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Thermodynamics of Saturated Aqueous Solutions Including Mixtures of NaCl, KCl, and CsCl

M. Conceição P. de Lima[1] and Kenneth S. Pitzer[2]

Abstract

The activity coefficients for saturated aqueous KCl, CsCl and mixtures of NaCl with each of these electrolytes are calculated from solution properties using the ion interaction model as well as from the solubility. The agreement between the two sets of results for both single and mixed electrolytes is, in general, good when it is considered that the saturated solution molalities are often much higher than those whose properties were used in the evaluation of the ion interaction parameters. Also, for pure KCl(aq) the agreement is good up to 300°C, an extrapolation 50°C above the range of data on which the equations were based.

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1. Introduction

Recently Holmes and Mesmer(1) have determined the osmotic coefficients of KCl(aq) and CsCl(aq) at high temperatures by isopiestic measurements up to 8 mol kg^{-1} and they combined their results with reported thermodynamic data to give equations for the enthalpy of solution and partial molar heat capacity at zero molality. They also give analytical equations for the ion-interaction parameters as a function of temperature by a least squares fitting of their isothermal osmotic coefficients to the ion interaction model. The validity of the resulting set of equations was claimed from 0 to 250°C and up to about 6 mol kg^{-1}. We now explore the question of the actual validity being wider by use of the data on the solubilities which are much above the range of the data considered by Holmes and Mesmer.

The above group(2) has also made isopiestic studies on aqueous solutions of the mixed electrolyte NaCl + KCl over the temperature range 383 to 474 K and up to 6 mol kg^{-1} for NaCl, used as the isopiestic standard. From a least squares fitting of their experimental results to Pitzer's equation they determined the mixing parameters, which together with the pure electrolyte parameters have been used in the present work to calculate the activity coefficients for NaCl and KCl in the saturated mixed electrolyte system. These calculations provide a check on the validity at high temperatures of the equations developed for mixed electrolytes.(3,4) Also the comparison with solubility data tests the extrapolation of the molality dependence above the range of measurement.

This same test has been applied to NaCl and CsCl mixture from the knowledge of the pure electrolyte properties and using for the mixing parameters the values derived by Rard and Miller(5) from their isopiestic measurements at 25°C.

2. Data and Equations

The solubility of KCl in Water is well-known over a wide range of temperature(6) and for CsCl the solubility data are available only up to 119.4°C.(6)

The ion interaction model gives the mean activity coefficient, $\gamma_\pm$, of a 1:1 electrolyte as

$$\ln \gamma_\pm = f^\gamma + mB^\gamma + m^2C^\gamma \tag{1}$$

where f^γ, the long range electrostatic term is given by

$$f^\gamma = -A_\phi[m^{1/2}/(1+bm^{1/2}) + (2/b)\ \ln(1+bm^{1/2})] \tag{2}$$

B^γ and C^γ, respectively the second and third virial coefficients, are given by

$$B^\gamma = 2\beta^{(0)} + (2\beta^{(1)}/\alpha^2 I)[1-(1+\alpha I^{1/2} - \alpha^2 I/2)\ \exp(-\alpha I^{1/2})] \tag{3}$$

$$C^\gamma = 3/2\ C^\phi \tag{4}$$

A_ϕ is the Debye-Hückel coefficient for the osmotic function whose values at the studied temperatures have been taken from Silvester and Pitzer.(7) For the present purposes the difference in A_ϕ from the more recent values of Bradley and Pitzer(8) is negligible. The conventional molality is m which for a single fully dissociated 1-1 electrolyte is equivalent to the ionic strength. The empirical parameters α and b have their conventional values, 2.0 and 1.2 $\text{kg}^{1/2} \cdot \text{mole}^{-1/2}$, respectively, while $\beta^{(0)}$, $\beta^{(1)}$ and C^ϕ, are specific parameters of each individual electrolyte. Holmes and Mesmer(1) represented these parameters by functions of temperature of the form

$$f(T) = p_1 + p_2(1/T - 1/T_R) + p_3\ \ln(T/T_R) + p_4(T - T_R) + p_5(T^2 - T_R^{\ 2}) + p_6\ \ln(T-260) \tag{5}$$

where T_R is set at 298.15 K.

Their equations were used in the present work to calculate the values of the ion interaction parameters for KCl and CsCl at the various temperatures.

They also expressed the partial molal enthalpy of solution at zero molality by the empirical equation

$$\Delta\bar{H}^\circ_s(T) = q_1 + q_2T + q_3T^2 + q_4T^3 + q_5\ \ell n(T-270) \tag{6}$$

This equation was integrated to obtain an equation for ΔG°_s, the Gibbs energy of solution, as a function of temperature. For either salt,

$$\begin{aligned}\Delta G^\circ_s/T = -\int_{T_R}^{T} (\Delta H^\circ_s/T^2)dT &= q_1(1/T - 1/T_R) - q_2\ \ell n(T/T_R) \\ &- q_3(T-T_R) - q_4(T^2/2 - T_R{}^2/2) - q_5\ \{-\ (\ell n(T/T_R))/270 \\ &+ [(T-270)/(270T)]\ \ell n(T-270) - [(T_R-270)/(270\ T_R)]\ \ell n(T_R-270)\} \\ &+ q_6.\end{aligned} \tag{7}$$

We then applied equation 7 and the equation which gives the standard Gibbs energy of solution

$$\Delta G^\circ_s = -2RT\ \ell n(m\gamma)_{sat} \tag{8}$$

to obtain values of the activity coefficient at different temperatures in the saturated KCl solution. Table I gives the q parameters of equation 7 for both electrolytes. The integration constant q_6 was calculated making equal the activity coefficients at 25°C obtained from Pitzer's equation and solubility data. Similar calculations were carried out for saturated CsCl(aq). The units for the q's are J mol^{-1} and various powers of K.

For the mixed electrolytes NaCl + KCl and NaCl + CsCl the solubility data have been taken from Seidell,(6) where for the first mixture, different authors(9-12) give values at various molality ratios when only one of the two electrolytes is present as solid phase. We have also used the data given by different authors when both electrolytes are present as solid phase. For this mixture the data are available up to 200°C. For the mixed system NaCl + CsCl we have adopted the solubility measurements of Plyushchev _et al_.(13) for NaCl in this mixture from 25 to 75°C.

Pitzer's equation for the activity coefficient of a 1-1 electrolyte MX in a common-ion mixture with NX is

$$\ell n\ \gamma_{MX} = -A_\phi\{I^{\frac{1}{2}}/(1+bI^{\frac{1}{2}}) + (2/b)\ \ell n(1+bI^{\frac{1}{2}})\} + I\{B^\gamma_{MX} + y(B^\phi_{NX} - B^\phi_{MX} + \theta_{MN})\}$$

$$+ I^2\{3C^\phi_{MX}/2 + y(C^\phi_{NX} - C^\phi_{MX} + \psi_{MNX}/2) + y(1-y)\psi_{MNX}/2 \qquad (9)$$

where B^γ was given above in equation (3) and B^ϕ is

$$B = \beta^{(0)} + \beta^{(1)}\ \exp(-\alpha I^{\frac{1}{2}})$$

I, the ionic strength, is in this case the total molality, and y is the ionic strength fraction of NX. θ_{MN} and ψ_{MNX} are the mixing parameters. θ_{MN} represents the difference in the interaction of unlike ions with charges of the same sign from the appropriate average for like ions. The ψ_{MXN} is similarly defined but for three ions with charges not all of the same sign. An analogous equation can be obtained for γ_{NX} by transposing subscripts and replacing y with (1-y). We have used for the ion interaction parameters of pure NaCl, the values given by Silvester and Pitzer(7) and those for pure KCl and CsCl were taken from Holmes and Mesmer's work.(1)

For the mixed system NaCl + KCl we accepted the equation for the temperature dependence of θ given by Holmes, Baes and Mesmer(2)

$$\theta/\text{kg mol}^{-1} = -6.726\ \text{K}/T + 0.0039$$

ψ was assumed to be equal to zero as recommended by the cited group.(2) For NaCl + CsCl mixture the mixing parameters, θ and ψ, taken from Rard and Miller's isopiestic studies at 25°C(5) were used at all temperatures; they are, respectively, -0.03886 and -0.00135. The activity coefficients obtained from solubility data were calculated using the equations of ΔG°_{s} as a function of temperature, derived for the pure KCl(1) and NaCl(7) electrolytes.

At certain points this thermodynamic treatment has an implied assumption of constant pressure whereas in fact it is applied at the saturation pressure above 100°C. The magnitude of this approximation is indicated by the results of Rogers and Pitzer(14) who obtained the pressure dependence of various thermodynamic properties of NaCl. Holmes and Mesmer(1) also discuss this approximation. In summary and for data of the present level of precision, this approximation is negligible up to 200°C and probably to 250°C. At 300°C there is appreciable error which increases rapidly above that temperature. Thus, agreement is not expected above 300°C.

3. Results and Discussion

Table II and Table III give the results comparing the activity coefficient obtained from solubility with that from solution properties for KCl and CsCl respectively. For KCl the agreement is very good not only below 250°C, where the test is essentially the extension to molality above the claimed range of validity, but also at 300°C, which involves an extrapolation upward by 50°C. Above 300°C the results begin to deviate rapidly as might be expected. For CsCl the agreement is good only up to about 50°C, which is reasonable, if one consider the extremely high values for its solubility. This comparison is shown in Figs. 1 and 2 respectively, where the solid line represents the predicted values from the ion interaction equation and the points were calculated from the experimental solubilities and equations (7) and (8). (The values at 350°C for KCl are not included in the plot). The plots give also the temperature dependence of the activity coefficient which for KCl is shown to be the general trend of activity coefficients for a simple 1-1 electrolyte at high temperature.

The comparison of the activity coefficients from solution and solubility data for the two studied mixtures is shown in Figs 3 and 4 for NaCl + KCl and in Fig. 5 for NaCl + CsCl. The activity coefficient values are plotted for some temperatures against the ionic strength fraction of KCl and CsCl for the two mixtures, respectively. Here, again, the solid lines represent the values or the activity coefficient given by Pitzer's equation and the points those obtained from solubility data. Considering first Figs 3 and 4, we note that the agreement between the two functions is in general good. At 40°C, as the mixture becomes more rich in KCl, the deviation of the experimental points from the predicted values is larger than that we would expect at this low temperature. This same deviation is observed at 100°C, but only for the results obtained from solubility data given by one group of authors. At this temperature, the activity coefficients obtained from solubility measurements of Cornec and Krombach(6) are in good agreement with the predicted values. The activity coefficients show a decrease with increase of temperature, and it seems apparent that they become less dependent upon the composition as the temperature increases. Considering Fig. 5, where the comparison of the results for the activity coefficients of NaCl in NaCl + CsCl mixture from the two sources is shown at three temperatures, one can say that at 50°C the agreement is good, at 25°C is reasonable and at 75°C is very poor. At this last temperature, the trend shown by the activity coefficients is very peculiar, and one believes that this is probably due to an inaccuracy of the experimental solubility measurements.

Tables showing the values of the activity coefficients for NaCl + KCl and NaCl + CsCl at different temperatures and appropriate saturated molalities are given in the appendix. The references 9 through 12 indicate the investigators who carried out the solubility measurements.

Acknowledgments

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Table I. Parameters of Equation 7 for Aqueous KCl and CsCl (q_1-q_5 from ref. 1)

Parameter	KCl(aq)	CsCl(aq)
q_1	1.5774×10^5	2.2559×10^5
q_2	-1037.86	-1519.99
q_3	2.7739	3.8313
q_4	-0.00284332	-0.00360769
q_5	-686	0
q_6	-17.3703	-30.5834

Table II. The Activity Coefficient of Aqueous Potassium Chloride from Two Sources

t/°C	m_{sat}	γ_{sat} from	
		Solubility	Solution data
10	4.189	0.556	0.556
20	4.591	0.583	0.580
25	4.811	(0.591)	0.591
30	4.986	0.603	0.600
40	5.372	0.618	0.616
50	5.748	0.628	0.628
60	6.139	0.631	0.636
70	6.517	0.630	0.639
80	6.878	0.626	0.638
90	7.222	0.620	0.633
100	7.544	0.611	0.623
120	8.047	0.592	0.593
130	8.361	0.573	0.575
140	8.684	0.551	0.554
150	9.016	0.526	0.531
160	9.359	0.499	0.507
180	10.11_8	0.439	0.453
200	10.79_7	0.380	0.395
220	11.59_0	0.318	0.335
250	12.88_6	0.232	0.244
280	14.18_5	0.157	0.161
300	15.61_8	0.116	0.111
350	18.83_0	0.0478	0.0195

Table III. The Activity Coefficient of Aqueous Cesium Chloride from Two Sources

t/°C	m_{sat}	γ_{sat} from	
		Solubility	Solution Data
10	10.37_7	0.495	0.511
20	11.07_7	0.534	0.546
25	11.29_2	(0.557)	0.557
30	11.71_9	0.568	0.570
40	12.35_4	0.594	0.586
50	12.97_8	0.614	0.594
60	13.64_3	0.623	0.595
70	14.22_5	0.631	0.589
80	14.84_9	0.631	0.578
90	15.44_9	0.626	0.562
100	16.06_7	0.616	0.542
119.4	17.22_5	0.588	0.494

Figure Captions

Figure 1. The activity coefficient of KCl at saturation molality. The points are calculated from the solubility while the curve is calculated from the ion interaction equations of Holmes and Mesmer.(1)

Figure 2. The activity coefficient of CsCl at KCl at saturation molality. The points are calculated from the solubility while the curve is calculated from the ion interaction equations of Holmes and Mesmer.(1)

Figure 3. The activity coefficient of NaCl and KCl in mixed solutions. The points are calculated from solubility; solid symbols indicate that both solids are present while open symbols indicate that only one solid is present. The curves are calculated from the ion interaction equations.

Figure 4. The activity coefficients of NaCl and KCl in mixed solutions. Details are the same as in Fig. 3.

Figure 5. The activity coefficient of NaCl in mixed solution with CsCl. Details are the same as in Fig. 3.

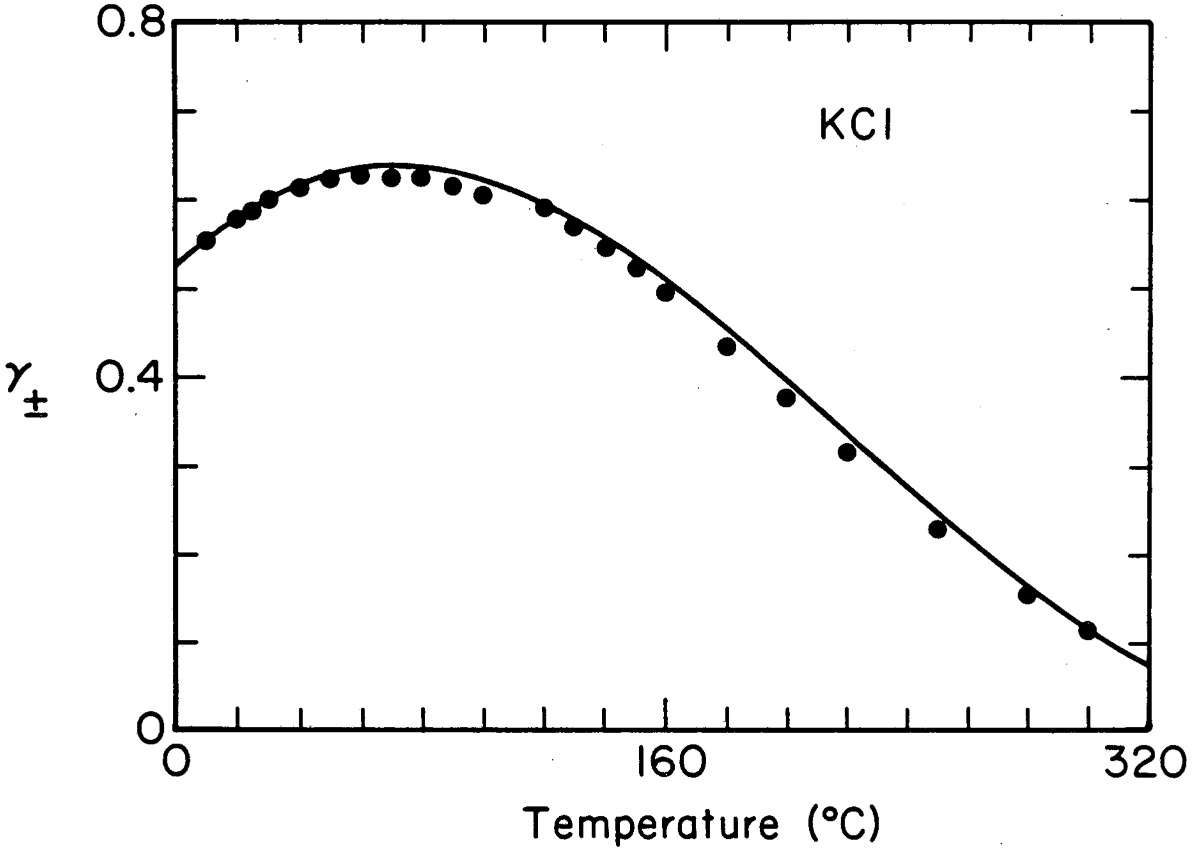

Figure 1. The activity coefficient of KCl at saturation molality. The points are calculated from the solubility while the curve is calculated from the ion interaction equations of Holmes and Mesmer.(1)

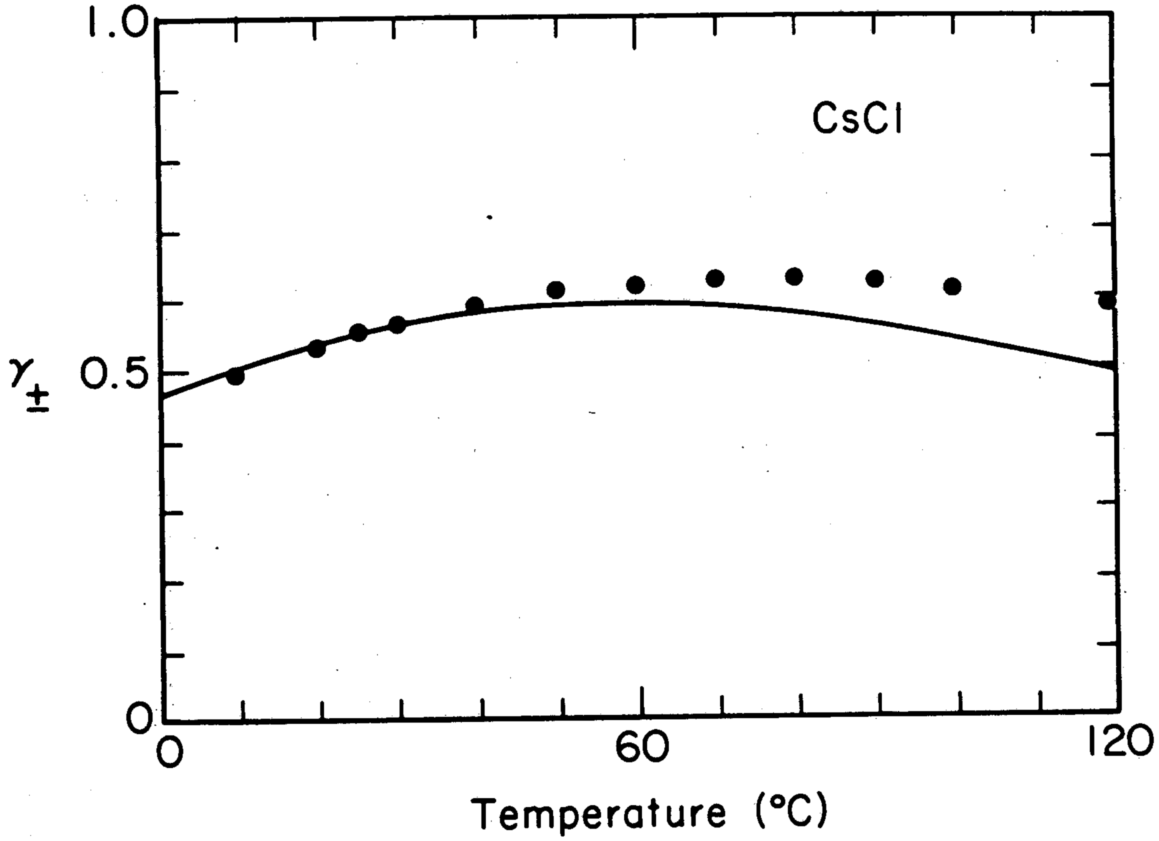

Figure 2. The activity coefficient of CsCl at KCl at saturation molality. The points are calculated from the solubility while the curve is calculated from the ion interaction equations of Holmes and Mesmer.(1)

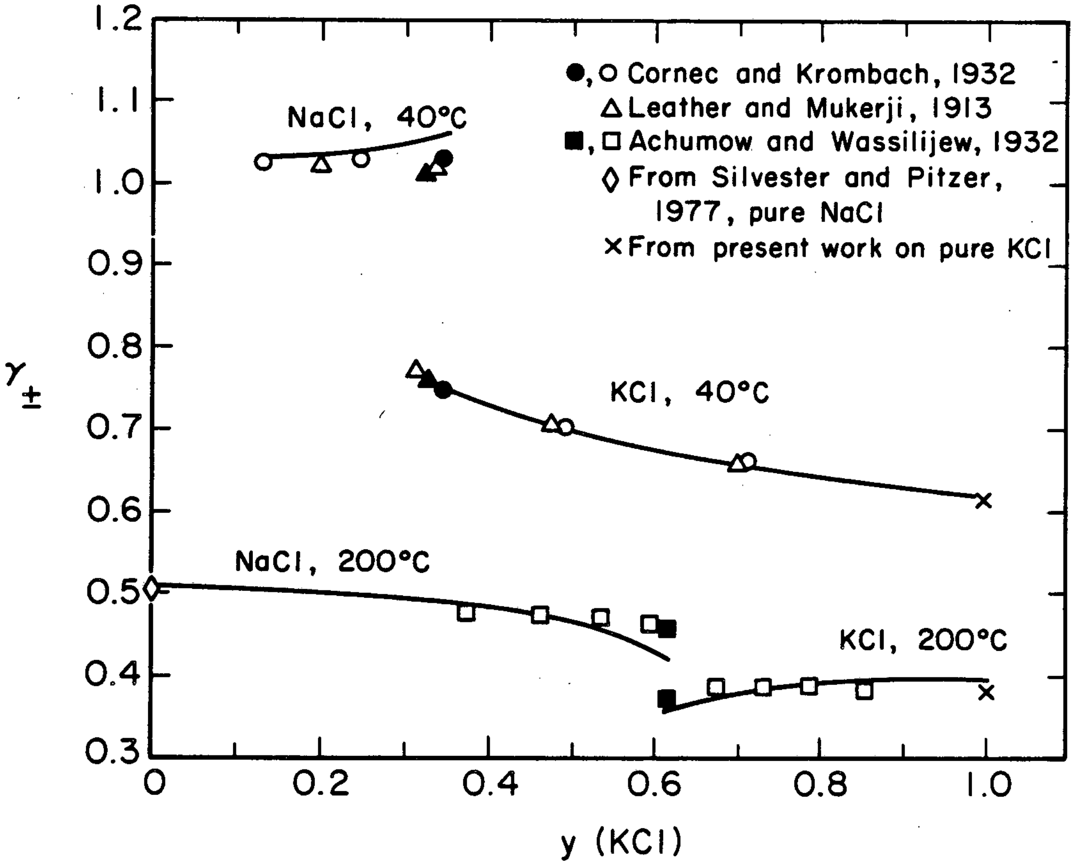

Figure 3. The activity coefficient of NaCl and KCl in mixed solutions. The points are calculated from solubility; solid symbold indicate that both solids are present while open symbols indicate that only one solid is present. The curves are calculated from the ion interaction equations.

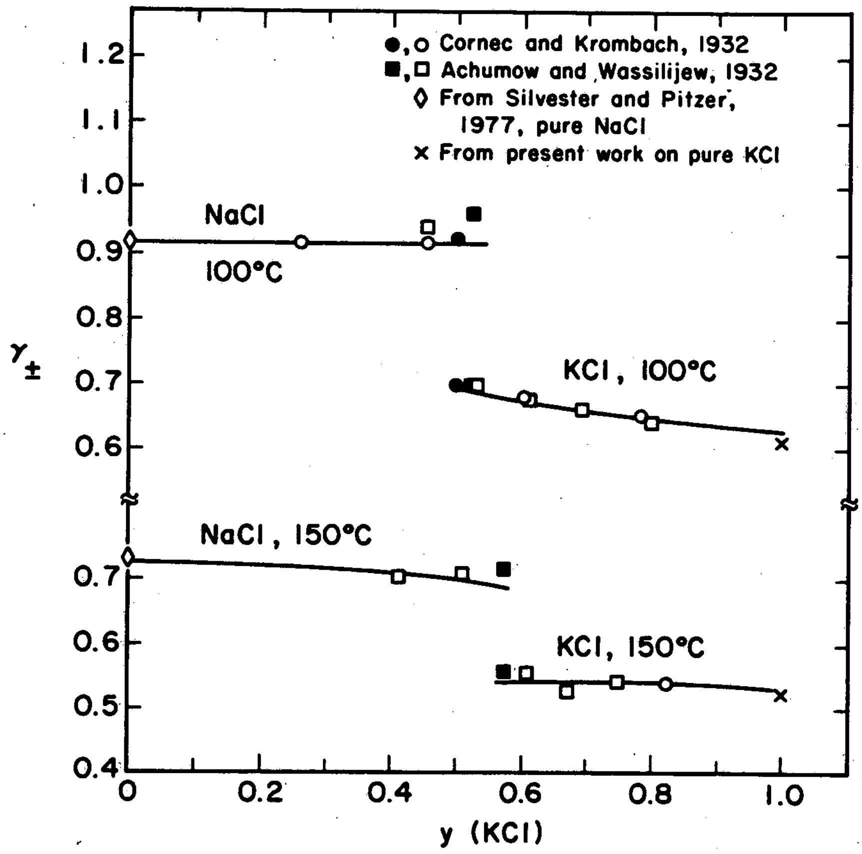

Figure 4. The activity coefficients of NaCl and KCl in mixed solutions. Details are the same as in Fig. 3.

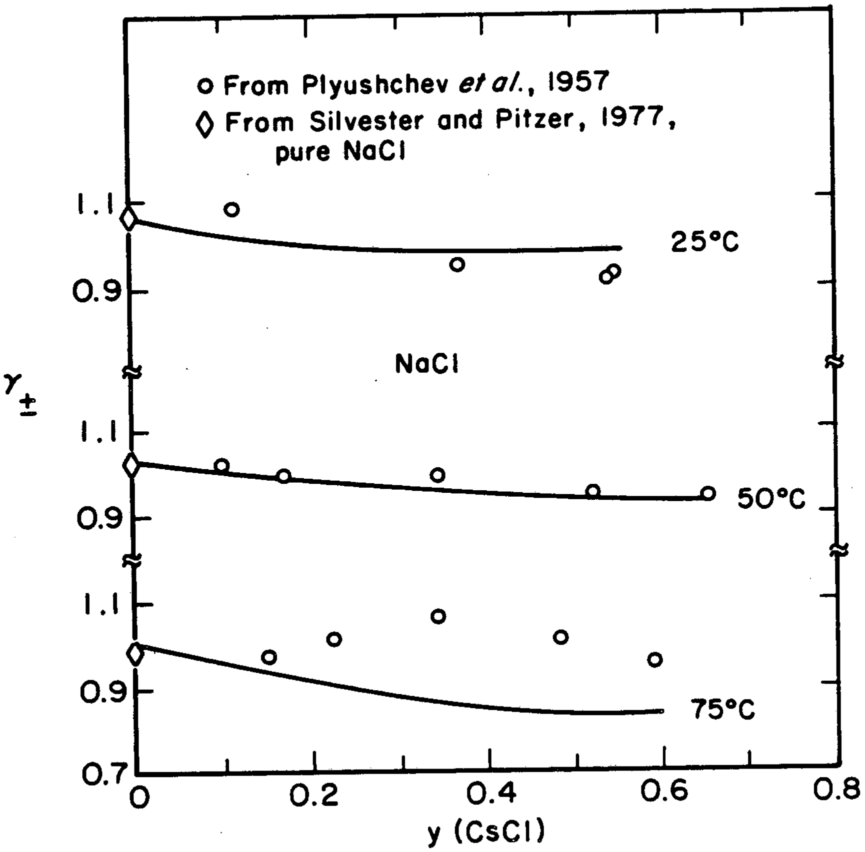

Figure 5. The activity coefficient of NaCl in mixed solution with CsCl. Details are the same as in Fig. 3.

A1. Activity Coefficients of NaCl and KCl in Saturated Aqueous Mixture NaCl+KCl. Both Electrolytes are present as Solid Phase

			$\gamma_{\pm}$ (NaCl) from		$\gamma_{\pm}$ (KCl) from		
t,°C	m_2(NaCl)	m_3(KCl)	Solution Data	Solubility Data	Solution Data	Solubility Data	Ref.
10	5.32_3	1.67_8	0.989	0.963	0.696	0.685	(9)
20	4.91_2	1.95_9	0.978	1.051	0.706	0.734	(11)
20	5.06_7	2.06_0	1.007	1.016	0.731	0.704	(9)
25	5.11_3	2.12_4	1.025	1.018	0.731	0.731	(12)
30	5.05_5	2.28_9	1.033	1.029	0.739	0.739	(9)
40	5.00_8	2.62_7	1.048	1.030	0.752	0.747	(9)
40	5.18_8	2.51_3	1.064	1.008	0.757	0.760	(11)
50	4.91_0	2.97_5	1.045	1.032	0.754	0.751	(9)
60	4.86_2	3.29_8	1.036	1.021	0.751	0.752	(9)
70	4.79_9	3.66_6	1.0 7	1.004	0.743	0.743	(9)
80	4.74_9	4.02_7	0.991	0.981	0.729	0.730	(9)
90	4.72_5	4.36_5	0.959	0.952	0.711	0.716	(9)
100	4.70_8	4.73_4	0.922	0.918	0.690	0.695	(9)
100	4.39_8	4.81_5	0.904	0.962	0.685	0.697	(10)
110	4.69_9	5.11_8	0.880	0.880	0.665	0.669	(9)
110	4.43_2	5.23_1	0.869	0.913	0.662	0.667	(10)
120	4.70_8	5.46_9	0.835	0.840	0.637	0.644	(9)
120	4.53_5	5.56_6	0.829	0.859	0.636	0.641	(10)
130	4.78_6	5.81_0	0.788	0.791	0.607	0.616	(9)
130	4.62_0	5.90_1	0.783	0.808	0.606	0.613	(10)
140	4.82_2	6.18_2	0.738	0.746	0.574	0.585	(9)
140	4.70_6	6.23_7	0.735	0.757	0.574	0.584	(10)
150	4.79_1	6.51_8	0.685	0.709	0.541	0.557	(10)

A1. (continued)

			$\gamma_\pm$ (NaCl) from		$\gamma_\pm$ (KCl) from		
t,°C	m_2(NaCl)	m_3(KCl)	Solution Data	Solubility Data	Solution Data	Solubility Data	Ref.
160	4.87_7	6.81_3	0.634	0.661	0.507	0.527	(10)
169.5	5.04_8	7.31_3	0.582	0.603	0.470	0.485	(10)
170	5.01_4	7.28_3	0.580	0.605	0.469	0.486	(10)
180	5.13_3	7.73_9	0.526	0.554	0.432	0.448	(10)
189.5	5.38_1	8.19_7	0.473	0.499	0.393	0.409	(10)
190	5.28_7	8.23_5	0.472	0.503	0.393	0.409	(10)
200	5.45_9	8.71_8	0.419	0.453	0.354	0.372	(10)
220	5.68_1	9.36_2	0.329	0.374	0.287	0.313	(10)
250	6.00_6	10.31	0.214	0.270	0.198	0.232	(10)
270	6.34_0	10.96	0.151	0.208	0.145	0.183	(10)
280	6.53_7	11.36	0.125	0.180	0.123	0.160	(10)
300	6.84_5	12.07	0.0797	0.133	0.0831	0.121	(10)

AII. Activity Coefficients of KCl in Saturated Aqueous Mixture NaCl+KCl. Only KCl is present as Solid Phase

			$\gamma_\pm$ from		
t,°C	m_2(NaCl)	m_3(KCl)	Solution Data	Solubility Data	Ref.
20	1.72_1	3.57_1	0.613	0.620	(9)
20	3.45_5	2.68_8	0.659	0.663	(9)
20	4.30_5	2.34_1	0.688	0.683	(9)
20	1.73_3	3.56_8	0.614	0.620	(11)
20	3.52_7	2.63_5	0.661	0.669	(11)
20	5.19_5	2.00_1	0.723	0.710	(11)
40	1.74_8	4.27_7	0.654	0.659	(9)
40	3.48_6	3.31_8	0.701	0.704	(9)
40	1.82_7	4.21_4	0.656	0.663	(11)
40	3.59_2	3.27_7	0.704	0.705	(11)
40	5.23_6	2.44_5	0.757	0.772	(11)
60	1.73_7	4.96_1	0.671	0.677	(9)
60	3.46_9	3.98_0	0.713	0.717	(9)
80	1.77_1	5.63_9	0.668	0.672	(9)
80	3.49_4	4.64_6	0.703	0.706	(9)
100	1.74_4	6.31_9	0.647	0.651	(9)
100	3.47_8	5.34_5	0.672	0.676	(9)
100	1.71_7	6.43_8	0.647	0.641	(10)
100	2.56_7	5.90_1	0.659	0.657	(10)
100	3.42_2	5.36_5	0.671	0.677	(10)
100	4.27_8	4.82_8	0.683	0.700	(10)
120	1.73_7	7.04_2	0.611	0.611	(9)
120	3.46_9	6.06_7	0.627	0.632	(9)
140	1.77_7	7.77_4	0.565	0.560	(9)
140	3.47_3	6.82_0	0.572	0.576	(9)

AII. (continued)

			$\gamma_\pm$ from		
t,°C	m_2(NaCl)	m_3(KCl)	Solution Data	Solubility Data	Ref.
150	1.71_1	8.12_8	0.539	0.535	(9)
150	2.56_7	7.64_5	0.541	0.541	(10)
150	3.42_2	7.14_9	0.542	0.550	(10)
150	4.27_8	6.70_6	0.542	0.557	(10)
169.5	1.78_2	8.78_7	0.483	0.478	(9)
169.5	3.51_5	7.97_7	0.479	0.481	(9)
169.5	4.53_7	7.52_4	0.473	0.484	(9)
189.6	1.76_8	9.60_5	0.421	0.413	(9)
189.6	3.46_1	8.85_1	0.425	0.414	(9)
189.6	4.40_5	8.45_0	0.404	0.414	(9)
200	1.71_1	9.96_5	0.389	0.383	(10)
200	2.56_7	9.49_6	0.385	0.386	(10)
200	3.42_2	9.14_7	0.379	0.385	(10)
200	4.27_8	8.86_5	0.371	0.383	(10)

AIII. Activity Coefficients of NaCl in Saturated Aqueous Mixture NaCl+KCl. Only NaCl is present as Solid Phase

t,°C	m_2(NaCl)	m_3(KCl)	$\gamma_\pm$ from		Ref.
			Solution Data	Solubility Data	
20	5.50_8	1.33_0	1.013	0.995	(9)
20	5.19_8	1.98_0	1.019	1.000	(11)
20	5.81_6	0.659_0	1.004	0.995	(9)
20	5.54_4	1.30_1	1.015	0.991	(11)
40	5.40_9	1.73_3	1.039	1.025	(9)
40	5.12_0	2.56_6	1.059	1.016	(11)
40	5.80_1	0.870_0	1.030	1.024	(9)
40	5.57_7	1.40_7	1.038	1.021	(11)
60	5.33_8	2.16_8	1.025	1.016	(9)
60	5.82_3	1.08_9	1.017	1.014	(9)
80	5.20_3	2.87_1	0.983	0.978	(9)
80	5.82_8	1.43_3	0.977	0.974	(9)
100	4.94_0	4.08_6	0.920	0.917	(9)
100	5.74_9	2.04_6	0.916	0.914	(10)
100	4.79_1	4.02_4	0.909	0.942	(9)
120	5.34_6	3.68_0	0.839	0.837	(9)
120	6.05_5	1.90_2	0.842	0.838	(9)
140	5.47_2	4.17_1	0.760	0.753	(9)
140	6.26_6	2.03_1	0.696	0.706	(9)
150	5.18_5	5.36_5	0.696	0.706	(10)
150	5.69_8	4.02_4	0.707	0.701	(10)
169.5	5.55_6	5.42_1	0.605	0.610	(9)
169.5	6.24_4	3.29_1	0.624	0.618	(9)
169.5	6.78_5	1.78_0	0.633	0.625	(9)

AIII. (continued)

t,°C	m_2(NaCl)	m_3(KCl)	$\gamma_\pm$ from Solution Data	$\gamma_\pm$ from Solubility Data	Ref.
189.6	5.77_6	6.16_6	0.505	0.513	(9)
189.6	6.31_6	4.12_9	0.528	0.525	(9)
189.6	6.98_7	2.07_1	0.544	0.536	(9)
200	5.51_0	8.04_7	0.432	0.462	(10)
200	5.81_8	6.70_6	0.452	0.467	(10)
200	6.22_9	5.36_5	0.469	0.469	(10)
200	6.65_6	4.02_4	0.483	0.473	(10)

AIV. Activity Coefficients of NaCl in Saturated Aqueous Mixture NaCl+CsCl. Only NaCl is present as Solid Phase; all solubilities are from ref. 13

t,°C	m_2(NaCl)	m_3(CsCl)	$\gamma_\pm$ from Solution Data	$\gamma_\pm$ from Solubility Data
25	5.32_8	0.705_9	0.926	1.093
25	5.19_8	3.00_9	0.985	0.949
25	4.61_5	5.40_7	1.000	0.911
25	4.47_3	5.49_9	0.983	0.928
50	5.95_4	0.684_9	0.999	1.022
50	5.83_2	1.17_1	0.995	1.005
50	5.25_2	2.75_7	0.963	0.991
50	4.64_7	5.09_8	0.944	0.955
50	3.98_9	7.61_4	0.916	0.944
75	6.03_0	1.06_3	0.954	0.974
75	5.53_6	1.63_3	0.914	1.012
75	4.83_0	2.54_9	0.861	1.067
75	4.49_8	4.23_8	0.846	1.017
75	4.26_3	6.20_7	0.833	0.954
76	3.53_9	9.89_5	0.762	0.924

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