; $(NH_4)_2Cr_2O_7$ and solid solutions represented by $nNH_4ClO_4.mNaClO_4$.

P, Q and R correspond to isothermal triple saturation points.



COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Magnesium chloride; $MgCl_2$; [7786-30-3]

(4) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Kudryakova, S.A.; Lepeshkhov, I.N.

Sb. Tr. Yarosl. Gos. Ped. Inst. 1969, *66*, 40-50.

VARIABLES:

One temperature: 363 K

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system : $NaClO_4$-$NaCl$-$Mg(ClO_4)_2$-$MgCl_2$-H_2O at 90°C

Liquid phase composition								Solid Phase[b]
mass %				mol %[a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
0.63	-	28.93	16.17	0.317	-	8.938	2.131	A + B
0.69	-	26.79	19.51	0.355	-	8.467	2.630	A + B
0.69	-	25.29	22.76	0.366	-	8.237	3.162	A + B + C
1.14	-	19.35	31.32	0.642	-	6.690	4.619	A + C
1.60	-	12.98	39.38	0.945	-	4.708	6.093	A + C
3.65	-	5.54	48.69	2.333	-	2.174	8.149	A + C
0.54	5.62	-	52.82	0.360	1.787	-	9.212	A + C
3.34	19.51	-	38.19	2.241	6.248	-	6.709	A + C
2.39	23.59	-	32.89	1.535	7.232	-	5.531	A + C + D
2.24	25.45	-	27.68	1.346	7.300	-	4.355	A + D
1.85	39.20	-	23.23	1.298	13.13	-	4.268	A + D
1.44	47.72	-	18.77	1.081	17.10	-	3.691	A + D
1.33	52.62	-	13.94	0.991	18.71	-	2.719	A + D
1.22	57.46	-	9.19	0.902	20.27	-	1.779	A + D

[a] Editors' calculations.

[b] A = NaCl; B = $MgCl_2.6H_2O$; C = $Mg(ClO_4)_2.6H_2O$; D = $NaClO_4$.

AUXILIARY INFORMATION

METHOD/PROCEDURE/APPARATUS:

The isothermal method was used. The solubility was studied by the method of nonvariant points: to the saturated solution corresponding to the eutonic composition of a ternary system, a third salt is added until a new solid phase appears. Mg^{2+} was determined with Trilon B; Na^+, by precipitation with zinc uranyl acetate, ClO_4^- gravimetrically by nitron precipitation, and Cl^- mercurimetrically.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

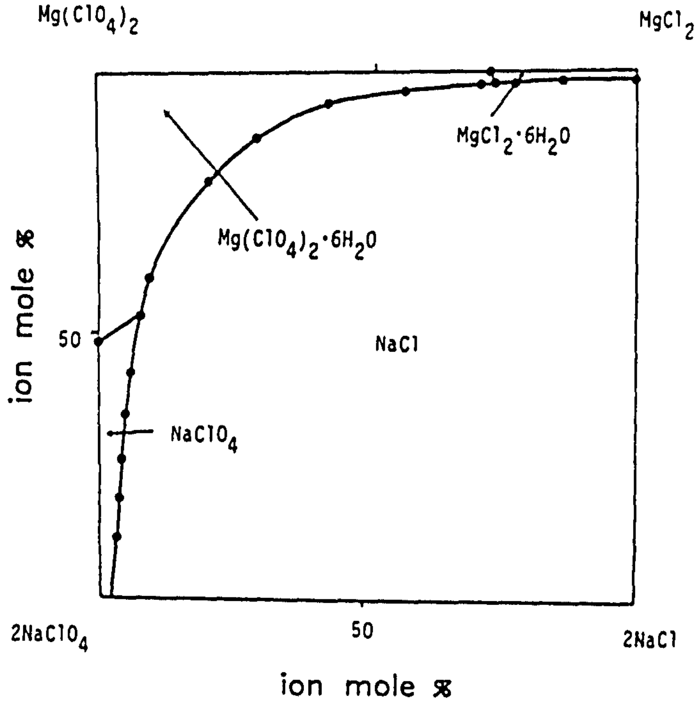
(continued next page)

COMPONENTS:	ORIGINAL MEASUREMENTS:
(1) Sodium chloride; NaCl; [7647-14-5] (2) Sodium perchlorate; $NaClO_4$; [7601-89-0] (3) Magnesium chloride; $MgCl_2$; [7786-30-3] (4) Magnesium perchlorate; $Mg(ClO_4)_2$; [10034-81-8] (5) Water; H_2O; [7732-18-5]	Kudryakova, S.A.; Lepeshkhov, I.N. *Sb. Tr. Yarosl. Gos. Ped. Inst.* 1969, *66*, 40-50.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA:

The Janecke diagram is given below.



COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium perchlorate; $Ba(ClO_4)_2$; [13465-95-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

1. Zaitseva, S.N.; Karnaukhov, A.S. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1969, *66*, 107-12.
2. Zaitseva, S.N.; Karnaukhov, A.S. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1970, *78*, 86-91.

VARIABLES:

Temperature/K: 298.2 and 323.2

Composition

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system : $Na^+,Ba^{2+}//ClO_4^-,Cl^--H_2O$ at 25.0°C

Liquid phase composition								Solid phase[b]
mass %				mol %[a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
24.72	-	3.12	-	9.519	-	0.337	-	A + B
23.38	3.16	3.04	-	9.198	0.593	0.336	-	"
19.38	12.83	2.97	-	8.417	2.599	0.354	-	"
17.77	16.61	3.18	-	7.755	3.460	0.389	-	"
9.00	38.06	2.62	-	4.709	9.504	0.385	-	"
6.07	43.02	2.43	-	3.289	11.13	0.370	-	"
4.96	49.25	1.66	-	2.882	13.66	0.271	-	"
2.26	53.08	1.24	-	1.339	15.01	0.206	-	"
1.30	61.76	1.62	-	0.892	20.22	0.312	-	A + B + C
1.35	66.18	-	-	0.976	22.85	-	-	B + C
1.80	61.39	-	4.14	1.306	21.26	-	0.522	A + C
-	47.17	2.58	1.74	-	14.45	0.400	0.167	A + C + D
-	45.84	4.23	1.93	-	12.22	0.663	0.187	A + D
-	38.07	5.90	1.49	-	9.223	0.840	0.131	"
-	32.37	7.31	1.84	-	7.444	0.989	0.154	"
-	8.63	22.11	0.25	-	1.759	2.649	0.019	"
-	1.54	23.87	1.18	-	0.299	2.726	0.083	"
-	0.48	24.78	1.70	-	0.094	2.845	0.121	"
-	-	26.18	1.74	-	-	3.043	0.125	"
1.37	59.15	-	10.11	1.082	22.29	-	1.388	C + D
1.43	44.35	-	21.76	1.086	16.08	-	2.872	"
1.57	40.84	-	25.75	1.219	15.13	-	3.474	"
1.52	35.67	-	34.84	1.318	14.76	-	5.250	C + D + E
-	41.32	-	32.90	-	18.08	-	5.243	C + F
-	32.53	2.61	27.74	-	10.97	0.518	3.407	D + E
-	28.01	1.91	32.68	-	9.488	0.380	4.031	"
-	23.05	4.08	33.25	-	7.512	0.782	3.946	"
-	18.42	7.84	29.84	-	5.544	1.387	3.270	"
-	8.84	6.84	33.71	-	2.395	1.090	3.326	"
-	-	6.78	50.82	-	-	1.283	5.957	"

[a] Editors' calculations.

[b] A = $BaCl_2.2H_2O$; B = NaCl ; C = $NaClO_4.H_2O$; D = $n(BaCl_2).m[Ba(ClO_4)_2]$; E = $n[Ba(ClO_4)_2].m(BaCl_2)$; F = $Ba(ClO_4)_2.H_2O$.

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium perchlorate; $Ba(ClO_4)_2$; [13465-95-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

1. Zaitseva, S.N.; Karnaukhov, A.S.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1969, *66*, 107-12.

2. Zaitseva, S.N.; Karnaukhov, A.S.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1970, *78*, 86-91.

EXPERIMENTAL VALUES: (continued)

Solubility system : $Na^+, Ba^{2+}//ClO_4^-, Cl^- - H_2O$ at 50.0°C

Liquid phase composition								Solid phase[b]
mass %				mol %[a]				
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
23.96	-	6.58	-	9.541	-	0.735	-	A + B
20.13	3.46	5.97	-	7.989	0.655	0.665	-	"
18.30	11.29	5.25	-	7.736	2.278	0.623	-	"
15.12	16.13	5.25	-	6.566	3.343	0.640	-	"
10.85	27.74	5.19	-	5.218	6.368	0.701	-	"
9.35	28.49	3.65	-	4.374	6.361	0.479	-	"
6.30	40.15	3.68	-	3.346	10.18	0.549	-	"
2.44	53.51	3.93	-	1.532	16.04	0.693	-	"
1.53	54.26	3.62	-	0.956	16.17	0.634	-	"
0.08	61.28	3.37	-	0.055	20.22	0.654	-	"
0.08	63.84	2.90	-	0.058	21.92	0.585	-	A + B + C
1.35	67.25	-	2.91	1.068	25.40	-	0.400	B + C
1.30	69.27	-	2.47	1.063	27.05	-	0.351	"
1.35	71.19	-	1.27	1.120	28.20	-	0.183	"
1.37	69.00	-	-	1.050	25.25	-	-	B + D
-	55.16	2.82	3.89	-	17.38	0.522	0.446	C + E + F
-	49.84	3.91	5.29	-	14.99	0.692	0.579	A + F
-	41.26	5.93	3.13	-	10.76	0.909	0.297	"
-	32.53	8.60	3.38	-	7.821	1.216	0.296	"
-	24.39	12.36	6.15	-	5.780	1.722	0.531	"
-	17.84	16.82	6.88	-	4.173	2.313	0.586	"
-	10.22	22.05	4.16	-	2.238	2.838	0.332	"
-	0.75	25.19	3.97	-	0.152	3.002	0.293	"
-	-	27.24	4.14	-	-	3.310	0.312	"
-	61.01	-	13.31	-	25.38	-	2.016	C + D
1.25	45.36	-	20.74	0.944	16.35	-	2.722	C + D + F
1.32	35.30	-	30.68	1.019	13.00	-	4.115	D + F
-	36.21	2.03	37.53	-	16.78	0.553	6.334	D + F + G
-	35.40	-	41.71	-	17.17	-	7.367	D + E
-	24.27	4.32	37.85	-	9.033	0.945	5.130	F + G
-	11.50	4.76	49.38	-	4.326	1.053	6.765	"
-	4.37	4.88	53.05	-	1.545	1.015	6.831	"
-	3.99	5.20	52.90	-	1.405	1.077	6.784	"
-	5.26	-	54.20	-	1.750	-	6.567	"

[a] Editors' calculations.

[b] A = $BaCl_2.2H_2O$; B = NaCl ; C = $NaClO_4.H_2O$; D = $NaClO_4$; E = $BaCl_2.H_2O$
F = $n(BaCl_2).m[Ba(ClO_4)_2]$; G = $n[Ba(ClO_4)_2].m(BaCl_2)$.

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Barium chloride; $BaCl_2$; [10361-37-2]

(4) Barium perchlorate; $Ba(ClO_4)_2$; [13465-95-7]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

1. Zaitseva, S.N.; Karnaukhov, A.S. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1969, *66*, 107-12.
2. Zaitseva, S.N.; Karnaukhov, A.S. *Uch. Zap. Yarosl. Gos. Ped. Inst.* 1970, *78*, 86-91.

EXPERIMENTAL VALUES: (continued)

COMMENTS AND/OR ADDITIONAL DATA:

The Janecke diagrams are given below.

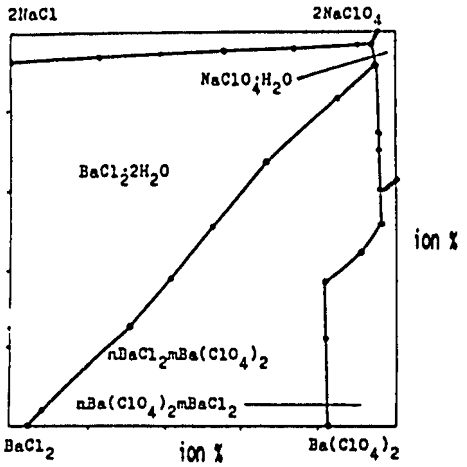


Fig. 1. Solubility isotherm at 25°C

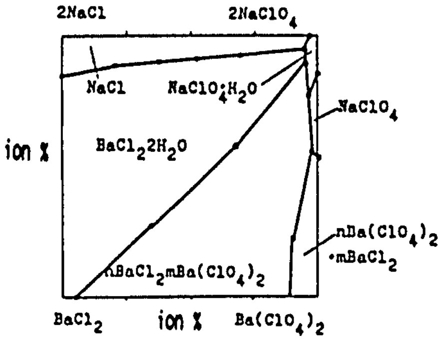


Fig. 2. Solubility isotherm at 50°C

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The method of nonvariant points. To the solution corresponding to the transition point of the ternary system a third salt was added until a new solid phase appeared. Conditions of saturation not stated. Ba^{2+} was determined gravimetrically in the presence of picric acid; Na^+ gravimetrically as sodium zinc uranyl acetate; Cl^- mercurimetrically; ClO_4^- by difference.

SOURCE AND PURITY MATERIALS:

The starting salts are of reagent and chemically pure grades were recrystallized twice.

ESTIMATED ERROR:

Temp.: ±0.1°C.

REFERENCES:

None.

COMPONENTS:

(1) Sodium nitrate; $NaNO_3$; [7631-99-4]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Nickel nitrate; $Ni(NO_3)_2$; [14216-75-2]

(4) Nickel perchlorate; $Ni(ClO_4)_2$ [13637-71-3]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Tarakanov, V.F.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1972, *103*, 3-6.

VARIABLES:

Temperature: 298 K.
Composition.

PREPARED BY:

E.S. Gryzlova

EXPERIMENTAL VALUES:

Solubility system $2Na^+$, Ni^{2+} || $2ClO_4^-$, $2NO_3^-$ - water at 25 °C :

Liquid phase composition								Solid
mass %				molality[a] / mol kg^{-1}				phase[b]
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	
11.58	58.47	-	-	4.549	15.945	-	-	A + B
12.10	46.56	-	8.94	4.394	11.737	-	1.071	A + B
12.61	38.38	-	15.34	4.406	9.310	-	1.769	A + B
15.06	16.36	-	32.89	4.965	3.744	-	3.577	A + B + C
17.11	3.92	-	41.61	5.388	0.857	-	4.323	A + C
12.61	-	12.54	34.82	3.706	-	1.714	3.377	A + C
8.05	-	24.70	25.91	2.291	-	3.270	2.433	A + C + D
8.03	-	37.93	9.85	2.138	-	4.698	0.865	A + D
8.96	-	44.87	-	2.283	-	5.319	-	A + D
5.18	-	24.87	27.18	1.425	-	3.182	2.467	C + D
-	-	28.19	25.89	-	-	3.360	2.189	C + D
9.74	24.71	-	32.11	3.427	6.035	-	3.727	B + C
-	31.09	-	29.42	-	6.430	-	2.892	B + C

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AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

To the satd. solutions corresponding to the compositions of the nodal points (in the presence of an excess of solid phases) a third salt was added until a new solid phase appeared. Nitrate was determined using Devarda's method; perchlorate by gravimetric method using nitron precipitation; nickel by complexometric titration with Trilon B. The solid phases were examined under a microscope.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

REFERENCES:

(continued next page)

COMPONENTS:

(1) Sodium nitrate; $NaNO_3$; [7631-99-4]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Nickel nitrate; $Ni(NO_3)_2$; [14216-75-2]

(4) Nickel perchlorate; $Ni(ClO_4)_2$ [13637-71-3]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Tarakanov, V.F.

Uch. Zap. Yarosl. Gos. Ped. Inst. 1972, *103*, 3-6.

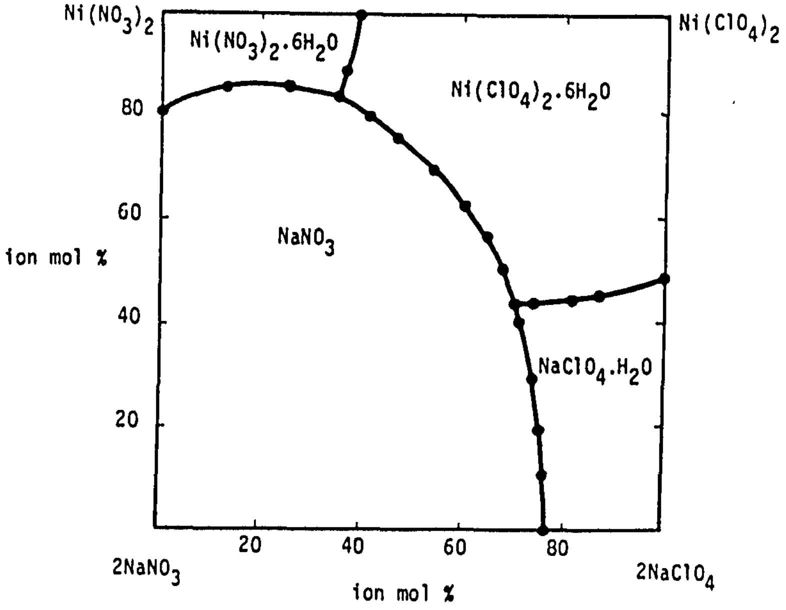
EXPERIMENTAL VALUES: (continued)

mol % [a]				ion mol % [a]				Solid phase[b]
				Cation		Anion		
(1)	(2)	(3)	(4)	$2Na^+$	Ni^{2+}	$2NO_3^-$	$2ClO_4^-$	
5.99	20.98	-	-	100.0	-	22.2	77.8	A + B
6.04	16.14	-	1.473	88.3	11.7	24.0	76.0	A + B
6.21	13.11	-	2.491	79.5	20.5	25.5	74.5	A + B
7.32	5.52	-	5.277	54.9	45.1	31.3	68.7	A + B + C
8.15	1.30	-	6.543	41.9	58.1	36.2	63.8	A + C
5.76	-	2.666	5.251	26.7	73.3	51.4	48.6	A + C
3.61	-	5.149	3.831	16.7	83.3	64.5	35.5	A + C + D
3.38	-	7.432	1.369	16.1	83.9	87.0	13.0	A + D
3.62	-	8.428	-	17.7	82.3	100.0	0.0	A + D
2.28	-	5.085	3.942	11.2	88.8	61.2	38.8	C + D
-	-	5.503	3.585	-	100.0	60.6	39.4	C + D
4.99	8.78	-	5.426	55.9	44.1	20.3	79.7	B + C
-	9.92	-	4.461	52.6	47.4	-	100.0	B + C

[a] Compiler's calculations

[b] A = $NaNO_3$ B = $NaClO_4$ C = $Ni(ClO_4)_2 \cdot 6H_2O$ D = $Ni(NO_3)_2 \cdot 6H_2O$

COMMENTS AND/OR ADDITIONAL DATA The phase diagram given below shows four crystallization fields: anhydrous $NaNO_3$, $Ni(NO_3)_2 \cdot 6H_2O$, $Ni(ClO_4)_2 \cdot H_2O$, and $NaClO_4 \cdot H_2O$.



COMPONENTS:

(1) Sodium sulfate; Na_2SO_4; [7757-82-6]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Zinc sulfate; $ZnSO_4$; [7733-02-0]

(4) Zinc perchlorate; $Zn(ClO_4)_2$ [13637-61-1]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Leboschina, V.I.

Tr. Yarosl. Gos. Ped. Inst. 1979, *178*, 24-7.

VARIABLES:

Temperature: 298 K.
Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

Solubility system $2Na^+, Zn^{2+} || 2ClO_4^-, SO_4^{2-}$ - water at 25 °C :

Point	Liquid phase composition mass % (1)	(2)	(3)	(4)	molality[a] / mol kg^{-1} (1)	(2)	(3)	(4)	Solid phase[b]
1	13.19	34.35	-	-	1.770	5.35	-	-	A + B
I	4.43	36.90	-	4.24	0.573	5.54	-	0.295	A + B
VII	0.82	41.02	-	6.34	0.111	6.47	-	0.463	A + B + D
2	0.58	49.87	-	2.58	0.087	8.67	-	0.208	A + D
II	0.79	67.42	-	-	0.175	17.32	-	-	A + D
3	0.59	42.70	-	10.38	0.090	7.53	-	0.848	B + D
4	0.60	31.73	-	14.34	0.079	4.86	-	1.017	B + D
5	-	28.29	-	23.47	-	4.79	-	1.841	B + D
VIII	-	26.62	0.60	32.96	-	5.46	0.093	3.132	B + D + E
III	-	24.92	-	35.39	-	5.13	-	3.374	D + E
IX	0.49	-	0.12	50.70	0.071	-	0.015	3.940	B + E + F
IV	-	-	0.55	53.43	-	-	0.074	4.393	E + F
6	2.50	-	0.22	34.45	0.280	-	0.022	2.075	B + F
7	6.14	-	2.71	27.33	0.677	-	0.263	1.620	B + F
X	7.42	-	8.24	21.00	0.825	-	0.806	1.255	B + F + G
8	11.75	-	11.61	11.88	1.277	-	1.111	0.694	B + G
V	15.63	-	17.54	-	1.647	-	1.626	-	B + G
9	0.16	4.93	32.25	-	0.018	0.643	3.188	-	F + G
VI	4.40	-	34.35	-	0.506	-	3.474	-	F + G

[a] Compiler's calculations

[b] A = Na_2SO_4; B = $Na_2SO_4 \cdot 10H_2O$; C = $Na_2SO_4 \cdot H_2O$;
D = $NaClO_4 \cdot H_2O$; E = $Zn(ClO_4)_2 \cdot 6H_2O$; F = $ZnSO_4 \cdot 7H_2O$;
G = $Na_2SO_4 \cdot ZnSO_4 \cdot 4H_2O$.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

Method of "invariant points" used. ClO_4^- was determined gravimetrically with nitron; SO_4^{2-} by precipitation as barium sulfate; Zn^{2+} by complexometric titration with Eriochrome Black as indicator; Na^+ by difference.

SOURCE AND PURITY OF MATERIALS:

Not stated.

ESTIMATED ERROR:

Not stated.

(continued next page)

COMPONENTS:

(1) Sodium sulfate; Na_2SO_4; [7757-82-6]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-0]

(3) Zinc sulfate; $ZnSO_4$; [7733-02-0]

(4) Zinc perchlorate; $Zn(ClO_4)_2$ [13637-61-1]

(5) Water; H_2O; [7732-18-5]

ORIGINAL MEASUREMENTS:

Karnaukhov, A.S.; Leboschina, V.I.

Tr. Yarosl. Gos. Ped. Inst. 1979, *178*, 24-7.

VARIABLES:

Temperature: 298 K.

Composition.

PREPARED BY:

I.S. Bodnya

EXPERIMENTAL VALUES:

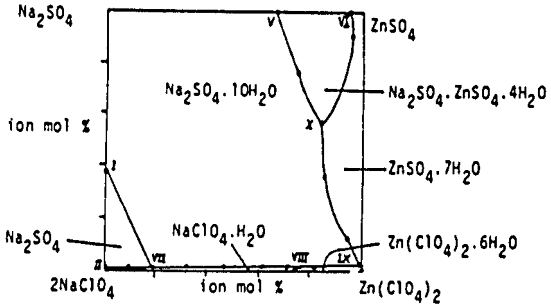
Point	Liquid phase composition mol %^{a} (1)	(2)	(3)	(4)	ion mol %^{a} $2Na^+$	Zn^{2+}	$2ClO_4^-$	SO_4^{2-}	Solid phase^b
1	2.826	8.54	-	-	100.0	-	60.2	39.8	A + B
I	0.925	8.94	-	0.476	91.9	8.1	84.2	15.8	A + B
VII	0.178	10.34	-	0.740	87.8	12.2	97.1	2.9	A + B + D
2	0.135	13.45	-	0.322	95.5	4.5	98.1	1.9	A + D
II	0.240	23.73	-	-	100.0	-	98.0	2.0	A + D
3	0.140	11.77	-	1.325	82.0	18.0	98.1	1.9	B + D
4	0.129	7.91	-	1.655	71.1	28.9	97.8	2.2	B + D
5	-	7.71	-	2.963	56.5	43.5	100.0	-	B + D
VIII	-	8.51	0.145	4.879	45.8	54.2	98.4	1.6	B + D + E
III	-	8.01	-	5.271	43.2	56.8	100.0	0.0	D + E
IX	0.119	-	0.026	6.618	1.8	98.2	97.9	2.1	B + E + F
IV	-	-	0.123	7.325	-	100.0	98.3	1.7	E + F
6	0.484	-	0.037	3.584	11.8	88.2	87.3	12.7	B + F
7	1.166	-	0.453	2.791	26.4	73.6	63.3	36.7	B + F
X	1.412	-	1.380	2.148	28.6	71.4	43.5	56.5	B + F + G
8	2.180	-	1.895	1.185	41.4	58.6	22.5	77.5	B + G
V	2.801	-	2.766	-	50.3	49.7	-	100.0	B + G
9	0.030	1.083	5.371	-	9.6	90.4	9.1	90.9	F + G
VI	0.850	-	5.840	-	12.7	87.3	-	100.0	F + G

[a] Compiler's calculations

[b] A = Na_2SO_4; B = $Na_2SO_4 \cdot 10H_2O$; C = $Na_2SO_4 \cdot H_2O$;
D = $NaClO_4 \cdot H_2O$; E = $Zn(ClO_4)_2 \cdot 6H_2O$; F = $ZnSO_4 \cdot 7H_2O$;
G = $Na_2SO_4 \cdot ZnSO_4 \cdot 4H_2O$.

COMMENTS AND/OR ADDITIONAL DATA

The phase diagram given below shows six crystallization fields: $Na_2SO_4 \cdot 10H_2O$ (77.06%); $ZnSO_4 \cdot 7H_2O$ (9.45%); Na_2SO_4 (3.88%); $Na_2SO_4 \cdot ZnSO_4 \cdot 4H_2O$ (7.33%); $NaClO_4 \cdot H_2O$ (1.59%); $Zn(ClO_4)_2 \cdot 6H_2O$ (0.69%). VII, VIII, IX and X are isothermal triple saturation points.



COMPONENTS:

(1) Sodium chloride; $NaCl$; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-07]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Ammonia; NH_3; [7664-41-7]

ORIGINAL MEASUREMENTS:

Marshall, P.R.; Hunt, H.

J. Chem. Eng. Data 1959, *4*, 217-22.

VARIABLES:

Temperature: 240 - 323 K.
Composition

PREPARED BY:

C.Y. Chan

EXPERIMENTAL VALUES:

Solubility system $Na^+,NH_4^+ \| Cl^-,ClO_4^-,-H_2O$ at various temperatures :

	Liquid phase composition								Solid phase^c
t/ °C	molality/ mol kg^{-1}				100X(cation)^a		100X(anion)^b		
	Na^+	NH_4^+	Cl^-	ClO_4^-	Na^+	NH_4^+	Cl^-	ClO_4^- ^{d}	
-33	0.78	12.39	2.1	11.1	5.9	94.1^d	15.8	84.2	(1)+(3)+(4)
0	0.32	20.51	0.88	19.95	1.54	98.46^d	4.22	95.78	" " "
25	0.76	19.15	1.4	18.5	3.84	96.16^d	7.0	93.0	" " "
50	0.58	23.9	1.49	23.0	2.36	97.64^d	6.08	93.92	" " "

(table continued next page)

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solubility determinations were carried out using a specially constructed apparatus (diagram given in original paper), involving a gas line connected to the saturation cell. The cell consisted of two compartments separated by a sintered glass partition, the larger one of which was connected to the gas line in such a way that the cell could be inverted, with either one of the compartments vertically above the other. Weighed amts of the salts were sealed in the smaller compartment of the cell which was then connected to the gas line via the larger compartment. Excess of dry ammonia was condensed in the cell until the salts had all dissolved at the set temperature. The coolants used were dry ice and CCl_4. The cell was thermostated in a liquid NH_3 bath for -33 °C determinations, in an ice + water bath for 0 °C, and in a water bath for the other temperatures. Ammonia was bled from the solution until salt

(continued next page)

COMPONENTS:

(1) Sodium chloride; NaCl; [7647-14-5]

(2) Sodium perchlorate; $NaClO_4$; [7601-89-07]

(3) Ammonium chloride; NH_4Cl; [12125-02-9]

(4) Ammonium perchlorate; NH_4ClO_4; [7790-98-9]

(5) Ammonia; NH_3; [7664-41-7]

ORIGINAL MEASUREMENTS:

Marshall, P.R.; Hunt, H.

J. Chem. Eng. Data 1959, *4*, 217-22.

EXPERIMENTAL VALUES: (continued)

Solubility system $Na^+, NH_4^+ \| Cl^-, ClO_4^-, -H_2O$ at various temperatures :

Liquid phase composition									Solid phase[c]
t/ °C	molality/ mol kg^{-1}				100X(cation)[a]		100X(anion)[b]		
	Na^+	NH_4^+	Cl^-	ClO_4^-	Na^+	NH_4^+	Cl^-	ClO_4^-	
-33	17.4	3.06	-	20.46	85.0[d]	15.0	-	100.0	(1)+(2)+(4)
0	19.45	4 1	0.086	23.33	95.9[d]	4.1	0.366	99.6	" " "
25	19.4	3.53	-	22.93	96.47[d]	3.53	-	100.0	" " "
50	25.1	4.74	-	29.84	84.1[d]	15.9	-	100.0	" " "

[a] $X(Na^+) = n(Na^+)/[n(Na^+) + n(NH_4^+)]$; $X(NH_4^+) = 1 - X(Na^+)$;

[b] $X(ClO_4^- = n(ClO_4^-)/[n(ClO_4^-) + n(Cl^-)]$; $X(Cl^-) = 1 - X(ClO_4^-)$

n( ) = amount of substance.

[c] All components anhydrous.

[d] Compiler's calculations.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

crystals were formed, and the cell inverted so that the solution filtered through the partition into the larger compartment. After filtration the ammonia in the solution was all removed by condensation into a reservoir in the apparatus and determined quantitatively by absorption in std. HCl sln and back-titrated with std. base. The cell was then opened and the solids removed for analysis. Ammonium ion was determined by a standard Kjeldahl procedure. Chloride was determined by titration with $AgNO_3$, using dichlorofluorescein as indicator.

SOURCE AND PURITY OF MATERIALS:

Not stated. Ammonia was dried with sodium.

ESTIMATED ERROR:

Reproducibility (3 detn) is within ± 2 % of the mean value in most cases.

SYSTEM INDEX

Page numbers preceded by E refer to evaluation text whereas those not preceded by E refer to compiled tables.

REGISTRY NUMBER INDEX

Page numbers preceded by E refer to evaluation text whereas those not preceded by E refer to compiled tables.

In the indexes of this volume, the names used in compilation sheets have been used, but it should be noted that Chemical Abstracts list salts as derivatives of the appropriate acid, for example, sodium dichromate is listed as chromic acid, disodium salt, $Cr_2H_2O_7.2Na$; manganese perchlorate is listed as perchloric acid, manganese(2+) salt, $ClHO_4.1/2Mn$.

[75-12-7]	CH_3NO	Formamide	E7, 33, 34
[75-56-9]	C_3H_6O	Methyl-oxirane	E7, 38
[75-64-9]	$C_4H_{11}N$	2-methyl-2-propanamine	E7, 30, 31
[75-65-0]	$C_4H_{10}O$	2-methyl-2-propanol	E7, 28, 29
[76-05-1]	$C_2HF_3O_2$	2-trifluoroethanoic	E7, 32
[78-83-1]	$C_4H_{10}O$	2-methyl-1-propanol	E7, E10,26, 27, 51, 52, E111, 129, 130
[78-92-2]	$C_4H_{10}O$	2-butanol	E7, 28, 29
[78-93-3]	C_4H_8O	2-butanone	E111, 135
[79-20-9]	$C_3H_6O_2$	Methyl acetate	E12, 64-66
[84-66-2]	$C_{12}H_{14}O_4$	Diethyl-1,2-benzenedicarboxylate	E8, 36, 37
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[100-47-0]	C_7H_5N	Benzonitrile	E8, 33, 34
[100-51-6]	C_7H_8O	Benzenemethanol	E8, 28, 29
[100-52-7]	C_7H_6O	Benzaldehyde	E8, 35
[100-61-8]	C_7H_9N	N-methylbenzenamine	E8, 30, 31
[100-97-0]	C6H12N4	Hexamethylenetetramine	E11, E17, 62, 63, 90-92, E112, E115, 155-157, 206, 207
[105-58-9]	$C_5H_{10}O_3$	Diethyl carbonate	E7, 36, 37
[107-10-8]	C_3H_9N	1-propanamine	E7, 30, 31
[107-12-0]	C_3H_5N	Propionitrile	E9, 50
[107-15-3]	$C_2H_8N_2$	1,2-ethane diamine	E7, 30, 31,E111, 132
[107-21-1]	$C_2H_6O_2$	1,2-ethanediol	E7, 28, 29,E111, 131
[107-92-6]	$C_4H_8O_2$	Butanoic acid	E7, 32
[108-24-7]	$C_4H_6O_3$	Acetic anhydride	E7, 33, 34
[108-32-7]	$C_4H_6O_3$	Propylene carbonate	E11, E12, 57,64-66
[108-39-4]	C_7H_8O	3-methylphenol	E8, 33, 34
[108-91-8]	C_6H_7N	Cyclohexanamine	E8, 30, 31
[108-93-0]	$C_6H_{12}O$	Cyclohexanol	E8, 28, 29
[108-94-1]	$C_6H_{10}O$	Cyclohexanone	E7, 35
[109-73-9]	$C_4H_{11}N$	1-butanamine	E7, 30, 31
[109-99-9]	C_4H_8O	Tetrahydrofurane	E7, 38, 40
[110-40-7]	$C_{14}H_{26}O_4$	Diethyl decanedioate	E8, 36, 37
[110-80-5]	$C_4H_{10}O_2$	2-ethoxyethanol	E7, 33, 34
[110-86-1]	C_5H_5N	Pyridine	E7, 30, 31

[111-87-5]	$C_8H_{18}O$	1-octanol	E8, 28, 29
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[123-38-6]	C_3H_6O	Propanal	E7, 35
[123-96-6]	$C_8H_{18}O$	2-octanol	E8, 28, 29
[124-07-2]	$C_8H_{16}O_2$	1-octanoic acid	E8, 32
[126-33-0]	$C_4H_8O_2S$	Tetrahydrothiophene	E111, 139, 140
[140-11-4]	$C_9H_{10}O_2$	Benzyl acetate	E8 36, 37
[141-43-5]	C_2H_7NO	2-aminoethanol	E7, 33, 34,E111, 131
[141-78-6]	$C_4H_8O_2$	Ethyl acetate	E7, E10, E17, 36, 37, 42, 54, 89, E111, E112, E115, 134, 204, 205
[141-97-9]	$C_6H_{10}O_3$	Ethyl-3-oxobutanoate	E7, 36, 37
[142-96-1]	$C_8H_{18}O$	1,1'-oxybis-butane	E8, 38
[302-01-2]	N_2H_4	Hydrazine	E8, 43, 44, E111, 141, 142
[544-16-1]	$C_4H_9NO_2$	1-butyl nitrite	E7, 36, 37
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[7601-90-3]	$HClO_4$	Perchloric acid	E8, 45,E111, E115, 143, 159-161
[7631-99-4]	$NaNO_3$	Sodium nitrate	E114,E118, 192, 193, 245, 246
[7647-14-5]	$NaCl$	Sodium chloride	E114, E115, E116, E118, 186-191, 202, 210-213, 217-227, 240-244, 249, 250
[7647-17-8]	$CsCl$	Cesium chloride	E116, 217-220
[7664-41-7]	NH_3	Ammonia	E111, E115, E118, 145, 202, 203, 249, 250
[7722-84-1]	H_2O_2	Hydrogen peroxide	E8, 46, E111, 144
[7732-18-5]	H_2O	Water	E2-E6, E10-E19, 23-25, 51-63, 67, 103, E104-E110,

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