COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Hexachloro-1,3-butadiene; C₄Cl₆; [87-68-3]

VARIABLES:
Temperature

EXPERIMENTAL VALUES:
Composition, densities, viscosities and refractive indices of saturated solutions.

<table>
<thead>
<tr>
<th>t/°C</th>
<th>mass %</th>
<th>mol kg⁻¹</th>
<th>d/g cm⁻³</th>
<th>n/p</th>
<th>nD ²⁰</th>
<th>solid phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.029</td>
<td>0.00116</td>
<td>1.679</td>
<td>0.0389</td>
<td>1.5553</td>
<td>NdCl₃·3.5H₂O</td>
</tr>
<tr>
<td>50</td>
<td>0.037</td>
<td>0.00148</td>
<td>1.648</td>
<td>0.0311</td>
<td>1.5553</td>
<td>&quot;</td>
</tr>
<tr>
<td>75</td>
<td>0.055</td>
<td>0.00220</td>
<td>1.612</td>
<td>0.0249</td>
<td>1.5550</td>
<td>NdCl₃·3H₂O</td>
</tr>
</tbody>
</table>

*aMolalities calculated by the compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method. Equilibrium attained after 12 d at 25°C, 10 d at 50°C, and 7 d at 75°C.

Initial salt, liquid phases and solid phases analysed for Nd by the oxalate method or by titration with Trilon B using Xylene Orange indicator, and for chloride by the Volhard method. Presumably water was found by difference. Solid phase compositions confirmed by X-ray analysis.

SOURCE AND PURITY OF MATERIALS:
NdCl₃·6H₂O prepd by dissolving 99.8% Nd₂O₃ in HCl, evaporating and cooling, recrystallizing, and drying in a desiccator. The oxide contained oxide impurities of other rare earths and Fe (0.01%), Ca(0.01-0.05%), and Cu (0.01%). The product was analysed for metal and halide (mass %): Nd 40.25%, Cl 26.30%, H₂O 33.45%.

Purified solvent (method not specified) had the following properties:
\[ d_4^2 = 1.6807 \text{ g cm}^{-3}, \text{ and } n_D^20 = 1.5543. \]

ESTIMATED ERROR:
Soly: nothing specified.
Temp: accuracy ± 0.1 K (authors).

REFERENCES:
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Methanol; CH₄O; [67-56-1]

EVALUATOR:
Mark Salomon
USA ET & DL
Ft. Monmouth, NJ, U.S.A.
and
Tomasz Mioduski
Institute of Nuclear Research
Warsaw, Poland

CRITICAL EVALUATION:

The solubility of NdCl₃ in methanol has been reported in three publications (1-3). West (1) studied the solubility from 283-313 K and reported his results in volume units. The results in (2) for 273-323 K and in (3) for 298.15 K are both in mass units, but there is serious disagreement between these results. For example at 298.2 K Grigorovich (2) reports a solubility of 4.466 mol kg⁻¹ (solid phase is NdCl₃·3CH₃OH) while Merbach et al. (3) report a solubility of 2.75 mol kg⁻¹ (solid phase is NdCl₃·4CH₃OH).

While we cannot directly compare West's solubility result of ~2.25 mol dm⁻³ at 298.2 K with those in (2,3), it certainly is more consistent with the result of Merbach et al. This does not necessarily imply that there is some systematic error in the results of Grigorovich, but rather that a metastable phase is involved.

Merbach et al. report two values for the solubility of NdCl₃ in methanol at 298.15 K. The first value of 2.75 mol kg⁻¹ was obtained when the solution was equilibrated with the tetrasolvate. Starting with the anhydrous salt, Merbach et al. found a solubility of 2.84 mol kg⁻¹, and the difference in these two results (3 %) is much greater than the experimental precision of 0.5 % estimated by the compilers. It would thus appear that the higher solubility result of Merbach et al. represents a solution in "quasi" equilibrium with both the stable NdCl₃·4CH₃OH and metastable NdCl₃·3CH₃OH solid phases.

At this time we designate both results of Grigorovich (2) and Merbach et al. (3) as tentative solubility data. For 298.15 K the tentative solubility in the stable tetrasolvate system is 2.75 mol kg⁻¹ (3), and at 273.2 K, 298.2 K and 323.2 K the tentative solubilities for the metastable trisolvate system are 3.349 mol kg⁻¹, 4.466 mol kg⁻¹ and 5.133 mol kg⁻¹, respectively (2).

REFERENCES


COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Methanol; CH₄O; [67-56-1]

VARIABLES:
T/K = 283 - 313

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>sample 1</th>
<th>sample 2</th>
<th>averageᵃ</th>
<th>solubility of NdCl₃ᵃᵇ</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>3.5696</td>
<td>3.5737</td>
<td>3.5717</td>
<td>2.1230</td>
</tr>
<tr>
<td>20</td>
<td>3.7587</td>
<td>3.7268</td>
<td>3.7428</td>
<td>2.2247</td>
</tr>
<tr>
<td>30</td>
<td>3.838</td>
<td>3.8162</td>
<td>3.8271ᶜ</td>
<td>2.2748</td>
</tr>
<tr>
<td>40</td>
<td>3.9727</td>
<td>3.9955</td>
<td>3.9841</td>
<td>2.3681</td>
</tr>
</tbody>
</table>

ᵃCalculated by compilers.
ᵇCalculated by compilers based on average mass of Nd₂O₃.
ᶜAuthor gives average value of 3.8221 g/10 cc.

The solid phase was not analyzed.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Methanol; CH₄O; [67-56-1]

ORIGINAL MEASUREMENTS:
Grigorovich, Z.I.

VARIABLES:
Temperature

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>solubility² mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>45.63</td>
<td>3.349</td>
</tr>
<tr>
<td>25</td>
<td>52.81</td>
<td>4.466</td>
</tr>
<tr>
<td>50</td>
<td>56.26</td>
<td>5.133</td>
</tr>
</tbody>
</table>

²Molalities calculated by the compiler. At 25°C the solid phase is NdCl₃·3CH₃OH.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method used. Solutions were thermostated and equilibrated for 3 days. Both the saturated solutions and the solid phase were analyzed for NdCl₃ (no details were given).

The alcohol adduct was studied thermographically.

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepared by dissolving "experimental" grade oxide in distilled HCl. The resulting chloride was dehydrated by treatment with thionyl chloride (1).

The alcohol was purified and dried by "standard methods."

ESTIMATED ERROR:
Soly: author states accuracy to be about 0.05 %.
Temp: nothing specified.

REFERENCES:
**COMPONENTS:**

1. Neodymium chloride; NdCl$_3$; [10224-93-8]
2. Methanol; CH$_4$O; [67-56-1]

**ORIGINAL MEASUREMENTS:**


**VARIABLES:**

T/K = 298.2

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>t/°C</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>2.75</td>
<td>2.84</td>
</tr>
</tbody>
</table>

a. Initial salt is the adduct NdCl$_3$.CH$_3$OH. Equilibrated solid phase analyzed and found to be NdCl$_3$.4CH$_3$OH.

b. Solutions equilibrated with anhydrous NdCl$_3$. Equilibrated solid phases not analyzed, but assumed by the compilers to be NdCl$_3$.4CH$_3$OH.

**PREPARED BY:**

T. Mioduski and M. Salomon

**AUXILIARY INFORMATION**

**METHOD/APPARATUS/PROCEDURE:**

Isothermal method as in (1,2). Mixtures were equilibrated for at least 4 days. Prolonged operations were performed in a dry box. Neodymium determined by titration with (NH$_4$)$_3$H(EDTA) using a small amount of urutropine buffer and Xylenol Orange indicator. Chloride was determined by potentiometric titration with AgNO$_3$ solution. Composition of the adduct NdCl$_3$.4CH$_3$OH confirmed by $^1$H NMR and X-ray diffraction.

The reported solubilities are mean values of 2-4 determinations.

**SOURCE AND PURITY OF MATERIALS:**

Nd$_2$O$_3$ of at least 99.9% purity dissolved in HCl to produce the hexahydrate. The salt was dehydrated as described in (3). The adduct NdCl$_3$.4CH$_3$OH prepared by dissolving the hydrate in a small excess of 0-methylformate followed by distillation and crystallization from methanol.

The reported solubilities are mean values of 2-4 determinations.

**ESTIMATED ERROR:**

Soly: precision ±0.5% as in (1) (compilers).

Temp: precision probably at least ± 0.05 K as in (1) (compilers).

**REFERENCES:**

2. Flatt, R. Chimia 1952, 6, 62.
COMPONENTS:
(1) Neodymium chloride; \(\text{NdCl}_3\); [10024-93-8]
(2) Ethanol; \(\text{C}_2\text{H}_6\text{O}\); [64-17-5]

EVALUATOR:
Mark Salomon
USA ET & DL
P.O. Monmouth, NJ, U.S.A.

and

T. Mioduski
Institute of Nuclear Research
Warsaw, Poland

CRITICAL EVALUATION:

The solubility of \(\text{NdCl}_3\) in ethanol has been reported in three publications (1-3).

King (1) studied the solubility from 273-323 K and reported his results in volume units. The results in (2) for 273-323 K and in (3) for 298.15 K are both in mass units, but there is serious disagreement between these results. For example at 298.2 K Grigorovich (2) reports a solubility of 3.080 mol kg\(^{-1}\) (solid phase is \(\text{NdCl}_3\cdot2\text{C}_2\text{H}_5\text{O}\)) while Merbach et al. (3) report a solubility of 1.35 mol kg\(^{-1}\) (solid phase is \(\text{NdCl}_3\cdot3\text{C}_2\text{H}_5\text{O}\)).

While we cannot directly compare King's solubility result of 1.2858 mol dm\(^{-3}\) at 298 K with those in (2,3), it certainly is more consistent with the result of Merbach et al. This does not necessarily imply that there is some systematic error in the results of Grigorovich, but rather that a metastable phase is involved.

Merbach et al. report two values for the solubility of \(\text{NdCl}_3\) in ethanol at 298.15 K. The first value of 1.35 mol kg\(^{-1}\) was obtained when the solution was equilibrated with the trisolvate. Starting with the anhydrous salt, Merbach et al. found a solubility of 1.52 mol kg\(^{-1}\), and the difference in these two results (11 %) is much greater than the experimental precision of 0.5 % estimated by the compilers. It would thus appear that the higher solubility result of Merbach et al. represents a solution in "quasi" equilibrium with both the stable \(\text{NdCl}_3\cdot3\text{C}_2\text{H}_5\text{O}\) and \(\text{NdCl}_3\cdot2\text{C}_2\text{H}_5\text{O}\) solid phases.

At this time we designate both results of Grigorovich (2) and Merbach et al. (3) as tentative solubility data. For 298.15 K the tentative solubility in the stable trisolvate system is 1.35 mol kg\(^{-1}\), and at 273.2 K, 298.2 K and 323.2 K, the tentative solubilities for the metastable disolvate system are 2.420 mol kg\(^{-1}\), 3.080 mol kg\(^{-1}\) and 2.333 mol kg\(^{-1}\), respectively. At this time we cannot explain the decrease in the solubility at 323 K in the metastable system; either an error exists or the system has reverted to the stable trisolvate system.

REFERENCES

1. King, F.E. Masters Thesis. University of Illinois. Urbana, IL 1932. Some of King's data have also been published in reference 4 below.


COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Ethanol; C₂H₆O; [64-17-5]

VARIABLES:
T/K = 273 - 323

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>g Nd₂O₃ in 10 cc satd sIn</th>
<th>density/g cm⁻³</th>
<th>solubility of NdCl₃ a,b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>experiment</td>
<td>average a</td>
<td>exp¹</td>
</tr>
<tr>
<td>0</td>
<td>1.5998</td>
<td>1.5673</td>
<td>1.0102</td>
</tr>
<tr>
<td>0</td>
<td>1.5718</td>
<td>1.6122</td>
<td>1.0108</td>
</tr>
<tr>
<td>10</td>
<td>1.6053</td>
<td>1.6330</td>
<td>1.0502</td>
</tr>
<tr>
<td>15</td>
<td>1.6190</td>
<td>1.6330</td>
<td>1.0613</td>
</tr>
<tr>
<td>20</td>
<td>2.0129</td>
<td>2.0082</td>
<td>1.1183</td>
</tr>
<tr>
<td>25</td>
<td>2.4274</td>
<td>2.4113</td>
<td>1.1184</td>
</tr>
<tr>
<td>30</td>
<td>1.9223</td>
<td>1.9242</td>
<td>1.0524</td>
</tr>
<tr>
<td>40</td>
<td>2.2178</td>
<td>2.2256</td>
<td>1.0832</td>
</tr>
<tr>
<td>40°C</td>
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<td>1.207</td>
</tr>
<tr>
<td>40°C</td>
<td>3.0164</td>
<td>3.0173</td>
<td>-----</td>
</tr>
<tr>
<td>50</td>
<td>2.9742</td>
<td>2.9705</td>
<td>1.1740</td>
</tr>
<tr>
<td>50</td>
<td>2.9667</td>
<td>2.9705</td>
<td>1.1740</td>
</tr>
</tbody>
</table>

㎡Calculated by compilers.
㎡Calculated by compilers using average values for mass Nd₂O₃ and density of satd sIn.
㎡These points detd after two points at 50°C detd: i.e. after cooling from 50°C to 40°C.
㎡These data points probably represent metastable equilibria.

AUXILIARY INFORMATION

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepd from spectro-pure Nd₂O₃ by treatment with aq HCl, and evapn to the point of crystn. Crystals dried in atm of dry HCl for 24 h followed by slow heating in dry HCl until the anhydr salt was obtained. The salt was stored in a vac desiccator over P₂O₅. The salt was analyzed for presence of H₂O by gravimetric analysis (oxalate-oxide method), but results not given: presumably little or no water was found. Ethanol obtained from the stock room (i.e. source and purity unknown) dried with anhydr Na₂SO₄.

ESTIMATED ERROR:
Soly: precision no better than ± 5% (compilers).
Temp: precision ± 1 K.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-0]
(2) Ethanol; C₂H₆O; [64-17-5]

VARIABLES:
Temperature

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>solubility⁸ mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>37.75</td>
<td>2.420</td>
</tr>
<tr>
<td>25</td>
<td>43.56</td>
<td>3.080</td>
</tr>
<tr>
<td>50</td>
<td>36.89</td>
<td>2.333</td>
</tr>
</tbody>
</table>

⁸Molarities calculated by the compiler. At 25° C the solid phase is NdCl₃·2C₂H₅OH.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method used. Solutions were thermostated and equilibrated for 3 days. Both the saturated solutions and the solid phase were analyzed for NdCl₃ (no details were given).

The alcohol adduct was studied thermographically.

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepared by dissolving "experimental" grade oxide in distilled HCl. The resulting chloride was dehydrated by treatment with thionyl chloride (1).

The alcohol was purified and dried by "standard methods."

ESTIMATED ERROR:
Soly: author states accuracy to be about 0.05%.

Temp: nothing specified.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Ethanol; C₂H₅OH; [64-17-5]

ORIGINAL MEASUREMENTS:

VARIABLES:
T/K = 298.2

PREPARED BY:
T. Mioduski and M. Salomon

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>mean solubilities/mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>a 1.35</td>
</tr>
<tr>
<td></td>
<td>b 1.52</td>
</tr>
</tbody>
</table>

a. Initial salt is the adduct NdCl₃·3C₂H₅OH. Equilibrated solid phase analyzed and found to be NdCl₃·3C₂H₅OH.
b. Solutions equilibrated with anhydrous NdCl₃. Equilibrated solid phases not analyzed, but assumed by the compilers to be NdCl₃·3C₂H₅OH.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method as in (1,2). Mixtures were equilibrated for at least 4 days. Prolonged operations were performed in a dry box. Neodymium determined by titration with (NH₄)₃H(EDTA) using a small amount of uretropine buffer and Xylenol Orange indicator. Chloride was determined by potentiometric titration with AgNO₃ solution. Composition of the adduct NdCl₃·3C₂H₅OH confirmed by IH NMR and X-ray diffraction.
The reported solubilities are mean values of 2-4 determinations.

COMMENTS AND/OR ADDITIONAL DATA:
Reference (3) was incorrectly cited in the source paper as: J. Inorg. Nucl. Chem. 1958, 7, 224 (this is the reference to a paper by J.H. Freeman and M.L. Smith which describes the preparation of anhydrous salts by treatment with thionyl chloride). Reference (3) was corrected by the compilers.

SOURCE AND PURITY OF MATERIALS:
Nd₂O₃ of at least 99.9% purity dissolved in HCl to produce the hexahydrate. The salt was dehydrated as in (3). The adduct NdCl₃·3C₂H₅OH prepared by dissolving the hydrate in a small excess of o-ethylformate followed by distillation and crystallization from ethanol.
Ethanol (Fluka) was used as received. Purity and absence of water was confirmed by NMR method.

ESTIMATED ERROR:
Soly: precision ± 0.5% as in (1) (compilers).
Temp: precision probably at least ± 0.05K as in (1) (compilers).

REFERENCES:
2. Flatt, R. Chimia 1952, 6, 62.
COMPONENTS:

(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Ethanol; C₂H₆O; [64-17-5]
(3) Water; H₂O; [7732-18-5]

VARIABLES:

Temperature

ORIGINAL MEASUREMENTS:

Sakharova, N.N.; Sakharova, Yu.Gl; Ezhova, T.A.; Izmailova, A.A.

PREPARED BY:

T. Mioduski and M. Salomon

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>sample 1 g/100 g</th>
<th>sample 2 g/100 g</th>
<th>sample 3 g/100 g</th>
<th>sample 4 g/100 g</th>
<th>mean solubilities g/100 g mol kg⁻¹c</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>35.38</td>
<td>35.54</td>
<td>35.44</td>
<td>35.50</td>
<td>35.47</td>
</tr>
<tr>
<td>30</td>
<td>36.75</td>
<td>36.80</td>
<td>36.87</td>
<td>36.70</td>
<td>36.80</td>
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<tr>
<td>40</td>
<td>38.92</td>
<td>38.86</td>
<td>39.39</td>
<td>39.03</td>
<td>39.05</td>
</tr>
<tr>
<td>50</td>
<td>42.98</td>
<td>43.19</td>
<td>48.64</td>
<td>42.78</td>
<td>42.89</td>
</tr>
<tr>
<td>60</td>
<td>47.89</td>
<td>47.60</td>
<td>47.68</td>
<td>48.18</td>
<td>47.84</td>
</tr>
</tbody>
</table>

It is not clearly stated whether the mixture is 96.8 mass % or 96.8 volume % ethanol.

Solubilities reported as grams of hexahydrate in 100 g of solvent.

Molalities calculated by the compilers.

This value appears to be a typographical error in the English translation. To obtain the reported mean solubility of 42.89 g/100 g, the correct value for this data point should be 42.64 g/100 g (compilers).

SOURCE AND PURITY OF MATERIALS:

NdCl₃·6H₂O prepd by dissolving c.p. grade oxide in dil (1:3) HCl followed by evapn and crystn. The crystals were dried in a desiccator over CaCl₂, P₂O₅ and NaOH. The crystals analysed for the metal by titrn with Trilon B, and for Cl by the Volhard method. Found (%) for Nd:40.30, 40.10 (calcd 40.20). Found (%) for Cl: 29.59, 29.45 (calcd 29.69). 98.8% ethanol prepd by prolonged boiling of c.p. grade 93.5% ethanol with anhydr CuSO₄ followed by distn. Ethanol concn determined refractometrically and pycnometrically.

ESTIMATED ERROR:

Soly: results apparently precise to within ± 0.8%. (compilers).

Temp: nothing specified.

REFERENCES:
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1,2-Ethanediol (ethylene glycol); C₂H₆O₂; [107-21-1]

ORIGINAL MEASUREMENTS:
Racster, L.V.

VARIABLES:
T/K = 283 - 333

EXPERIMENTAL VALUES:
g Nd₂O₃ in 10 cc of satd sln

<table>
<thead>
<tr>
<th>t/°C</th>
<th>experimental</th>
<th>average</th>
<th>density/g cm⁻³</th>
<th>solubility NdCl₃ a,b</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.5788</td>
<td>1.5996</td>
<td>1.3123</td>
<td>0.9508 0.7245</td>
</tr>
<tr>
<td>15</td>
<td>2.2830</td>
<td>2.2821</td>
<td>1.4029</td>
<td>1.3566 0.9670</td>
</tr>
<tr>
<td>20</td>
<td>2.7850</td>
<td>2.8095</td>
<td>1.4087</td>
<td>1.6678 1.1389</td>
</tr>
<tr>
<td>25</td>
<td>2.7790</td>
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<td>1.4550</td>
<td>1.6549 1.1370</td>
</tr>
<tr>
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<tr>
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<td>2.9200</td>
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<td>1.7554 1.1972</td>
</tr>
<tr>
<td>50</td>
<td>3.3283</td>
<td>3.3517</td>
<td>1.5050</td>
<td>1.9922 1.3228</td>
</tr>
<tr>
<td>60</td>
<td>3.0925</td>
<td>3.0814</td>
<td>1.8316</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>3.0703</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aCalculated by compilers.
bCalculated by compilers from average mass Nd₂O₃ and average density of satd sln.
cAuthor gives av value of 2.3218 g Nd₂O₃: this appears to be a typographical error.
dAuthor gives av value of 2.9589 g Nd₂O₃: this appears to be a typographical error.
The solid phase was not analyzed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
NdCl₃ and solvent placed in 250 cc glass stoppered bottle and mechanically agitated for 24 h. Rubber tubing placed over stopper and neck of bottle, and end of tubing sealed with a rubber stopper to prevent water from entering the bottle. Slns allowed to settle for 12-18 h, but slight turbidity persisted, particularly at the lowest and highest temps. At 60°C turbidity was significant and appeared different leading author to speculate possible reaction between solute and solvent. Results at 50° and 60°C said to be approximate. Duplicate 10 cc aliquots pipetted from the bottle for each temp. Each aliquot diluted with 25 cc H₂O and the rare earth pptd as the oxalate with oxalic acid. The oxalate was filtered, ignited, and weighed as the oxide. Densities of satd slns detd pycnometrically using pycnometer calibrated at each temp. Densities at 10°C and 15°C may be high due to the condensation of atm water on the surface of the pycnometer.

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepd by addn of HCl to spectro-pure Nd₂O₃, and evapn of solvent until crystn. Crystals dehydrated by method of Kremers (2). Salt analyzed for presence of H₂O gravimetrically by conversion to oxalate and ignition to the oxide. No water of crystn was found. Ethylene glycol (source and purity not specified) was distilled and initial 5% of distillate discarded. The distilled solvent was stored in a flask sealed with paraffin.

ESTIMATED ERROR:
Soly: precision no better than ± 3% (compilers).
Temp: not specified.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1-Propanol; C₃H₈O; [71-23-8]

EVALUATOR:
Mark Salomon
USA ET & DL
Ft. Monmouth, NJ, U.S.A.

Tomasz Mioduski
Institute of Nuclear Research
Warsaw, Poland

CRITICAL EVALUATION:

The solubility of NdCl₃ in 1-propanol has been reported in three publications (1-3). West (1) reported solubility data over the temperature range of 283-313 K, and his data are in volume units. The results for 273-323 K (2) and 298 K (3) are both in mass units, but there is serious disagreement between these two publications. For example at 298.2 K Grigorovich (2) reports a solubility of 1.587 mol kg⁻¹ (solid phase is NdCl₃·2C₃H₇OH), and Kirmse (3) reports a solubility of 1.295 % (the nature of the solid phase was not specified).

Since the difference in the results of (2,3) is much greater than the experimental precision in either study, a probable explanation is that the results of Grigorovich are for metastable equilibria (see the critical evaluations for the NdCl₃ - CH₃OH and NdCl₃ - C₂H₅OH systems).

Kirmse's data probably represent the stable system at 298 K, and for which we assign a tentative solubility of 1.295 mol kg⁻¹ and a solid phase of NdCl₃·nC₃H₇OH where n ≥ 3.

Grigorovich's data probably represent metastable equilibria involving the solid phase NdCl₃·2C₃H₇OH, and for which the tentative solubilities at 273.2 K, 298.2 K and 323.2 K are 1.474 mol kg⁻¹, 1.547 mol kg⁻¹ and 1.483 mol kg⁻¹, respectively. Again the low solubility at 323.2 K either represents experimental error or (partial) reversion to the stable higher solvate system.

REFERENCES

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1-Propanol; C₃H₆O; [71-23-8]

VARIABLES:
T/K = 283-313

EXPERIMENTAL VALUES:
g Nd₂O₃ in 10 cc of saturated sln

<table>
<thead>
<tr>
<th>t/°C</th>
<th>sample 1</th>
<th>sample 2</th>
<th>average</th>
<th>mol dm⁻³</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1.0896</td>
</tr>
<tr>
<td>30</td>
<td>2.0328</td>
<td>2.0293</td>
<td>2.0311</td>
<td>1.2072</td>
</tr>
<tr>
<td>40</td>
<td>2.5593</td>
<td>2.5753</td>
<td>2.5673</td>
<td>1.5260</td>
</tr>
</tbody>
</table>

aCalculated by compilers.
bCalculated by compilers using average mass of Nd₂O₃.

The solid phase was not analyzed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method. About 100 cc of alcohol and excess salt placed in 250 cc glass stoppered bottle, and rubber tubing placed over the stopper and neck of the bottle and a rubber stopper fitted into the open end of the tubing to prevent leakage of water into the bottle. The bottle was immersed in a thermostat and mechanically agitated for at least 12 h. The saturated solutions were then permitted to settle for a minimum of 12 h, and duplicate 10 cc aliquots removed with a pipet. Water was added to the aliquots and the sln heated and oxalic acid added to precipitate the rare earth oxalate. The precipitate was filtered, washed with distilled water, and ignited and weighed as the oxide.

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepd by addn of HCl to spectro-pure Nd₂O₃, and evaporating the sln to a paste which crystallized upon cooling. The hydrate was dried in a stream of dry HCl by slowly increasing the temp. The anhyd salt was stored in cork-stoppered bottles in a desiccator over P₂O₅. Analysis by conversion to the oxalate and ignition to the oxide showed the salt to be anhydr. Commercial alcohol placed over CaO for 1 wk and then distilled: the first and last 15-20 cc were discarded. CuSO₄ test for H₂O was neg.

ESTIMATED ERROR:
Soly: precision probably within ± 3% (compilers).
Temp: precision ± 0.2 K (author).

REFERENCES:
**COMPONENTS:**

(1) Neodymium chloride; NdCl₃; [10024-93-8]

(2) 1-Propanol; C₃H₇OH; [71-23-8]

**ORIGIONAL MEASUREMENTS:**

Grigorovich, Z.I.


**VARIABLES:**

Temperature

**PREPARED BY:**

T. Mioduski

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>t/°C</th>
<th>solubility^a mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>26.98</td>
<td>1.474</td>
</tr>
<tr>
<td>25</td>
<td>28.46</td>
<td>1.587</td>
</tr>
<tr>
<td>50</td>
<td>27.10</td>
<td>1.483</td>
</tr>
</tbody>
</table>

^aMolalities calculated by the compiler. At 25°C the solid phase is NdCl₃·2C₃H₇OH.

**AUXILIARY INFORMATION**

**METHOD/APPARATUS/PROCEDURE:**

Isothermal method used. Solutions were thermostated and equilibrated for 3 days. Both the saturated solutions and the solid phase were analyzed for NdCl₃ (no details were given).

The alcohol adduct was studied thermogravimetrically.

**SOURCE AND PURITY OF MATERIALS:**

NdCl₃ prepared by dissolving "experimental" grade oxide in distilled HCl. The resulting chloride was dehydrated by treatment with thionyl chloride (1).

The alcohol was purified and dried by "standard methods."

**ESTIMATED ERROR:**

Soly: author states accuracy to be about 0.05%.

Temp: nothing specified.

**REFERENCES:**

**COMPONENTS:**

1. Neodymium chloride; NdCl$_3$; [10024-93-8]
2. Alcohols

**ORIGINAL MEASUREMENTS:**

Kirmse, E.M.


**VARIABLES:**

$T/K = 298$

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>Solvent</th>
<th>NdCl$_3$ solubility$^a,b$</th>
<th>mass %</th>
<th>mol kg$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-methoxyethanol;</td>
<td></td>
<td>16.8</td>
<td>0.806</td>
</tr>
<tr>
<td>$C_3H_8O_2$;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[109-86-4]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-ethoxyethanol;</td>
<td></td>
<td>18.3</td>
<td>0.894</td>
</tr>
<tr>
<td>$C_4H_{10}O_2$;</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>[110-80-5]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,2-ethanediol;</td>
<td></td>
<td>31.0</td>
<td>1.793</td>
</tr>
<tr>
<td>$C_2H_6O_2$;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[107-21-1]</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1-propanol;</td>
<td></td>
<td>24.5</td>
<td>1.295</td>
</tr>
<tr>
<td>$C_3H_8O$;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[71-23-8]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$Molalities calculated by the compilers.

$^b$Nature of the solid phases not specified.

**AUXILIARY INFORMATION**

**METHOD/APPARATUS/PROCEDURE:**

Experimental details not given, but were probably similar to previous works of the author which are compiled throughout this volume.

**SOURCE AND PURITY OF MATERIALS:**

Nothing specified, but based on previous work by the authors the anhydrous salt was probably prepared by the method of Taylor and Carter (1).

**ESTIMATED ERROR:**

Nothing specified.

**REFERENCES:**

1. Taylor, M.D.; Carter, C.P.
**COMPONENTS:**
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 2-Propanol; C₃H₆O; [67-63-0]

**VARIABLES:**
T/K = 283 - 313

**ORIGINAL MEASUREMENTS:**
West, D.H.
Masters Thesis. The University of Illinois. Urbana, IL. 1932

**PREPARED BY:**
M. Salomon and T. Mioduski

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>t/°C</th>
<th>sample 1</th>
<th>sample 2</th>
<th>average</th>
<th>solubility of NdCl₃ b</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.0152</td>
<td>0.0149</td>
<td>0.0151</td>
<td>0.0089 s</td>
</tr>
<tr>
<td>20</td>
<td>0.0175</td>
<td>0.0187</td>
<td>0.0181</td>
<td>0.0108</td>
</tr>
<tr>
<td>30</td>
<td>0.0300</td>
<td>0.0295</td>
<td>0.0298</td>
<td>0.0177</td>
</tr>
<tr>
<td>40</td>
<td>0.0743</td>
<td>0.0710</td>
<td>0.0727</td>
<td>0.0432</td>
</tr>
</tbody>
</table>

aCalculated by compilers.
bCalculated by compilers using average mass of Nd₂O₃.

The solid phase was not analyzed.

**AUXILIARY INFORMATION**

**METHOD/APPARATUS/PROCEDURE:**
Isothermal method. About 100 cc of alcohol and excess salt placed in 250 cc glass stoppered bottle, and rubber tubing placed over the stopper and neck of the bottle and a rubber stopper fitted into the open end of the tubing to prevent leakage of water into the bottle. The bottle was immersed in a thermostat and mechanically agitated for at least 12 h. The saturated solutions were then permitted to settle for a minimum of 12 h, and duplicate 10 cc aliquots removed with a pipet. Water was added to the aliquots and the sln heated and oxalic acid added to precipitate the rare earth oxalate. The precipitate was filtered, washed with distilled water, and ignited and weighed as the oxide.

**SOURCE AND PURITY OF MATERIALS:**
NdCl₃ prep'd by addn of HCl to spectro-pure Nd₂O₃, and evaporating the sln to a paste which crystallized upon cooling. The hydrate was dried in a stream of dry HCl by slowly increasing the temp. The anhyd salt was stored in cork-stoppered bottles in a desiccator over P₂O₅. Analysis by conversion to the oxide showed the salt to be anhyd. Commercial alcohol placed over CaO for 1 week and then distilled; the first and last 15-20 cc were discarded. CuSO₄ test for H₂O was negative.

**ESTIMATED ERROR:**
Soly: precision probably within ± 3% (compilers).
Temp: precision ± 0.2 K (author).

**REFERENCES:**
**COMPONENTS:**

(1) Neodymium chloride; NdCl₃; [10024-93-8]

(2) 2-Propanol; C₃H₇OH; [67-63-0]

**ORIGINAL MEASUREMENTS:**


**ORIGINAL MEASUREMENTS:**


**VARIABLES:**

T/K = 298.2

**PREPARED BY:**

T. Mioduski and M. Salomon

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>t/°C</th>
<th>mean solubilities/mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
</tr>
<tr>
<td>25</td>
<td>0.04</td>
</tr>
</tbody>
</table>

a. Initial salt is the adduct NdCl₃·3C₃H₇OH. Equilibrated solid phase analyzed and found to be NdCl₃·3C₃H₇OH.

b. Solutions equilibrated with anhydrous NdCl₃. Equilibrated solid phases not analyzed, but assumed by the compilers to be NdCl₃·3C₃H₇OH.

**REFERENCE AND PURITY OF MATERIALS:**

Nd₂O₃ of at least 99.9% purity dissolved in HCl to produce the hexahydrate. The salt was dehydrated as in (3). The adduct NdCl₃·3C₃H₇OH prepared by dissolving the hydrate in a small excess of o-methylformate followed by distillation and trans-solvation of the methanol complex with 2-propanol. Iso-propanol (Fluka) was used as received. Purity and absence of water was confirmed by NMR.

**ESTIMATED ERROR:**

Soly: precision ± 0.5% as in (1) (compilers).

Temp: precision probably at least ± 0.05K as in (1) (compilers).

**METHOD/APPARATUS/PROCEDURE:**

Isothermal method as in (1,2). Mixtures were equilibrated for at least 4 days. Prolonged operations were performed in a dry box. Neodymium determined by titration with (NH₄)₃H(EDTA) using a small amount of urotropine buffer and Xylenol Orange indicator. Chloride was determined by potentiometric titration with AgNO₃ solution. Composition of the adduct NdCl₃·3C₃H₇OH confirmed by ¹H NMR and X-ray diffraction.

The reported solubilities are mean values of 2-4 determinations.

**COMMENTS AND/OR ADDITIONAL DATA:**

Reference (3) was incorrectly cited in the source paper as: J. Inorg. Nucl. Chem. 1964, 7, 224 (this is the reference to a paper by J.H. Freeman and M.L. Smith which describes the preparation of anhydrous salts by treatment with thionyl chloride). Reference (3) was corrected by the compilers.

**REFERENCES:**

2. Flatt, R. Chimia 1952, 6, 62.
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1,2,3-Propanetriol (glycerol); C₃H₆O₃; [56-81-5]

ORIGINAL MEASUREMENTS:
Dawson, L.R.

VARIABLES:
T/K = 283 - 333

PREPARED BY:
M. Salomon and T. Mioduski

EXPERIMENTAL VALUES:
\( g \text{Nd}_2O_3 \) in 25 cc satd sln density/g cm\(^{-3}\) soly Neodymium Chloride \(a,b\)
t/°C experimental average\(^a\) exp'tl ave\(^c\) mol dm\(^{-3}\) mol kg\(^{-1}\)
10 0.4982 0.4971 1.2690 1.2737 0.1182 0.0928
20 2.7237 2.7264 1.3593 1.3595 0.6482 0.4768
25 2.1932 2.1851 1.3386 1.3403 0.3205 0.7398
30 1.3407 1.3418 1.3135 1.3147 0.3190 0.2428
40 2.2771 2.2793 1.3360 1.329 0.417 0.407
50 3.0694 3.0875 1.3857 1.3718 0.7319 0.5334
60 2.8782 2.8865 2.8824 2.8865 0.6853 2.8865

\(^a\)Calculated by compilers.
\(^b\)Based on average mass of \(\text{Nd}_2O_3\).
\(^c\)Recalculated by compilers.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
About 175 cc glycerol placed in 250 cc glass stoppered bottles and "liberal amounts" of salt added. Mixtures mechanically agitated in thermostat for 24 h, then permitted to stand for 15 h after which slns were still turbid. For analyses, duplicate 25 cc aliquots of turbid slns were taken from each bottle and the rare earth pptd as the oxalate. The ppt was filtered, ignited, and weighed as the oxide. Author states the presence of turbidity had a small effect on the overall accuracy of the soly determinations. Densities of satd slns determined by withdrawing samples from the bottles, placing them into a pycnometer, and weighing "as quickly as possible." The pycnometer was calibrated for each temp.

COMMENTS AND/OR ADDITIONAL DATA:
Since there is a sharp rise in soly from 100°C to 20°C followed by a sharp decrease to 10°C at which point the soly begins to rise again, it is evident that the solid phase in equil with the satd slns is changing. Unsuccessful attempts were made to isolate and identify the solid phases.

SOURCE AND PURITY OF MATERIALS:
NaCl₃ prepd by adding HCl to spectro-pure \(\text{Nd}_2O_3\), and evaporating the solvent to the point of crystallization. Dehydration was carried out in a stream of dry HCl first at room temp for 24 h, then at 100°C for -12 h 110°C for -6 h, and 200°C for 3-4 h. HCl prepd from NaCl + H₂SO₄ and passed through H₂SO₄ drying towers. Glycerol (presumably c.p. or A.R. grade: compilers) distilled at reduced pressure and the "first portion" rejected (no other details given).

ESTIMATED ERROR:
Soly: based upon precision in analyses and temp control, overall precision in soly around ±3% (compilers). Error in accuracy due to turbidity is unknown. Temp: precision ± 0.5 K except for the 100°C run where precision was ± 1.5 K.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1-Butanol; C₄H₁₀O; [71-36-3]

ORIGINAL MEASUREMENTS:
West, D.H.

VARIABLES:
T/K = 283 - 313

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>sample 1 (g)</th>
<th>sample 2 (g)</th>
<th>average (g)</th>
<th>Solubility of NdCl₃ (mol dm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.9230</td>
<td>1.9047</td>
<td>1.9139</td>
<td>1.1376</td>
</tr>
<tr>
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<td>2.1351</td>
<td>1.2691</td>
</tr>
<tr>
<td>30</td>
<td>2.2974</td>
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<td>2.3001</td>
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</tr>
<tr>
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<td>2.9250</td>
<td>2.8954</td>
<td>2.9102</td>
<td>1.7298</td>
</tr>
</tbody>
</table>

*Calculated by compilers

PREPARED BY:
M. Salomon and T. Mioduski

METHOD/APPARATUS/PROCEDURE:
Isothermal method. About 100 cc of alcohol and excess salt placed in 250 cc glass stoppered bottle, and rubber tubing placed over the stopper and neck of the bottle and a rubber stopper fitted into the open end of the tubing to prevent leakage of water into the bottle. The bottle was immersed in a thermostat and mechanically agitated for at least 12 h. The saturated solutions were then permitted to settle for a minimum of 12 h, and duplicate 10 cc aliquots removed with a pipet. Water was added to the aliquots and the sln heated and oxalic acid added to precipitate the rare earth oxalate. The precipitate was filtered, washed with distilled water, and ignited and weighed as the oxide.

REFERENCES:
**COMPONENTS:**

1. Neodymium chloride; NdCl$_3$; [10024-93-8]
2. 1-Butanol; C$_4$H$_{10}$O; [71-36-3]

**ORIGIANL MEASUREMENTS:**

Grigorovich, Z.I.

**VARIABLES:**

Temperature

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>$t/{}^\circ C$</th>
<th>solubility$^a$</th>
<th>mass %</th>
<th>mol kg$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>25</td>
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<td></td>
</tr>
<tr>
<td>50</td>
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<td></td>
</tr>
</tbody>
</table>

$^a$Molalities calculated by the compiler. At 25$^\circ$C the solid phase is 2NdCl$_3$.3C$_4$H$_9$OH.

**AUXILIARY INFORMATION**

**METHOD/APPARATUS/PROCEDURE:**

Isothermal method used. Solutions were thermostated and equilibrated for 3 days. Both the saturated solutions and the solid phase were analyzed for NdCl$_3$ (no details were given).

The alcohol adduct was studied thermographically.

**SOURCE AND PURITY OF MATERIALS:**

NdCl$_3$ prepared by dissolving "experimental" grade oxide in distilled HCl. The resulting chloride was dehydrated by treatment with thionyl chloride (1).

The alcohol was purified and dried by "standard methods."

**ESTIMATED ERROR:**

Soly: author states accuracy to be about 0.05%.

Temp: nothing specified.

**REFERENCES:**

Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1-Pentanol (amyl alcohol); C₅H₁₂O; [71-41-0]

ORIGINAL MEASUREMENTS:
West, D.H.
Masters Thesis. The University of Illinois. Urbana, IL. 1932.¹

VARIABLES:
T/K = 283 - 313

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>sample 1</th>
<th>sample 2</th>
<th>average</th>
<th>solubility of NdCl₃ a,b</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.5211</td>
<td>2.4910</td>
<td>2.5061</td>
<td>1.4896</td>
</tr>
<tr>
<td>20</td>
<td>2.5312</td>
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</tr>
<tr>
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<td>2.8731</td>
<td>2.8873</td>
<td>2.8802</td>
<td>1.7120</td>
</tr>
</tbody>
</table>

ᵃCalculated by compilers.
ᵇCalculated by compilers from average mass Nd₂O₃.

The solid phase was not analyzed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method. About 100 cc of alcohol and excess salt placed in 250 cc glass stoppered bottle, and rubber tubing placed over the stopper and neck of the bottle and a rubber stopper fitted into the open end of the tubing to prevent leakage of water into the bottle. The bottle was immersed in a thermostat and mechanically agitated for at least 12 h. The saturated solutions were then permitted to settle for a minimum of 12, and duplicate 10 cc aliquots removed with a pipet. Water was added to the aliquots and the sln heated and oxalic acid added to precipitate the rare earth oxalate. The precipitate was filtered, washed with distilled water, and ignited and weighed as the oxide.

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepd by addn of HCl to spectro-pure Nd₂O₃, and evaporating the sln to a paste which crystallized upon cooling. The hydrate was dried in a stream of dry HCl by slowly increasing the temp. The anhyd salt was stored in cork-stoppered bottles in a desiccator over P₂O₅. Analysis by conversion to the oxalate and ignition to the oxide showed the salt to be anhyd. Commercial alcohol placed over CaO for 1 wk and then distilled; the first and last 15-20 cc were discarded. CuSO₄ test for H₂O was neg.

ESTIMATED ERROR:
Soly: precision probably within ± 3% (compilers).
Temp: precision ± 0.2 K (author).

REFERENCES:
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 1-Pentanol; C₅H₁₂O; [71-41-0]

ORIGINAL MEASUREMENTS:
Grigorovich, Z.I.

VARIABLES:
Temperature

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>solubility at t/°C</th>
<th>mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15.96</td>
<td>0.758</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>15.30</td>
<td>0.721</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>14.23</td>
<td>0.662</td>
<td></td>
</tr>
</tbody>
</table>

*Molarities calculated by the compiler. At 25°C the solid phase is NdCl₃·1.0C₅H₁₂O.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method used. Solutions were thermostated and equilibrated for 3 days. Both the saturated solutions and the solid phase were analyzed for NdCl₃ (no details were given).

The alcohol adduct was studied thermally.

SOURCE AND PURITY OF MATERIALS:
NdCl₃ prepared by dissolving "experimental" grade oxide in distilled HCl. The resulting chloride was dehydrated by treatment with thionyl chloride (1).

The alcohol was purified and dried by "standard methods."

ESTIMATED ERROR:
Soly: author states accuracy to be about 0.05%.
Temp: nothing specified.

REFERENCES:
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃;
[10024-93-8]
(2) 2-Methoxyethanol (methyl cellosolve);
C₃H₈O₂; [109-86-4]

VARIABLES:
T/K = 273 - 323

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Composition</th>
<th>Nd₂O₃</th>
<th>NdCl₃</th>
<th>NdCl₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>aNd₂O₃</td>
<td>0.3470</td>
<td>20.67</td>
<td>0.0825</td>
</tr>
<tr>
<td>10</td>
<td>bNdCl₃</td>
<td>0.5709</td>
<td>34.02</td>
<td>0.1357</td>
</tr>
<tr>
<td>20</td>
<td>bNdCl₃</td>
<td>0.7465</td>
<td>44.48</td>
<td>0.1775</td>
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<tr>
<td>30</td>
<td>bNdCl₃</td>
<td>0.9132</td>
<td>54.41</td>
<td>0.2171</td>
</tr>
<tr>
<td>40</td>
<td>bNdCl₃</td>
<td>1.1691</td>
<td>69.66</td>
<td>0.2780</td>
</tr>
<tr>
<td>50</td>
<td>bNdCl₃</td>
<td>1.2654</td>
<td>75.39</td>
<td>0.3009</td>
</tr>
</tbody>
</table>

a Apparently these are average values of at least two analyses from a given bottle. The author did not indicate whether there were any differences in results using NdCl₃ from preparations 1 and 2.
b Recalculated by the compilers using 1977 IUPAC recommended atomic masses.

Equilibrated solid phase not analyzed

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method. About 75-100 cc of solvent + excess salt were placed in bottles and agitated in a thermostat for at least 12 h. Ice + water was used for the 0°C measurements. The bottles were fitted with ground glass stoppers and were sealed from the atmosphere by placing gum rubber tubing over the stoppers and necks of the bottles, and a rubber stopper was fitted into the open end of the tubing. After equilibration, the solutions were allowed to settle for at least 12 h, and using a calibrated 25 cc pipet, two samples were removed for analysis. The samples were evaporated to dryness and dissolved inaq HCl and pptd as the oxalate by addn of oxalic acid. The samples were filtered, washed with dist water and ignited to constant weight as the oxide. The oxide was found to be insoluble in the organic solvent.

ESTIMATED ERROR:
Soly: precision probably within 3% (compilers).
Temp: precision ± 0.2 K (author).

SOURCE AND PURITY OF MATERIALS:
Commercial solvent was permitted to stand over CaO for at least 1 wk and then distilled. A middle portion (fraction not specified) was retained and stored in a stoppered flask: b.p. 123°C. Nd salts prepd in 1925 as double ammonium nitrates were of "spectroscopic purity" and converted to the oxide (no details) and the anhydr chloride prepd by two methods. 1. The oxide was dissolved in aq HCl and the excess HCl evapd. The crystallized salt was dehydrated by heating in the presence of dry HCl first at 100°C for several h, then at 200°C. 2. The rare earth benzoate was pptd from the aq chloride or nitrate with sodium benzoate, and the benzoate dehydrated by heating to 110°C for at least 24 h. Extraction of the chloride was carried out with HCl satd ether, and the resulting chloride heated at 60°C first in a stream of dry HCl and then in dry air. The salt was stored in a desicator over P₂O₅. Dry HCl was prepd from NaCl + H₂SO₄ and by passing the resulting HCl through H₂SO₄ drying towers.
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) 2-Ethoxyethanol (ethyl cellosolve); C₄H₁₀O₂; [110-80-5]

VARIABLES:
T/K = 273 - 323

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>t/°C</th>
<th>Nd₂O₃ ¹</th>
<th>NdCl₃ ²</th>
<th>NdCl₃ ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.2556</td>
<td>15.82</td>
<td>0.0631</td>
</tr>
<tr>
<td>10</td>
<td>0.4642</td>
<td>27.66</td>
<td>0.1104</td>
</tr>
<tr>
<td>20</td>
<td>0.6396</td>
<td>37.95</td>
<td>0.1514</td>
</tr>
<tr>
<td>30</td>
<td>0.7627</td>
<td>45.44</td>
<td>0.1813</td>
</tr>
<tr>
<td>40</td>
<td>0.9410</td>
<td>56.07</td>
<td>0.2237</td>
</tr>
<tr>
<td>50</td>
<td>1.1581</td>
<td>69.00</td>
<td>0.2753</td>
</tr>
</tbody>
</table>

¹ Apparently these are average values of at least two analyses from a given bottle. The author did not indicate whether there were any differences in results using NdCl₃ from preparations 1 and 2.

² Recalculated by the compilers using 1977 IUPAC recommended atomic masses.

Equilibrated solid phase not analyzed.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method. About 75-100 cc of solvent + excess salt were placed in bottles and agitated in a thermostat for at least 12 h. Ice + water was used for the 0°C measurements. The bottles were fitted with ground glass stoppers and necks of the bottles, and a rubber stopper was fitted into the open end of the tubing. After equilibration, the solutions were allowed to settle for at least 12 h, and using a calibrated 25 cc pipet, two samples were removed for analysis. The samples were evaporated to dryness and dissolved in aqu HCl and pptd as the oxalate by addn of oxalic acid. The samples were filtered, washed with dist water and ignited to constant weight as the oxide. The oxide was found to be insoluble in the organic solvent.

SOURCE AND PURITY OF MATERIALS:
Commercial solvent was permitted to stand over CaO for at least 1 week and then distilled. A middle portion (fraction not specified) was retained and stored in a stoppered flask: b.p. 134°C. Nd salts prep'd in 1925 as double ammonium nitrates were of "spectroscopic purity" and converted to the oxide (no details) and the anhydr chloride prep'd by two methods. 1. The oxide was dissolved in aqu HCl and the excess HCl evapd. The crystallized salt was dehydrated by heating in the presence of dry HCl first at 100°C for several h, then at 200°C. 2. The rare earth benzoate was pptd from the aqu chloride or nitrate with sodium benzoate and the benzoate dehydrated by heating to 110°C for at least 24 h. Extraction of the chloride was carried out with HCl satd ether, and the resulting chloride heated at 60°C first in a stream of dry HCl and then in dry air. The salt was stored in a desiccator over P₂O₅. Dry HCl was prep'd from NaCl + H₂SO₄ and by passing the resulting HCl through H₂SO₄ drying towers.

ESTIMATED ERROR:
Soly: precision probably within 3% (compilers).
Temp: precision ± 0.2 K (author).
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Diethyl ether (ethyl ether); C₄H₁₀O; [60-29-7]

ORIGINAL MEASUREMENTS:
Dzhuraev, Kh. Sh.; Mirsaidov, U.; Kurbanbekov, A.; Rakhimova, A.

VARIABLES:
T/K = 293

PREPARED BY:
T. Mioduski

EXPERIMENTAL VALUES:

The solubility of NdCl₃ in diethyl ether at 20°C was reported to be

5.8 x 10⁻³ mass %

The corresponding molality calculated by the compiler is

2.31 x 10⁻⁴ mol kg⁻¹

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method employed. Equilibrium was attained within 24 h and it was verified by constancy in the Nd concentration. Both the saturated solution and the equilibrated solid phase were analyzed. Nd determined by complexometric titration in the presence of urotropine buffer and methyl-thymol blue indicator. Chloride determined by titration with AgNO₃. The solid phase corresponded to NdCl₃.0.3Et₂O (the etherate was dried under vacuum at 40°C prior to analysis).

SOURCE AND PURITY OF MATERIALS:
Anhydrous NdCl₃ prepared by the ethanol solvate method (no details given). Ethyl ether was dried with Na and distilled from LiAlH₄.

ESTIMATED ERROR:
Nothing specified.

REFERENCES:
COMPONENTS:

(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Ethers

ORIGIANAL MEASUREMENTS:

Kirmse, E.M.; Zwietasch, K.J.; Tirschmann, J.; Oelsner, L.; Niedergeases, U.
Z. Chem. 1968, 8, 472-3.


VARIABLES:

Room temperature: T/K around 298

EXPERIMENTAL VALUES:

solubilityₐ,ₐ

<table>
<thead>
<tr>
<th>solvent</th>
<th>mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-ethoxy-2-methoxyethane; C₅H₁₀O₂; [5137-45-1]</td>
<td>0.04</td>
<td>1.6 x 10⁻³</td>
</tr>
<tr>
<td>1-methoxypentane; C₆H₁₄O; [628-80-8]</td>
<td>0.07</td>
<td>2.8 x 10⁻³</td>
</tr>
<tr>
<td>1,3-dioxolane; C₃H₆O₂; [646-06-0]</td>
<td>0.8</td>
<td>3.2 x 10⁻²</td>
</tr>
<tr>
<td>1,4-dioxane; C₄H₈O₂; [123-91-1]</td>
<td>0.1</td>
<td>4.0 x 10⁻²</td>
</tr>
</tbody>
</table>

ₐ Molalities calculated by the compilers.

ₐ Nature of the solid phases not specified.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:

The solute-solvent mixtures were isothermally agitated at 25°C or at room temperature. Authors state that the difference found for the solubility was within experimental error limits.

Nd was determined by complexometric titration.

No other details given.

SOURCE AND PURITY OF MATERIALS:

The anhydrous salt was prepared by the method of Taylor and Carter (1).

No other information given.

ESTIMATED ERROR:

Nothing specified.

REFERENCES:

1. Taylor, M.D.; Carter, C.P.
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Alkyl ethers

VARIABLES:
Room Temperature (293–298 K)

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>solvent</th>
<th>mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>l-methoxyheptane</td>
<td>0.4b</td>
<td>0.016</td>
</tr>
<tr>
<td>l-methoxynonane</td>
<td>0.02c</td>
<td>8 x 10⁻⁴</td>
</tr>
</tbody>
</table>

a Solubilities calculated by the compilers.
b Solid phase NdCl₃·C₈H₁₈O found to be 1: > 2.
c Solid phase not specified.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
The solute-solvent mixtures were isothermally agitated (at room temperature) until equilibrium was attained. The anhydrous reagents were handled in a dry box containing P₄O₁₀. Nd was determined by complexometric titration using Xylenol Orange indicator.

The reported solubilities are mean values based on four determinations.

SOURCE AND PURITY OF MATERIALS:
Nothing specified.

ESTIMATED ERROR:
Nothing specified.

REFERENCES:
### COMPONENTS:
1. Neodymium chloride; \( \text{NdCl}_3 \); [10024-93-8]
2. Tetrahydrofuran; \( \text{C}_4\text{H}_8\text{O} \); [109-99-9]

### ORIGINAL MEASUREMENTS:

### VARIABLES:
Room temperature: \( T/K \) about 293

### EXPERIMENTAL VALUES:
The solubility of \( \text{NdCl}_3 \) in tetrahydrofuran at room temperature (about 20°C) was reported as

\[
1.16 \text{ g/100 ml solution (0.046 mol dm}^{-3}, \text{ compiler).}
\]

### AUXILIARY INFORMATION

**METHOD/APPARATUS/PROCEDURE:**
Isothermal method employed. The solution was equilibrated in an extractor for 60-80 hours at room temperature. Neodymium was determined by the oxalate method and by titration with EDTA using Xylenol Orange indicator. For the solid phase analysis, the solvent was determined by difference.

Anhydrous substances were handled in a dry box through which was passed a current of dry and \( \text{CO}_2 \)-free nitrogen.

Analysis of the solid phase yielded a \( \text{NdCl}_3:\text{C}_4\text{H}_8\text{O} \) ratio of 1:1.99.

**SOURCE AND PURITY OF MATERIALS:**
Sources and purities not specified.

\( \text{NdCl}_3 \) prepared by reaction of the oxide at high temperatures with an excess of \( \text{NH}_4\text{Cl} \) followed by heating the product in a current of dry nitrogen, and then in vacuum to remove unreacted \( \text{NH}_4\text{Cl} \).

Tetrahydrofuran was distilled from \( \text{LiAlH}_4 \).

**ESTIMATED ERROR:**
Nothing specified.

**REFERENCES:**
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Tributylphosphate; C₁₂H₂₇O₄P; [126-73-8]

ORIGINAL MEASUREMENTS:
Korovin, S.S.; Galaktionova, O.V.; Lebedeva, E.N.; Voronskaya, G.N.

VARIABLES:
One temperature

EXPERIMENTAL VALUES:

Composition of saturated solution

<table>
<thead>
<tr>
<th>mass %</th>
<th>mol/kg sln</th>
<th>g dm⁻³</th>
<th>mol dm⁻³</th>
<th>mol kg⁻¹(compiler)</th>
<th>density/g cm⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.8</td>
<td>1.27</td>
<td>408.0</td>
<td>1.63</td>
<td>1.86</td>
<td>1.28</td>
</tr>
</tbody>
</table>

The solid phase is NdCl₃.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Satd slns prepared isothermally with magnetic stirring. Equil was attained after 25-30 d. The sln was centrifuged and an aliquot for analysis taken and added to methanol and pptd with aq NH₃. The pptd Pr(OH)₃ was washed repeatedly and heated to the oxide for gravimetric analysis. The solid phase was analysed (no details given) for phosphorous and only anhydr PrCl₃ was found. All operations were performed in a dry box through which a stream of argon was passed.

The major objective of this work was to establish the nature of complexation between TBP and PrCl₃ in solution. Additional studies with unsaturated solutions (IR spectra, viscosity, molar conductivities) are discussed in the source paper.

SOURCE AND PURITY OF MATERIALS:
Anhydrous NdCl₃ prepd by chlorination of Nd₂O₃ with CCl₄ vapor (1,2). Source and purity of materials not given. Nd was analyzed gravimetrically, and Cl by Volhard's method. Tributylphosphate (TBP) was purified "by the standard method." No additional details given.

ESTIMATED ERROR:
No estimates possible.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Alkyl amines

VARIABLES:
T/K = 298

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Mass %</th>
<th>mol kg⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-propanamine; C₃H₇N;</td>
<td>25.7</td>
<td>1.380</td>
</tr>
<tr>
<td>2-propanamine; iso-C₃H₇N;</td>
<td>0.1</td>
<td>0.004</td>
</tr>
<tr>
<td>2-propen-1-amine b; C₃H₇N;</td>
<td>0.05</td>
<td>0.002</td>
</tr>
</tbody>
</table>

solubility a

a Molalities calculated by the compilers.

b The original paper simply specifies the solvent as C₃H₅NH₂, and upon request the author kindly identified the solvent as allylamine.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Experimental details not given, but were probably similar to previous works of the author which are compiled throughout this volume.

Nature of solid phases not specified.

SOURCE AND PURITY OF MATERIALS:
Nothing specified, but based on previous work by the author the anhydrous salt was probably prepared by the method of Taylor and Carter (1).

ESTIMATED ERROR:
Nothing specified.

REFERENCES:
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; \( \text{NdCl}_3 \); [10024-93-8]

(2) Hexamethylphosphorotriamide; \( \text{C}_6\text{H}_{18}\text{N}_3\text{OP} \); [680-31-9]

ORIGINAL MEASUREMENTS:
Mikheev, N.B.; Kamenskaya, A.N.; Konovalova, N.A.; Zhilina, T.A.

VARIABLES:
Room temperature: \( T/\text{K} = 298 \pm 3 \)

PREPARED BY:
T. Mioduski

EXPERIMENTAL VALUES:
The solubility of the anhydrous salt at \( 25 \pm 3^\circ\text{C} \) was given as
\[
0.119 \pm 0.005 \text{ mol dm}^{-3}
\]
Starting with the solvate \( \text{NdCl}_3.3\left(\text{CH}_3\right)_2\text{N}_3\text{OP} \), the solubility at \( 25 \pm 3^\circ\text{C} \) was given as
\[
0.125 \pm 0.001 \text{ mol dm}^{-3}
\]

*Table 3 in the English translation of the source paper states the temperature to be \( 23 \pm 3^\circ\text{C} \). This is probably a typographical error as the text clearly states that all measurements were carried out at room temperature (25 ± 3°C).

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method used. Salt and solvent were placed in a test-tube in a dry box, and the tube agitated at room temperature (25 ± 3°C) until equilibrium was reached. Aliquots were withdrawn periodically and analysed for the metal content. Rare earth concentration was determined by complexometric titration, and by the radiometric method using the isotope Tm-170 (\( t_1/2 = 169 \text{ d} \)). Authors state that results for both methods agreed. Although not clearly stated, it appears that equilibrium was reached in several weeks to several months.

Solid phase samples washed three times with benzene or ether and dried on a steam bath in an argon atmosphere. The solid phase was analysed and found to be \( \text{NdCl}_3.3\text{C}_6\text{H}_{18}\text{N}_3\text{OP} \).

The solvate was analysed for metal content by complexometric titration, for chloride by the Volhard method, and the solvent was obtained by difference. IR spectra confirmed the absence of water. Structural studies of the solvate also carried out by X-ray analysis.

SOURCE AND PURITY OF MATERIALS:
Anhyd \( \text{NdCl}_3 \) prepd similarly to that in (1) by subliming \( \text{NH}_4\text{Cl} \) from a mixt of \( \text{NdCl}_3 \) and 6 moles of \( \text{NN Cl} \) in a stream of inert gas at 200-400°C (NdCl3 content less than 3%). The solvent was purified as in (2).

\( \text{NdCl}_3.3\text{C}_6\text{H}_{18}\text{N}_3\text{OP} \) prepd by dissolving the hydrate in \( \text{C}_6\text{H}_{18}\text{N}_3\text{OP} \) and heating to 140-145°C for 5 m. The solvate was pptd by addition of abs ether, washing 7 times with ether, and drying over P,O_5 in a stream of dry nitrogen. Yield was about 90 %.

ESTIMATED ERROR:
Soly: precision ± 0.001 mol dm\(^{-3}\) at a 95 % level of confidence (authors).
Temp: precision ± 3 K.

REFERENCES:
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-43-8]
(2) Gallium chloride; GaCl₃; [13450-90-3]
(3) Phosphorus oxychloride; POCl₃; [10025-87-3]

VARIABLES:
Concentration of GaCl₃ at 298 K

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>GaCl₃/NdCl₃ molar ratio</th>
<th>GaCl₃ concentration mmol dm⁻³</th>
<th>NdCl₃ solubility mmol dm⁻³</th>
<th>equiv conductivity S cm² equiv⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>pure POCl₃</td>
<td>1.0</td>
<td>0.01</td>
<td>----</td>
</tr>
<tr>
<td>1:22.4</td>
<td>2.3</td>
<td>23</td>
<td>4.6</td>
</tr>
<tr>
<td>1:17.8</td>
<td>3.0</td>
<td>39</td>
<td>3.9</td>
</tr>
<tr>
<td>1:11.9</td>
<td>4.1</td>
<td>41</td>
<td>5.2</td>
</tr>
<tr>
<td>1:10.0</td>
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<td>42</td>
<td>5.1</td>
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<tr>
<td>1:7.5</td>
<td>6.1</td>
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<td>4.8</td>
</tr>
<tr>
<td>1:5.9</td>
<td>7.1</td>
<td>51</td>
<td>4.6</td>
</tr>
<tr>
<td>1:6.3</td>
<td>8.1</td>
<td>51</td>
<td>5.4</td>
</tr>
<tr>
<td>1:5.6</td>
<td>9.1</td>
<td>51</td>
<td>5.7</td>
</tr>
<tr>
<td>1:5.3</td>
<td>10.1</td>
<td>54</td>
<td>5.8</td>
</tr>
</tbody>
</table>

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Anhydrous GaCl₃ and NdCl₃ were added to POCl₃ in an argon filled dry box. The specified amounts of GaCl₃ were dissolved first in POCl₃. Solubilities were determined at 25°C.

SOURCE AND PURITY OF MATERIALS:
Anhydrous NdCl₃ and GaCl₃ were prepared as described in (1).
POCl₃ was dehydrated with P₂O₅ and distilled twice under vacuum.

COMMENTS AND/OR ADDITIONAL DATA:
The authors state that the increase in the solubility of NdCl₃ upon increasing GaCl₃ concentration is due to complex formation.

REFERENCES:
1. Puzankova, N.L.; Slastenova, N.M.; Solov'ev, M.A.; Batyaev, I.M. 
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Gallium chloride; GaCl₃; [13450-89-0]
(3) Phosphorus oxychloride; POC₁₃; [10025-87-3]

VARIABLES:
Concentration of GaCl₃
Temp not specified, but probably 298 K

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>GaCl₃ concentration (mol dm⁻³)</th>
<th>NdCl₃ solubility (mol dm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
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<tr>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>54</td>
<td>54</td>
</tr>
</tbody>
</table>

Authors state that the increase in the solubility of NdCl₃ with increasing concentration is due to the formation of NdCl₃(POC₁₃)ₓ(GaCl₃)ᵧ complexes. Stepwise formation constants for these complexes are given below.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
The NdCl₃-POC₁₃-GaCl₃ systems were synthesized in sealed tubes by the solvolothermal method at 120°C as described in (1). No other details given. The compilers assume that after treating the solutions at 120°C for about 2 h, they were then isothermally equilibrated at 25°C (see the compilations of references 1 and 2 in this volume.)

COMMENTS AND/OR ADDITIONAL DATA:
For the equilibria
NdCl₃ + yGaCl₃ = NdCl₃·yGaCl₃
the following stepwise formation constants, βₘ, were given:

β₁ = (2.7 ± 0.1) x 10⁶
β₂ = (3.6 ± 0.2) x 10⁹
β₃ = (3.8 ± 0.2) x 10⁸
β₄ = (3.6 ± 0.2) x 10¹⁴

SOURCE AND PURITY OF MATERIALS:
Anhydrous metal chlorides were prepared as described in (3).
POC₁₃ was purified by the usual method.

ESTIMATED ERROR:
Nothing specified.

REFERENCES:
COMPONENTS:
(1) Neodymium chloride; NdCl₃;
[10024-93-8]
(2) Tetrachlorostannate; SnCl₄;
[7646-78-8]
(3) Phosphorus oxychloride; POCl₃;
[10023-87-3]

VARIABLES:
SnCl₄ concentration
T/K = 293 and 333

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>SnCl₄:POCl₃ ratio (by volume)</th>
<th>SnCl₄ concn mol dm⁻³</th>
<th>solubility of Nd₂O₃/mol dm⁻³ᵃ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20°Cᵇ</td>
<td>20°Cᶜ</td>
</tr>
<tr>
<td>1:250</td>
<td>0.035</td>
<td>0.11</td>
</tr>
<tr>
<td>1:100</td>
<td>0.085</td>
<td>0.27</td>
</tr>
<tr>
<td>1:50</td>
<td>0.17</td>
<td>0.30</td>
</tr>
<tr>
<td>1:25</td>
<td>0.33</td>
<td>0.26</td>
</tr>
<tr>
<td>1:15</td>
<td>0.59</td>
<td>0.15</td>
</tr>
<tr>
<td>1:10</td>
<td>0.78</td>
<td>0.11</td>
</tr>
<tr>
<td>1:5</td>
<td>1.4</td>
<td>-----</td>
</tr>
<tr>
<td>1:1:5</td>
<td>3.0</td>
<td>-----</td>
</tr>
<tr>
<td>4:1</td>
<td>6.8</td>
<td>-----</td>
</tr>
<tr>
<td>pure SnCl₄</td>
<td>8.5</td>
<td>2 x 10⁻⁴</td>
</tr>
</tbody>
</table>

ᵃThis is also the solubility of NdCl₃ since the oxide is quantitatively converted to the chloride according to

\[
Nd₂O₃ + 6POCl₃ = 2NdCl₃ + 3P₂O₃Cl₄
\]

Assuming P₂O₃Cl₄ to be soluble, the equilibrated solutions would then constitute a four component mixture.

ᵇPreheated at 120°C for 2 hours.
ᶜPreheated at 60°C (time not specified).
ᵈNo pretreatment.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
Isothermal method used. POCl₃ + SnCl₄ solutions were prepared by volume in a dry box. The SnCl₄ content was verified by chemical analysis for Sn. This solution and Nd₂O₃ were placed in sealed ampoules, heated to 120°C for 2 hours to increase the rate of solution, and then rotated in an air thermostat at 20°C for 2 hours. Without preheating equilibrium was established after 200 hours. Preheating to 120°C lowered the equilibration time at 20°C to 2 hours.

Nd was determined by colorimetric analysis, and in some cases by the oxalate method. The reported solubilities are mean values based on 3–5 parallel determinations.

The solubility of NdCl₃ in pure POCl₃ is small, but in the presence of SnCl₄ the solubility increases due to complexation:

\[
2NdCl₃ + 3SnCl₄ = Nd₂(SnCl₆)₃
\]

SOURCE AND PURITY OF MATERIALS:
Nd₂O₃ of "the first sort" was ignited at 950°C for 2 hours.

"Pure" grade SnCl₄ and POCl₃ were dehydrated with P₂O₅ and distilled under vacuum.

ESTIMATED ERROR:
Soly: authors state the "coefficient of variance" to be less than 7%.
Temp: precision presumably ± 0.2K (compiler).

REFERENCES:
# Neodymium Chloride

## COMPONENTS:
1. Neodymium chloride; NdCl₃; [10024-93-8]
2. Tetrachlorostannate; SnCl₄; [7646-78-8]
3. Phosphorous oxychloride; POCl₃; [10025-87-3]

## ORIGINAL MEASUREMENTS:
Batyaev, I.M.; Solov'ev, M.A.

## VARIABLES:
- SnCl₄ concentration
- T/K = 293

## EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>SnCl₄/POCl₃ volume ratio</th>
<th>SnCl₄ concn 10⁻² c₂/mol dm⁻³</th>
<th>SnCl₄/NdCl₃ mol ratio</th>
<th>solubility of NdCl₃ 10⁻³ c₁/mol dm⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25:29.7</td>
<td>5.0</td>
<td>10:1</td>
<td>5.0</td>
</tr>
<tr>
<td>0.50:29.5</td>
<td>10.0</td>
<td>19.2:1</td>
<td>5.2</td>
</tr>
<tr>
<td>1.0:29.0</td>
<td>15.0</td>
<td>27.7:1</td>
<td>5.4</td>
</tr>
<tr>
<td>1.25:28.7</td>
<td>20.0</td>
<td>35.7:1</td>
<td>5.6</td>
</tr>
<tr>
<td>1.50:28.5</td>
<td>25.0</td>
<td>43.9:1</td>
<td>5.7</td>
</tr>
<tr>
<td>1.75:28.2</td>
<td>30.0</td>
<td>50.9:1</td>
<td>5.9</td>
</tr>
<tr>
<td>2.0:28.0</td>
<td>35.0</td>
<td>57.4:1</td>
<td>6.1</td>
</tr>
<tr>
<td>2.25:27.7</td>
<td>40.0</td>
<td>63.5:1</td>
<td>6.3</td>
</tr>
<tr>
<td>2.50:27.5</td>
<td>45.0</td>
<td>69.2:1</td>
<td>6.5</td>
</tr>
<tr>
<td>2.75:27.2</td>
<td>50.0</td>
<td>74.6:1</td>
<td>6.7</td>
</tr>
<tr>
<td>3.0:27.0</td>
<td>55.0</td>
<td>79.7:1</td>
<td>6.9</td>
</tr>
</tbody>
</table>

The solubility of NdCl₃ in pure POCl₃ was reported to be 10⁻⁵ mol dm⁻³ (solubility product = 2.7 x 10⁻¹⁹ mol⁴ dm⁻₁²). The increasing solubility of NdCl₃ observed upon increasing the SnCl₄ concentration from 0.05-0.55 mol dm⁻³ is attributed to outer sphere coordination of SnCl₄ by POCl₃. Stability constants, $\beta_i$, for the reactions

$$NdCl_3 + nPOCl_3 = NdCl_3.nPOCl_3$$

were calculated for $i = 1-4$.

## AUXILIARY INFORMATION

**METHOD/APPARATUS/PROCEDURE:**
Isothermal method used. Solvent-solute mixtures were sealed in glass ampoules and rotated in an air thermostat at 120°C for 24 h. The ampoules were then rotated in a thermostat at 20°C for 24 h. After equilibrium was reached, aliquots were withdrawn in a dry argon atmosphere and evaporated in vacuum. The dry residues were hydrolyzed, the hydrolyzed products filtered, and Nd determined spectrophotometrically. The solutions were analyzed at pH 3 (phormic buffer) using 0.05% arsenazo III solution. A calibration curve was used for these analyses.

**SOURCE AND PURITY OF MATERIALS:**
Nothing specified.

**ESTIMATED ERROR:**
Nothing specified.

**REFERENCES:**
1. Lyubimov, E.I.; Batyaev, I.M.
   (see previous page for the compilation of this paper).
Neodymium Chloride

COMPONENTS:
(1) Neodymium chloride; NdCl₃; [10024-93-8]
(2) Tetrachlorostannate; SnCl₄; [7646-78-8]
(3) Phosphorus oxychloride; POCl₃; [10025-87-3]

ORIGINAL MEASUREMENTS:
Batyaev, I.M.; Solov'ev, M.A.

VARIABLES:
Concentration of SnCl₄
Temp not specified, but probably 298 K

EXPERIMENTAL VALUES:

<table>
<thead>
<tr>
<th>SnCl₄ concentration (mol dm⁻³)</th>
<th>NdCl₃ solubility (mol dm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>50</td>
<td>5.0</td>
</tr>
<tr>
<td>100</td>
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<td>150</td>
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<tr>
<td>200</td>
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<tr>
<td>250</td>
<td>5.7</td>
</tr>
<tr>
<td>300</td>
<td>5.9</td>
</tr>
<tr>
<td>350</td>
<td>6.1</td>
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<tr>
<td>400</td>
<td>6.3</td>
</tr>
<tr>
<td>450</td>
<td>6.5</td>
</tr>
<tr>
<td>500</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Authors state that the increase in the solubility of NdCl₃ with increasing concentration is due to the formation of NdCl₃(POCl₃)ₓ(SnCl₄)ᵧ complexes. Stepwise formation constants for these complexes are given below.

AUXILIARY INFORMATION

METHOD/APPARATUS/PROCEDURE:
The NdCl₃-POCl₃-SnCl₄ systems were synthesized in sealed tubes by the solvolothermal method at 120°C as described in (1). No other details given. The compilers assume that after treating the solutions at 120°C for about 2 h, they were then isothermally equilibrated at 25°C as in (2): see the compilations of references 1 and 2 in this volume.

COMMENTS AND/OR ADDITIONAL DATA:
For the equilibria

NdCl₃ + ySnCl₄ = NdCl₃.ySnCl₄

the following stepwise formation constants, βᵧ, were given:

β₁ = (1.5 ± 0.1) x 10⁴
β₂ = (3.8 ± 0.2) x 10⁶
β₃ = (3.6 ± 0.2) x 10⁵
β₄ = (1.2 ± 0.1) x 10⁸

SOURCE AND PURITY OF MATERIALS:
Anhydrous metal chlorides were prepared as described in (3).

POCl₃ and SnCl₄ were purified by the usual methods.

ESTIMATED ERROR:
Nothing specified.

REFERENCES:
**COMMENTS:**

<table>
<thead>
<tr>
<th>COMPONENTS:</th>
<th>ORIGINAL MEASUREMENTS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Neodymium chloride; NdCl₃; [10024-93-8]</td>
<td>Batyaev, I.M.; Solov'ev, M.A.</td>
</tr>
<tr>
<td>(3) Phosphorus oxychloride; POCl₃; [10025-87-3]</td>
<td>T. Mioduski and M. Salomon</td>
</tr>
</tbody>
</table>

**VARIABLES:**

Concentration of ZnCl₂
Temp not specified, but probably 298 K

**EXPERIMENTAL VALUES:**

<table>
<thead>
<tr>
<th>ZnCl₂ concentration mol dm⁻³</th>
<th>NdCl₃ solubility mol dm⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.01</td>
</tr>
<tr>
<td>17</td>
<td>2.0</td>
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<td>16</td>
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<td>1.2</td>
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<tr>
<td>9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Authors state that the increase in the solubility of NdCl₃ with increasing concentration is due to the formation of NdCl₃(POCl₃)ₓ(ZnCl₂)ᵧ complexes. Stepwise formation constants for these complexes are given below.

**METHOD/APPARATUS/PROCEDURE:**
The NdCl₃-POCl₃-ZnCl₂ systems were synthesized in sealed tubes by the solvothermal method at 120°C as described in (1). No other details given. The compilers assume that after treating the solutions at 120°C for about 2 h, they were then isothermally equilibrated at 25°C as in (2): see the compilations of references 1 and 2 in this volume.

**COMMENTS and/OR ADDITIONAL DATA:**
For the equilibria

NdCl₃ + yZnCl₂ = NdCl₃·yZnCl₂

the following stepwise formation constants, $β_y$, were given:

$β_1 = (6.7 ± 0.3) \times 10^4$

$β_2 = (2.5 ± 0.1) \times 10^5$

$β_3 = (7.4 ± 0.3) \times 10^7$

$β_4 = (5.4 ± 0.2) \times 10^9$

**SOURCE AND PURITY OF MATERIALS:**
Anhydrous metal chlorides were prepared as described in (3). POCl₃ was purified by the usual method.

**ESTIMATED ERROR:**
Nothing specified.

**REFERENCES:**