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Theoretical studies on the utilization of reciprocal salt pairs for solar heat storage

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Abstract

The double conversion of reciprocal salt pairs can be used for solar energy storage in buildings when the transition point of pair stability lies between 10°C and 70°C, when the enthalpy of reaction is sufficiently high and when the reaction is exotherm below the transformation temperature and endotherm above the transformation temperature.

The approximate transformation temperatures of more than 500 reciprocal salt pairs are determined by the solubility criterion of van't Hoff. The enthalpies of reaction are calculated from the enthalpies of formation of the components. About 30 of these reactions seem to be suitable for solar heat storage, when no other criteria as transformation temperature and enthalpy of reaction are used.

First experimental results of reciprocal salt pair reactions of $Ba(OH)_2$ and the nitrates of the alkaline metal group are presented.

1. Introduction

Storage materials can accumulate thermal energy as specific heat or as heat of physical or chemical reactions including their combined effects. Experimental work has been favoring rocks, water, salthydrates, paraffins and other organic compounds. In rocks and water only the specific heat can be stored, while in salthydrates, paraffins and other organic compounds the latent heat of fusion and the specific heat can be used for energy storage.

Latent heat storage systems have the advantage of a high heat storage capacity within a small temperature range. The optimum transformation temperature of such a system for heating and hot water production in buildings lies between 45°C and 70°C [R.1].

The most prospective and most investigated salthydrates are $CaCl_2 \cdot 6H_2O$(30°C), $Na_2SO_4 \cdot 10H_2O$ (32°C), $Na_2CO_3 \cdot 10H_2O$ (32°C), $Na_2HPO_4 \cdot 12H_2O$ (36°C) and $Na_2S_2O_3 \cdot 5H_2O$ (48°C). The melting points are given in parentheses. Except for the last one, these salthydrates have low transformation temperatures, and the heat stored in these transformations can only be used for floor-heating or in connection with a heat pump or a post-heating system for radiator heating of buildings and for hot water production. Another promising salthydrate system is $Ba(OH)_2 \cdot 8H_2O$ (78°C). Between 48°C and 78°C there is no further anorganic system, which seems to be suitable for energy storage [R.2]. In this temperature range there are however the melting points of several organic compounds, but the latent heats of fusion of these substances are only between 35 and 40 kcal/dm^3. This is about half of the corresponding values of salthydrate systems.

Several reversible chemical reactions are envisaged for heat storage, e.g. the separation and addition of water or ammonia, the oxidation and reduction of metals and metal oxides, the dissociation and formation of ammonia, water, sulphur trioxide, magnesium or calcium hydroxide, ammonium hydrogensulphate, metal hydrides etc. Most of these reactions are

characterized by two facts:

- The reactions are equilibrium reactions, where the equilibrium is shifted from 10% to 90% in a large temperature interval. Therefore only a part of the enthalpy of reaction can generally be used for energy storage.
- The gaseous components of these reactions cannot be released, if the reaction is reversible. In this way the energy storage density is reduced.

A more favourable chemical heat storage system will therefore utilize a chemical reaction, which will take place at a certain temperature without gaseous components. A type of chemical reaction, which meets these conditions, is the double conversion of a reciprocal salt pair.

2. Reciprocal Salt Pairs

A system of two salts with different cations and different anions is called a reciprocal salt pair. In this system the reaction

$$AB + CD \rightleftharpoons AD + CB \quad + \Delta H \qquad (1)$$

is possible (A,C cations, B,D anions). This type of reaction is called the double conversion of a reciprocal salt pair. A wellknown example of a double conversion of a reciprocal salt pair is the conversion of Chile saltpeter with potassium chloride to potassium nitrate and sodium chloride:

$$NaNO_3 + KCl \rightleftharpoons KNO_3 + NaCl \qquad (2)$$

This reaction was very important for the production of fertilizer and gunpowder and for other applications.

Let us now consider a system of four solid phases of the four salts in eq. (1) in equilibrium with their vapour or their saturated aqueous solution.

In accordance with the phase rule of Gibbs:

$$F = Co - Ph + 2 \qquad (3)$$

this system can only exist at one temperature. The number of components Co of system (1) is 3 (four chemical components minus one equation of condition between them). The number of phases Ph is 5 (four solid phases plus one gaseous phase, if reaction (1) takes place in the vapour phase, or four solid phases plus one liquid phase, if reaction (1) takes place in the saturated aqueous phase). Then the number of freedoms F of system (1) in eq. (3) is zero. The four solid phases in equilibrium with their gaseous or saturated aqueous phase can only exist at one temperature, i.e. the transformation temperature. Below this temperature the reaction goes in one direction until at least one solid phase disappears completely. Above this temperature the reaction goes in the other direction until at least one solid phase of the other side of the equation of reaction disappears completely.

The double conversion of a reciprocal salt pair can be used for solar energy storage, when the reaction is exotherm below the transformation temperature and endotherm above this temperature. If the transformation temperature is between 45°C and 70°C the reciprocal salt pair can directly be used for house heating and hot water production. Reciprocal salt pair reactions with transformation temperatures between 30°C and 45°C can be used for floor-heating and systems with transformation temperatures between 10°C and 45°C can be used in connection with a heat pump for radiator heating of buildings and hot water production.

3. Determination of the transformation temperatures of reciprocal salt pairs

The approximate transformation temperature can be determined by a method given by van't Hoff [R.3]. He showed that a

salt pair is the stable pair at any given temperature, which has the smaller product of solubility products. If we then plot the product of K_{AB} and K_{CD} (solubility products in gram equivalents per liter of water) and the corresponding product of the reciprocal pair AD and CB, both as f(T), the intersection of the two curves should give, at least approximately, the transition point of pair stability. Van't Hoff tested this criterion with the reciprocal salt pair:

$$Na_2SO_4 \cdot 10H_2O + 2KCl \rightleftharpoons 2NaCl + K_2SO_4 + 10H_2O \qquad (4)$$

According to the solubility products the transition was estimated to be at about 10°C. The experimental determination of the transformation temperature in a dilatometer gave a halting point of temperature at 3.7°C indicated by a change of density of the reactants.

The solubility criterion of van't Hoff becomes inexact at high concentrations and at the incomplete dissociation of the dissolved salts. In both cases the solubilities must be multiplied by the corresponding activity coefficients, a property which is mostly unknown. However, the practical importance of the solubility criterion in these cases without knowledge of the activity coefficients is only slightly impaired, as it can still give an important indication of the existence and the approximate temperature of transition.

In Table 1 (p. 8 - 10) the solubility products of salts composed of one of the cations Li^+, Na^+, K^+, Rb^+, Cs^+, NH_4^+, Mg^{2+}, Ca^{2+}, Sr^{2+} or Ba^{2+} and of one of the anions OH^-, F^-, Cl^-, Br^-, J^-, NO_2^-, NO_3^-, SO_3^{2-}, SO_4^{2-}, $S_2O_3^{2-}$ or CO_3^{2-} are presented in the temperature interval between 0°C and 120°C, as far as they are given in [R.4]. Then the products of solubility products of all possible combinations of these salt pairs are formed and compared graphically with the product of solubility products of the corresponding reciprocal salt pairs. The points of intersection of two correlated curves then gives, according to the solubility criterion of van't Hoff, the approximate point (temperature) of transition of pair stability.

The results of more than 500 reciprocal salt pairs are given in Table 2 (p. 11- 31). Column 1 contains the two cations and the two anions of a reciprocal salt pair. In column 2 the approximate transformation temperature T_o is given, if there is a transition of pair stability between 0°C and 120°C. In column 3 is presented the stable pair below the transformation temperature and in column 4 the stable pair above the transformation temperature. In these two columns the salts of the stable pair are given as they are present as solid phases in a saturated aqueous solution, that is in many cases as salthydrates.

In most of the investigated cases in this work there is no transition of pair stability in the temperature interval between 0°C and 120°C. For these cases the salt pair which is stable between 0°C and 120°C is given in column 5.

4. Determination of the enthalpies of reaction of the double conversion of reciprocal salt pairs

The enthalpies of reaction are calculated from the enthalpies of formation from the elements in their standard states at T = 298.15°K and p = 1 atm. The enthalpy of reaction ΔH in eq. (1) is given by

$$\Delta H = H_{AD} + H_{CB} - H_{AB} - H_{CD} \qquad (5)$$

where

$$H = H^{(o)} + \int_{298,15°K}^{T} C_p \, dt \qquad (6)$$

is the molar enthalpy of formation at the transition temperature T and at 1 atm, $H^{(o)}$ is the molar enthalpy of formation in the standard state and C_p is the molar heat at constant pressure. As the integral in (6) in the temperature range between 0°C and 120°C for salts is generally more than two orders of magnitude smaller than the standard state enthalpy

of formation, the enthalpies of reaction are calculated from these standard state enthalpies of formation:

$$\Delta H = H_{AD}^{(o)} + H_{CB}^{(o)} - H_{AB}^{(o)} - H_{CD}^{(o)} \qquad (7)$$

The standard state enthalpies of formation are taken from [R.5] and [R.6]. In many cases, where salthydrates take part (e.g. in eq. (4)), the enthalpies of formation of these salthydrates are used for the calculation of the enthalpy of reaction. These enthalpies of formation are given in Table 3 (p. 32 - 34). The data of a salt are given in one row. In cases, in which one or more salthydrates are stable in the temperature range considered in this study, the number of molecules of water are given in parenthesis. Consequently the difference Δn of molecules of water between the right and the left side of the equation of reaction has to be added, when salthydrates take part at the reaction:

$$\Delta H = H_{AD}^{(o)} + H_{CB}^{(o)} - H_{AB}^{(o)} - H_{CD}^{(o)} - \Delta n \cdot H_{H_2O}^{(o)} \qquad (8)$$

The enthalpies of reaction calculated in this way, are given in column 6 of Table 2 in kcal/mol and in column 7 in kcal/dm^3 for those reciprocal salt pair reactions, where a transition point was found between 0°C and 120°C. The densities [R.5] of the reactants AB and CD of the left side of the equation of reaction are used for the calculation of the enthalpy of reaction per unit of volume in column 7.

5. Results

Reciprocal salt pair reactions with high enthalpies of reaction ($\Delta H > 50$ kcal/dm^3) and transformation temperatures between 10°C and 70°C are suitable for solar energy storage for house heating and hot water production. These values, transformation temperature and enthalpy of reaction, are given in columns 2 and 7 of Table 2 for more than 500 reciprocal salt pair reactions. About 30 of these reactions seem

to be suitable for solar heat storage for habitat, when no other criteria as transformation temperature and enthalpy of reaction are used.

An experimental programme has been started for the measurements of transformation temperatures and enthalpies of reaction of these selected reciprocal salt pairs in a simple calorimetric device, in which the cooling curves from 100°C to 0°C will be studied. At first the reactions of the nitrates of the alkaline-metal group with barium hydroxide are studied and the following transition temperatures are found:

Reaction	Transition Temperature(°C) experimental	calculated
1) $2LiNO_3 \cdot 3H_2O + Ba(OH)_2 \cdot 8H_2O \rightleftharpoons 2LiOH \cdot H_2O + Ba(NO_3)_2 + 12H_2O$	-	10
2) $2NaNO_3 + Ba(OH)_2 \cdot 8H_2O \rightleftharpoons 2NaOH + Ba(NO_3)_2 + 8H_2O$	44	72
3) $2KNO_3 + Ba(OH)_2 \cdot 8H_2O \rightleftharpoons 2KOH + Ba(NO_3)_2 + 8H_2O$	64	65
4) $2RbNO_3 + Ba(OH)_2 \cdot 8H_2O \rightleftharpoons 2RbOH + Ba(NO_3)_2 + 8H_2O$	65	-
5) $2CsNO_3 + Ba(OH)_2 \cdot 8H_2O \rightleftharpoons 2CsOH + Ba(NO_3)_2 + 8H_2O$	71	-

No transition between 20°C and 100°C was found for the first reciprocal salt pair. The transformation temperatures of reaction 4 and 5 couldn't be calculated, because no solubility data of RbOH and CsOH were available. The enthalpies of reaction were always very large and were indicated by long halting temperatures in the cooling curves.

The results of this experimental programme will be shortly published.

Table 1 : Solubility products (g-equivalents/l H_2O)

Formula	0°C	20°C	40°C	60°C	80°C	100°C	120°C
LiOH	5.26	5.31	5.47	5.79	6.34	7.30	9.15
LiF	0.0597	0.0566	0.0532	0.0497	0.0466	0.0431	0.0404
LiCl	16.3	19.4	21.1	23.2	26.3	30.2	31.2
LiBr	16.4	18.5	24.2	25.7	28.2	30.6	35.5
LiJ	11.3	12.3	13.5	15.1	32.7	36.0	44.0
$LiNO_2$	15.3	19.0	26.2	34.6	44.3	61.5	
$LiNO_3$	7.67	10.6	21.2	26.5	34.1	50.5	
Li_2SO_4	6.56	6.22	6.04	5.82	5.66	5.52	5.42
Li_2CO_3	0.206	0.181	0.157	0.135	0.116	0.098	
NaOH	10.6	27.2	32.2	44.6	77.0	83.7	91.3
NaF	1.02	1.03	1.05	1.10	1.17	1.28	1.40
NaCl	6.10	6.16	6.23	6.35	6.48	6.68	6.88
NaBr	7.70	8.83	10.4	11.4	11.5	11.8	12.1
NaJ	10.7	11.9	13.9	17.2	19.5	20.0	20.6
$NaNO_2$	10.4	11.9	13.8	16.3	19.4	23.1	28.4
$NaNO_3$	8.45	10.1	12.3	14.6	17.4	20.5	24.4
Na_2SO_3	2.19	4.17	5.90	5.12	4.53	4.19	3.89
Na_2SO_4	0.648	2.64	6.78	6.36	6.07	5.92	5.84
$Na_2S_2O_3$	6.35	8.76	13.0	23.8	29.0	30.8	32.9
Na_2CO_3	1.29	3.49	10.5	9.29	8.60	8.48	8.01
KOH	17.1	20.3	24.2	25.8	28.5	32.0	37.5
KF	7.48	16.3	24.5	24.7	25.8	28.1	32.0
KCl	3.76	4.61	5.40	6.11	6.78	7.44	8.04
KBr	4.51	5.49	6.39	7.19	7.98	8.78	9.55
KJ	7.64	8.67	9.62	10.6	11.5	12.5	13.5
KNO_2	31.1	33.4	36.0	38.9	42.2	46.1	50.8
KNO_3	1.25	3.12	6.38	10.8	16.6	23.9	32.9
K_2SO_3	13.3	13.5	13.7	13.9	14.1	14.4	14.6
K_2SO_4	0.851	1.28	1.67	2.07	2.42	2.78	3.09
$K_2S_2O_3$	10.1	16.3	21.5	24.8	30.9	37.3	
K_2CO_3	15.3	15.9	17.1	18.3	20.1	22.6	26.3
RbCl	6.36	7.54	8.57	9.47	10.5	11.5	12.4

Table 1 (continued)

Formula	0°C	20°C	40°C	60°C	80°C	100°C	120°C
RbBr	5.67	6.74	7.79	8.92	10.1	11.4	12.8
RbJ	5.90	7.52	8.86	10.1	11.6	13.3	14.9
$RbNO_3$	1.37	3.65	7.83	13.6	21.2	30.5	49.8
Rb_2SO_4	2.73	3.61	4.36	5.04	5.60	6.08	6.59
CsCl	9.61	11.0	12.4	13.7	15.0	16.1	17.2
CsBr	3.29	5.24	7.26	9.12	11.0	12.3	13.2
CsJ	1.67	2.95	4.32	5.82	7.28	8.90	10.4
$CsNO_3$	0.477	1.19	2.44	4.28	6.91	10.0	14.6
Cs_2SO_4	9.21	9.87	10.4	11.1	11.7	12.2	12.6
NH_4F	19.6	22.1	25.4	30.2	39.2	52.5	73.0
NH_4Cl	5.46	6.98	8.60	10.3	12.1	14.4	16.7
NH_4Br	6.05	7.46	8.91	10.5	12.3	14.1	16.4
NH_4J	10.6	11.9	13.0	14.3	15.7	17.2	18.5
NH_4NO_3	14.5	23.5	36.3	51.0	78.1	**126**	**248**
$(NH_4)_2SO_3$	8.22	10.5	13.6	17.9	24.6	26.4	29.4
$(NH_4)_2SO_4$	10.7	11.4	12.3	13.3	14.3	15.5	16.6
$MgCl_2$	11.0	11.5	12.1	12.8	13.9	15.4	18.0
$MgBr_2$	10.6	11.1	11.6	12.2	12.9	13.6	14.4
$Mg(NO_3)_2$	8.55	9.61	10.9	12.4	14.7	35.2	42.2
$MgSO_4$	4.37	5.78	7.40	9.03	9.31	8.11	6.65
MgS_2O_3	1.36	3.49	6.65	12.3	32.1		
$Ca(OH)_2$	0.0513	0.0437	0.0391	0.0302	0.0238	0.0178	0.0130
$CaCl_2$	10.7	13.4	20.5	24.7	26.3	28.5	30.9
$CaBr_2$	12.5	14.3	21.3	27.6	28.9	30.5	32.6
$Ca(NO_2)_2$	9.97	13.3	18.7	20.3	23.0	26.8	32.2
$Ca(NO_3)_2$	12.2	15.4	23.1	43.0	43.5	44.5	45.8
$CaSO_4$	0.0262	0.0300	0.0309	0.0220	0.0151	0.0098	0.0062
$Sr(OH)_2$	0.0494	0.133	0.301	0.614	1.45	4.79	
$SrCl_2$	5.46	6.64	8.30	10.7	11.7	13.0	14.7
$SrBr_2$	7.11	7.99	9.19	11.0	14.2	18.0	19.6
SrJ_2	9.52	10.5	11.7	13.3	16.4	21.8	24.7

Table 1 (continued)

Formula	0°C	20°C	40°C	60°C	80°C	100°C	120°C
$Sr(NO_2)_2$	4.89	7.55	8.61	10.1	12.2	15.3	19.0
$Sr(NO_3)_2$	3.59	6.41	8.66	8.94	9.23	9.60	10.0
$Ba(OH)_2$	0.214	0.461	1.01	2.49	13.4	20.0	
BaF_2	0.0200	0.0173	0.0148	0.0125	0.0106	0.0090	0.0078
$BaCl_2$	2.95	3.42	3.90	4.45	5.01	5.68	5.93
$BaBr_2$	6.26	6.65	7.09	7.59	8.19	8.92	9.68
BaJ_2	8.56	10.1	11.7	12.2	12.9	13.8	14.7
$Ba(NO_2)_2$	4.01	5.62	9.44	13.0	18.4	27.3	39.7
$Ba(NO_3)_2$	0.394	0.702	1.08	1.56	2.10	2.66	3.22

Table 2 : Transformation temperatures and enthalpies of reaction of reciprocal salt pairs

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
1) Li^+, Na^+, OH^-, F^-				$LiF+NaOH$		
2) Li^+, Na^+, OH^-, Cl^-				$LiOH+NaCl$		
3) Li^+, Na^+, OH^-, Br^-				$LiOH+NaBr$		
4) Li^+, Na^+, OH^-, J^-				$LiOH+NaJ$		
5) Li^+, Na^+, OH^-, NO_2^-				$LiOH+NaNO_2$		
6) Li^+, Na^+, OH^-, NO_3^-				$LiOH+NaNO_3$		
7) $Li^+, Na^+, OH^-, SO_4^{2-}$				$LiOH+Na_2SO_4$		
8) $Li^+, Na^+, OH^-, CO_3^{2-}$				Li_2CO_3+NaOH		
9) Li^+, K^+, OH^-, F^-				$LiF+KOH$		
10) Li^+, K^+, OH^-, Cl^-				$LiOH+KCl$		
11) Li^+, K^+, OH^-, Br^-				$LiOH+KBr$		
12) Li^+, K^+, OH^-, J^-				$LiOH+KJ$		
13) Li^+, K^+, OH^-, NO_2^-				$LiOH+KNO_2$		
14) Li^+, K^+, OH^-, NO_3^-				$LiOH+KNO_3$		
15) $Li^+, K^+, OH^-, SO_4^{2-}$				$LiOH+K_2SO_4$		
16) $Li^+, K^+, OH^-, CO_3^{2-}$				Li_2CO_3+KOH		
17) $Li^+, Sr^{2+}, OH^-, Cl^-$	92°C	$2LiCl \cdot H_2O+Sr(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+SrCl_2 \cdot 2H_2O$		12.1	58
18) $Li^+, Sr^{2+}, OH^-, Br^-$	95°C	$2LiBr \cdot H_2O+Sr(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+SrBr_2 \cdot 2H_2O$		14.3	64
19) Li^+, Sr^{2+}, OH^-, J^-	98°C	$2LiJ \cdot H_2O+Sr(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+SrJ_2 \cdot 2H_2O$		14.6	62
20) $Li^+, Sr^{2+}, OH^-, NO_2^-$	83°C	$2LiNO_2 \cdot 0.5H_2O+Sr(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+Sr(NO_2)_2 \cdot H_2O$		27.2	120
21) $Li^+, Sr^{2+}, OH^-, NO_3^-$	82°C	$2LiNO_3+Sr(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+Sr(NO_3)_2$		12.4	63
22) Li^+, Ba^{2+}, OH^-, F^-	48°C	$2LiF+Ba(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+BaF_2$		17.3	106
23) $Li^+, Ba^{2+}, OH^-, Cl^-$	40°C	$2LiCl \cdot H_2O+Ba(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+BaCl_2 \cdot 2H_2O$		3.2	15
24) $Li^+, Ba^{2+}, OH^-, Br^-$	50°C	$2LiBr \cdot H_2O+Ba(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+BaBr_2 \cdot 2H_2O$		2.2	10
25) Li^+, Ba^{2+}, OH^-, J^-	68°C	$2LiJ \cdot 3H_2O+Ba(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O+BaJ_2 \cdot 2H_2O$		17.2	67

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
26) $Li^+, Ba^{2+}, OH^-, NO_2^-$	55°C	$2LiNO_2 \cdot H_2O + Ba(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O + Ba(NO_2) \cdot H_2O$		24.4	105
27) $Li^+, Ba^{2+}, OH^-, NO_3^-$	10°C	$2LiNO_3 \cdot 3H_2O + Ba(OH)_2 \cdot 8H_2O$	$2LiOH \cdot H_2O + Ba(NO_3)_2$		22.1	86
28) Li^+, Na^+, F^-, Cl^-				LiF+NaCl		
29) Li^+, Na^+, F^-, Br^-				LiF+NaBr		
30) Li^+, Na^+, F^-, J^-				LiF+NaJ		
31) Li^+, Na^+, F^-, NO_2^-				$LiF+NaNO_2$		
32) Li^+, Na^+, F^-, NO_3^-				$LiF+NaNO_3$		
33) $Li^+, Na^+, F^-, SO_4^{2-}$				$LiF+Na_2SO_4$		
34) $Li^+, Na^+, F^-, CO_3^{2-}$	18°C	$2LiF+Na_2CO_3 \cdot 10H_2O$	Li_2CO_3+2NaF		20.3	94
35) Li^+, K^+, F^-, Cl^-				LiF+KCl		
36) Li^+, K^+, F^-, Br^-				LiF+KBr		
37) Li^+, K^+, F^-, J^-				LiF+KJ		
38) Li^+, K^+, F^-, NO_2^-				$LiF+KNO_2$		
39) Li^+, K^+, F^-, NO_3^-				$LiF+KNO_3$		
40) $Li^+, K^+, F^-, SO_4^{2-}$				$LiF+K_2SO_4$		
41) $Li^+, K^+, F^-, CO_3^{2-}$				$LiF+K_2CO_3$		
42) Li^+, NH_4^+, F^-, Cl^-				$LiF+NH_4Cl$		
43) Li^+, NH_4^+, F^-, Br^-				$LiF+NH_4Br$		
44) Li^+, NH_4^+, F^-, J^-				$LiF+NH_4J$		
45) $Li^+, NH_4^+, F^-, NO_3^-$				$LiF+NH_4NO_3$		
46) $Li^+, NH_4^+, F^-, SO_4^{2-}$				$LiF+(NH_4)_2SO_4$		
47) Li^+, Ba^{2+}, F^-, Cl^-	120°C	$2LiF+BaCl_2 \cdot H_2O$	$2LiCl+BaF_2$		20.1	227
48) Li^+, Ba^{2+}, F^-, Br^-				$LiBr+BaF_2$		
49) Li^+, Ba^{2+}, F^-, J^-				LiJ+BaF2		
50) $Li^+, Ba^{2+}, F^-, NO_2^-$	22°C	$2LiF+BaNO_2 \cdot H_2O$	$2LiNO_2 \cdot H_2O + BaF_2$		- 7.1	- 73
51) $Li^+, Ba^{2+}, F^-, NO_3^-$				$LiF+Ba(NO_3)_2$		
52) Li^+, Na^+, Cl^-, Br^-				LiBr+NaCl		
53) Li^+, Na^+, Cl^-, J^-				LiJ+NaCl		

Table 1 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
54) Li^+, Na^+, Cl^-, NO_2^-				$LiNO_2+NaCl$		
55) Li^+, Na^+, Cl^-, NO_3^-				$LiNO_3+NaCl$		
56) $Li^+, Na^+, Cl^-, SO_4^{2-}$	16°C	$2LiCl \cdot 2H_2O+Na_2SO_4 \cdot 10H_2O$	$Li_2SO_4 \cdot H_2O+2NaCl$		17.8	55
57) $Li^+, Na^+, Cl^-, CO_3^{2-}$				Li_2CO_3+NaCl		
58) Li^+, K^+, Cl^-, Br^-				$LiBr+KCl$		
59) Li^+, K^+, Cl^-, J^-				$LiJ+KCl$		
60) Li^+, K^+, Cl^-, NO_2^-				$LiNO_2+KCl$		
61) Li^+, K^+, Cl^-, NO_3^-	8°C	$LiCl \cdot 2H_2O+KNO_3$	$LiNO_3 \cdot 3H_2O+KCl$		- 9.6	- 78
62) $Li^+, K^+, Cl^-, SO_4^{2-}$	30°C	$2LiCl \cdot 2H_2O+K_2SO_4$	$Li_2SO_4 \cdot H_2O+2KCl$		22.1	86
63) $Li^+, K^+, Cl^-, CO_3^{2-}$				Li_2CO_3+KCl		
64) Li^+, Rb^+, Cl^-, Br^-				$LiCl+RbBr$		
65) Li^+, Rb^+, Cl^-, J^-	75°C	$LiJ \cdot 3H_2O+RbCl$	$LiCl \cdot H_2O+RbJ$		2.4	24
66) Li^+, Rb^+, Cl^-, NO_3^-	48°C	$LiCl \cdot H_2O+RbNO_3$	$LiNO_3 \cdot 0.5H_2O+RbCl$		- 0.6	- 7
67) $Li^+, Rb^+, Cl^-, SO_4^{2-}$				Li_2SO_4+RbCl		
68) Li^+, Cs^+, Cl^-, Br^-				$LiCl+CsBr$		
69) Li^+, Cs^+, Cl^-, J^-				$LiCl+CsCl$		
70) Li^+, Cs^+, Cl^-, NO_3^-				$LiCl+CsNO_3$		
71) $Li^+, Cs^+, Cl^-, SO_4^{2-}$				Li_2SO_4+CsCl		
72) Li^+, NH_4^+, Cl^-, Br^-	30°C	$LiBr \cdot 2H_2O+NH_4Cl$	$LiCl \cdot H_2O+NH_4Br$		1.3	14
73) Li^+, NH_4^+, Cl^-, J^-	100°C	$LiJ \cdot H_2O+NH_4Cl$	$LiCl+NH_4J$		1.9	23
74) $Li^+, NH_4^+, Cl^-, NO_3^-$				$LiNO_3+NH_4Cl$		
75) $Li^+, NH_4^+, Cl^-, SO_4^{2-}$				$Li_2SO_4+NH_4Cl$		
76) $Li^+, Mg^{2+}, Cl^-, Br^-$				$LiCl+MgBr_2$		
77) $Li^+, Mg^{2+}, Cl^-, NO_3^-$	90°C	$2LiCl \cdot H_2O+Mg(NO_3)_2 \cdot 6H_2O$	$2LiNO_3+MgCl_2 \cdot 6H_2O$		0	0
78) $Li^+, Mg^{2+}, Cl^-, SO_4^{2-}$				$Li_2SO_4+MgCl_2$		
79) $Li^+, Ca^{2+}, Cl^-, Br^-$	110°C	$2LiBr \cdot H_2O+CaCl_2 \cdot 2H_2O$	$2LiCl_2+CaBr_2 \cdot 2H_2O$		11.2	65
80) $Li^+, Ca^{2+}, Cl^-, NO_2^-$				$LiCl+Ca(NO_2)_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
81) $Li^+, Ca^{2+}, Cl^-, NO_3^-$	95°C	$2LiNO_3+CaCl_2 \cdot 2H_2O$	$2LiCl_2+Ca(NO_3)_2$		10.1	69
82) $Li^+, Sr^{2+}, Cl^-, Br^-$				$LiBr+SrCl_2$		
83) Li^+, Sr^{2+}, Cl^-, J^-				$LiJ+SrCl_2$		
84) $Li^+, Sr^{2+}, Cl^-, NO_2^-$				$LiCl+Sr(NO_2)_2$		
85) $Li^+, Sr^{2+}, Cl^-, NO_3^-$	44°C	$2LiNO_3 \cdot \frac{1}{2}H_2O+SrCl_2 \cdot 6H_2O$	$2LiCl \cdot H_2O+Sr(NO_3)_2$		17.5	100
86) $Li^+, Ba^{2+}, Cl^-, Br^-$				$LiBr+BaCl_2$		
87) Li^+, Ba^{2+}, Cl^-, J^-				$LiJ+BaCl_2$		
88) $Li^+, Ba^{2+}, Cl^-, NO_2^-$				$LiNO_2+BaCl_2$		
89) $Li^+, Ba^{2+}, Cl^-, NO_3^-$				$LiCl+Ba(NO_3)_2$		
90) Li^+, Na^+, Br^-, J^-				$LiJ+NaBr$		
91) Li^+, Na^+, Br^-, NO_2^-	93°C	$LiNO_2 \cdot \frac{1}{2}H_2O+NaBr$	$LiBr \cdot H_2O+NaNO_2$		8.2	107
92) Li^+, Na^+, Br^-, NO_3^-				$LiNO_3+NaBr$		
93) $Li^+, Na^+, Br^-, SO_4^{2-}$	24°C	$2LiBr \cdot 2H_2O+Na_2SO_4 \cdot 10H_2O$	$Li_2SO_4 \cdot H_2O+2NaBr \cdot 2H_2O$		8.9	26
94) $Li^+, Na^+, Br^-, CO_3^{2-}$				Li_2CO_3+NaBr		
95) Li^+, K^+, Br^-, J^-				$LiJ+KBr$		
96) Li^+, K^+, Br^-, NO_2^-				$LiNO_2+KBr$		
97) Li^+, K^+, Br^-, NO_3^-	22°C	$LiBr \cdot 2H_2O+KNO_3$	$LiNO_3 \cdot 3H_2O+KBr$		- 6.9	- 64
98) $Li^+, K^+, Br^-, SO_4^{2-}$	35°C	$2LiBr \cdot 2H_2O+K_2SO_4$	$Li_2SO_4 \cdot H_2O+2KBr$		- 4.7	- 43
99) $Li^+, K^+, Br^-, CO_3^{2-}$				Li_2CO_3+KBr		
100) Li^+, Rb^+, Br^-, J^-	79°C	$LiJ \cdot 3H_2O+RbBr$	$LiBr \cdot H_2O+RbJ$		4.4	42
101) Li^+, Rb^+, Br^-, NO_3^-	24°C	$LiBr \cdot 3H_2O+RbNO_3$	$LiNO_3 \cdot 0.5H_2O+RbBr$		2.9	23
102) $Li^+, Rb^+, Br^-, SO_4^{2-}$				Li_2SO_4+RbBr		
103) Li^+, Cs^+, Br^-, J^-				$LiBr+CsJ$		
104) Li^+, Cs^+, Br^-, NO_3^-				$LiBr+CsNO_3$		
105) $Li^+, Cs^+, Br^+, SO_4^{2-}$				Li_2SO_4+CsBr		
106) Li^+, NH_4^+, Br^-, J^-	105°C	$LiJ \cdot H_2O+NH_4Br$	$LiBr \cdot H_2O+NH_4J$		- 0.9	- 10

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm³
107) $Li^+, NH_4^+, Br^-, NO_3^-$				$LiNO_3+NH_4Br$		
108) $Li^+, NH_4^+, Br^-, SO_4^{2-}$				$Li_2SO_4+NH_4Br$		
109) $Li^+, Mg^{2+}, Br^-, NO_3^-$				$LiNO_3+MgBr_2$		
110) $Li^+, Mg^{2+}, Br^-, SO_4^{2-}$				$Li_2SO_4+MgBr_2$		
111) $Li^+, Ca^{2+}, Br^-, NO_2^-$				$LiBr+Ca(NO_2)_2$		
112) $Li^+, Ca^{2+}, Br^-, NO_3^-$	93°C	$2LiNO_3+CaBr_2 \cdot 2H_2O$	$2LiBr \cdot H_2O+Ca(NO_3)_2$		- 1.1	- 7
113) $Li^+, Ca^{2+}, Br^-, SO_4^{2-}$				$LiBr+CaSO_4$		
114) Li^+, Sr^{2+}, Br^-, J^-				$LiJ+SrBr_2$		
115) $Li^+, Sr^{2+}, Br^-, NO_2^-$	27°C	$2LiBr \cdot 2H_2O+Sr(NO_2)H_2O$	$2LiNO_2 \cdot H_2O+SrBr_2 \cdot 6H_2O$		- 23.9	- 93
116) $Li^+, Sr^{2+}, Br^-, NO_3^-$	46°C	$2LiNO_3 \cdot \frac{1}{2}H_2O+SrBr_2 \cdot 6H_2O$	$2LiBr \cdot H_2O+Sr(NO_3)_2$		14.4	78
117) Li^+, Ba^{2+}, Br^-, J^-				$LiJ+BaBr_2$		
118) $Li^+, Ba^{2+}, Br^-, NO_2^-$	28°C	$2LiBr \cdot 2H_2O+Ba(NO_2) \cdot H_2O$	$2LiNO_2 \cdot H_2O+BaBr_2 \cdot 2H_2O$		- 16.9	- 86
119) $Li^+, Ba^{2+}, Br^-, NO_3^-$				$LiBr+Ba(NO_3)_2$		
120) Li^+, Na^+, J^-, NO_2^-				$LiJ+NaNO_2$		
121) Li^+, Na^+, J^-, NO_3^-	19°C	$LiNO_3 \cdot 3H_2O+NaJ \cdot 2H_2O$	$LiJ \cdot 3H_2O+NaNO_3$		6.7	42
122) $Li^+, Na^+, J^-, SO_4^{2-}$	32°C	$2LiJ \cdot 3H_2O+Na_2SO_4 \cdot 10H_2O$	$Li_2SO_4 \cdot H_2O+2NaJ \cdot 2H_2O$		15.6	47
123) Li^+, Na^+, J^-, CO_3^-				Li_2CO_3+NaJ		
124) Li^+, K^+, J^-, NO_2^-				$LiNO_2+KJ$		
125) Li^+, K^+, J^-, NO_3^-	72°C	$LiJ \cdot 3H_2O+KNO_3$	$LiNO_3+KJ$		4.0	38
126) $Li^+, K^+, J^-, SO_4^{2-}$	74°C	$2LiJ \cdot 3H_2O+K_2SO_4$	$Li_2SO_4 \cdot H_2O+2KJ$		0.5	3
127) $Li^+, K^+, J^-, CO_3^{2-}$				Li_2CO_3+KJ		
128) Li^+, Rb^+, J^-, NO_3^-	66°C	$LiJ \cdot 3H_2O+RbNO_3$	$LiNO_3+RbJ$		0.6	6
129) $Li^+, Rb^+, J^-, SO_4^{2-}$	26°C	$2LiJ \cdot 3H_2O+Rb_2SO_4$	$Li_2SO_4 \cdot H_2O+2RbJ$		- 2.0	- 11
130) Li^+, Cs^+, J^-, NO_3^-				$LiJ+CsNO_3$		
131) $Li^+, Cs^+, J^-, SO_4^{2-}$				Li_2SO_4+CsJ		
132) $Li^+, NH_4^+, J^-, NO_3^-$				$LiNO_3+NH_4J$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm³
133) $Li^+, NH_4^+, J^-, SO_4^{2-}$				$Li_2SO_4+NH_4J$		
134) $Li^+, Sr^{2+}, J^-, NO_2^-$				$LiJ+Sr(NO_2)_2$		
135) $Li^+, Sr^{2+}, J^-, NO_3^-$				$LiJ+Sr(NO_3)_2$		
136) $Li^+, Ba^{2+}, J^-, NO_2^-$	76°C	$2LiJ \cdot 3H_2O+Ba(NO_2)_2 \cdot H_2O$	$2LiNO_2 \cdot 0.5H_2O+BaJ_2 \cdot 2H_2O$		- 4.5	- 24
137) $Li^+, Ba^{2+}, J^-, NO_3^-$				$LiJ+Ba(NO_3)_2$		
138) $Li^+, Na^+, NO_2^-, NO_3^-$				$LiNO_3+NaNO_2$		
139) $Li^+, Na^+, NO_2^-, SO_4^{2-}$	26°C	$2LiNO_2 \cdot H_2O+Na_2SO_4 \cdot 10H_2O$	$Li_2SO_4 \cdot H_2O+2NaNO_2$		31.8	103
140) $Li^+, Na^+, NO_2^-, CO_3^-$				$Li_2CO_3+NaNO_2$		
141) $Li^+, K^+, NO_2^-, NO_3^-$				$LiNO_2+KNO_3$		
142) $Li^+, K^+, NO_2^-, SO_4^{2-}$				$LiNO_2+K_2SO_4$		
143) $Li^+, K^+, NO_2^-, CO_3^{2-}$				$Li_2CO_3+KNO_2$		
144) $Li^+, Ca^{2+}, NO_2^-, NO_3^-$				$LiNO_3+Ca(NO_2)_2$		
145) $Li^+, Sr^{2+}, NO_2^-, NO_3^-$	76°C	$2LiNO_3 \cdot 0.5H_2O+Sr(NO_2)_2 \cdot H_2O$	$2LiNO_2 \cdot 0.5H_2O+Sr(NO_3)_2$		- 12.1	- 69
146) $Li^+, Ba^{2+}, NO_2^-, NO_3^-$				$LiNO_2+Ba(NO_3)_2$		
147) $Li^+, Na^+, NO_3^-, SO_4^{2-}$	28°C	$2LiNO_3 \cdot 3H_2O+Na_2SO_4 \cdot 10H_2O$	$Li_2SO_4 \cdot H_2O+NaNO_3$		29.1	75
148) $Li^+, Na^+, NO_3^-, CO_3^{2-}$				$Li_2CO_3+NaNO_3$		
149) $Li^+, K^+, NO_3^-, SO_4^{2-}$	92°C	$2LiNO_3+K_2SO_4$	$Li_2SO_4 \cdot H_2O+2KNO_3$		- 7.5	- 53
150) $Li^+, K^+, NO_3^-, CO_3^{2-}$				$Li_2CO_3+KNO_3$		
151) $Li^+, Rb^+, NO_3^-, SO_4^{2-}$				$Li_2SO_4+RbNO_3$		
152) $Li^+, Cs^+, NO_3^-, SO_4^{2-}$				$Li_2SO_4+CsNO_3$		
153) $Li^+, NH_4^+, NO_3^-, SO_4^{2-}$	28°C	$2LiNO_3 \cdot 3H_2O+(NH_4)_2SO_4$	$Li_2SO_4 \cdot H_2O+2NH_4NO_3$		62.1	257
154) $Li^+, Mg^{2+}, NO_3^- SO_4^{2-}$	18°C	$2LiNO_3 \cdot 3H_2O+MgSO_4 \cdot 7H_2O$	$Li_2SO_4 \cdot H_2O+Mg(NO_3) \cdot 6H_2O$		14.1	45
155) $Li^+, Ca^{2+}, NO_3^-, SO_4^{2-}$				$LiNO_3+CaSO_4$		
156) $Li^+, Na^+, SO_4^{2-}, CO_3^{2-}$				$Li_2CO_3+Na_2SO_4$		
157) $Li^+, K^+, SO_4^{2-}, CO_3^{2-}$				$Li_2CO_3+K_2SO_4$		
158) Na^+, K^+, OH^-, F^-				$NaF+KOH$		
159) Na^+, K^+, OH^-, Cl^-	20°C	$NaOH \cdot 3\frac{1}{2}H_2O+KCl$	$NaCl+KOH \cdot 2H_2O$		9.7	82

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
160) Na^+, K^+, OH^-, Br^-	52°C	$NaOH \cdot H_2O + KBr$	$NaBr + KOH \cdot H_2O$		7.9	99
161) Na^+, K^+, OH^-, J^-	54°C	$NaOH \cdot H_2O + KJ$	$NaJ \cdot 2H_2O + KOH \cdot H_2O$		4.1	32
162) Na^+, K^+, OH^-, NO_2^-				$NaNO_2 + KOH$		
163) Na^+, K^+, OH^-, NO_3^-	48°C	$NaOH \cdot H_2O + KNO_3$	$NaNO_3 + KOH \cdot H_2O$		6.5	76
164) $Na^+, K^+, OH^-, SO_3^{2-}$				$Na_2SO_3 + KOH$		
165) $Na^+, K^+, OH^-, SO_4^{2-}$	78°C	$2NaOH \cdot H_2O + K_2SO_4$	$Na_2SO_4 + KOH \cdot H_2O$		7.1	69
166) Na^+, K^+, OH^-, CO_3^-				$Na_2CO_3 + KOH$		
167) $Na^+, Sr^{2+}, OH^-, Cl^-$				$NaCl + Sr(OH)_2$		
168) $Na^+, Sr^{2+}, OH^-, Br^-$				$NaBr + Sr(OH)_2$		
169) Na^+, Sr^{2+}, OH^-, J^-				$NaJ + Sr(OH)_2$		
170) $Na^+, Sr^{2+}, OH^-, NO_2^-$				$NaNO_2 + Sr(OH)_2$		
171) $Na^+, Sr^{2+}, OH^-, NO_3^-$				$NaNO_3 + Sr(OH)_2$		
172) $Na^+, Ba^{2+}, OH^-, Cl^-$				$NaCl + Ba(OH)_2$		
173) $Na^+, Ba^{2+}, OH^-, Br^-$				$NaBr + Ba(OH)_2$		
174) Na^+, Ba^{2+}, OH^-, J^-				$NaJ + Ba(OH)_2$		
175) $Na^+, Ba^{2+}, OH^-, NO_2^-$				$NaNO_2 + Ba(OH)_2$		
176) $Na^+, Ba^{2+}, OH^-, NO_3^-$	72°C	$2NaNO_3 + Ba(OH)_2 \cdot 8H_2O$	$2NaOH + Ba(NO_3)_2$		35.0	160
177) Na^+, K^+, F^-, Cl^-				$NaF + KCl$		
178) Na^+, K^+, F^-, Br^-				$NaF + KBr$		
179) Na^+, K^+, F^-, J^-				$NaF + KJ$		
180) Na^+, K^+, F^-, NO_2^-				$NaF + KNO_2$		
181) Na^+, K^+, F^-, NO_3^-				$NaF + KNO_3$		
182) $Na^+, K^+, F^-, SO_3^{2-}$				$NaF + K_2SO_3$		
183) $Na^+, K^+, F^-, SO_4^{2-}$				$NaF + K_2SO_4$		
184) $Na^+, K^+, F^-, CO_3^{2-}$	5°C	$Na_2CO_3 \cdot 10H_2O + 2KF \cdot 4H_2O$	$2NaF + K_2CO_3 \cdot 1.5H_2O$		29.4	95
185) Na^+, NH_4^+, F^-, Cl^-				$NaF + NH_4Cl$		
186) Na^+, NH_4^+, F^-, Br^-				$NaF + NH_4Br$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
187) Na^+, NH_4^+, F^-, J^-				$NaF+NH_4J$		
188) $Na^+, NH_4^+, F^-, NO_3^-$				$NaF+NH_4NO_3$		
189) $Na^+, NH_4^+, F^-, SO_4^{2-}$				$NaF+(NH_4)_2SO_4$		
190) Na^+, Ba^{2+}, F^-, Cl^-				$NaCl+BaF_2$		
191) Na^+, Ba^{2+}, F^-, Br^-				$NaBr+BaF_2$		
192) Na^+, Ba^{2+}, F^-, J^-				$NaJ+BaF_2$		
193) $Na^+, Ba^{2+}, F^-, NO_2^-$				$NaNO_2+BaF_2$		
194) $Na^+, Ba^{2+}, F^-, NO_3^-$				$NaNO_3+BaF_2$		
195) Na^+, K^+, Cl^-, Br^-				$NaCl+KBr$		
196) Na^+, K^+, Cl^-, J^-	15°C	$NaJ \cdot 2H_2O+KCl$	$NaCl+KJ$		2.1	19
197) Na^+, K^+, Cl^-, NO_2^-				$NaNO_2+KCl$		
198) Na^+, K^+, Cl^-, NO_3^-	91°C	$NaCl+KNO_3$	$NaNO_3+KCl$		0.2	3
199) $Na^+, K^+, Cl^-, SO_3^{2-}$				Na_2SO_3+KCl		
200) $Na^+, K^+, Cl^-, SO_4^{2-}$	10°C	$Na_2SO_4 \cdot 10H_2O+2KCl$	$2NaCl+K_2SO_4 \cdot H_2O$		19.3	65
201) $Na^+, K^+, Cl^-, CO_3^{2-}$				Na_2CO_3+KCl		
202) Na^+, Rb^+, Cl^-, Br^-				$NaCl+RbBr$		
203) Na^+, Rb^+, Cl^-, J^-				$NaCl+RbJ$		
204) Na^+, Rb^+, Cl^-, NO_3^-	112°C	$NaCl+RbNO_3$	$NaNO_3+RbCl$		0.8	11
205) $Na^+, Rb^+, Cl^-, SO_4^{2-}$	24°C	$Na_2SO_4 \cdot 10H_2O+2RbCl$	$2NaCl+Rb_2SO_4$		18.9	61
206) Na^+, Cs^+, Cl^-, Br^-				$NaCl+CsBr$		
207) Na^+, Cs^+, Cl^-, J^-				$NaCl+CsJ$		
208) Na^+, Cs^+, Cl^-, NO_3^-				$NaCl+CsNO_3$		
209) $Na^+, Cs^+, Cl^-, SO_4^{2-}$	30°C	$Na_2SO_4 \cdot 10H_2O+2CsCl$	$2NaCl+Cs_2SO_4$		21.3	70
210) Na^+, NH_4^+, Cl^-, Br^-				$NaCl+NH_4Br$		
211) Na^+, NH_4^+, Cl^-, J^-	8°C	$NaJ \cdot 2H_2O+NH_4Cl$	$NaCl+NH_4J$		3.1	28

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
212) $Na^+, NH_4^+, Cl^-, NO_3^-$				$NaNO_3+NH_4Cl$		
213) $Na^+, NH_4^+, Cl^-, SO_4^{2-}$				$Na_2SO_4+NH_4Cl$		
214) $Na^+, Mg^{2+}, Cl^-, Br^-$				$NaCl+MgBr_2$		
215) $Na^+, Mg^{2+}, Cl^-, NO_3^-$				$NaCl+Mg(NO_3)_2$		
216) $Na^+, Mg^{2+}, Cl^-, SO_4^{2-}$	24°C	$Na_2SO_4 \cdot 10H_2O+MgCl_2 \cdot 6H_2O$	$2NaCl+MgSO_4 \cdot 7H_2O$		14.5	42
217) $Na^+, Mg^{2+}, Cl^-, S_2O_3^{2-}$				$NaCl+MgS_2O_3$		
218) $Na^+, Ca^{2+}, Cl^-, Br^-$				$NaCl+CaBr_2$		
219) $Na^+, Ca^{2+}, Cl^-, NO_2^-$				$NaCl+Ca(NO_2)_2$		
220) $Na^+, Ca^{2+}, Cl^-, NO_3^-$				$NaCl+Ca(NO_3)_2$		
221) $Na^+, Ca^{2+}, Cl^-, SO_4^{2-}$				$NaCl+CaSO_4$		
222) $Na^+, Sr^{2+}, Cl^-, Br^-$	4°C	$2NaBr \cdot 2H_2O+SrCl_2 \cdot 6H_2O$	$2NaCl+SrBr_2 \cdot 6H_2O$		11.8	45
223) Na^+, Sr^{2+}, Cl^-, J^-	0°C	$2NaJ \cdot 2H_2O+SrCl_2 \cdot 6H_2O$	$2NaCl+SrJ_2 \cdot 6H_2O$		12.6	44
224) $Na^+, Sr^{2+}, Cl^-, NO_2^-$				$NaCl+Sr(NO_2)_2$		
225) $Na^+, Sr^{2+}, Cl^-, NO_3^-$				$NaCl+Sr(NO_3)_2$		
226) $Na^+, Ba^{2+}, Cl^-, Br^-$	53°C	$2NaBr \cdot 2H_2O+BaCl_2 \cdot 2H_2O$	$2NaCl+BaBr_2 \cdot 2H_2O$		7.8	38
227) Na^+, Ba^{2+}, Cl^-, J^-	62°C	$2NaJ+BaCl_2 \cdot 2H_2O$	$2NaCl+BaJ_2 \cdot 2H_2O$		- 0.6	- 4
228) $Na^+, Ba^{2+}, Cl^-, NO_2^-$	30°C	$2NaCl+Ba(NO_2)_2 \cdot H_2O$	$2NaNO_2+BaCl_2 \cdot 2H_2O$		- 1.6	- 11
229) $Na^+, Ba^{2+}, Cl^-, NO_3^-$				$NaCl+Ba(NO_3)_2$		
230) Na^+, K^+, Br^-, J^-	56°C	$NaJ \cdot 2H_2O+KBr$	$NaBr+KJ$		3.8	32
231) Na^+, K^+, Br^-, NO_2^-				$NaNO_2+KBr$		
232) Na^+, K^+, Br^-, NO_3^-	70°C	$NaBr+KNO_3$	$NaNO_3+KBr$		3.2	29
233) $Na^+, K^+, Br^-, SO_3^{2-}$				Na_2SO_3+KBr		
234) $Na^+, K^+, Br^-, SO_4^{2-}$	15°C	$Na_2SO_4 \cdot 10H_2O+2KBr$	$2NaBr \cdot 2H_2O+K_2SO_4$		13.5	44
235) $Na^+, K^+, Br^-, CO_3^{2-}$				Na_2CO_3+KBr		
236) Na^+, Rb^+, Br^-, J^-				$NaBr+RbJ$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
237) Na^+, Rb^+, Br^-, NO_3^-	47°C	$NaBr \cdot 2H_2O + RbNO_3$	$NaNO_3 + RbBr$		3.2	29
238) $Na^+, Rb^+, Br^-, SO_4^{2-}$				$Na_2SO_4 + RbBr$		
239) Na^+, Cs^+, Br^-, J^-				$NaBr + CsJ$		
240) Na^+, Cs^+, Br^-, NO_3^-				$NaBr + CsNO_3$		
241) $Na^+, Cs^+, Br^-, SO_4^{2-}$				$Na_2SO_4 + CsBr$		
242) Na^+, NH_4^+, Br^-, J^-	48°C	$NaJ \cdot 2H_2O + NH_4Br$	$NaBr + NH_4J$		4.7	41.3
243) $Na^+, NH_4^+, Br^-, NO_3^-$				$NaNO_3 + NH_4Br$		
244) $Na^+, NH_4^+, Br^-, SO_4^{2-}$				$Na_2SO_4 + NH_4Br$		
245) $Na^+, Mg^{2+}, Br^-, NO_3^-$	90°C	$2NaBr + Mg(NO_3)_2 \cdot 6H_2O$	$2NaNO_3 + MgBr_2 \cdot 6H_2O$		- 2.1	- 10
246) $Na^+, Mg^{2+}, Br^-, SO_4^{2-}$	114°C	$Na_2SO_4 + MgBr_2 \cdot 6H_2O$	$2NaBr + MgSO_4 \cdot H_2O$		12.6	57
247) $Na^+, Mg^{2+}, Br^-, S_2O_3^{2-}$	80°C	$2NaBr + MgS_2O_3 \cdot 6H_2O$	$Na_2S_2O_3 + MgBr_2 \cdot 6H_2O$		7.1	36
248) $Na^+, Ca^{2+}, Br^-, NO_2^-$				$NaBr + Ca(NO_2)_2$		
249) $Na^+, Ca^{2+}, Br^-, NO_3^-$				$NaBr + Ca(NO_3)_2$		
250) $Na^+, Ca^{2+}, Br^-, SO_4^{2-}$				$NaBr + CaSO_4$		
251) Na^+, Sr^{2+}, Br^-, J^-				$NaBr + SrJ_2$		
252) $Na^+, Sr^{2+}, Br^-, NO_2^-$				$NaBr + Sr(NO_2)_2$		
253) $Na^+, Sr^{2+}, Br^-, NO_3^-$				$NaBr + Sr(NO_3)_2$		
254) Na^+, Ba^{2+}, Br^-, J^-	68°C	$2NaJ \cdot 2H_2O + BaBr_2 \cdot 2H_2O$	$2NaBr + BaJ_2 \cdot 2H_2O$		11.9	50
255) $Na^+, Ba^{2+}, Br^-, NO_2^-$	40°C	$2NaBr \cdot 2H_2O + Ba(NO_2) \cdot H_2O$	$2NaNO_2 + BaBr_2 \cdot 2H_2O$		6.1	30
256) $Na^+, Ba^{2+}, Br^-, NO_3^-$				$NaBr + Ba(NO_3)_2$		
257) Na^+, K^+, J^-, NO_2^-				$NaNO_2 + KJ$		
258) Na^+, K^+, J^-, NO_3^-	52°C	$NaJ \cdot 2H_2O + KNO_3$	$NaNO_3 + KJ$		2.4	20
259) $Na^+, K^+, J^-, SO_3^{2-}$				$Na_2SO_3 + KJ$		
260) $Na^+, K^+, J^-, SO_4^{2-}$	11°C	$Na_2SO_4 \cdot 10H_2O + 2KJ$	$2NaJ \cdot 2H_2O + K_2SO_4$		15.1	46
261) $Na^+, K^+, J^-, CO_3^{2-}$				$Na_2CO_3 + KJ$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair $T < T_o$	Stable Pair $T > T_o$	between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
262) Na^+, Rb^+, J^-, NO_3^-	40°C	$NaJ \cdot 2H_2O + RbNO_3$	$NaNO_3 + RbJ$		1.5	12
263) $Na^+, Rb^+, J^-, SO_4^{2-}$				$Na_2SO_4 + RbJ$		
264) Na^+, Cs^+, J^-, NO_3^-	72°C	$NaJ \cdot 2H_2O + CsNO_3$	$NaNO_3 + CsJ$		0.6	4
265) $Na^+, Cs^+, J^-, SO_4^{2-}$				$Na_2SO_4 + CsJ$		
266) $Na^+, NH_4^+, J^-, NO_3^-$				$NaNO_3 + NH_4J$		
267) $Na^+, NH_4^+, J^-, SO_4^{2-}$				$Na_2SO_4 + NH_4J$		
268) $Na^+, Sr^{2+}, J^-, NO_2^-$				$NaJ + Sr(NO_2)_2$		
269) $Na^+, Sr^{2+}, J^-, NO_3^-$				$NaJ + Sr(NO_3)_2$		
270) $Na^+, Ba^{2+}, J^-, NO_2^-$	52°C	$2NaJ \cdot 2H_2O + Ba(NO_2)_2 \cdot H_2O$	$2NaNO_2 + BaJ_2 \cdot 2H_2O$		8.8	38
271) $Na^+, Ba^{2+}, J^-, NO_3^-$				$NaJ + Ba(NO_3)_2$		
272) $Na^+, K^+, NO_2^-, NO_3^-$				$NaNO_2 + KNO_3$		
273) $Na^+, K^+, NO_2^-, SO_3^{2-}$				$Na_2SO_3 + KNO_2$		
274) $Na^+, K^+, NO_2^-, SO_4^{2-}$				$NaNO_2 + K_2SO_4$		
275) $Na^+, K^+, NO_2^-, CO_3^{2-}$				$Na_2CO_3 + KNO_2$		
276) $Na^+, Ca^{2+}, NO_2^-, NO_3^-$				$NaNO_3 + Ca(NO_2)_2$		
277) $Na^+, Ca^{2+}, NO_2^-, SO_4^{2-}$				$NaNO_2 + CaSO_4$		
278) $Na^+, Sr^{2+}, NO_2^-, NO_3^-$	59°C	$2NaNO_3 + Sr(NO_2)_2 \cdot H_2O$	$2NaNO_2 + Sr(NO_3)_2$		1.9	12
279) $Na^+, Ba^{2+}, NO_2^-, NO_3^-$				$NaNO_2 + Ba(NO_3)_2$		
280) $Na^+, K^+, NO_3^-, SO_3^{2-}$				$Na_2SO_3 + KNO_3$		
281) $Na^+, K^+, NO_3^-, SO_4^{2-}$	27°C	$Na_2SO_4 \cdot 10H_2O + 2KNO_3$	$2NaNO_3 + K_2SO_4$		19.9	74
282) $Na^+, K^+, NO_3^-, CO_3^{2-}$				$Na_2CO_3 + KNO_3$		
283) $Na^+, Rb^+, NO_3^-, SO_4^{2-}$	40°C	$Na_2SO_4 + 2RbNO_3$	$2NaNO_3 + Rb_2SO_4$		1.4	14
284) $Na^+, Cs^+, NO_3^-, SO_4^{2-}$				$Na_2SO_4 + CsNO_3$		
285) $Na^+, NH_4^+, NO_3^-, SO_4^{2-}$	28°C	$Na_2SO_4 \cdot 10H_2O + 2NH_4NO_3$	$2NaNO_3 + (NH_4)_2SO_4$		- 33.2	- 106
286) $Na^+, Mg^{2+}, NO_3^-, SO_4^{2-}$	75°C	$Na_2SO_4 + Mg(NO_3)_2 \cdot 6H_2O$	$2NaNO_3 + MgSO_4 \cdot H_2O$		10.3	49

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair $T < T_o$	Stable Pair $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
287) $Na^+, Mg^{2+}, NO_3^-, S_2O_3^{2-}$	73°C	$2NaNO_3+MgS_2O_3 \cdot 6H_2O$	$Na_2S_2O_3 \cdot 0.5H_2O+Mg(NO_3)_2 \cdot 6H_2O$		8.3	39
288) $Na^+, Ca^{2+}, NO_3^-, SO_4^{2-}$				$NaNO_3+CaSO_4$		
289) $Na^+, K^+, SO_3^{2-}, SO_4^{2-}$				$Na_2SO_3+K_2SO_4$		
290) $Na^+, K^+, SO_3^{2-}, CO_3^{2-}$	32°C	$Na_2CO_3 \cdot 10H_2O+K_2SO_3$	$Na_2SO_3+K_2CO_3 \cdot 1.5H_2O$		19.7	76
291) $Na^+, K^+, SO_4^{2-}, CO_3^{2-}$				$Na_2CO_3+K_2SO_4$		
292) $Na^+, Mg^{2+}, SO_4^{2-}, S_2O_3^{2-}$				$Na_2SO_4+MgS_2O_3$		
293) K^+, Sr^{2+}, OH^-, Cl^-				$KCl+Sr(OH)_2$		
294) K^+, Sr^{2+}, OH^-, Br^-				$KBr+Sr(OH)_2$		
295) K^+, Sr^{2+}, OH^-, J^-				$KJ+Sr(OH)_2$		
296) $K^+, Sr^{2+}, OH^-, NO_2^-$				$KNO_2+Sr(OH)_2$		
297) $K^+, Sr^{2+}, OH^-, NO_3^-$				$KNO_3+Sr(OH)_2$		
298) K^+, Ba^{2+}, OH^-, F^-				$KOH+BaF_2$		
299) K^+, Ba^{2+}, OH^-, Cl^-				$KCl+Ba(OH)_2$		
300) K^+, Ba^{2+}, OH^-, Br^-				$KBr+Ba(OH)_2$		
301) K^+, Ba^{2+}, OH^-, J^-				$KJ+Ba(OH)_2$		
302) $K^+, Ba^{2+}, OH^-, NO_2^-$	77°C	$2KNO_2+Ba(OH)_2 \cdot 8H_2O$	$2KOH \cdot H_2O+Ba(NO_2)_2 \cdot H_2O$		30.6	132
303) $K^+, Ba^{2+}, OH^-, NO_3^-$	65°C	$2KNO_3+Ba(OH)_2 \cdot 8H_2O$	$2KOH \cdot H_2O+Ba(NO_3)_2$		38.3	160
304) K^+, NH_4^+, F^-, Cl^-	105°C	$KCl+NH_4F$	$KF+NH_4Cl$		6.2	84
305) K^+, NH_4^+, F^-, Br^-	81°C	$KBr+NH_4F$	$KF+NH_4Br$		6.2	78
306) K^+, NH_4^+, F^-, J^-	68°C	$KJ+NH_4F$	$KF+NH_4J$		7.1	79
307) K^+, NH_4^+, F^-, NO_3^-				KNO_3+NH_4F		
308) $K^+, NH_4^+, F^-, SO_4^{2-}$				$K_2SO_4+NH_4F$		
309) K^+, Ba^{2+}, F^-, Cl^-				$KCl+BaF_2$		
310) K^+, Ba^{2+}, F^-, Br^-				$KBr+BaF_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair $T < T_o$	$T > T_o$	between 0° and 100°	Enthalpy of reaction kcal/mol	kcal/dm^3
311) K^+, Ba^{2+}, F^-, J^-				$KJ+BaF_2$		
312) $K^+, Ba^{2+}, F^-, NO_2^-$				KNO_2+BaF_2		
313) $K^+, Ba^{2+}, F^-, NO_3^-$				KNO_3+BaF_2		
314) K^+, Rb^+, Cl^-, Br^-				$KCl+RbBr$		
315) K^+, Rb^+, Cl^-, J^-				$KCl+RbJ$		
316) K^+, Rb^+, Cl^-, NO_3^-				$KCl+RbNO_3$		
317) $K^+, Rb^+, Cl^-, SO_4^{2-}$				K_2SO_4+RbCl		
318) K^+, Cs^+, Cl^-, Br^-	64°C	$KCl+CsBr$	$KBr+CsCl$		1.3	15
319) K^+, Cs^+, Cl^-, J^-				$KCl+CsJ$		
320) K^+, Cs^+, Cl^-, NO_3^-				$KCl+CsNO_3$		
321) $K^+, Cs^+, Cl^-, SO_4^{2-}$				K_2SO_4+CsCl		
322) K^+, NH_4^+, Cl^-, Br^-				$KCl+NH_4Br$		
323) K^+, NH_4^+, Cl^-, J^-				$KCl+NH_4J$		
324) $K^+, NH_4^+, Cl^-, NO_3^-$				KNO_3+NH_4Cl		
325) $K^+, NH_4^+, Cl^-, SO_4^{2-}$				$K_2SO_4+NH_4Cl$		
326) K^+, Mg^{2+}, Cl^-, Br^-				$KCl+MgBr_2$		
327) $K^+, Mg^{2+}, Cl^-, NO_3^-$	29°C	$2KNO_3+MgCl_2 \cdot 6H_2O$	$2KCl+Mg(NO_3)_2 \cdot 6H_2O$		0.4	2
328) $K^+, Mg^{2+}, Cl^-, SO_4^{2-}$	116°C	$K_2SO_4+MgCl_2 \cdot 6H_2O$	$2KCl+MgSO_4 \cdot H_2O$		9.8	50
329) K^+, Ca^{2+}, Cl^-, Br^-				$KCl+CaBr_2$		
330) $K^+, Ca^{2+}, Cl^-, NO_2^-$				$KCl+Ca(NO_2)_2$		
331) $K^+, Ca^{2+}, Cl^-, NO_3^-$	37°C	$2KNO_3+CaCl_2 \cdot 6H_2O$	$2KCl+Ca(NO_3)_2 \cdot 4H_2O$		4.7	27
332) $K^+, Ca^{2+}, Cl^-, SO_4^{2-}$				$KCl+CaSO_4$		
333) K^+, Sr^{2+}, Cl^-, Br^-				$KBr+SrCl_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair $T < T_o$	Stable Pair $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
334) K^+, Sr^{2+}, Cl^-, J^-				$KCl+SrJ_2$		
335) $K^+, Sr^{2+}, Cl^-, NO_2^-$				$KCl+Sr(NO_2)_2$		
336) $K^+, Sr^{2+}, Cl^-, NO_3^-$	32°C	$2KNO_3+SrCl_2 \cdot 6H_2O$	$2KCl+Sr(NO_3)_2$		15.2	65
337) K^+, Ba^{2+}, Cl^-, Br^-				$KBr+BaCl_2$		
338) K^+, Ba^{2+}, Cl^-, J^-				$KJ+BaCl_2$		
339) $K^+, Ba^{2+}, Cl^-, NO_2^-$	115°C	$2KCl+Ba(NO_2)_2 \cdot H_2O$	$2KNO_2+BaCl_2 \cdot H_2O$		7.8	51
340) $K^+, Ba^{2+}, Cl^-, NO_3^-$				$KCl+Ba(NO_3)_2$		
341) K^+, Rb^+, Br^-, J^-				$KBr+RbJ$		
342) K^+, Rb^+, Br^-, NO_3^-	104°C	$KBr+RbNO_3$	KNO_3+RbBr		0	0
343) $K^+, Rb^+, Br^-, SO_4^{2-}$				K_2SO_4+RbBr		
344) K^+, Cs^+, Br^-, J^-				$KBr+CsJ$		
345) K^+, Cs^+, Br^-, NO_3^-				$KBr+CsNO_3$		
346) $K^+, Cs^+, Br^-, SO_4^{2-}$				K_2SO_4+CsBr		
347) K^+, NH_4^+, Br^-, J^-	24°C	$KJ+NH_4Br$	$KBr+NH_4J$		0.9	10
348) $K^+, NH_4^+, Br^-, NO_3^-$				KNO_3+NH_4Br		
349) $K^+, NH_4^+, Br^-, SO_4^{2-}$				$K_2SO_4+NH_4Br$		
350) $K^+, Mg^{2+}, Br^-, NO_3^-$	37°C	$2KNO_3+MgBr_2 \cdot 6H_2O$	$2KBr+Mg(NO_3)_2 \cdot 6H_2O$		- 0.7	- 3
351) $K^+, Mg^{2+}, Br^-, SO_4^{2-}$				$K_2SO_4+MgBr_2$		
352) $K^+, Ca^{2+}, Br^-, NO_2^-$				$KBr+Ca(NO_2)_2$		
353) $K^+, Ca^{2+}, Br^-, NO_3^-$	62°C	$2KNO_3+CaBr_2 \cdot 2H_2O$	$2KBr+Ca(NO_3)_2$		- 3.7	- 19
354) $K^+, Ca^{2+}, Br^-, SO_4^{2-}$				$KBr+CaSO_4$		
355) K^+, Sr^{2+}, Br^-, J^-				$KBr+SrJ_2$		
356) $K^+, Sr^{2+}, Br^-, NO_2^-$				$KBr+Sr(NO_2)_2$		
357) $K^+, Sr^{2+}, Br^-, NO_3^-$	35°C	$2KNO_3+SrBr_2 \cdot 6H_2O$	$2KBr+Sr(NO_3)_2$		9.1	38

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
358) K^+, Ba^{2+}, Br^-, J^-	25°C	$2KBr+BaJ_2 \cdot 6H_2O$	$2KJ+BaBr_2 \cdot 2H_2O$		10.4	37
359) $K^+, Ba^{2+}, Br^-, NO_2^-$				$KBr+Ba(NO_2)_2$		
360) $K^+, Ba^{2+}, Br^-, NO_3^-$				$KBr+Ba(NO_3)_2$		
361) K^+, Rb^+, J^-, NO_3^-				KNO_3+RbJ		
362) $K^+, Rb^+, J^-, SO_4^{2-}$				K_2SO_4+RbJ		
363) K^+, Cs^+, J^-, NO_3^-	25°C	KNO_3+CsJ	$KJ+CsNO_3$		1.8	17
364) K^+, Cs^+, J^-, SO_4^-				K_2SO_4+CsJ		
365) K^+, NH_4^+, J^-, NO_3^-				KNO_3+NH_4J		
366) $K^+, NH_4^+, J^-, SO_4^{2-}$				$K_2SO_4+NH_4J$		
367) $K^+, Sr^{2+}, J^-, NO_2^-$				$KJ+Sr(NO_2)_2$		
368) $K^+, Sr^{2+}, J^-, NO_3^-$	46°C	$2KNO_3+SrJ_2 \cdot 6H_2O$	$2KJ+Sr(NO_3)_2$		6.7	25
369) $K^+, Ba^{2+}, J^-, NO_2^-$				$KJ+Ba(NO_2)_2$		
370) $K^+, Ba^{2+}, J^-, NO_3^-$				$KJ+Ba(NO_3)_2$		
371) $K^+, Ca^{2+}, NO_2^-, NO_3^-$				$KNO_3+Ca(NO_2)_2$		
372) $K^+, Ca^{2+}, NO_2^-, SO_4^{2-}$				KNO_2+CaSO_4		
373) $K^+, Sr^{2+}, NO_2^-, NO_3^-$	108°C	$2KNO_3+Sr(NO_2)_2 \cdot H_2O$	$2KNO_2+Sr(NO_3)_2$		9.1	51
374) $K^+, Ba^{2+}, NO_2^-, NO_3^-$	30°C	$2KNO_3+Ba(NO_2)_2 \cdot H_2O$	$2KNO_2+Ba(NO_3)_2$		7.7	44
375) $K^+, Rb^+, NO_3^-, SO_4^{2-}$				$K_2SO_4+RbNO_3$		
376) $K^+, Cs^+, NO_3^-, SO_4^{2-}$				$K_2SO_4+CsNO_3$		
377) $K^+, NH_4^+, NO_3^-, SO_4^{2-}$	104°C	$K_2SO_4+NH_4NO_3$	$KNO_3+(NH_4)_2SO_4$		- 52.9	- 310
378) $K^+, Mg^{2+}, NO_3^-, SO_4^{2-}$	9°C	$2KNO_3+MgSO_4 \cdot 7H_2O$	$K_2SO_4+Mg(NO_3)_2 \cdot 6H_2O$		5.0	21
379) $K^+, Ca^{2+}, NO_3^-, SO_4^{2-}$				KNO_3+CaSO_4		
380) Rb^+, Cs^+, Cl^-, Br^-				$RbCl+CsBr$		
381) Rb^+, Cs^+, Cl^-, J^-				$RbCl+CsJ$		
382) Rb^+, Cs^+, Cl^-, NO_3^-				$RbCl+CsNO_3$		
383) $Rb^+, Cs^+, Cl^-, SO_4^{2-}$				Rb_2SO_4+CsCl		
384) Rb^+, NH_4^+, Cl^-, Br^-	95°C	$RbBr+NH_4Cl$	$RbCl+NH_4Br$		0.6	7

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
385) Rb^+, NH_4^+, Cl^-, J^-	105°C	$RbJ+NH_4Cl$	$RbCl+NH_4J$		2.4	25
386) $Rb^+, NH_4^+, Cl^-, NO_3^-$				$RbNO_3+NH_4Cl$		
387) $Rb^+, NH_4^+, Cl^-, SO_4^{2-}$				$Rb_2SO_4+NH_4Cl$		
388) $Rb^+, Mg^{2+}, Cl^-, Br^-$	66°C	$2RbBr+MgCl_2 \cdot 6H_2O$	$2RbCl+MgBr_2 \cdot 6H_2O$		2.2	10
389) $Rb^+, Mg^{2+}, Cl^-, NO_3^-$	39°C	$2RbNO_3+MgCl_2 \cdot 6H_2O$	$2RbCl+Mg(NO_3)_2 \cdot 6H_2O$		1.5	8
390) $Rb^+, Mg^{2+}, Cl^-, SO_4^{2-}$	99°C	$Rb_2SO_4+MgCl_2 \cdot 6H_2O$	$2RbCl+MgSO_4 \cdot H_2O$		10.3	51
391) $Rb^+, Ca^{2+}, Cl^-, Br^-$				$RbBr+CaCl_2$		
392) $Rb^+, Ca^{2+}, Cl^-, NO_3^-$	68°C	$2RbNO_3+CaCl_2 \cdot 2H_2O$	$2RbCl+Ca(NO_3)_2$		3.2	18
393) $Rb^+, Ca^{2+}, Cl^-, SO_4^{2-}$				$RbCl+CaSO_4$		
394) $Rb^+, Sr^{2+}, Cl^-, Br^-$				$RbBr+SrCl_2$		
395) Rb^+, Sr^{2+}, Cl^-, J^-				$RbJ+SrCl_2$		
396) $Rb^+, Sr^{2+}, Cl^-, NO_3^-$	44°C	$2RbNO_3+SrCl_2 \cdot 6H_2O$	$2RbCl+Sr(NO_3)_2$		16.3	70
397) $Rb^+, Ba^{2+}, Cl^-, Br^-$				$RbBr+BaCl_2$		
398) Rb^+, Ba^{2+}, Cl^-, J^-				$RbJ+BaCl_2$		
399) $Rb^+, Ba^{2+}, Cl^-, NO_3^-$				$RbCl+Ba(NO_3)_2$		
400) Rb^+, Cs^+, Br^-, J^-				$RbBr+CsJ$		
401) Rb^+, Cs^+, Br^-, NO_3^-				$RbBr+CsNO_3$		
402) $Rb^+, Cs^+, Br^-, SO_4^{2-}$				Rb_2SO_4+CsBr		
403) Rb^+, NH_4^+, Br^-, J^-	110°C	$RbJ+NH_4Br$	$RbBr+NH_4J$		1.8	18
404) $Rb^+, NH_4^+, Br^-, NO_3^-$				$RbNO_3+NH_4Br$		
405) $Rb^+, NH_4^+, Br^-, SO_4^{2-}$				$Rb_2SO_4+NH_4Br$		
406) $Rb^+, Mg^{2+}, Br^-, NO_3^-$	36°C	$2RbNO_3+MgBr_2 \cdot 6H_2O$	$2RbBr+Mg(NO_3)_2 \cdot 6H_2O$		- 0.8	- 3
407) $Rb^+, Mg^{2+}, Br^-, SO_4^{2-}$	110°C	$Rb_2SO_4+MgBr_2 \cdot 6H_2O$	$2RbBr+MgSO_4 \cdot H_2O$		8.2	37
408) $Rb^+, Ca^{2+}, Br^-, NO_3^-$	62°C	$2RbNO_3+CaBr_2 \cdot 2H_2O$	$2RbBr+Ca(NO_3)_2$		- 3.7	- 26
409) $Rb^+, Ca^{2+}, Br^-, SO_4^{2-}$				$RbBr+CaSO_4$		
410) Rb^+, Sr^{2+}, Br^-, J^-				$RbJ+SrBr_2$		
411) $Rb^+, Sr^{2+}, Br^-, NO_3^-$	36°C	$2RbNO_3+SrBr_2 \cdot 6H_2O$	$2RbBr+Sr(NO_3)_2$		9.0	47

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^2
412) Rb^+, Ba^{2+}, Br^-, J^-				$RbJ+BaBr_2$		
413) $Rb^+, Ba^{2+}, Br^-, NO_3^-$				$RbBr+Ba(NO_3)_2$		
414) Rb^+, Cs^+, J^-, NO_3^-	8°C	$RbNO_3+CsJ$	$RbJ+CsNO_3$		0.9	9
415) $Rb^+, Cs^+, J^-, SO_4^{2-}$				Rb_2SO_4+CsJ		
416) $Rb^+, NH_4^+, J^-, NO_3^-$				$RbNO_3+NH_4J$		
417) $Rb^+, NH_4^+, J^-, SO_4^{2-}$				$Rb_2SO_4+NH_4J$		
418) $Rb^+, Sr^{2+}, J^-, NO_3^-$	28°C	$2RbNO_3+SrJ_2 \cdot 6H_2O$	$2RbJ+Sr(NO_3)_2$		4.9	19
419) $Rb^+, Ba^{2+}, J^-, NO_3^-$				$RbJ+Ba(NO_3)_2$		
420) $Rb^+, Cs^+, NO_3^-, SO_4^{2-}$				$Rb_2SO_4+CsNO_3$		
421) $Rb^+, NH_4^+, NO_3, SO_4^{2-}$				$RbNO_3+(NH_4)_2SO_4$		
422) $Rb^+, Mg^{2+}, NO_3^-, SO_4^{2-}$	33°C	$2RbNO_3+MgSO_4 \cdot 7H_2O$	$Rb_2SO_4+Mg(NO_3)_2 \cdot 6H_2O$		5.8	24
423) $Rb^+, Ca^{2+}, NO_3^-, SO_4^{2-}$				$RbNO_3+CaSO_4$		
424) Cs^+, NH_4^+, Cl^-, Br^-				$CsBr+NH_4Cl$		
425) Cs^+, NH_4^+, Cl^-, J^-				$CsJ+NH_4Cl$		
426) $Cs^+, NH_4^+, Cl^-, NO_3^-$				$CsNO_3+NH_4Cl$		
427) $Cs^+, NH_4^+, Cl^-, SO_4^{2-}$				$Cs_2SO_4+NH_4Cl$		
428) $Cs^+, Mg^{2+}, Cl^-, Br^-$				$CsBr+MgCl_2$		
429) $Cs^+, Mg^{2+}, Cl^-, NO_3^-$				$CsNO_3+MgCl_2$		
430) $Cs^+, Mg^{2+}, Cl^-, SO_4^{2-}$				$CsCl+MgSO_4$		
431) $Cs^+, Ca^{2+}, Cl^-, Br^-$				$CsBr+CaCl_2$		
432) $Cs^+, Ca^{2+}, Cl^-, NO_3^-$				$CsNO_3+CaCl_2$		
433) $Cs^+, Ca^{2+}, Cl^-, SO_4^{2-}$				$CsCl+CaSO_4$		
434) Cs^+, Sr^{2+}, Cl^-, J^-				$CsBr+SrCl_2$		
435) Cs^+, Sr^{2+}, Cl^-, J^-				$CsJ+SrCl_2$		
436) $Cs^+, Sr^{2+}, Cl^-, NO_3^-$	108°C	$2CsNO_3+SrCl_2 \cdot 2H_2O$	$2CsCl+Sr(NO_3)_2$		2.8	16
437) $Cs^+, Ba^{2+}, Cl^-, Br^-$				$CsBr+BaCl_2$		
438) Cs^+, Ba^{2+}, Cl^-, J^-				$CsJ+BaCl_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
439) $Cs^+, Ba^{2+}, Cl^-, NO_3^-$	68°C	$2CsNO_3+BaCl_2 \cdot 2H_2O$	$2CsCl+Ba(NO_3)_2$		4.7	26
440) Cs^+, NH_4^+, Br^-, J^-				$CsJ+NH_4Br$		
441) $Cs^+, NH_4^+, Br^-, NO_3^-$				$CsNO_3+NH_4Br$		
442) $Cs^+, NH_4^+, Br^-, SO_4^{2-}$	49°C	$2CsBr+(NH_4)_2SO_4$	$Cs_2SO_4+2NH_4Br$		54.6	320
443) $Cs^+, Mg^{2+}, Br^-, NO_3^-$				$CsNO_3+MgBr_2$		
444) $Cs^+, Mg^{2+}, Br^-, SO_4^{2-}$				$CsBr+MgSO_4$		
445) $Cs^+, Ca^{2+}, Br^-, NO_3^-$				$CsNO_3+CaBr_2$		
446) $Cs^+, Ca^{2+}, Br^-, SO_4^{2-}$				$CsBr+CaSO_4$		
447) Cs^+, Sr^{2+}, Br^-, J^-				$CsJ+SrBr_2$		
448) $Cs^+, Sr^{2+}, Br^-, NO_3^-$	82°C	$2CsNO_3+SrBr_2 \cdot 6H_2O$	$2CsBr+Sr(NO_3)_2$		8.6	34
449) Cs^+, Ba^{2+}, Br^-, J^-				$CsJ+BaBr_2$		
450) $Cs^+, Ba^{2+}, Br^-, NO_3^-$				$CsBr+Ba(NO_3)_2$		
451) $Cs^+, NH_4^+, J^-, NO_3^-$				$CsNO_3+NH_4J$		
452) $Cs^+, NH_4^+, J^-, SO_4^{2-}$				$CsJ+(NH_4)_2SO_4$		
453) $Cs^+, Sr^{2+}, J^-, NO_3^-$	54°C	$2CsNO_3+SrJ_2 \cdot 6H_2O$	$2CsJ+Sr(NO_3)_2$		3.0	11
454) $Cs^+, Ba^{2+}, J^-, NO_3^-$				$CsJ+Ba(NO_3)_2$		
455) $Cs^+, NH_4^+, NO_3^-, SO_4^{2-}$				$CsNO_3+(NH_4)_2SO_4$		
456) $Cs^+, Mg^{2+}, NO_3^-, SO_4^{2-}$				$CsNO_3+MgSO_4$		
457) $Cs^+, Ca^{2+}, NO_3^-, SO_4^{2-}$				$CsNO_3+CaSO_4$		
458) $NH_4^+, Ba^{2+}, F^-, Cl^-$				$NH_4Cl+BaF_2$		
459) $NH_4^+, Ba^{2+}, F^-, Br^-$				$NH_4Br+BaF_2$		
460) $NH_4^+, Ba^{2+}, F^-, J^-$				NH_4J+BaF_2		
461) $NH_4^+, Ba^{2+}, F^-, NO_3^-$				$NH_4NO_3+BaF_2$		
462) $NH_4^+, Mg^{2+}, Cl^-, Br^-$				$NH_4Cl+MgBr_2$		
463) $NH_4^+, Mg^{2+}, Cl^-, NO_3^-$				$NH_4Cl+Mg(NO_3)_2$		
464) $NH_4^+, Mg^{2+}, Cl^-, SO_4^{2-}$				$NH_4Cl+Mg\ SO_4$		
465) $NH_4^+, Ca^{2+}, Cl^-, Br^-$				$NH_4Br+CaCl_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
466) $NH_4^+, Ca^{2+}, Cl^-, NO_3^-$				$NH_4Cl+Ca(NO_3)_2$		
467) $NH_4^+, Ca^{2+}, Cl^-, SO_4^{2-}$				$NH_4Cl+CaSO_4$		
468) $NH_4^+, Sr^{2+}, Cl^-, Br^-$				$NH_4Br+SrCl_2$		
469) $NH_4^+, Sr^{2+}, Cl^-, J^-$	71°C	$2NH_4Cl+SrJ_2 \cdot 6H_2O$	$2NH_4J+SrCl_2 \cdot 2H_2O$		- 6.4	- 45
470) $NH_4^+, Sr^{2+}, Cl^-, NO_3^-$				$NH_4Cl+Sr(NO_3)_2$		
471) $NH_4^+, Ba^{2+}, Cl^-, Br^-$				$NH_4Br+BaCl_2$		
472) $NH_4^+, Ba^{2+}, Cl^-, J^-$				$NH_4J+BaCl_2$		
473) $NH_4^+, Ba^{2+}, Cl^-, NO_3^-$				$NH_4Cl+Ba(NO_3)_2$		
474) $NH_4^+, Mg^{2+}, Br^-, NO_3^-$				$NH_4Br+Mg(NO_3)_2$		
475) $NH_4^+, Mg^{2+}, Br^-, SO_4^{2-}$				$NH_4Br+MgSO_4$		
476) $NH_4^+, Ca^{2+}, Br^-, NO_3^-$				$NH_4Br+Ca(NO_3)_2$		
477) $NH_4^+, Ca^{2+}, Br^-, SO_4^{2-}$				$NH_4Br+CaSO_4$		
478) $NH_4^+, Sr^{2+}, Br^-, J^-$	101°C	$2NH_4Br+SrJ_2 \cdot 2H_2O$	$2NH_4J+SrBr_2 \cdot 2H_2O$		12.8	52
479) $NH_4^+, Sr^{2+}, Br^-, NO_3^-$				$NH_4Br+Sr(NO_3)_2$		
480) $NH_4^+, Ba^{2+}, Br^-, J^-$	25°C	$2NH_4Br+BaJ_2 \cdot 6H_2O$	$2NH_4J+BaBr \cdot 2H_2O$		12.1	45
481) $NH_4^+, Ba^{2+}, Br^-, NO_3^-$				$NH_4Br+Ba(NO_3)_2$		
482) $NH_4^+, Sr^{2+}, J^-, NO_3^-$				$NH_4J+Sr(NO_3)_2$		
483) $NH_4^+, Ba^{2+}, J^-, NO_3^-$				$NH_4J+Ba(NO_3)_2$		
484) $NH_4^+, Mg^{2+}, NO_3^-, SO_4^{2-}$	13°C	$2NH_4NO_3+MgSO_4 \cdot 7H_2O$	$(NH_4)_2SO_4+Mg(NO_3)_2 \cdot 6H_2O$		- 47.9	- 200
485) $NH_4^+, Ca^{2+}, NO_3^-, SO_4^{2-}$				$NH_4NO_3+CaSO_4$		
486) $Mg^{2+}, Ca^{2+}, Cl^-, Br^-$				$MgBr_2+CaCl_2$		
487) $Mg^{2+}, Ca^{2+}, Cl^-, NO_3^-$	90°C	$Mg(NO_3)_2 \cdot 6H_2O+CaCl_2 \cdot 2H_2O$	$MgCl_2 \cdot 6H_2O+Ca(NO_3)_2$		1.7	7
488) $Mg^{2+}, Ca^{2+}, Cl^-, SO_4^{2-}$				$MgCl_2+CaSO_4$		
489) $Mg^{2+}, Sr^{2+}, Cl^-, Br^-$				$MgBr_2+SrCl_2$		
490) $Mg^{2+}, Sr^{2+}, Cl^-, NO_3^-$	51°C	$Mg(NO_3)_2 \cdot 6H_2O+SrCl_2 \cdot 6H_2O$	$MgCl_2 \cdot 6H_2O+Sr(NO_3)_2$		14.8	51
491) $Mg^{2+}, Ba^{2+}, Cl^-, Br^-$				$MgBr_2+BaCl_2$		
492) $Mg^{2+}, Ba^{2+}, Cl^-, NO_3^-$				$MgCl_2+Ba(NO_3)_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
493) $Mg^{2+}, Ca^{2+}, Br^-, NO_3^-$	88°C	$Mg(NO_3)_2 \cdot 6H_2O + CaBr_2 \cdot 2H_2O$	$MgBr_2 \cdot 6H_2O + Ca(NO_3)_2$		- 2.9	- 12
494) $Mg^{2+}, Ca^{2+}, Br^-, SO_4^{2-}$				$MgBr_2 + CaSO_4$		
495) $Mg^{2+}, Sr^{2+}, Br^-, NO_3^-$				$MgBr_2 + Sr(NO_3)_2$		
496) $Mg^{2+}, Ba^{2+}, Br^-, NO_3^-$				$MgBr_2 + Ba(NO_3)_2$		
497) $Mg^{2+}, Ca^{2+}, NO_3^-, SO_4^{2-}$				$Mg(NO_3)_2 + CaSO_4$		
498) $Ca^{2+}, Sr^{2+}, Cl^-, Br^-$				$CaBr_2 + SrCl_2$		
499) $Ca^{2+}, Sr^{2+}, Cl^-, NO_2^-$	4°C	$CaCl_2 \cdot 6H_2O + Sr(NO_2)_2 \cdot 4H_2O$	$Ca(NO_2)_2 \cdot 4H_2O + SrCl_2 \cdot 6H_2O$		- 6.8	- 26
500) $Ca^{2+}, Sr^{2+}, Cl^-, NO_3^-$				$CaCl_2 + Sr(NO_3)_2$		
501) $Ca^{2+}, Ba^{2+}, Cl^-, Br^-$				$CaBr_2 + BaCl_2$		
502) $Ca^{2+}, Ba^{2+}, Cl^-, NO_2^-$				$Ca(NO_2)_2 + BaCl_2$		
503) $Ca^{2+}, Ba^{2+}, Cl^-, NO_3^-$				$CaCl_2 + Ba(NO_3)_2$		
504) $Ca^{2+}, Sr^{2+}, Br^-, NO_2^-$				$CaBr_2 + Sr(NO_2)_2$		
505) $Ca^{2+}, Sr^{2+}, Br^-, NO_3^-$				$CaBr_2 + Sr(NO_3)_2$		
506) $Ca^{2+}, Ba^{2+}, Br^-, NO_2^-$	24°C	$CaBr_2 \cdot 6H_2O + Ba(NO_2)_2 \cdot H_2O$	$Ca(NO_2)_2 \cdot 4H_2O + BaBr_2 \cdot 2H_2O$		- 6.3	- 30
507) $Ca^{2+}, Ba^{2+}, Br^-, NO_3^-$				$CaBr_2 + Ba(NO_3)2$		
508) $Ca^{2+}, Sr^{2+}, NO_2^-, NO_3^-$				$Ca(NO_2)_2 + Sr(NO_3)_2$		
509) $Ca^{2+}, Ba^{2+}, NO_2^-, NO_3^-$				$Ca(NO_2)_2 + Ba(NO_3)_2$		
510) $Sr^{2+}, Ba^{2+}, OH^-, Cl^-$				$Sr(OH)_2 + BaCl_2$		
511) $Sr^{2+}, Ba^{2+}, OH^-, Br^-$				$Sr(OH)_2 + BaBr_2$		
512) $Sr^{2+}, Ba^{2+}, OH^-, J^-$				$Sr(OH)_2 + BaJ_2$		
513) $Sr^{2+}, Ba^{2+}, OH^-, NO_2^-$				$Sr(OH)_2 + Ba(NO_2)_2$		
514) $Sr^{2+}, Ba^{2+}, OH^-, NO_3^-$				$Sr(OH)_2 + Ba(NO_3)_2$		
515) $Sr^{2+}, Ba^{2+}, Cl^-, Br^-$				$SrBr_2 + BaCl_2$		
516) $Sr^{2+}, Ba^{2+}, Cl^-, J^-$				$SrJ_2 + BaCl_2$		
517) $Sr^{2+}, Ba^{2+}, Cl^-, NO_2^-$				$Sr(NO_2)_2 + BaCl_2$		

Table 2 (continued)

Ions	Temp. T_o (°C)	Stable Pair at $T < T_o$	Stable Pair at $T > T_o$	Stable Pair between 0° and 100°	Enthalpy of reaction kcal/mol	Enthalpy of reaction kcal/dm^3
518) $Sr^{2+}, Ba^{2+}, Cl^-, NO_3^-$				$SrCl_2+Ba(NO_3)_2$		
519) $Sr^{2+}, Ba^{2+}, Br^-, J^-$				SrJ_2+BaBr_2		
520) $Sr^{2+}, Ba^{2+}, Br^-, NO_2^-$	27°C	$SrBr_2 \cdot 6H_2O+Ba(NO_2)_2 \cdot H_2O$	$Sr(NO_2)_2 \cdot H_2O+BaBr_2 \cdot 2H_2O$		7.0	31
521) $Sr^{2+}, Ba^{2+}, Br^-, NO_3^-$				$SrBr_2+Ba(NO_3)_2$		
522) $Sr^{2+}, Ba^{2+}, J^-, NO_2^-$	36°C	$SrJ_2 \cdot 6H_2O+Ba(NO_2)_2 \cdot H_2O$	$Sr(NO_2)_2 \cdot H_2O+BaJ_2 \cdot 2H_2O$		8.9	36
523) $Sr^{2+}, Ba^{2+}, J^-, NO_3^-$				$SrJ_2+Ba(NO_3)_2$		
524) $Sr^{2+}, Ba^{2+}, NO_2^-, NO_3^-$				$Sr(NO_2)_2+Ba(NO_3)_2$		

Table 3 : Enthalpies of formation (kcal/mol)
(The number of bound H_2O-molecules is given in parenthesis).

LiOH	0-120°C : - 188.8 (1)
LiF	0-120°C : - 146.1 (0)
LiCl	0-20°C: - 241.3 (2); 20-95°C: - 170.1 (1); 95-120°C: - 97.6 (0)
LiBr	0-20°C: - 300.3 (3); 20-33.2°C: - 229.2 (2); 33.2-120°C: - 158.1 (1)
LiJ	0-75°C: - 284.7 (3); 75-79°C: - 212.8 (2); 79-120°C: - 141.0 (1)
$LiNO_2$	0-50°C: - 167.7 (1); 50-94.2°C: - 132.1 (0.5); 94.2-120°C: - 96.6 (0)
$LiNO_3$	0-30°C: - 328.4 (3); 30-61.1°C: - 150.7 (0.5); 61.1 -100°C: - 115.2 (0)
Li_2SO_4	0-120°C: - 413.2 (1)
Li_2CO_3	0-100°C: - 290.2 (0)
NaOH	0-15.5°C: - 354.1 (3.5); 15.5-64.3°C: - 175.0 (1); 64.3-120°C: - 101.9 (0)
NaF	0-120°C: - 136.2 (0)
NaCl	0-120°C: - 98.1 (0)
NaBr	0-51°C: - 227.1 (2); 51-120°C: - 85.9 (0)
NaJ	0-68°C: - 210.9 (2); 68-120°C: - 68.8 (0)
$NaNO_2$	0-120°C: - 85.8 (0)
$NaNO_3$	0-120°C: - 111.4 (0)
Na_2SO_3	0-33.4°C: - 753.0 (7); 33.4-120°C: - 260.3 (0)
Na_2SO_4	0-32.4°C: - 1032.5 (10); 32.4-120°C: - 330.5 (0)
$Na_2S_2O_3$	0-48.2°C: - 621.2 (5); 48.2-65°C: - 408.6 (2); 67-75°C: - 302.1 (0.5); 75-120°C: - 266.8 (0)
Na_2CO_3	0-32°C: - 973.7 (10); 32-35.5°C: - 764.7 (7); 35.5-112.5°C: - 341.8 (1); 112.5-120°C: - 269.6 (0)
KOH	0-33°C: - 247.9 (2); 33-120°C: - 174.8(0)
KF	0-18°C: - 417.5 (4); 18-40°C: - 276.8 (2); 40-120°C: - 134.3 (0)

Table 3 (continued)

KCl	0-120°C: - 104.1 (0)
KBr	0-120°C: - 93.6 (0)
KJ	0-120°C: - 78.2 (0)
KNO_2	0-120°C: - 88.4 (0)
KNO_3	0-120°C: - 117.6 (0)
K_2SO_3	0-120°C: - 266.8 (0)
K_2SO_4	0-10°C: - 413.9 (1); 10-120°C: - 342.2 (0)
$K_2S_2O_3$	
K_2CO_3	0-120°C: - 380.0 (1.5)
RbCl	0-120°C: - 102.8 (0)
RbBr	0-120°C: - 92.9 (0)
RbJ	0-120°C: - 78.4 (0)
$RbNO_3$	0-120°C: - 116.9 (0)
Rb_2SO_4	0-120°C: - 340.1 (0)
CsCl	0-120°C: - 103.4 (0)
CsBr	0-120°C: - 94.2 (0)
CsJ	0-120°C: - 80.4 (0)
$CsNO_3$	0-120°C: - 118.0 (0)
Cs_2SO_4	0-120°C: - 338.9 (0)
NH_4F	0-120°C: - 111.5 (0)
NH_4Cl	0-120°C: - 75.1 (0)
NH_4Br	0-120°C: - 64.6 (0)
NH_4J	0-120°C: - 48.3 (0)
NH_4NO_3	0-120°C: - 87.2 (0)
$(NH_4)_2SO_3$	
$(NH)_2SO_4$	0-120°C: - 334.3 (0)
$MgCl_2$	0-120°C: - 596.8 (6)

Table 3 (continued)

$MgBr_2$	0-120°C: - 574.9 (6)
$Mg(NO_3)_2$	0-90°C: - 623.6 (6); 90-120°C: - 336.9 (2)
$MgSO_4$	0-48°C: - 803.9 (7); 48-68°C: - 736.3 (6); 68-120°C: - 379.5 (0)
MgS_2O_3	0-86°C: - 677.0 (6)
$Ca(OH)_2$	0-120°C: - 235.5 (0)
$CaCl_2$	0-29.5°C: - 622.9 (6); 29.5-45.3: - 481.3 (4); 45.3-120°C: - 335.3 (2)
$CaBr_2$	0-34.2°C: - 596.8 (6); 34.2-53.9°C: - 455.0 (4); 53.9-120°C: - 308.7 (2)
$Ca(NO_2)_2$	0-34.6°C: - 463.2 (4); 34.6-120°C: - 250.6 (1)
$Ca(NO_3)_2$	0-42.6°C: - 508.7 (4); 42.6-51.6°C: - 436.6 (3); 51.6-120°C: - 223.8 (0)
$CaSO_4$	0-42°C: - 482.4 (2); 42-120°C: - 340.1 (0)
$Sr(OH)_2$	0-100°C: - 802.4 (8)
$SrCl_2$	0-61.3°C: - 630.8 (6); 61.3-120°C: - 343.2 (2)
$SrBr_2$	0-88.6°C: - 603.8 (6); 88.6-120°C: - 317.2 (2)
SrJ_2	0-84°C: - 570.6 (6); 84-120°C: - 282.5 (2)
$Sr(NO_2)_2$	0-15°C: - 464.3 (4); 15-120°C: - 252.0 (1)
$Sr(NO_3)_2$	0-31.3°C: - 518.0 (4); 31.3-120°C: - 233.0 (0)
$Ba(OH)_2$	0-77.8°C: - 799.1 (8); 77.8-120°C: - 440.9 (3)
BaF_2	0-120°C: - 286.6 (0)
$BaCl_2$	0-102.1°C: - 348.9 (2); 102.1-120°C: - 278.0 (1)
$BaBr_2$	0-113°C: - 326.0 (2); 113-120°C: - 254.8 (1)
BaJ_2	0-35°C: - 578.7 (6); 35-120°C: - 290.9 (2)
$Ba(NO_2)_2$	0-120°C: - 254.4 (1)
$Ba(NO_3)_2$	0-120°C: - 236.8 (0)
H_2O	0-100°C: - 68.3

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