COMPONENTS:	EVALUATOR:
(1) Trisodium phosphate; Na_3PO_4; [7601-54-9] (2) Water; H_2O; [7732-18-5]	J. Eysseltová Charles University Prague, Czechoslovakia May 1985

CRITICAL EVALUATION:

THE BINARY SYSTEM

There is a good deal of uncertainty about this system. There is disagreement about the solubility and about the composition of the solid phase. The data published by Apfel (1) for the solubility of trisodium phosphate over the temperature range of 273-356 K disagree with the data of Mulder (2) as quoted by others (3). Kobe and Leipper (4) reported the solubility of a substance having the composition $Na_3PO_4 \cdot 1/7NaOH \cdot 12H_2O$ and their results agree to some extent with those of Apfel (1). Ravich and Shcherbakova (5) reported the existence of solid solutions $mNa_3PO_4 \cdot nNaH_2PO_4$ in equilibrium with saturated solutions having Na/P ratios = 1/3 above 523 K.

The matter of the hydrates of Na_3PO_4 has also been the subject of disagreement. Most authors consider $Na_3PO_4 \cdot 12H_2O$ to be the solid phase at temperatures below 323 K, but Wendrow and Kobe (3) suggest that it is $Na_3PO_4 \cdot 1/4NaOH \cdot 12H_2O$. The solid phase in equilibrium with saturated solutions is reported to be $Na_3PO_4 \cdot 10H_2O$ over the temperature range 323-333 K and $Na_3PO_4 \cdot 8H_2O$ at temperatures from 343 to 348 K (1). But others (3), on the basis of extrapolated data, suggest that the equilibrium solid phases are $Na_3PO_4 \cdot 1/4NaOH \cdot 12H_2O$ at temperatures up to 328 K, $Na_3PO_4 \cdot 8H_2O$ from 328-338 K, and $Na_3PO_4 \cdot 6H_2O$ from 338-373 K. More work is needed to clarify the nature of the solid phases before the solubility data can be evaluated.

Schroeder, et al. (6) made solubility measurements over the temperature interval 348-523 K. They reported the equilibrium solid phase to be $Na_3PO_4 \cdot H_2O$ in the temperature interval 393-488 K and the anhydrous Na_3PO_4 to be the solid phase above 488 K. Attempts to fit these data to the general solubility equations described and discussed in the section on NaH_2PO_4 (chap. 3) were unsuccessful. The number of experimental points remaining after the iteration was too small to consider the results to be reasonable. Perhaps a different model is needed to treat these data.

MULTICOMPONENT SYSTEMS

The phase diagrams for systems in which Na_3PO_4 is a component differ substantially from those in which NaH_2PO_4 or Na_2HPO_4 are components. The latter usually form simple eutonic systems, while with systems containing Na_3PO_4 the formation of solid solutions or complex compounds has often been reported. Solubility values reported for these systems often disagree with each other. This is probably due to the chemical complexity of the systems and the fact that the analyses are complicated by the high pH values of these systems.

No solid solutions or complex compounds have been reported as equilibrium solid phases for the following systems:

$Na_3PO_4-NaNO_2-H_2O$ at 298 K (7);

$Na_3PO_4-NaCl-H_2O$ at 298 and 378 K (8);

$Na_3PO_4-Na_2WO_4-H_2O$ at 503 K (9);

$Na_3PO_4-Na_2CO_3-H_2O$ at 273 and 293 K (10), and 298 K (11).

The presence of a small amount of NaOH in one study of the last system above (4) resulted in only a small increase in the concentration of the other salt components.

Solid solutions have been reported as solid phases for the following systems:

$Na_3PO_4-Na_2B_4O_7-H_2O$ at 293 K (12);

$Na_3PO_4-NaClO_4-H_2O$ at 293 K (12);

$Na_3PO_4-NaF-H_2O$ at 298 K (13).

Complex compounds that have been reported as solid phases are:
$Na_3PO_4 \cdot 4.5H_2O_2$ in the $Na_3PO_4-H_2O_2-H_2O$ system at 253 K (14);
$Na_3PO_4 \cdot 4.5H_2O_2$ and $Na_3PO_4 \cdot H_2O_2$ in the above system at 273 K (14);
$Na_3PO_4 \cdot Cu_3(PO_4)_2$ in the $Na_3PO_4-Cu_3(PO_4)_2-H_2O$ system at 298 and 323 K (15).

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CRITICAL EVALUATION:

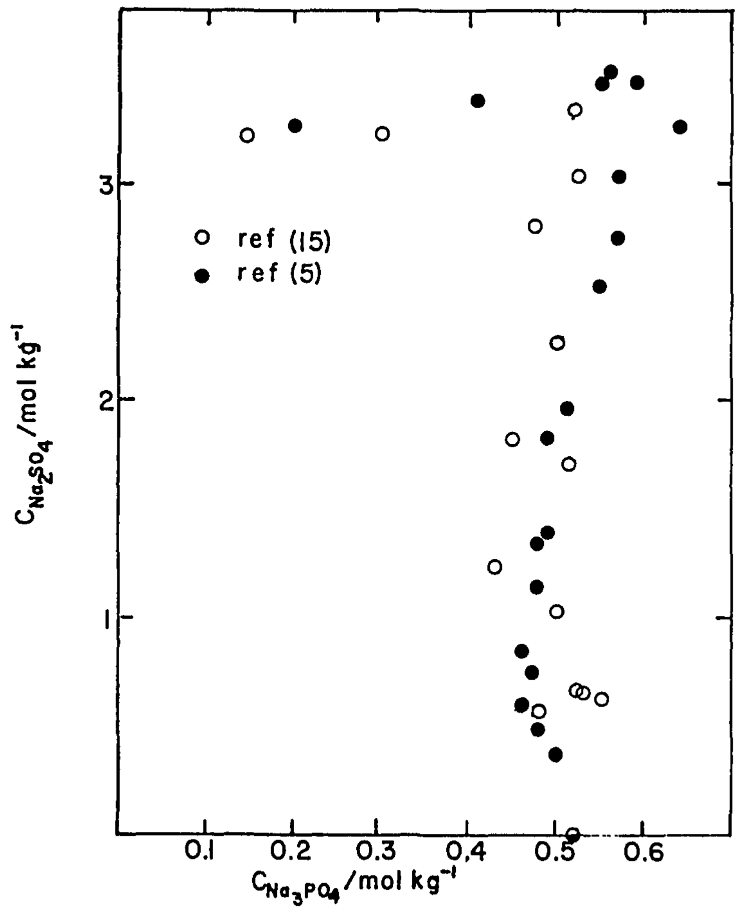

Figure 1. Solubility in the Na_3PO_4-Na_2SO_4-H_2O system at 523 K.

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CRITICAL EVALUATION: (cont'd)

Three groups of systems have been studied in more detail.

1. The Na_3PO_4-Na_2SO_4-H_2O system. This system has been studied at 523 K (16) and at 423, 473, 523 and 573 K (6). (In the latter paper some data were also reported for the Na_3PO_4-Na_2SO_4-NaOH-H_2O system.) The results obtained at 523 K, Figure 1, agree reasonably well with each other. However, one group reports a solid phase of $Na_2SO_4 \cdot 2Na_3PO_4$ (6) while the other group (16) reports instead two types of phases having varying compositions. Additional work is needed to settle this matter.

2. Abduragimova, et al. have studied the following systems at 298 K:

Na_3PO_4-$NaVO_3$-H_2O (17)

Na_3PO_4-Na_2SO_4-H_2O (17)

Na_3PO_4-$NaVO_3$-Na_2SO_4-H_2O (18)

($NaAlO_2$ + NaOH)-Na_3PO_4-$NaVO_3$-H_2O (19)

($NaAlO_2$ + NaOH)-Na_3PO_4-Na_2SO_4-H_2O (19).

The following solid phases were reported as being present:

$4Na_2O \cdot P_2O_5 \cdot V_2O_5 \cdot 30H_2O$; $4Na_2O \cdot P_2O_5 \cdot V_2O_5 \cdot 18H_2O$; and $3Al_2O_3 \cdot 4Na_2O \cdot P_2O_5 \cdot 15H_2O$.

However, these data are not considered to be reliable because of many obvious errors in the tabular data. The errors make it difficult to interpret the data.

3. A group of Armenian authors has studied the following systems:

Na_3PO_4-Na_2SiO_3-H_2O (20,21);

Na_3PO_4-K_3PO_4-H_2O (22);

Na_3PO_4-Na_2SiO_3-NaOH-H_2O (23);

Na_3PO_4-Na_2SiO_3-Na_2CO_3-H_2O (21);

$3K^+, 3Na^+ || PO_4^{3-}, 3/2SiO_3^{2-}$-$H_2O$ (24).

Ref. (23) contains only graphical data and in the other papers the data consist of limits within which the individual phases exist, rather than precise solubility data. The most recent report (21) maintains that no solid solutions of Na_2SiO_3 and Na_3PO_4 are formed, but does not substantiate this statement. Therefore, more work is needed before this set of papers can be evaluated.

The system Na_3PO_4-CH_3COCH_3-H_2O has also been studied (25). In contrast to the NaH_2PO_4-CH_3COCH_3-H_2O and Na_2HPO_4-CH_3COCH_3-H_2O systems (26), no limited miscibility has been observed.

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CRITICAL EVALUATION: (cont'd)

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