Evaluated Activity and Osmotic Coefficients for Aqueous Solutions: Thirty-Six Uni-Bivalent Electrolytes

R. N. Goldberg

National Measurement Laboratory, National Bureau of Standards, Washington, D. C. 20234

A critical evaluation of the mean activity and osmotic coefficients in aqueous solutions of thirty-six uni-bivalent electrolytes at 298.15 K is presented. The systems which have been treated are ammonium orthophosphate, guanadinium carbonate, 1,2-ethane disulfonic acid, *m*-benzene disulfonic acid, ammonium decahydroborate, and the uni-bivalent compounds of lithium, sodium, potassium, rubidium, and cesium. Osmotic coefficients were calculated from direct vapor pressure measurements, from isopiestic measurements and from freezing-point depression measurements. Activity coefficients were calculated from electromotive force measurements on galvanic cells without transference and from diffusion measurements. Given are empirical coefficients for three different correlating equations, obtained by a weighted least squares fit to the experimental data, and tables consisting of the activity coefficients of the compounds, the osmotic coefficients and activity of water, and the excess Gibbs energy of the solution as functions of the molality for each electrolyte system. The literature coverage is through the computerized version of Chemical Abstracts of September 1979.

Key words: Activity coefficient; cesium; critical evaluation; electrolyte; excess Gibbs energy; lithium; osmotic coefficient; potassium; rubidium; sodium; solutions; thermodynamic properties.

Contents

0047-2689/81/030671-94/$7.00

1. Introduction

This paper is a continuation of research at the National Bureau of Standards on the systematic evaluation of activity and osmotic coefficients of aqueous electrolyte solutions. Previous evaluations have been performed for the uni-univalent electrolytes [1],[1] calcium chloride [2], the alkaline earth metal halides [3], sulfuric acid [4], and the bi-univalent electrolytes, which include compounds of iron, nickel and cobalt [5], lead, copper, manganese, and uranium [6], and zinc and cadmium [7]. The evaluation procedures have been described [2,3,8] in substantial detail and a bibliography [9] giving the results of a search of the scientific literature for relevant sources of experimental data has been published.

We present our evaluations in detail so that any potential users of the data, as well as future data evaluators, can have a better view of the status of the measurements on these systems. We also give coefficients, obtained by a weighted least-squares fit of the experimental data, for three different correlating equations and tables consisting of the mean activity coefficients of the electrolyte, the osmotic coefficient and activity of water, and the excess Gibbs energy of the solution as functions of the molality for each electrolyte system at 298.15 K. The literature coverage is through the computerized version of Chemical Abstracts of September 1979 accompanied by a search of several journals most likely to contain relevant data.

The reader is referred to the glossary of symbols at the end of this paper for the definitions of the various symbols used throughout the paper. In general, we have attempted to adhere to the recommendations of the IUPAC [10] with regard to nomenclature and units.

2. Evaluated Activity and Osmotic Coefficients

2.1. Presentation of Data

We have arranged the presentation of data according to compound. For each compound that has been evaluated we present:

1. The recommended values of the activity and osmotic coefficients, the activity of water, and the excess Gibbs energy per kilogram of solvent at selected molalities, which extend up to the highest molality for which data of non-zero weight exist, including, where possible, values at saturation. The latter molalities, indicated by (sat) in the tables, unless indicated otherwise, were calculated from the data given in the compilation of Linke and Seidell [11] and were also verified by checking one or more of the reference cited by Linke and Seidell. Estimates of the standard deviations of the calculated values of the osmotic coefficient [$\sigma(\phi)$], the activity coefficient [$\sigma(\gamma)$], and the natural logarithm of the activity coefficient [$\sigma(\ln\gamma)$], all at selected molalities, are given at the bottom of each table.

[1]Figures in brackets indicate literature references.

2. The coefficients, standard deviations of the coefficients [σ(coeff)], and standard deviations for observations of unit weights [σ(eqs n)] for as many as three different correlating equations. The correlating equations we have used are:

$$\ln\gamma = -\frac{A_1 I^{1/2}}{1+BI^{1/2}} + Cm + Dm^2 + Em^3 + \ldots, \quad (1a)$$

$$\ln\gamma = -A_1 I^{1/2} - A_2 I \ln I + \sum_{i=1}^{N} B_i m^{(i+1)/2} \quad (2a)$$

$$\ln\gamma = A_1 I^{1/2} + \sum_{i=1}^{N} B_i m^{(i+1)/2} \quad (3a)$$

The corresponding equations for the osmotic coefficient become:

$$\phi = 1 + \frac{A_1}{B^3 I} \times \{-(1+BI^{1/2}) + 2\ln(1+BI^{1/2}) + 1/(1+BI^{1/2})\} + 1/2\,Cm + 2/3\,Dm^2 + 3/4\,Em^3 + \ldots, \quad (1b)$$

$$\phi = 1 - \frac{A_1}{3} I^{1/2} - \frac{A_2}{2} I\,[\ln I + 1/2] + \sum_{i=1}^{N} B_i \frac{(i+1)}{(i+3)} m^{(i+1)/2} \quad (2b)$$

and

$$\phi = 1 - \frac{A_1}{3} I^{1/2} + \sum_{i=1}^{N} B_i \frac{(i+1)}{(i+3)} m^{(i+1)/2}. \quad (3b)$$

For 1–2 electrolytes in water at 25 °C, $A_1 = 2A$ and $A_2 = \frac{2}{3}A^2$, where A is the constant in the Debye-Hückel equation and is equal to 0.51084 $\log_e 10$ $\text{kg}^{1/2}\cdot\text{mol}^{-1/2}$ at 25 °C. Using this value of A and ten significant figures, $A_1 = 2.352505138\ \text{mol}^{-1/2}\cdot\text{kg}^{1/2}$ and $A_2 = 0.9223800706\ \text{mol}^{-1}\cdot\text{kg}$. The user should note that in our tables, where we have given the coefficients of these correlating equations for the various systems that have been evaluated, we have used a shorthand notation to designate the various parameters, i.e., parameter 1 corresponds to either B in eqs 1, or B_1 in eqs 2 or 3, parameter 2 corresponds to either C in eqs 1 or B_2 in eqs 2 or 3, parameter 3 corresponds to either D in eqs 1 or B_3 in eqs 2 or 3, etc. Also, powers of ten are implied in the representation of a number, e.g., .499–02 is $.499\times10^{-2}$. We have retained ten digits for the coefficients in order to avoid a loss of potentially useful information which might be of value for some applications in which the derivative of the activity coefficient with respect to the molality is of interest. The digits in excess of those required to ensure a precision of 0.001 or better in the calculation of ϕ or $\ln\gamma$ have not been underlined. Unless indicated otherwise, eqs (1a) and (1b) were used to produce the activity and osmotic coefficients given in the tables of recommended values.

3. The calculated values of ϕ and/or γ/γ_{ref} obtained from the experimental measurements reported by the various authors and the weights assigned to the various data sets. It should be noted that, in most cases, these are not original data, but rather the result of an intermediate calculation. Individual data points designated by an asterisk (*) were given zero weight.
and

4. A deviation plot of $\Delta\phi$ and/or $\Delta\gamma$ as a function of the molality. In these plots the symbol Δ means "observed mi-

nus calculated" values.

The excess Gibbs energy ΔG^{ex}, is given by

$$\Delta G^{ex} = G_{real} - G_{ideal} = \nu mRT(1 - \phi + \ln \gamma).$$

2.2. Criteria for Choice of Number of Coefficients

The items the author has examined in deciding upon the number of coefficients to be used in a given correlating equation have been the following: (1) the standard deviations of the fit for observations of unit weight, (2) the statistical F ratio, (3) the ratio of the coefficients to their standard deviations, and (4) the individual deviations of the data points and the general smoothness of the fit. Typically, as the number of coefficients is increased, the standard deviations for observations of unit weight decrease rapidly and then settle down to some fairly constant value. The number of coefficients selected is most commonly that which first gives this approximately constant value and it has generally been found to be consistent with an F ratio of approximately two and a ratio of an individual coefficient to its standard deviation being greater than two. Subjective judgment has also been exercised in deciding upon the number of coefficients to be used. For data sets containing large numbers of observations, the numerical values of the tabulated properties have been found to be quite insensitive to the choice of the number of coefficients.

2.3. Evaluated Systems

$(NH_4)_2HPO_4$

Recommended Values for the mean activity and osmotic coefficient of ammonium orthophosphate, $(NH_4)_2HPO_4$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8823	.9588	.999948	-1.
.002	.8394	.9428	.999898	-2.
.003	.8085	.9309	.999849	-3.
.004	.7838	.9211	.999801	-5.
.005	.7629	.9126	.999753	-7.
.006	.7447	.9051	.999707	-9.
.007	.7285	.8983	.999660	-11.
.008	.7139	.8920	.999614	-14.
.009	.7006	.8863	.999569	-16.
.010	.6884	.8809	.999524	-19.
.020	.6002	.8400	.999092	-52.
.030	.5435	.8114	.998685	-94.
.040	.5018	.7889	.998296	-142.
.050	.4689	.7704	.997920	-196.
.060	.4420	.7545	.997556	-255.
.070	.4192	.7405	.997202	-317.
.080	.3996	.7281	.996857	-384.
.090	.3825	.7169	.996519	-454.
.100	.3673	.7068	.996187	-527.
.200	.2729	.6370	.993138	-1392.
.300	.2241	.5954	.990393	-2435.
.400	.1929	.5664	.987831	-3605.
.500	.1709	.5445	.985394	-4875.
.600	.1544	.5272	.983050	-6228.
.700	.1413	.5130	.980779	-7651.
.800	.1308	.5011	.978567	-9135.
.900	.1220	.4909	.976405	-10674.
1.000	.1145	.4820	.974287	-12263.
1.250	.1000	.4639	.969148	-16422.
1.500	.0893	.4497	.964198	-20811.
1.750	.0810	.4381	.959408	-25396.
2.000	.0744	.4283	.954763	-30149.
2.250	.0689	.4196	.950252	-35053.
2.500	.0643	.4119	.945871	-40093.
2.750	.0603	.4048	.941614	-45255.
3.000	.0569	.3982	.937481	-50531.
3.107	.0555	.3955	.935749	-52822.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0000	.0001	.0001
.010	.0004	.0008	.0006
.100	.0023	.0054	.0020
1.000	.0049	.0169	.0019
2.000	.0055	.0171	.0013
3.107	.0111	.0178	.0010

Coefficients of Correlating Equations

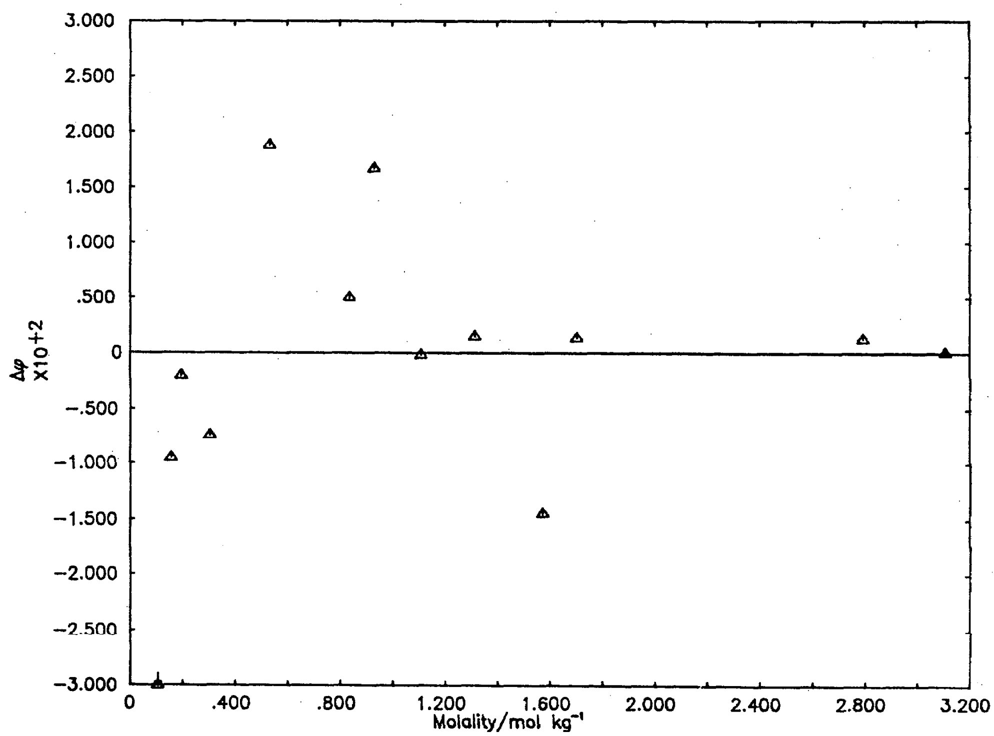
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.5355157884+00	.162-01	-.8700265146+01	.125+01	.3124303465+01	.103+00
2	-.5304261940-01	.159-01	.3562225580+02	.547+01	-.1536588636+01	.129+00
3			-.4243786230+02	.964+01	.3091381117+00	.422-01
4			.2956126034+02	.833+01		
5			-.1065191439+02	.350+01		
6			.1542662741+01	.574+00		

σ(eqs 1) = .145-01
σ(eqs 2) = .105-01
σ(eqs 3) = .125-01

Experimental Data Employed in Generation of Correlating Equations

Platford [12]. Isopiestic measurements, reference salt is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.105800	.6652
.157200	.6521
.195100	.6375
.304400	.5865
.530500	.5576
.834400	.5024
.928500	.5049
1.107400	.4734
1.312200	.4615
1.571600	.4317
1.700500	.4416
2.792000	.4049
3.107000	.3955



Deviation Plot for $(NH_4)_2HPO_4$: $\Delta\phi$ vs molality

▲ Platford [12], isopiestic vs NaCl

$(CN_3H_6)_2CO_3$

Recommended Values for the mean activity and osmotic coefficient of guanadinium carbonate, $(CN_3H_6)_2CO_3$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8837	.9596	.999948	-1.
.002	.8420	.9443	.999898	-2.
.003	.8122	.9331	.999849	-3.
.004	.7885	.9240	.999800	-5.
.005	.7685	.9162	.999752	-7.
.006	.7512	.9093	.999705	-9.
.007	.7359	.9031	.999658	-11.
.008	.7221	.8975	.999612	-13.
.009	.7095	.8923	.999566	-16.
.010	.6980	.8875	.999520	-18.
.020	.6156	.8518	.999080	-50.
.030	.5631	.8276	.998659	-90.
.040	.5246	.8090	.998253	-135.
.050	.4942	.7937	.997857	-185.
.060	.4693	.7807	.997471	-240.
.070	.4482	.7694	.997093	-298.
.080	.4299	.7593	.996723	-359.
.090	.4139	.7501	.996358	-423.
.100	.3996	.7417	.995999	-490.
.200	.3081	.6812	.992664	-1277.
.300	.2577	.6398	.989679	-2222.
.400	.2238	.6071	.986960	-3285.
.500	.1989	.5799	.984452	-4443.
.600	.1796	.5567	.982111	-5683.
.700	.1642	.5367	.979899	-6994.
.800	.1515	.5195	.977787	-8368.
.900	.1410	.5047	.975748	-9798.
1.000	.1320	.4919	.973764	-11280.
1.250	.1146	.4670	.968943	-15180.
1.500	.1020	.4494	.964222	-19319.
1.750	.0924	.4365	.959556	-23656.
2.000	.0848	.4264	.954953	-28165.
2.250	.0786	.4182	.950420	-32824.
2.500	.0734	.4114	.945925	-37618.
2.613	.0713	.4090	.943878	-39825.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0000	.0001	.0001
.010	.0003	.0007	.0005
.100	.0012	.0032	.0013
1.000	.0003	.0032	.0004
2.000	.0004	.0034	.0003
2.613	.0005	.0035	.0002

Coefficients of Correlating Equations

Par	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	-.1392704913+01	.109+00	.5429400011+01	.933-01
2	.1037864836+02	.332+00	-.6897307060+01	.284+00
3	-.5368379733+01	.398+00	.5257637603+01	.340+00
4	.1853256442+01	.214+00	-.2062927876+01	.183+00
5	-.2840721229+00	.429-01	.3230122358+00	.367-01

σ(eqs 2) = .618-03
σ(eqs 3) = .528-03

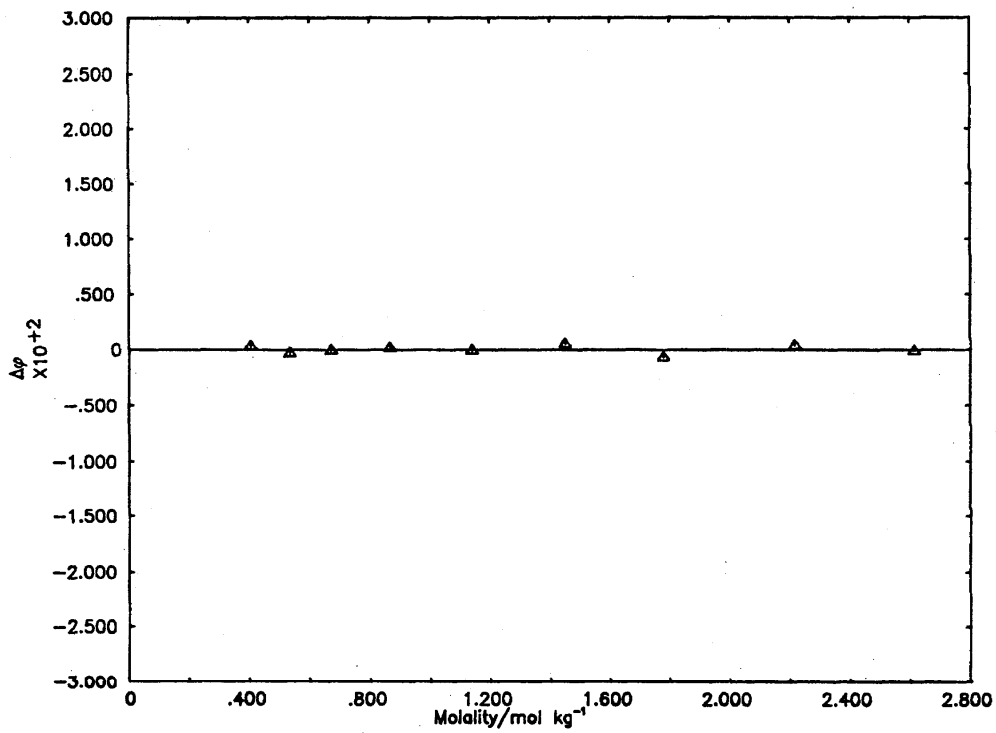
Experimental Data Employed in Generation of Correlating Equations

Bonner [13]. Isopiestic measurements, reference salt is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.404100	.6062
.533700	.5713
.670600	.5422
.865100	.5098
1.139000	.4769
1.450000	.4530
1.777000	.4346
2.215000	.4196
2.613000	.4089

Comments

Eqs 1 could not be used and we have based our table of recommended values on eqs 3.



Deviation Plot for $(CH_3H_6)_2CO_3$: $\Delta\phi$ vs molality

▲ Bonner [13], isopiestic vs NaCl

$C_2H_6S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of 1,2-ethane disulfonic acid, $C_2H_6S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8896	.9629	.999948	-1.
.002	.8528	.9505	.999897	-2.
.003	.8273	.9419	.999847	-3.
.004	.8075	.9353	.999798	-4.
.005	.7911	.9299	.999749	-6.
.006	.7772	.9254	.999700	-8.
.007	.7651	.9214	.999651	-10.
.008	.7543	.9180	.999603	-12.
.009	.7447	.9149	.999555	-14.
.010	.7359	.9122	.999507	-16.
.020	.6761	.8946	.999034	-43.
.030	.6409	.8857	.998566	-74.
.040	.6167	.8808	.998098	-108.
.050	.5986	.8780	.997630	-145.
.060	.5846	.8767	.997161	-184.
.070	.5733	.8763	.996690	-225.
.080	.5641	.8766	.996217	-267.
.090	.5565	.8774	.995741	-310.
.100	.5501	.8787	.995262	-354.
.200	.5210	.9021	.990297	-824.
.300	.5195	.9333	.984982	-1312.
.400	.5296	.9671	.979310	-1793.
.500	.5466	1.0022	.973280	-2254.
.600	.5686	1.0382	.966895	-2689.
.700	.5949	1.0746	.960160	-3093.
.800	.6248	1.1114	.953081	-3461.
.900	.6584	1.1485	.945667	-3791.
1.000	.6955	1.1857	.937926	-4082.
1.250	.8038	1.2790	.917218	-4624.
1.500	.9358	1.3720	.894737	-4889.
1.750	1.0938	1.4637	.870715	-4868.
2.000	1.2806	1.5536	.845413	-4555.
2.250	1.4993	1.6410	.819099	-3948.
2.500	1.7532	1.7255	.792045	-3049.
2.750	2.0455	1.8067	.764510	-1862.
3.000	2.3795	1.8844	.736733	-390.
3.250	2.7585	1.9585	.708927	1359.
3.500	3.1861	2.0289	.681273	3381.
3.750	3.6657	2.0959	.653918	5666.
4.000	4.2016	2.1595	.626970	8208.
4.250	4.7987	2.2203	.600502	11001.
4.500	5.4634	2.2786	.574548	14038.
4.750	6.2040	2.3351	.549110	17314.
5.000	7.0317	2.3904	.524159	20824.
5.250	7.9617	2.4455	.499634	24566.
5.500	9.0150	2.5012	.475454	28538.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0001	.0002	.0002
.010	.0007	.0015	.0011
.100	.0019	.0057	.0031
1.000	.0015	.0067	.0046
2.000	.0017	.0067	.0086
5.000	.0025	.0070	.0489
5.500	.0040	.0081	.0731

Coefficients of Correlating Equations

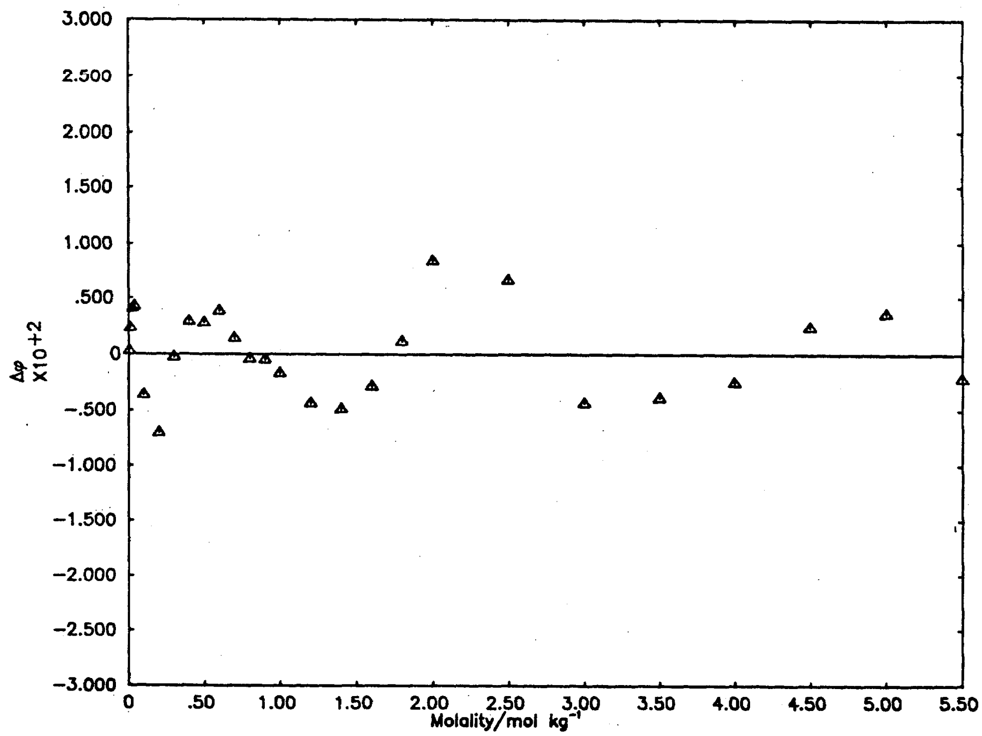
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1751607997+01	.413-01	.2511879952+01	.568-01	.1004119346+02	.225+00
2	.5914063894+00	.228-01	.5513768250+01	.924-01	-.1406516343+02	.727+00
3	.7595113014-01	.129-01	-.1392592493+01	.518-01	.1258667842+02	.968+00
4	-.2201141906-01	.315-02	.1643752563+00	.967-02	-.6369901036+01	.639+00
5	.1626487327-02	.265-03			.1675129050+01	.207+00
6					-.1784308188+00	.261-01

σ(eqs 1) = .420-02
σ(eqs 2) = .657-02
σ(eqs 3) = .560-02

Experimental Data Employed in Generation of Correlating Equations

Bonner, Rushing and Torres [14]. Vapor pressure osmometry and isopiestic measurements. The reference electrolytes were NaCl, up to its limit of solubility in water, and LiCl for the more concentrated solutions [15]. The isopiestic molalities were not reported. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.006400	.9240
.014400	.9050
.025600	.8930
.040000	.8850
.100000	.8750
.200000	.8950
.300000	.9330
.400000	.9700
.500000	1.0050
.600000	1.0420
.700000	1.0760
.800000	1.1110
.900000	1.1480
1.000000	1.1840
1.200000	1.2560
1.400000	1.3300
1.600000	1.4060
1.800000	1.4830
2.000000	1.5620
2.500000	1.7320
3.000000	1.8800
3.500000	2.0250



Deviation Plot for $C_2H_6S_2O_6$: Δ∅ vs molality

▲ Bonner, Rushing and Torres [14], vapor pressure osmometry and isopiestic vs NaCl and LiCl

$C_6H_6S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of m-benzene disulfonic acid, $C_6H_6S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8897	.9629	.999948	-1.
.002	.8530	.9506	.999897	-2.
.003	.8276	.9421	.999847	-3.
.004	.8078	.9356	.999798	-4.
.005	.7916	.9302	.999749	-6.
.006	.7778	.9257	.999700	-8.
.007	.7657	.9219	.999651	-10.
.008	.7550	.9185	.999603	-12.
.009	.7454	.9155	.999555	-14.
.010	.7367	.9128	.999507	-16.
.020	.6777	.8957	.999032	-42.
.030	.6432	.8874	.998562	-73.
.040	.6195	.8830	.998093	-108.
.050	.6020	.8807	.997623	-144.
.060	.5885	.8798	.997151	-183.
.070	.5777	.8799	.996677	-223.
.080	.5689	.8805	.996200	-265.
.090	.5616	.8817	.995720	-307.
.100	.5556	.8832	.995238	-350.
.200	.5287	.9078	.990236	-811.
.300	.5275	.9372	.984918	-1287.
.400	.5361	.9673	.979305	-1758.
.500	.5502	.9973	.973409	-2212.
.600	.5682	1.0274	.967234	-2645.
.700	.5894	1.0577	.960776	-3052.
.800	.6138	1.0885	.954028	-3430.
.900	.6413	1.1200	.946978	-3777.
1.000	.6720	1.1525	.939614	-4090.
1.250	.7640	1.2378	.919779	-4712.
1.500	.8800	1.3278	.897947	-5083.
1.750	1.0200	1.4181	.874485	-5184.
1.800	1.0504	1.4355	.869663	-5171.

m/mol·kg^{-1}	σ(ø)	σ(ℓnγ)	σ(γ)
.001	.0001	.0002	.0002
.010	.0005	.0012	.0009
.100	.0010	.0035	.0019
1.000	.0011	.0037	.0025
1.800	.0029	.0046	.0049

Coefficients of Correlating Equations

Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1746561701+01	.415-01	.4673759881+00	.268+00	.1283462970+02	.592+00
2	.7335009529+00	.553-01	.1553037784+02	.160+01	-.3162708511+02	.453+01
3	-.2756594183+00	.850-01	-.2114873800+02	.384+01	.6149041881+02	.144+02
4	.2025011185+00	.600-01	.1928403355+02	.450+01	-.7993034081+02	.240+02
5	-.4555922673-01	.151-01	-.9135685108+01	.256+01	.6325495649+02	.218+02
6			.1732780589+01	.568+00	-.2719019435+02	.103+02
7					.4844918242+01	.195+01

σ(eqs 1) = .310-02
σ(eqs 2) = .286-02
σ(eqs 3) = .312-02

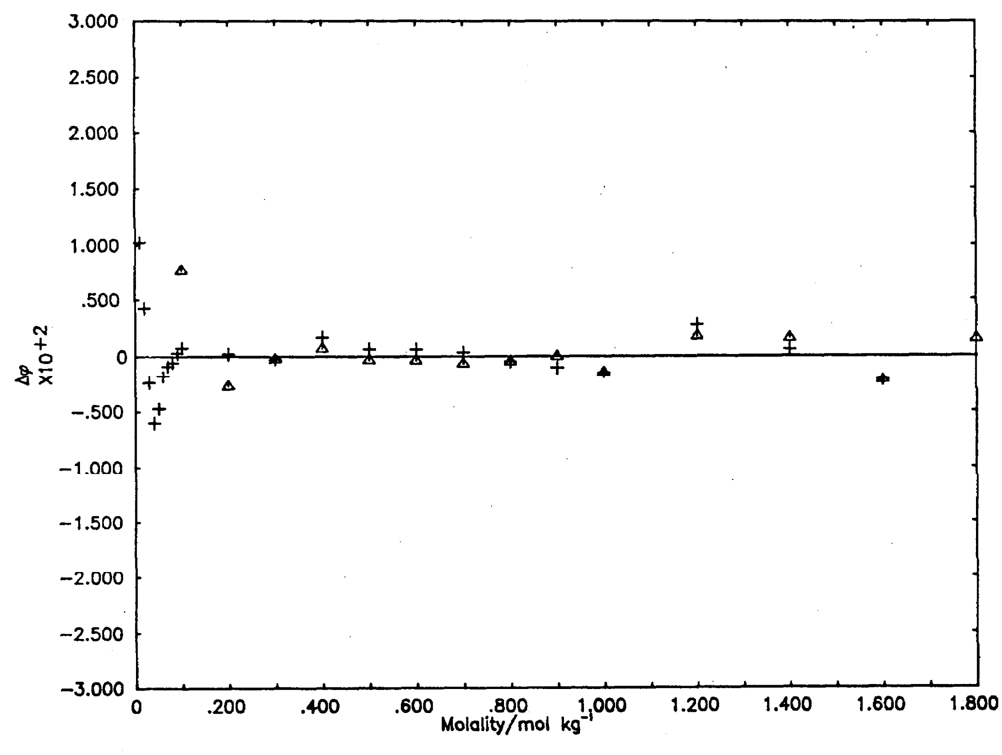
Experimental Data Employed in Generation of Correlating Equations

Bonner, Holland and Smith [16]. Isopiestic measurements, reference electrolyte was NaCl [15]. The isopiestic molalities were not reported. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.100000	.8910
.200000	.9050
.300000	.9370
.400000	.9680
.500000	.9970
.600000	1.0270
.700000	1.0570
.800000	1.0880
.900000	1.1200
1.000000	1.1510
1.200000	1.2220
1.400000	1.2930
1.600000	1.3620
1.800000	1.4370

Bonner and Rogers [17]. Vapor pressure osmometry measurements. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.9230
.020000	.9000
.030000	.8850
.040000	.8770
.050000	.8760
.060000	.8780
.070000	.8790
.080000	.8800
.090000	.8820
.100000	.8840
.200000	.9080
.300000	.9370
.400000	.9690
.500000	.9980
.600000	1.0280
.700000	1.0580
.800000	1.0880
.900000	1.1190
1.000000	1.1510
1.200000	1.2230
1.400000	1.2920
1.600000	1.3620



Deviation Plot for $C_6H_6S_2O_6$: $\Delta\phi$ vs molality

▲ Bonner, Holland and Smith [16], isopiestic vs NaCl

+ Bonner and Rogers [17], vapor pressure osmometry

$(NH_4)_2B_{10}H_{10}$

Recommended Values for the mean activity and osmotic coefficient of ammonium decahydroborate, $(NH_4)_2B_{10}H_{10}$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8867	.9613	.999948	-1.
.002	.8475	.9475	.999898	-2.
.003	.8199	.9376	.999848	-3.
.004	.7982	.9298	.999799	-5.
.005	.7801	.9233	.999751	-6.
.006	.7645	.9176	.999702	-8.
.007	.7508	.9126	.999655	-10.
.008	.7386	.9082	.999607	-13.
.009	.7275	.9041	.999560	-15.
.010	.7174	.9004	.999514	-17.
.020	.6465	.8743	.999055	-46.
.030	.6026	.8582	.998609	-81.
.040	.5711	.8469	.998171	-121.
.050	.5466	.8383	.997737	-164.
.060	.5268	.8315	.997307	-211.
.070	.5103	.8260	.996880	-260.
.080	.4961	.8214	.996455	-311.
.090	.4838	.8175	.996031	-364.
.100	.4730	.8142	.995609	-419.
.200	.4063	.7975	.991417	-1038.
.300	.3720	.7926	.987231	-1743.
.400	.3501	.7917	.983029	-2502.
.500	.3346	.7927	.978807	-3300.
.600	.3228	.7945	.974566	-4128.
.700	.3135	.7967	.970309	-4981.
.800	.3059	.7991	.966038	-5853.
.900	.2995	.8017	.961757	-6742.
1.000	.2941	.8042	.957467	-7645.
1.250	.2834	.8103	.946730	-9956.
1.500	.2755	.8158	.936001	-12328.
1.750	.2691	.8207	.925318	-14747.
2.000	.2639	.8247	.914709	-17206.
2.250	.2595	.8281	.904203	-19699.
2.500	.2555	.8307	.893825	-22222.
2.750	.2519	.8327	.883595	-24772.
3.000	.2486	.8339	.873535	-27348.
3.250	.2455	.8345	.863664	-29947.
3.500	.2424	.8343	.853998	-32570.
3.750	.2395	.8336	.844554	-35216.
3.806	.2389	.8333	.842470	-35812.

m/mol·kg^{-1}	σ(ø)	σ(ℓnγ)	σ(γ)
.001	.0000	.0001	.0001
.010	.0002	.0005	.0004
.100	.0009	.0023	.0011
1.000	.0009	.0040	.0012
2.000	.0012	.0037	.0010
3.806	.0020	.0044	.0011

Coefficients of Correlating Equations

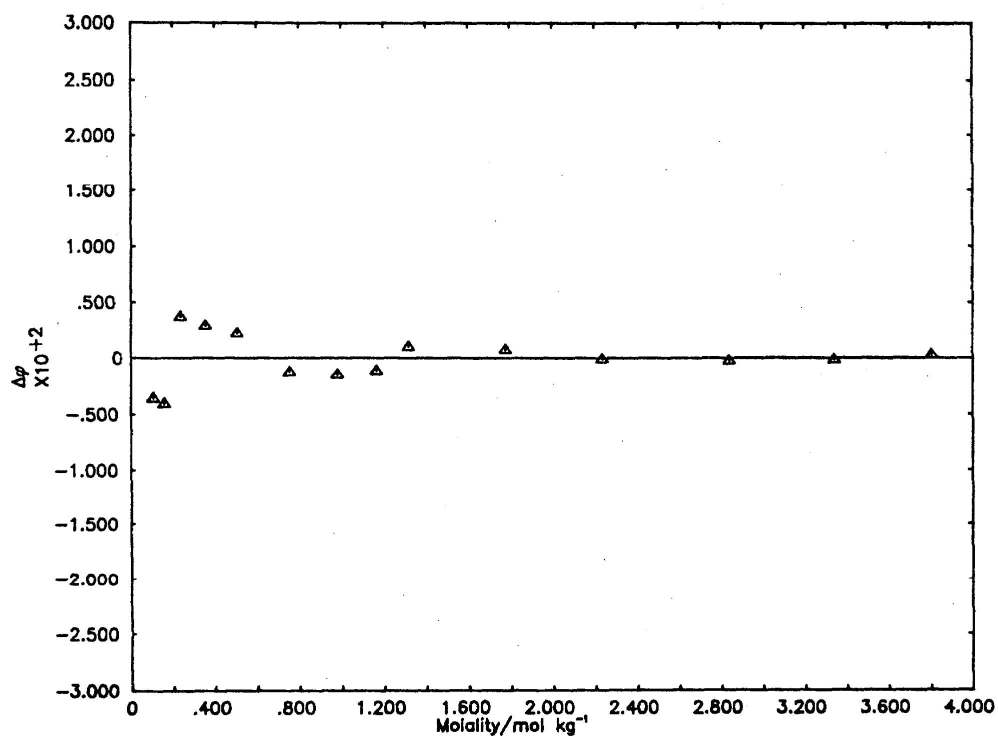
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1302265468+01	.116-01	-.4085401947+01	.608+00	.7615229159+01	.140+00
2	.3390392911-01	.558-02	.3213025606+02	.376+01	-.9817144008+01	.552+00
3	-.6141942770-02	.102-02	-.5828436528+02	.101+02	.8046868483+01	.883+00
4			.7004175239+02	.149+02	-.3937253675+01	.695+00
5			-.5191489846+02	.128+02	.1041220858+01	.267+00
6			.2304409373+02	.644+01	-.1142660489+00	.401-01
7			-.5622411274+01	.175+01		
8			.5800327459+00	.199+00		

σ(eqs 1) = .241-02
σ(eqs 2) = .141-02
σ(eqs 3) = .171-02

Experimental Data Employed in Generation of Correlating Equations

Wen and Chen [18]. Isopiestic measurements, reference salt is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.107000	.8086
.160200	.7977
.237500	.7986
.356000	.7947
.508400	.7950
.754600	.7967
.981600	.8022
1.166000	.8071
1.320000	.8129
1.779000	.8219
2.235000	.8278
2.840000	.8329
3.342000	.8343
3.806000	.8336



Deviation Plot for $(NH_4)_2B_{10}H_{10}$: $\Delta\phi$ vs molality

▲ Wen and Chen [18], isopiestic vs KCl

Li_2SO_4

Recommended Values for the mean activity and osmotic coefficient of lithium sulfate, Li_2SO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8866	.9612	.999948	-1.
.002	.8473	.9473	.999898	-2.
.003	.8196	.9374	.999848	-3.
.004	.7978	.9296	.999799	-5.
.005	.7796	.9230	.999751	-6.
.006	.7639	.9172	.999703	-8.
.007	.7502	.9122	.999655	-10.
.008	.7378	.9077	.999608	-13.
.009	.7267	.9035	.999561	-15.
.010	.7165	.8998	.999514	-17.
.020	.6450	.8731	.999057	-46.
.030	.6006	.8566	.998612	-82.
.040	.5686	.8449	.998175	-122.
.050	.5438	.8358	.997744	-165.
.060	.5236	.8287	.997316	-212.
.070	.5067	.8228	.996892	-262.
.080	.4923	.8178	.996470	-313.
.090	.4797	.8136	.996050	-367.
.100	.4686	.8100	.995632	-422.
.200	.3998	.7903	.991494	-1052.
.300	.3641	.7832	.987381	-1771.
.400	.3411	.7809	.983261	-2548.
.500	.3248	.7809	.979120	-3366.
.600	.3126	.7823	.974951	-4218.
.700	.3031	.7848	.970747	-5094.
.800	.2955	.7880	.966502	-5992.
.900	.2894	.7919	.962212	-6906.
1.000	.2845	.7964	.957870	-7835.
1.250	.2759	.8099	.946757	-10203.
1.500	.2713	.8262	.935211	-12615.
1.750	.2696	.8454	.923151	-15048.
2.000	.2703	.8674	.910502	-17484.
2.250	.2732	.8921	.897191	-19907.
2.500	.2780	.9196	.883154	-22304.
2.750	.2848	.9499	.868332	-24663.
3.000	.2935	.9830	.852672	-26971.
3.140 (sat)	.2993	1.0027	.843520	-28237.
3.165	.3003	1.0064	.841857	-28461.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0000	.0001	.0001
.010	.0003	.0006	.0004
.100	.0010	.0027	.0013
1.000	.0015	.0040	.0011
2.000	.0019	.0042	.0011
3.165	.0034	.0055	.0016

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1289443996+01	.147-01	-.1253521405+00	.171+00	.7757667445+01	.134+00
2	-.3273850848-01	.104-01	.1003195308+02	.593+00	-.1023234522+02	.464+00
3	.3577748322-01	.242-02	-.5886845990+01	.760+00	.7959797142+01	.595+00
4			.2246321829+01	.421+00	-.3197263002+01	.329+00
5			-.3579333626+00	.847-01	.5154963081+00	.663-01

σ(eqs 1) = .793-02
σ(eqs 2) = .103-01
σ(eqs 3) = .807-02

Experimental Data Employed in Generation of Correlating Equations

Appleby et al. [19]. Vapor pressure measurements. These workers report the vapor pressure over the saturated solution. We have assumed that this pertains to a molality of 3.14 mol·kg^{-1}. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
3.140000	.8781

Frolov and Nasanova [20]. Isopiestic measurements. These authors do not report either the reference electrolyte or the isopiestic molalities. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
1.290000	.7206 *
1.612000	.8256
1.968000	.8640

Indelli [21]. Freezing point depression measurements. The Φ_L data for Li_2SO_4 and the Φ_C data for Na_2SO_4 given in the table of auxiliary data were used in treating these measurements. The first nine data points up to a molality of 0.17163 mol·kg^{-1} were given a weight of 0.8, the next eight pts. up to a molality of 0.4884 mol·kg^{-1} were weighted at 0.4, and the remaining data were weighted at zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.007043	.9256
.013120	.8890
.017581	.8703
.032880	.8422
.042710	.8331
.061580	.8154
.092660	.7986
.158410	.7828
.171630	.7805
.212780	.7809
.219340	.7798
.224750	.7817
.277860	.7808
.322250	.7851
.379230	.7904
.440550	.7998
.488400	.8075
.510200	.8131 *
.536800	.8177 *
.582900	.8286 *
.595800	.8303 *
.665700	.8486 *
.708000	.8580 *
.819900	.8911 *
.917200	.9231 *
1.013900	.9585 *

Kangro and Groeneveld [22]. Vapor pressure measurements. Assigned weight is 0.50.

m/mol·kg^{-1}	$\phi_{298.15}$
.500000	.7826
1.000000	.7872
1.500000	.8274
2.000000	.8685
2.500000	.9237
3.000000	.9803

Pearce and Eckstrom [23]. Vapor pressure measurements. Assigned weight is 0.20.

m/mol·kg^{-1}	$\phi_{298.15}$
.100000	.7890
.200000	.7758
.400000	.7706
.600000	.7741
.800000	.7833
1.000000	.7928
1.500000	.8234
2.000000	.8600
2.500000	.8874
3.094400	.9468

Robinson, Wilson and Stokes [24]. Isopiestic measurements, reference salt is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.073100	.8312
.086350	.8237
.117800	.8108
.138100	.8034
.242400	.7874
.273300	.7842
.400600	.7778
.423500	.7767
.572800	.7739
.649700	.7755
.854900	.7809
.947200	.7862
1.034000	.7905
1.259000	.8047
1.409000	.8156
1.475000	.8202
1.676000	.8384
1.799000	.8454
1.841000	.8510
2.052000	.8727
2.194000	.8863
2.282000	.8939
2.382000	.9078
2.504000	.9251
2.572000	.9307
2.612000	.9356
2.786000	.9578
3.037000	.9884
3.080000	.9970
3.158000	1.0058
3.165000	1.0036

Åkerlof [25,25a]. Emf measurements on the cell Hg(l), Hg_2SO_4(s); Li_2SO_4(s); Li_2SO_4(m); Li(Hg)$_x$; Li_2SO_4(m_{ref}); Hg_2SO_4(s), Hg(l). m_{ref} = 0.05 mol·kg^{-1}. Assigned weight is 0.60.

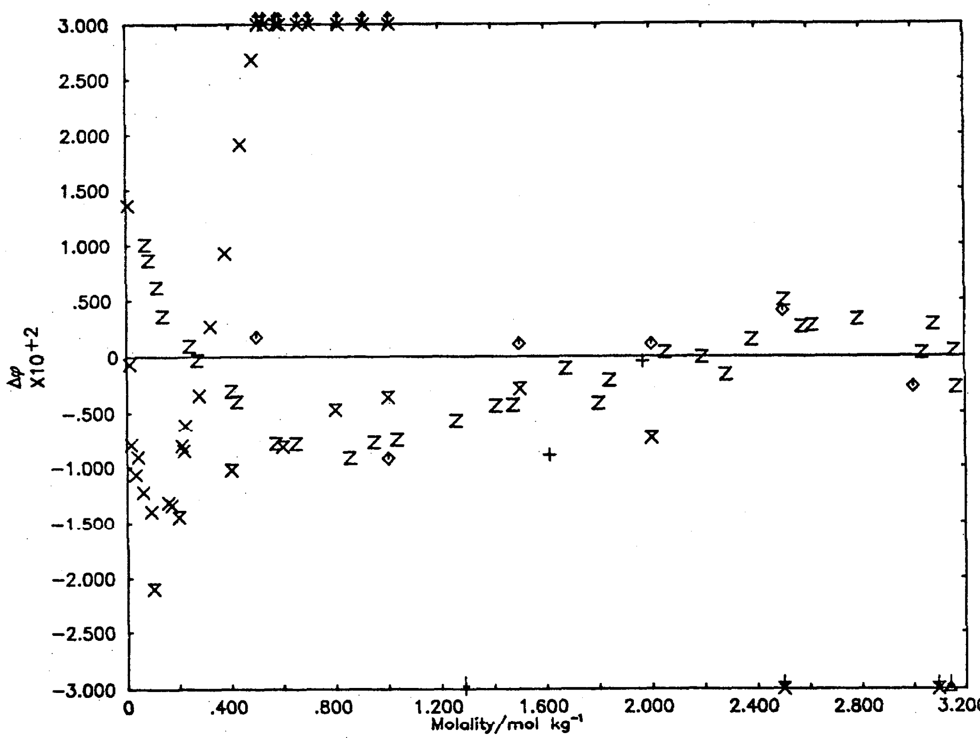
m/mol·kg^{-1}	γ/γ_{ref}
.025000	1.1744
.125000	.8154
.249000	.6996
.495000	.5959
.979000	.5151
1.447000	.5150
1.903000	.5108

Harned [26]. Calculated from the diffusion measurements of Harned and Blake[26a]. Assigned weight is 0.60.

m/mol·kg^{-1}	γ
0.0001	0.961
0.0004	0.925
0.00100	0.887
0.00200	0.848
0.00500	0.779
0.00700	0.749
0.001000	0.747

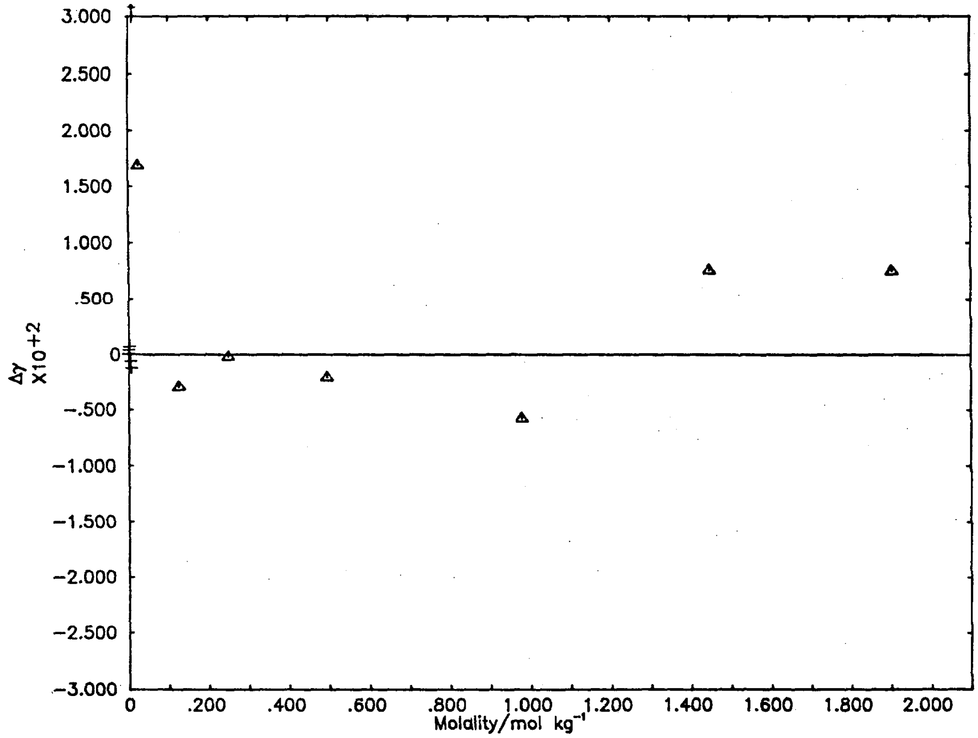
Comments

The most reliable data for this system appear to be those of Robinson, Wilson and Stokes [24]. There is reasonable agreement with the vapor pressure measurements of Kangro and Groeneveld [22] and Pearce and Eckstrom [23]. The final fit is consistent with the emf measurements of Åkerlof [25,25a] and the activity coefficients calculated by Harned [26] from the diffusion measurements of Harned and Blake[26a]. The electrochemical cell measurements of Sircar et al. [84] involve unknown liquid junction potentials and we have chosen not to treat these measurements.



Deviation Plot for Li_2SO_4: Δφ vs molality

- ▲ Appleby et al. [19], vapor pressure
- + Frolov and Nasanova [20], isopiestic vs ?
- X Indelli [21], freezing point depression
- ◇ Kangro and Groeneveld [22], vapor pressure
- X̄ Pearce and Eckstrom [23], vapor pressure
- Z Robinson, Wilson and Stokes [24], isopiestic vs KCl



Deviation Plot for Li_2SO_4: Δγ vs molality

▲ Äkerlof [25,25a], emf measurements

+ Harned [26], calculated from diffusion measurements

$Li_2C_6H_4S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of lithium m-benzene disulfonate, $Li_2C_6H_4S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8896	.9629	.999948	-1.
.002	.8528	.9505	.999897	-2.
.003	.8274	.9420	.999847	-3.
.004	.8076	.9354	.999798	-4.
.005	.7913	.9300	.999749	-6.
.006	.7774	.9254	.999700	-8.
.007	.7652	.9215	.999651	-10.
.008	.7545	.9181	.999603	-12.
.009	.7448	.9150	.999555	-14.
.010	.7360	.9122	.999507	-16.
.020	.6763	.8946	.999033	-43.
.030	.6410	.8857	.998565	-74.
.040	.6167	.8806	.998098	-108.
.050	.5985	.8777	.997631	-145.
.060	.5843	.8762	.997163	-184.
.070	.5729	.8756	.996693	-225.
.080	.5635	.8757	.996221	-267.
.090	.5557	.8763	.995747	-310.
.100	.5491	.8773	.995270	-355.
.200	.5175	.8976	.990344	-827.
.300	.5126	.9246	.985121	-1323.
.400	.5182	.9532	.979604	-1817.
.500	.5295	.9822	.973806	-2298.
.600	.5448	1.0113	.967738	-2760.
.700	.5630	1.0402	.961411	-3200.
.800	.5835	1.0689	.954838	-3614.
.900	.6062	1.0972	.948028	-4001.
1.000	.6308	1.1253	.940993	-4358.
1.250	.7002	1.1943	.922485	-5119.
1.500	.7805	1.2615	.902789	-5681.
1.750	.8719	1.3269	.882053	-6039.
2.000	.9749	1.3908	.860423	-6190.
2.250	1.0903	1.4530	.838038	-6133.
2.500	1.2191	1.5137	.815032	-5868.

m/mol·kg^{-1}	σ(ø)	σ(ℓnγ)	σ(γ)
.001	.0001	.0001	.0001
.010	.0004	.0010	.0007
.100	.0013	.0037	.0021
1.000	.0014	.0052	.0033
2.000	.0019	.0052	.0051
2.500	.0036	.0066	.0081

Coefficients of Correlating Equations

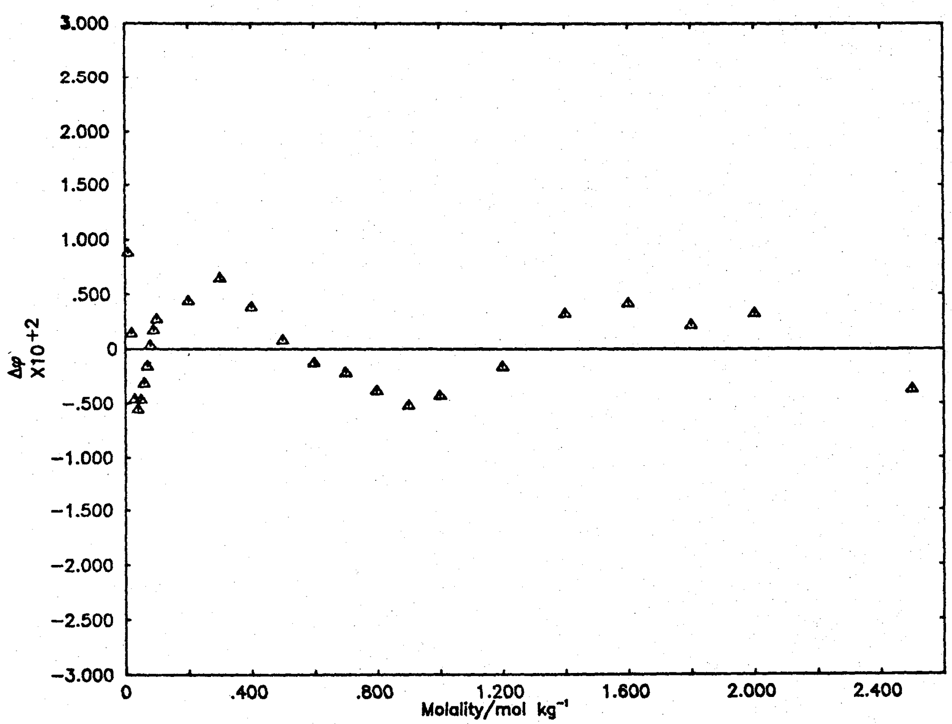
Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1764665339+01	.252-01	.1243912720+01	.179+00	.1036076167+02	.127+00
2	.5589271807+00	.107-01	.9842613994+01	.666+00	-.1485659022+02	.474+00
3	-.1514644621-01	.325-02	-.7267999218+01	.952+00	.1272120492+02	.678+00
4			.3575366613+01	.595+00	-.5603958437+01	.423+00
5			-.7251528512+00	.136+00	.9808056280+00	.965-01
6						
7						

σ(eqs 1) = .415-02
σ(eqs 2) = .492-02
σ(eqs 3) = .350-02

Experimental Data Employed in Generation of Correlating Equations

Bonner and Rogers [17]. Vapor pressure osmometry. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.9210
.020000	.8960
.030000	.8810
.040000	.8750
.050000	.8730
.060000	.8730
.070000	.8740
.080000	.8760
.090000	.8780
.100000	.8800
.200000	.9020
.300000	.9310
.400000	.9570
.500000	.9830
.600000	1.0100
.700000	1.0380
.800000	1.0650
.900000	1.0920
1.000000	1.1210
1.200000	1.1790
1.400000	1.2380
1.600000	1.2920
1.800000	1.3420
2.000000	1.3940
2.500000	1.5100



Deviation Plot for $Li_2C_6H_4S_2O_6$: $\Delta\phi$ vs molality

▲ Bonner and Rogers [17], vapor pressure osmometry

$Li_2C_{14}H_{12}S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of lithium 4,4'-bibenzyl disulfonate, $Li_2C_{14}H_{12}S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	Ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8851	.9604	.999948	-1.
.002	.8447	.9459	.999898	-2.
.003	.8162	.9356	.999848	-3.
.004	.7936	.9273	.999800	-5.
.005	.7748	.9203	.999751	-7.
.006	.7587	.9143	.999704	-8.
.007	.7445	.9090	.999656	-11.
.008	.7318	.9042	.999609	-13.
.009	.7203	.8999	.999562	-15.
.010	.7098	.8960	.999516	-18.
.020	.6370	.8691	.999061	-48.
.030	.5928	.8536	.998617	-84.
.040	.5618	.8434	.998178	-125.
.050	.5382	.8363	.997743	-169.
.060	.5194	.8311	.997309	-217.
.070	.5040	.8272	.996875	-267.
.080	.4909	.8242	.996443	-319.
.090	.4796	.8219	.996010	-373.
.100	.4698	.8200	.995578	-428.
.200	.4083	.8085	.991299	-1047.
.300	.3729	.7975	.987153	-1749.
.400	.3480	.7880	.983108	-2509.
.500	.3306	.7843	.979028	-3314.
.600	.3190	.7880	.974771	-4152.
.700	.3122	.7982	.970254	-5010.
.800	.3085	.8125	.965480	-5881.
.900	.3068	.8280	.960624	-6758.
1.000	.3060	.8429	.955465	-7637.
1.200	.3086	.8772	.944696	-9396.

m/mol·kg^{-1}	σ(Ø)	σ(ℓnγ)	σ(γ)
.001	.0002	.0003	.0003
.010	.0009	.0022	.0016
.100	.0013	.0043	.0020
1.000	.0030	.0056	.0017
1.200	.0035	.0056	.0017

Coefficients of Correlating Equations

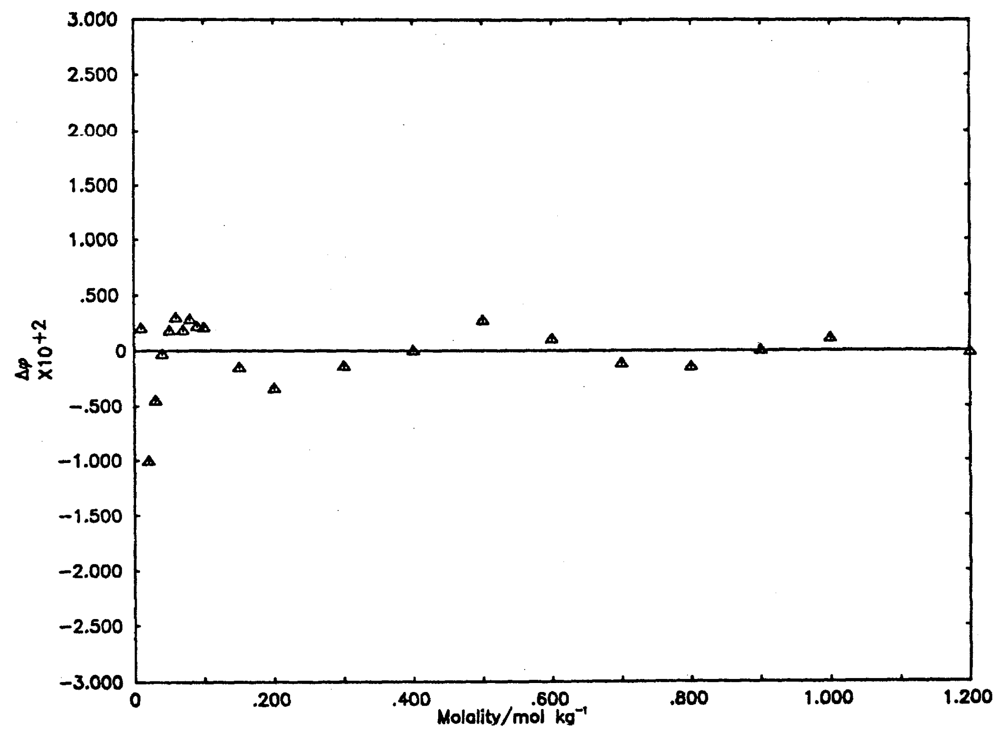
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.6062873166+00	.167+00	-.9743794377+01	.103+01	.3981426985+01	.100+01
2	.2653933419+01	.768+00	.8413526560+02	.974+01	.2392270072+02	.953+01
3	-.6162291259+01	.153+01	-.2478539896+03	.391+02	-.1134580698+03	.383+02
4	.8594957410+01	.227+01	.4244202401+03	.818+02	.2195437130+03	.801+02
5	-.5774371756+01	.175+01	-.4136837003+03	.933+02	-.2244839521+03	.913+02
6	.1491257827+01	.521+00	.2149508590+03	.550+02	.1195646808+03	.538+02
7			-.4629495283+02	.131+02	-.2618843628+02	.128+02

σ(eqs 1) = .354-02
σ(eqs 2) = .283-02
σ(eqs 3) = .277-02

Experimental Data Employed in Generation of Correlating Equations

Bonner and Rogers [17]. Vapor pressure osmometry. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.8980
.020000	.8590
.030000	.8490
.040000	.8430
.050000	.8380
.060000	.8340
.070000	.8290
.080000	.8270
.090000	.8240
.100000	.8220
.150000	.8120
.200000	.8050
.300000	.7960
.400000	.7880
.500000	.7870
.600000	.7890
.700000	.7970
.800000	.8110
.900000	.8280
1.000000	.8440
1.200000	.8770



Deviation Plot for $Li_2C_{14}H_{12}S_2O_6$: $\Delta\phi$ vs molality

▲ Bonner and Rogers [17], vapor pressure osmometry

Na_2SO_3

Recommended Values for the mean activity and osmotic coefficient of sodium sulfite, Na_2SO_3, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8866	.9612	.999948	-1.
.002	.8472	.9473	.999898	-2.
.003	.8195	.9374	.999848	-3.
.004	.7976	.9295	.999799	-5.
.005	.7794	.9228	.999751	-6.
.006	.7637	.9170	.999703	-8.
.007	.7498	.9119	.999655	-10.
.008	.7374	.9073	.999608	-13.
.009	.7262	.9032	.999561	-15.
.010	.7160	.8993	.999514	-17.
.020	.6437	.8720	.999058	-46.
.030	.5986	.8548	.998615	-82.
.040	.5659	.8421	.998181	-122.
.050	.5403	.8322	.997754	-167.
.060	.5195	.8241	.997331	-214.
.070	.5019	.8173	.996913	-264.
.080	.4867	.8114	.996498	-316.
.090	.4734	.8062	.996086	-371.
.100	.4616	.8016	.995677	-427.
.200	.3865	.7719	.991692	-1075.
.300	.3451	.7547	.987839	-1826.
.400	.3171	.7423	.984080	-2650.
.500	.2962	.7326	.980397	-3531.
.600	.2796	.7247	.976772	-4458.
.700	.2662	.7182	.973193	-5424.
.800	.2549	.7129	.969647	-6425.
.900	.2453	.7086	.966121	-7456.
1.000	.2370	.7052	.962603	-8514.
1.250	.2208	.7008	.953756	-11260.
1.500	.2093	.7019	.944685	-14120.
1.750	.2013	.7084	.935198	-17066.
2.000	.1960	.7201	.925114	-20072.
2.058	.1952	.7236	.922670	-20776.

m/mol·kg^{-1}	σ(ø)	σ(ℓnγ)	σ(γ)
.001	.0001	.0002	.0002
.010	.0006	.0014	.0010
.100	.0022	.0061	.0028
1.000	.0013	.0080	.0019
2.000	.0023	.0086	.0017
2.058	.0026	.0088	.0017

Coefficients of Correlating Equations

Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1324160140+01	.338-01	-.8272898114+00	.442+00	.6548451340+01	.165+00
2	-.2692000688+00	.209-01	.1199522443+02	.157+01	-.6876457712+01	.405+00
3	.6673197958-01	.603-02	-.8769479033+01	.217+01	.3681116677+01	.351+00
4			.4102318694+01	.135+01	-.7558470088+00	.102+00
5			-.7894801944+00	.312+00		

σ(eqs 1) = .344-02
σ(eqs 2) = .353-02
σ(eqs 3) = .384-02

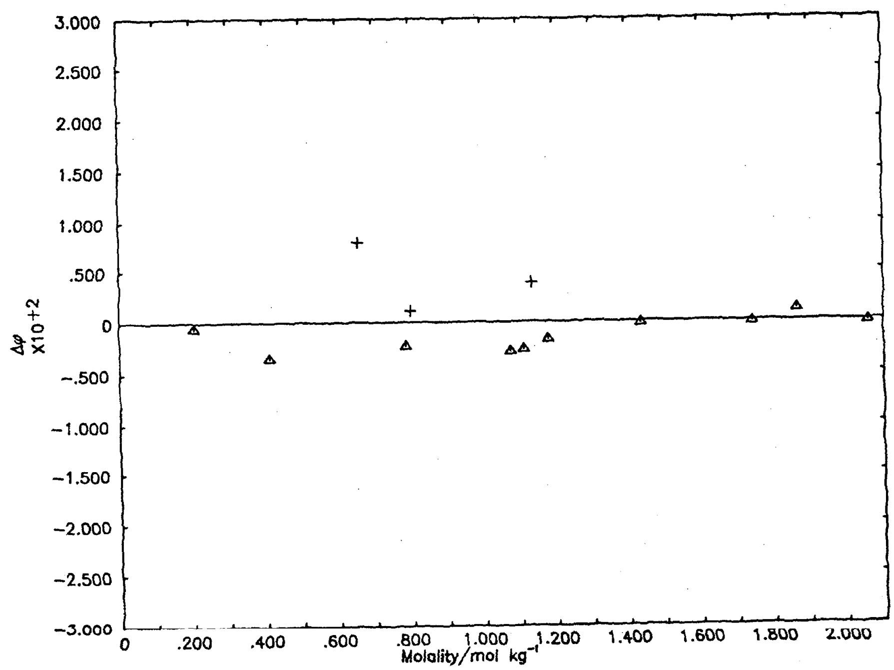
Experimental Data Employed in Generation of Correlating Equations

Morgan [29]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.207100	.7698
.409500	.7378
.784400	.7113
1.073000	.7005
1.110000	.6999
1.178000	.6998
1.436000	.7009
1.742000	.7079
1.865000	.7142
2.058000	.7234

Lantzke et al. [30]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.655600	.7290
.799800	.7140
1.134300	.7060



Deviation Plot for Na_2SO_3: $\Delta\phi$ vs molality

+ Lantzke et al. [29], isopiestic vs NaCl

Δ *Morgan* [30], isopiestic vs NaCl

Na_2SO_4

Recommended Values for the mean activity and osmotic coefficient of Na_2SO_4 in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8859	.9608	.999948	-1.
.002	.8460	.9466	.999898	-2.
.003	.8178	.9364	.999848	-3.
.004	.7955	.9282	.999799	-5.
.005	.7768	.9212	.999751	-6.
.006	.7607	.9152	.999703	-8.
.007	.7465	.9099	.999656	-11.
.008	.7338	.9050	.999609	-13.
.009	.7223	.9006	.999562	-15.
.010	.7117	.8965	.999516	-18.
.020	.6369	.8672	.999063	-47.
.030	.5900	.8482	.998626	-84.
.040	.5557	.8341	.998198	-125.
.050	.5289	.8229	.997779	-171.
.060	.5069	.8136	.997365	-220.
.070	.4883	.8056	.996957	-272.
.080	.4723	.7986	.996553	-327.
.090	.4582	.7924	.996153	-383.
.100	.4457	.7869	.995756	-443.
.200	.3656	.7494	.991932	-1124.
.300	.3212	.7262	.988294	-1923.
.400	.2910	.7088	.984794	-2806.
.500	.2684	.6945	.981407	-3755.
.600	.2506	.6824	.978113	-4759.
.700	.2359	.6720	.974897	-5811.
.800	.2236	.6629	.971745	-6905.
.900	.2131	.6550	.968643	-8037.
1.000	.2040	.6481	.965579	-9204.
1.250	.1859	.6351	.958004	-12248.
1.500	.1725	.6273	.950415	-15449.
1.750	.1623	.6243	.942659	-18775.
1.957 (sat)	.1558	.6252	.936013	-21607.
2.000	.1546	.6257	.934600	-22203.
2.250	.1488	.6311	.926127	-25711.
2.500	.1444	.6401	.917144	-29282.
2.750	.1414	.6525	.907581	-32901.
3.000	.1394	.6678	.897385	-36552.
3.250	.1383	.6857	.886523	-40224.
3.500	.1380	.7060	.874984	-43905.
3.750	.1383	.7283	.862774	-47586.
4.000	.1393	.7522	.849919	-51258.
4.250	.1409	.7774	.836460	-54913.
4.445	.1424	.7978	.825580	-57747.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0000	.0001	.0000
.010	.0002	.0004	.0003
.100	.0006	.0017	.0008
1.000	.0010	.0022	.0004
2.000	.0010	.0023	.0003
4.445	.0054	.0062	.0009

Coefficients of Correlating Equations

Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1215973148+01	.105-01	-.1249022044+01	.120+00	.6573833280+01	.541-01
2	-.3557285519+00	.110-01	.1281837942+02	.497+00	-.7807147467+01	.160+00
3	.8294655619-01	.472-02	-.1021050890+02	.802+00	.5240992270+01	.177+00
4	-.4869541257-02	.674-03	.5759847483+01	.624+00	-.1786182357+01	.850-01
5			-.1770883964+01	.235+00	.2440743105+00	.149-01
6			.2231409674+00	.342-01		

σ(eqs 1) = .816-02 σ(eqs 2) = .909-02 σ(eqs 3) = .826-02

Experimental Data Employed in Generation of Correlating Equations

Archibald [31]. Freezing point depression measurements. The Φ_L and Φ_C data for Na_2SO_4 given in the table of auxiliary data were used in treating these and the other freezing point depression measurements on Na_2SO_4. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.025000	.8497
.027500	.8458
.030000	.8420
.035000	.8352
.050020	.8166
.100080	.7774
.125140	.7636
.150200	.7531
.175270	.7416
.200330	.7372
.225430	.7283
.250520	.7246
.300780	.7121
.351100	.7051

Burge [32]. Vapor pressure osmometry measurements performed at 37°C. The Φ_L and Φ_C data for Na_2SO_4 given in the table of auxiliary data were used to adjust these measurements to 25°C. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.8790
.020000	.8430
.050000	.8090
.100000	.7790
.200000	.7380
.300000	.7100
.400000	.6910

Childs and Platford [33]. Isopiestic measurements performed at 15°C, reference electrolytes were urea and H_2SO_4. These workers did not report the measured isopiestic molalities. The Φ_L and Φ_C data for Na_2SO_4 given in the table of auxiliary data were used to adjust these measurements to 25°C. Assigned weight is 0.30.

m/mol·kg^{-1}	$\phi_{298.15}$
.100000	.7910
.200000	.7520
.300000	.7250
.400000	.7050
.500000	.6890
.600000	.6780
.700000	.6660
.800000	.6580
.900000	.6500
1.000000	.6450
1.500000	.6300
2.000000	.6370
2.500000	.6600
3.000000	.6870

de Coppet [34]. Freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.140000	.7742
.280000	.7898
.350000	.7595
.430000	.7478
.710000	.7610
.860000	.7259
1.060000	.7314
1.410000	.7300

Downes and Pitzer [35]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.216700	.7478
.255600	.7372
.318500	.7235
.556700	.6846
.649900	.6727
.661000	.6725
.732000	.6646
.821400	.6564
.977700	.6461
1.196800	.6331

Foote et al. [36]. Vapor pressure measurement over the saturated solution. Asigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
1.971000	1.2411

Frolov and Nasanova [20]. Isopiestic measurements. These workers did not state the reference electrolyte used. Assigned weight is 0.30.

m/mol·kg^{-1}	$\phi_{298.15}$
1.113000	.6268
1.998000	.6264
2.906000	.6701

Gibson and Adams [37]. Vapor pressure measurements performed at 27.5°C. The Φ_L and Φ_C data for Na_2SO_4 given in the table of auxiliary data were used to adjust these measurements to 25°C. Assigned weight is 0.80.

m/mol·kg^{-1}	$\phi_{298.15}$
.960000	.6490
1.338000	.6320
1.544400	.6250
1.759000	.6240
1.984600	.6260
2.222000	.6340

Harkins and Roberts [38]. Freezing point depression measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.002367	.9095
.005175	.8825
.011100	.8563
.024630	.8172
.050020	.7767
.099800	.7303

Indelli [21]. Freezing point depression measurements. Assigned weight is 0.50 expect for one point at the highest molality investigated.

m/mol•kg^{-1}	$\phi_{298.15}$
.006678	.9139
.012612	.8862
.018072	.8680
.019288	.8618
.022833	.8567
.027169	.8485
.035862	.8363
.037395	.8306
.043520	.8240
.054240	.8119
.059370	.8079
.063650	.8048
.073020	.7969
.088970	.7884
.090470	.7854
.099580	.7811
.118750	.7700
.123700	.7678
.160470	.7527
.222090	.7259*

Jackli et al. [39]. Vapor pressure measurements performed at 37°C. The Φ_L and Φ_C data for Na_2SO_4 given in the table of auxiliary data were used to adjust these measurements to 25°C. Assigned weight is zero.

m/mol•kg^{-1}	$\phi_{298.15}$
2.000000	.5790
3.457000	.7760

Jones et al. [40]. Freezing point depression measurement. Assigned weight is zero.

m/mol•kg^{-1}	$\phi_{298.15}$
.500000	.7065

Kangro and Groeneveld[22]. Vapor pressure measurements. Assigned weight is 0.50.

m/mol•kg^{-1}	$\phi_{298.15}$
.500000	.7032
1.000000	.6485
1.500000	.6283
2.000000	.6275
2.500000	.6421
3.000000	.6678

Klein and Svanberg [41]. Freezing point depression measurements. Assigned weight is zero.

m/mol•kg^{-1}	$\phi_{298.15}$
.100000	.8444
.250000	.7760
.500000	.7159

Kopecky and Dymes [42]. Vapor pressure osmometry measurements. Assigned weight is 0.20 for the lowest two molalities and zero for the highest two.

m/mol•kg^{-1}	$\phi_{298.15}$
.040000	.8300
.100000	.7860
.150000	.7490*
.200000	.7150*

Leopold and Johnston [43]. Vapor pressure measurements over the saturated solution. Assigned weight is zero.

m/mol•kg^{-1}	$\phi_{298.15}$
1.953000	1.4361

Loomis [44,45]. Freezing point depression measurements. Assigned weight is 0.50.

m/mol•kg^{-1}	$\phi_{298.15}$
.010000	.9081
.020000	.8687
.050000	.8211
.100000	.7802
.200000	.7426
.300000	.7177

Pearce and Eckstrom [23]. Vapor pressure measurements. Assigned weight is 0.50.

m/mol•kg^{-1}	$\phi_{298.15}$
.100000	.7816*
.200000	.7244*
.400000	.7052
.600000	.6900
.800000	.6727
1.000000	.6548
1.500000	.6331
1.964100	.6298

Perreu [46]. Vapor pressure measurements performed at 20°C. The Φ_L and Φ_C data for Na_2SO_4 given in the table of auxiliary data were used to adjust these measurements to 25°C. Assigned weight is zero.

m/mol•kg^{-1}	$\phi_{298.15}$
.326900	.6530
.599500	.6850
.891500	.6460
.975300	.6710
1.097000	.6720
1.199000	.6580
1.256700	.6630
1.368300	.6600

Platford [47]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol•kg^{-1}	$\phi_{298.15}$
.115600	.7840
.162600	.7620
.210200	.7460
.275300	.7328
.282600	.7334
.344600	.7184
.477000	.6956
.710000	.6679
1.035600	.6416
1.221000	.6339
1.710500	.6231
1.853600	.6243
1.950300	.6244
1.990500	.6248
2.207500	.6307
2.625600	.6455
2.758800	.6534
2.947200	.6648
3.316300	.6900
3.510900	.7057
3.640000	.7214
3.814000	.7348

Randall and Scott [48]. Freezing point depression measurements. Assigned weight is 0.80.

m/mol·kg^{-1}	$\phi_{298.15}$
.000875	.9804*
.001797	.9501
.003527	.9307
.005766	.9166
.008603	.9033
.016155	.8762
.032064	.8436
.060975	.8126
.103380	.7842

Rard and Miller [49]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.627600	.6771
.681750	.6706
.749580	.6638
.814020	.6578
.894270	.6511
.991400	.6451
1.114400	.6378
1.238700	.6320
1.356200	.6280
1.452800	.6249
1.577500	.6231
1.641100	.6233
1.736400	.6223
1.750500	.6254
1.860800	.6254
1.922100	.6234
1.952600	.6254
1.961100	.6255
2.009400	.6262
2.171900	.6290
2.215300	.6306
2.249500	.6313
2.292300	.6327
2.317900	.6341
2.333800	.6344
2.373200	.6346
2.378400	.6356
2.423700	.6377
2.475300	.6394
2.536700	.6421
2.595700	.6449
2.612200	.6459
2.650700	.6473
2.703000	.6503
2.720000	.6512
2.757200	.6534
2.812400	.6562
2.869400	.6601
2.921000	.6633
2.977600	.6670
3.045800	.6703
3.110100	.6757
3.176600	.6793
3.246300	.6860
3.309600	.6913
3.385300	.6971
3.460700	.7042
3.537900	.7105
3.618900	.7174
3.700000	.7240

Robinson, Wilson and Stokes [24]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.098300	.7940
.134500	.7743
.141900	.7739
.318600	.7218
.508100	.6882
.593000	.6837
.746000	.6634
.869000	.6524
.960000	.6432
1.273000	.6320
1.325000	.6284
1.335000	.6265
1.514000	.6257
1.594000	.6215
1.725000	.6192
1.778000	.6205
2.178000	.6232
2.429000	.6326
2.456000	.6337
2.945000	.6579
3.334000	.6810
3.784000	.7225
4.185000	.7590

Wu, Rush and Scatchard [50,51]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
4.445000	.8115
2.377000	.6407
1.533000	.6281
1.116000	.6409
.861000	.6575
1.889000	.6282
1.157000	.6395
.736200	.6691
.521500	.6936
.356500	.7214

Akerlof [25,25a]. Emf measurements on the cell Hg(l), Hg_2SO_4(s); Na_2SO_4(m); $Na(Hg)_x$(l). m_{ref} = 0.05 mol·kg^{-1}. Assigned weight is 0.40.

m/mol·kg^{-1}	γ/γ_{ref}
.025000	1.1845
.125000	.7746
.249000	.6494
.495000	.5242
.975000	.4189
1.438000	.3682
1.882000	.3216

Harned and Hecker [52]. Emf measurements on the cell Pb(s), $PbSO_4$(s); Na_2SO_4(m); $Na(Hg)_x$(l). m_{ref} = 0.05 mol·kg^{-1}. Assigned weight is 0.80.

m/mol·kg^{-1}	γ/γ_{ref}
.075000	.8474 *
.100000	.8424
.200000	.6906
.300000	.6083
.400000	.5459
.500000	.5084
.700000	.4456
.800000	.4228
.900000	.4033
1.000000	.3862
1.200000	.3575

Shibata and Murata [53]. Emf measurements on the cell $Na(Hg)_x$(l); Na_2SO_4(m); Hg_2SO_4(s), Hg(l). m_{ref} = 0.098 mol·kg^{-1}. Assigned weight is 0.30.

m/mol·kg^{-1}	γ/γ_{ref}
.685000	.5274
1.670000	.3675

Shibata and Murata [53]. Emf measurements on the cell $Na(Hg)_x$(l); Na_2SO_4(m); Hg_2SO_4(s), Hg(l). m_{ref} = 0.049 mol·kg^{-1}. Assigned weight is 0.30.

m/mol·kg^{-1}	γ/γ_{ref}
.391000	.5380
.977000	.3770
1.380000	.3229

Shibata and Murata [54]. Emf measurements on the cell $Na(Hg)_x$(l); Na_2SO_4(m); Hg_2SO_4(s), Hg(l). m_{ref} = 0.049 mol·kg^{-1}. Assigned weight is 0.30.

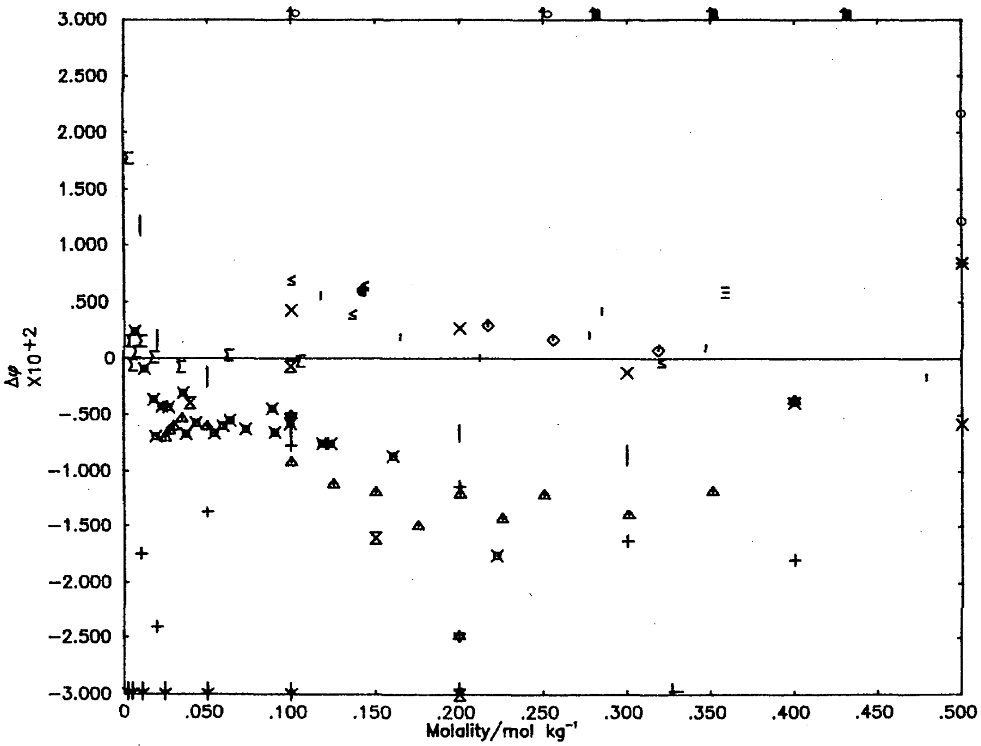
m/mol·kg^{-1}	γ/γ_{ref}
1.975000	.3038
1.760000	.2906
1.380000	.3230
.977000	.3770
.685000	.4395
.391000	.5380
.098000	.8333

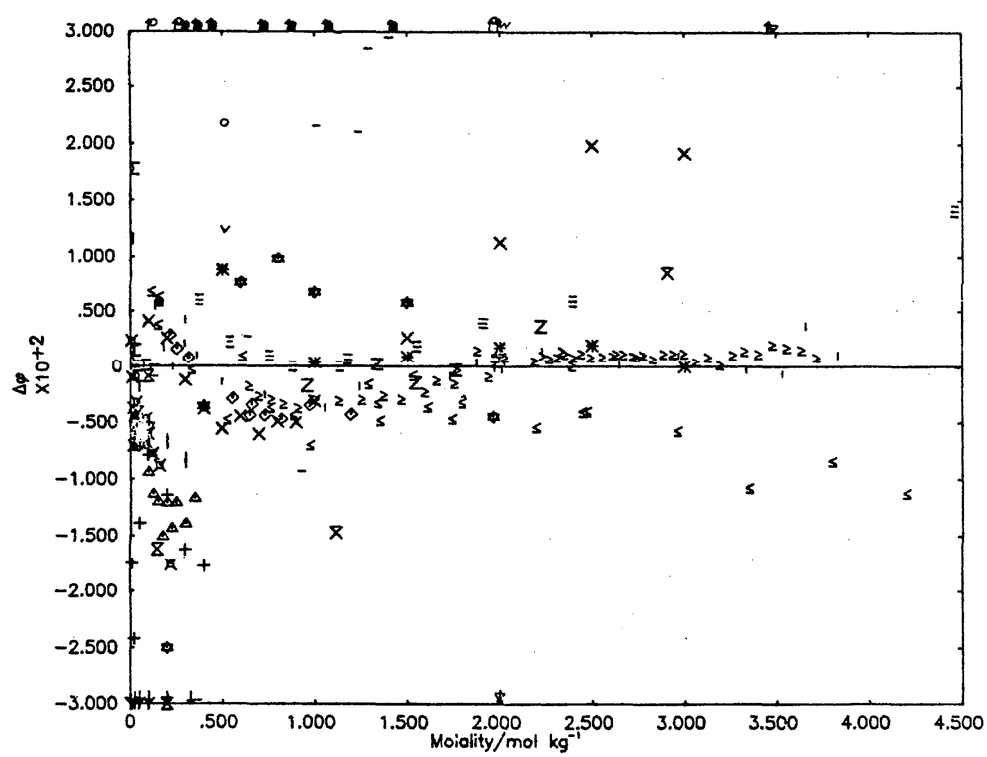
Comments

The data for Na_2SO_4 are remarkably consistent and appear to be, for the most part, highly reliable. There are several distinct isopiestic investigations [20,24,33,35,47,49,50,51] involving the use of four different reference electrolytes (unfortunately neither Platford [33] nor Frolov and Nasanova [20] reported their measured isopiestic molalities) that are, with the exception of a few scattered measurements, in excellent agreement with each other and with the more carefully done of the direct vapor pressure measurements [22,23,37]. The merger of the freezing point depression measurements with the vapor pressure and isopiestic measurements is smooth and the carefully done measurements of Indelli [21], Loomis [44,45], and Randall and Scott [48] are in excellent agreement with our final fit. The emf measurements are also highly consistent with the other measurements and lend overall credence to the final fit. Harned and Blake [55] report diffusion measurements from 0.00081 to 0.00479 mol·l^{-1} which we have chosen not to treat.

The data for this system extend well past saturation and the supersaturated solutions are apparently sufficiently stable to permit isopiestic measurements to be performed. However, Rard and Miller [49] report difficulties performing measurements past 3.70 mol·kg^{-1}, while Platford [47], Robinson et al. [24] and Wu et al. [50,51] report a few measurements for higher molalities.

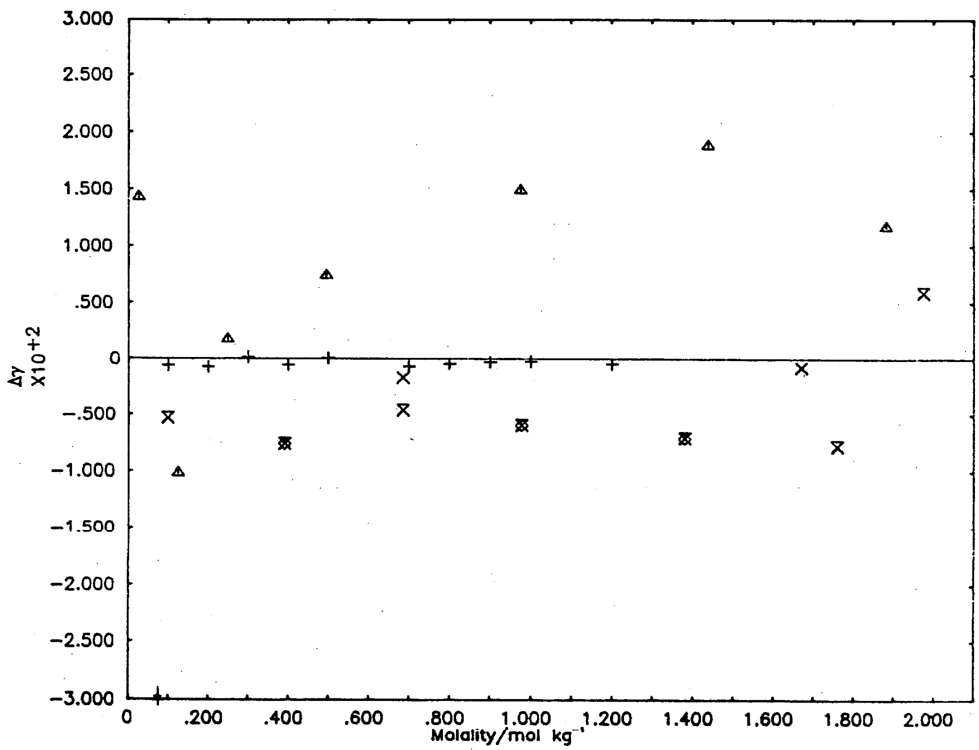
Isopiestic data for this system also exist at temperatures ranging from 45 to 165°C [55a.b.c.d.e].


Δφ X10+2
3.000
2.500
2.000
1.500
1.000
.500
0
−.500
−1.000
−1.500
−2.000
−2.500
−3.000
0 .050 .100 .150 .200 .250 .300 .350 .400 .450 .500
Molality/mol kg⁻¹


Δφ X10+2
3.000
2.500
2.000
1.500
1.000
.500
0
−.500
−1.000
−1.500
−2.000
−2.500
−3.000
0 .500 1.000 1.500 2.000 2.500 3.000 3.500 4.000 4.500
Molality/mol kg⁻¹

Deviation Plot for Na_2SO_4: $\Delta\phi$ vs molality

- Archibald [31], freezing point depression
- + Burge [32], vapor pressure osmometry
- × Childs and Platford [33], isopiestic vs urea and H_2SO_4
- @ deCoppet [34], freezing point depression
- Downes and Pitzer [35], isopiestic vs NaCl
- U Foote et al. [36], vapor pressure
- Frolov and Nasanova [20], isopiestic vs ?
- Z Gibson and Adams [37], vapor pressure
- Y Harkins and Roberts [38], freezing point depression
- Indelli [21], freezing point depression
- Jakli et al. [39], vapor pressure
- V Jones et al. [40], freezing point depression
- * Kangro and Groeneveld [22], vapor pressure
- ○ Klein and Svanberg [41], freezing point depression
- Kopecky and Dymes [42], vapor pressure osmometry
- W Leopold and Johnston [43], vapor pressure
- | Loomis [44,45], freezing point depression
- Pearce and Eckstrom [23], vapor pressure
- − Perreu [46], vapor pressure
- ı Platford [47], isopiestic vs NaCl
- ∑ Randall and Scott [48], freezing point depression
- ≥ Rard and Miller [49], isopiestic vs KCl
- ≤ Robinson, Wilson and Stokes [24], isopiestic vs KCl
- ≡ Wu, Rush, and Scatchard [50,51], isopiestic vs NaCl



Deviation Plot for Na_2SO_4: $\Delta\gamma$ vs molality

- Åkerlof [25,25a], emf, Hg, Hg_2SO_4 vs Na-Hg amalgam
- + Harned and Hecker [52], emf, Pb, $PbSO_4$ vs Na-Hg amalgam
- × Shibata and Murata [53], emf, Hg, Hg_2SO_4 vs Na-Hg amalgam "A"
- Shibata and Murata [53], emf, Hg, Hg_2SO_4 vs Na-Hg amalgam "B"
- Shibata and Murata [54], emf, Hg, Hg_2SO_4 vs Na-Hg amalgam

$Na_2S_2O_3$

Recommended Values for the mean activity and osmotic coefficient of sodium thiosulfate, $Na_2S_2O_3$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8867	.9613	.999948	-1.
.002	.8475	.9475	.999898	-2.
.003	.8199	.9376	.999848	-3.
.004	.7981	.9297	.999799	-5.
.005	.7800	.9231	.999751	-6.
.006	.7643	.9174	.999703	-8.
.007	.7506	.9124	.999655	-10.
.008	.7382	.9078	.999608	-13.
.009	.7271	.9037	.999561	-15.
.010	.7169	.8999	.999514	-17.
.020	.6450	.8729	.999057	-46.
.030	.6001	.8557	.998614	-82.
.040	.5675	.8432	.998179	-122.
.050	.5420	.8333	.997751	-166.
.060	.5212	.8252	.997328	-213.
.070	.5036	.8183	.996909	-263.
.080	.4884	.8124	.996494	-315.
.090	.4751	.8072	.996082	-369.
.100	.4633	.8025	.995672	-425.
.200	.3877	.7719	.991691	-1070.
.300	.3459	.7540	.987849	-1820.
.400	.3177	.7415	.984099	-2642.
.500	.2967	.7320	.980414	-3521.
.600	.2803	.7247	.976773	-4446.
.700	.2671	.7192	.973159	-5410.
.800	.2561	.7151	.969555	-6408.
.900	.2470	.7123	.965946	-7435.
1.000	.2392	.7107	.962320	-8487.
1.250	.2243	.7110	.953104	-11210.
1.500	.2141	.7166	.943557	-14035.
1.750	.2072	.7269	.933561	-16933.
2.000	.2028	.7410	.923024	-19882.
2.250	.2004	.7586	.911877	-22861.
2.500	.1996	.7793	.900057	-25854.
2.750	.2004	.8030	.887505	-28848.
3.000	.2025	.8295	.874158	-31828.
3.250	.2060	.8590	.859942	-34782.
3.500	.2109	.8918	.844763	-37699.
3.750	.2173	.9282	.828510	-40566.
4.000	.2256	.9688	.811045	-43370.
4.052	.2275	.9778	.807238	-43946.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ell n\gamma)$	$\sigma(\gamma)$
.001	.0001	.0001	.0001
.010	.0004	.0009	.0006
.100	.0011	.0033	.0015
1.000	.0009	.0035	.0008
2.000	.0008	.0038	.0008
4.052	.0090	.0111	.0025

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1366124344+01	.243-01	-.3663793997+01	.686+00	.7855917884+01	.153+00
2	-.3377769061+00	.267-01	.2929772547+02	.435+01	-.1182037199+02	.604+00
3	.1376569962+00	.202-01	-.5393963664+02	.121+02	.1112357021+02	.974+00
4	-.2187102199-01	.702-02	.6754110088+02	.183+02	-.6123977630+01	.777+00
5	.1878017944-02	.872-03	-.5224638331+02	.162+02	.1821164563+01	.304+00
6			.2418924116+02	.837+01	-.2249233315+00	.467-01
7			-.6150974173+01	.234+01		
8			.6608880542+00	.273+00		

σ(eqs 1) = .220-02 σ(eqs 2) = .213-02 σ(eqs 3) = .198-02

Experimental Data Employed in Generation of Correlating Equations

Perreu [56]. Vapor pressure measurements performed at 20°C. The Φ_L data for Na_2SO_4 and the Φ_C data for $Na_2S_2O_3$ given in the table of auxiliary data were used in adjusting these measurements to 25°C. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.949200	.7230
1.720800	.7680
2.561100	.9130
3.177300	.9410
3.680200	1.0030
4.052100	1.0190

Richards and Faber [57]. Freezing point depression measurements. The Φ_L data for Na_2SO_4 and the Φ_C data for $Na_2S_2O_3$ given in the table of auxiliary data were used in treating these measurements. Assigned weight is 0.30.

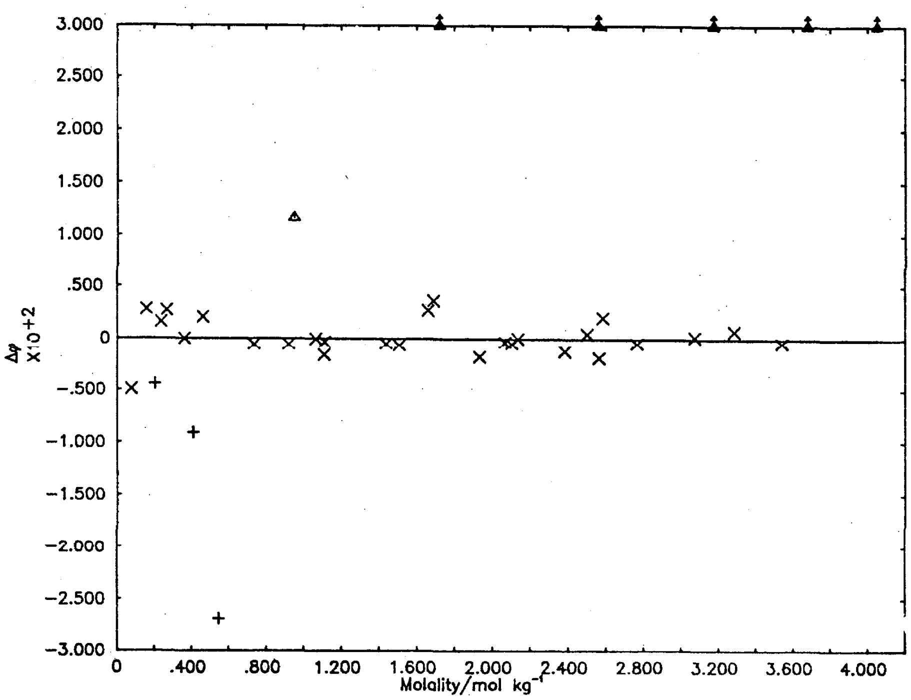
m/mol·kg^{-1}	$\phi_{298.15}$
.203400	.7667
.410100	.7313
.545900	.7016*

Robinson, Wilson, and Stokes [24]. Isopiestic measurements, reference eletrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.077100	.8091
.157900	.7851
.236500	.7661
.266800	.7619
.361000	.7459
.461300	.7374
.734500	.7170
.919800	.7113
1.065000	.7101
1.109000	.7084
1.112000	.7097
1.436000	.7142
1.507000	.7162
1.659000	.7254
1.688000	.7276
1.932000	.7350
2.066000	.7450
2.102000	.7473
2.136000	.7502
2.382000	.7679
2.501000	.7799
2.564000	.7832
2.585000	.7891
2.766000	.8041
3.073000	.8380
3.285000	.8642
3.541000	.8971

Comments

We prefer the isopiestic measurements of Robinson et al. [24] to the less accurate results of Perreu [56]. The accord with the freezing point depression measurements of Richards and Faber [57] is fair.



Deviation Plot for $Na_2S_2O_3$: $\Delta\phi$ vs molality

▲ Perreu [56], vapor pressure

+ Richards and Faber [57], freezing point depression

× Robinson, Wilson and Stokes [24], isopiestic vs KCl

$Na_2S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of sodium thionate, $Na_2S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8887	.9624	.999948	-1.
.002	.8509	.9494	.999897	-2.
.003	.8245	.9402	.999848	-3.
.004	.8038	.9330	.999798	-5.
.005	.7866	.9269	.999750	-6.
.006	.7718	.9217	.999701	-8.
.007	.7588	.9171	.999653	-10.
.008	.7471	.9130	.999605	-12.
.009	.7366	.9093	.999558	-14.
.010	.7269	.9058	.999511	-17.
.020	.6590	.8812	.999048	-44.
.030	.6161	.8663	.998598	-78.
.040	.5845	.8532	.998157	-116.
.050	.5596	.8434	.997723	-158.
.060	.5390	.8352	.997295	-202.
.070	.5214	.8279	.996873	-249.
.080	.5061	.8215	.996454	-299.
.090	.4925	.8158	.996040	-351.
.100	.4804	.8105	.995629	-404.
.200	.4019	.7756	.991652	-1022.
.300	.3589	.7574	.987795	-1745.
.400	.3309	.7472	.983976	-2538.
.500	.3105	.7410	.980176	-3385.
.600	.2947	.7364	.976405	-4275.
.700	.2818	.7326	.972664	-5201.
.800	.2713	.7302	.968921	-6157.
.852	.2666	.7300	.966943	-6665.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0003	.0006	.0005
.010	.0016	.0037	.0027
.100	.0016	.0086	.0041
.852	.0008	.0077	.0021

Coefficients of Correlating Equations

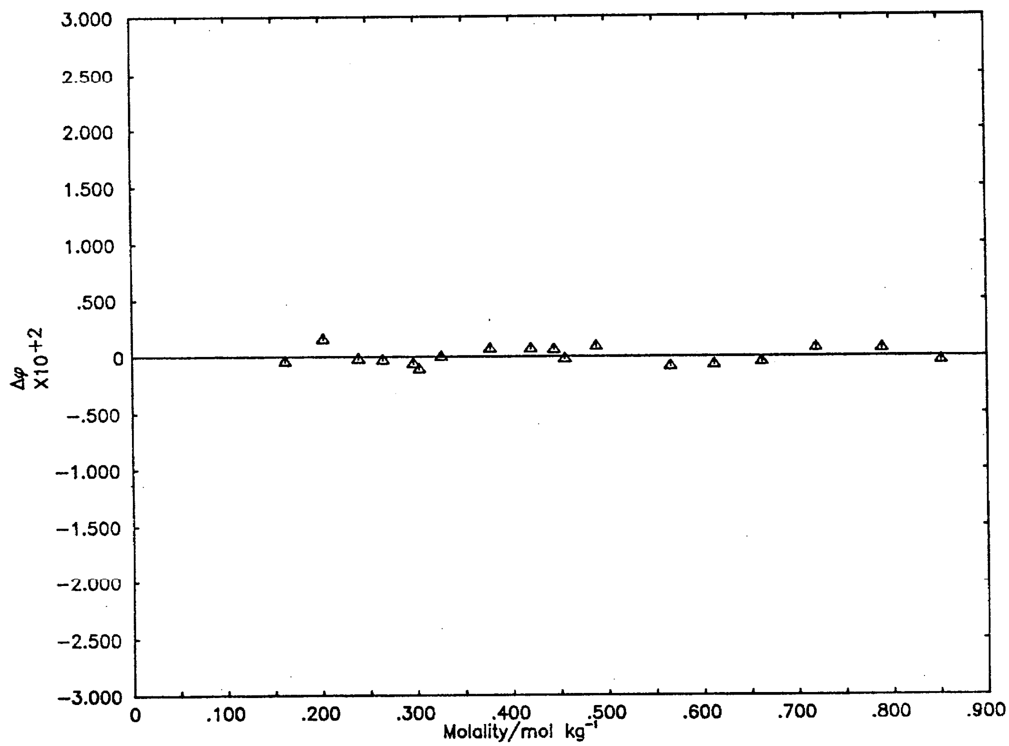
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1866867110+01	.139+00	-.1217824474+00	.109+00	.1013279051+02	.484+00
2	-.1116833758+01	.194+00	.9280089590+01	.403+00	-.2273874974+02	.246+01
3	.1718101595+01	.431+00	-.4511429554+01	.522+00	.3177937570+02	.497+01
4	-.1626256172+01	.500+00			-.2340572159+02	.454+01
5	.6303865006+00	.222+00			.6940535580+01	.156+01

σ(eqs 1) = .834-03
σ(eqs 2) = .832-03
σ(eqs 3) = .833-03

Experimental Data Employed in Generation of Correlating Equations

Lantzke et al. [29]. Isopiestic measurements, reference salt is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.162300	.7855
.202400	.7765
.239500	.7668
.265100	.7622
.297300	.7571
.303400	.7558
.326400	.7541
.377700	.7497
.420200	.7464
.444500	.7447
.455900	.7432
.488600	.7424
.566300	.7369
.612200	.7351
.662700	.7334
.719800	.7327
.789600	.7310
.852000	.7296



Deviation Plot for $Na_2S_2O_6$: $\Delta\phi$ vs molality

▲ Lantzke et al. [29], isopiestic vs NaCl

$Na_2S_2O_8$

Recommended Values for the mean activity and osmotic coefficient of sodium persulfate, $Na_2S_2O_8$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8867	.9613	.999948	-1.
.002	.8476	.9475	.999898	-2.
.003	.8200	.9377	.999848	-3.
.004	.7984	.9300	.999799	-5.
.005	.7803	.9235	.999750	-6.
.006	.7648	.9179	.999702	-8.
.007	.7512	.9129	.999655	-10.
.008	.7390	.9085	.999607	-13.
.009	.7280	.9045	.999560	-15.
.010	.7179	.9008	.999513	-17.
.020	.6478	.8755	.999054	-46.
.030	.6048	.8603	.998606	-81.
.040	.5741	.8499	.998164	-120.
.050	.5505	.8423	.997726	-163.
.060	.5315	.8366	.997291	-209.
.070	.5158	.8321	.996857	-257.
.080	.5025	.8286	.996424	-307.
.090	.4911	.8259	.995991	-359.
.098	.4829	.8241	.995645	-402.

m/mol·kg^{-1}	σ(ø)	σ(ℓnγ)	σ(γ)
.001	.0001	.0002	.0001
.010	.0006	.0013	.0009
.100	.0026	.0066	.0032
.098	.0026	.0065	.0031

Coefficients of Correlating Equations

	Eqs 1		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1262357611+01	.267-01	.8615753431+01	.547+00
			-.9495129587+01	.150+01

σ(eqs 1) = .477-02
σ(eqs 3) = .376-02

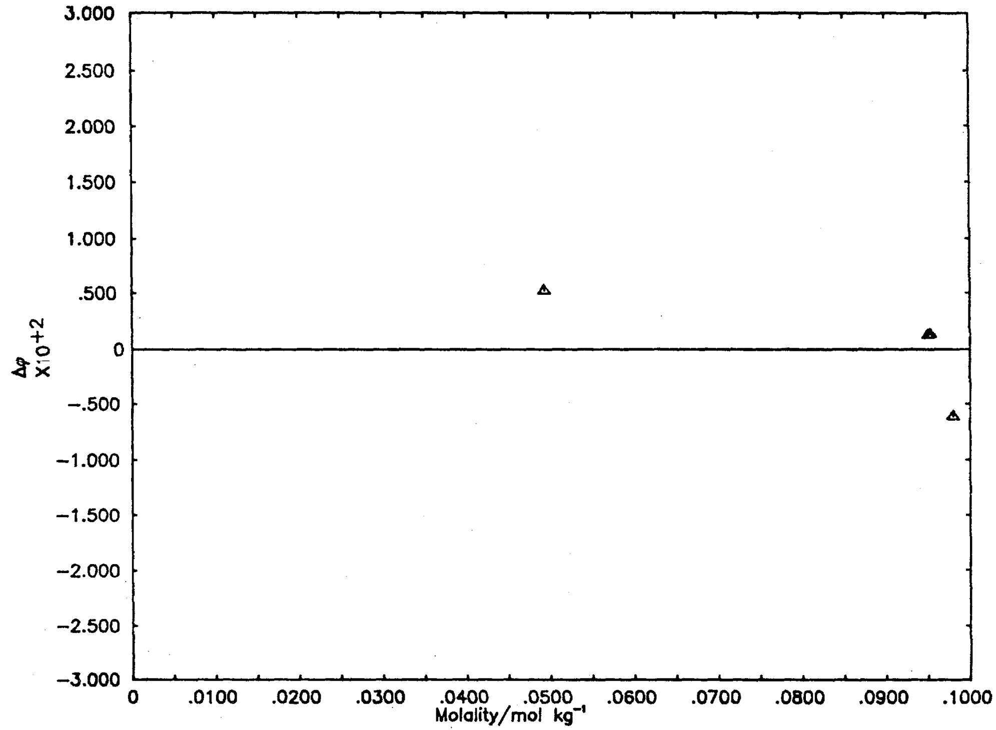
Experimental Data Employed in Generation of Correlating Equations

Chlebek and Lister [58]. Vapor pressure osmometry. Assigned weight is 1.0.

m/mol·kg^{-1}	$ø_{298.15}$
.049300	.8480
.095000	.8260
.095300	.8260
.098000	.8180

Comments

We have based the fit for this system on only four data points. A more detailed and definitive study would be useful. An adequate fit could not be obtained using eqs. 2.



Deviation Plot for $Na_2S_2O_8$: ΔØ vs molality

▲ Chlebek and Lister [58], vapor pressure osmometry

Na_2HPO_4

Recommended Values for the mean activity and osmotic coefficient of sodium orthophosphate, Na_2HPO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8868	.9613	.999948	-1.
.002	.8476	.9475	.999898	-2.
.003	.8200	.9376	.999848	-3.
.004	.7982	.9297	.999799	-5.
.005	.7800	.9231	.999751	-6.
.006	.7643	.9174	.999703	-8.
.007	.7505	.9123	.999655	-10.
.008	.7382	.9077	.999608	-13.
.009	.7270	.9035	.999561	-15.
.010	.7167	.8997	.999514	-17.
.020	.6442	.8720	.999058	-46.
.030	.5986	.8540	.998616	-82.
.040	.5652	.8405	.998185	-122.
.050	.5389	.8297	.997760	-167.
.060	.5172	.8205	.997343	-214.
.070	.4988	.8126	.996931	-264.
.080	.4829	.8055	.996523	-317.
.090	.4687	.7991	.996120	-373.
.100	.4561	.7933	.995722	-430.
.200	.3732	.7504	.991922	-1095.
.300	.3252	.7199	.988395	-1881.
.400	.2916	.6948	.985091	-2758.
.500	.2659	.6731	.981976	-3710.
.600	.2453	.6538	.979021	-4726.
.700	.2283	.6367	.976201	-5798.
.800	.2140	.6213	.973493	-6921.
.900	.2017	.6077	.970875	-8090.
1.000	.1911	.5955	.968329	-9301.
1.250	.1699	.5709	.962165	-12491.
1.500	.1541	.5536	.956114	-15880.
1.750	.1421	.5422	.950015	-19435.
2.000	.1327	.5353	.943776	-23128.
2.121	.1289	.5333	.940695	-24958.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0001	.0001	.0001
.010	.0005	.0010	.0007
.100	.0012	.0038	.0017
1.000	.0010	.0039	.0007
2.000	.0025	.0051	.0007
2.121	.0033	.0053	.0007

Coefficients of Correlating Equations

Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1424416976+01	.289-01	-.5949562284+01	.815+00	.7683250020+01	.145+00
2	-.6285063812+00	.303-01	.4344887267+02	.539+01	-.1159589935+02	.553+00
3	.1668102536+00	.229-01	-.9336812442+02	.152+02	.9903500535+01	.825+00
4	-.1827148314-01	.604-02	.1228967860+03	.228+02	-.4363865147+01	.544+00
5			-.9224751821+02	.188+02	.7790004460+00	.132+00
6			.3665914504+02	.811+01		
7			-.5990528341+01	.142+01		

σ(eqs 1) = .347-02
σ(eqs 2) = .300-02
σ(eqs 3) = .297-02

Experimental Data Employed in Generation of Correlating Equations

Husain [59]. Freezing point depression measurements. The Φ_L data for K_2HPO_4 and the Φ_C data for Na_2SO_4 given in the table of auxiliary data were used in treating these and the other freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.021400	.4451
.051600	.4398
.073100	.4306
.097800	.4208
.111800	.4186

Jones et al. [40]. Freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.100000	.7573
.050000	.8413

Loomis [45,60]. Freezing point depression measurements. Assigned weight is 0.30.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.8886
.020000	.8613
.050000	.8176
.100000	.7707

Platford [12]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

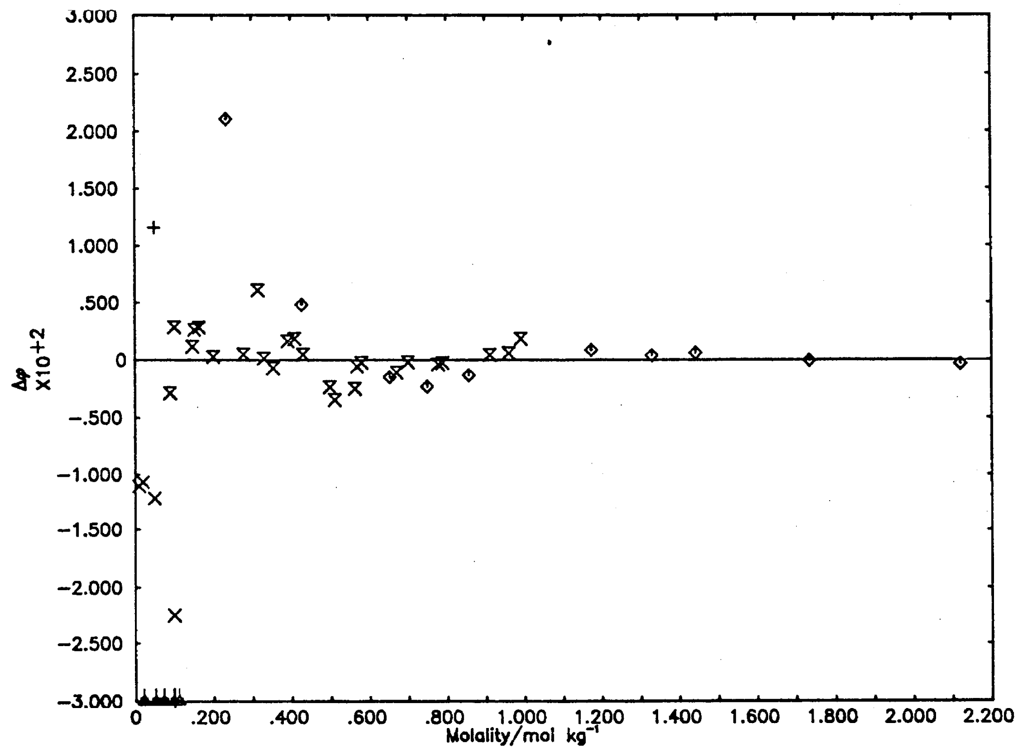
m/mol·kg^{-1}	$\phi_{298.15}$
.234900	.7600
.651800	.6432
.748000	.6268
.856500	.6121
1.172900	.5785
1.329000	.5651
1.441000	.5577
1.734000	.5427
2.121000	.5330

Scatchard and Breckenridge [61]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.991430	.5983
.960440	.6007
.910840	.6067
.787560	.6229
.776610	.6244
.699200	.6366
.669510	.6406
.579790	.6573
.567450	.6593
.561860	.6584
.510340	.6675
.498060	.6711
.428920	.6887
.407280	.6950
.390450	.6987
.352750	.7055
.329610	.7122
.314530	.7221
.277470	.7267
.200160	.7506
.164670	.7662
.152530	.7709
.147310	.7716
.101150	.7955
.090020	.7962

Comments

The isopiestic results of Platford [12] are in excellent agreement with the earlier results of Scatchard and Breckenridge [61]. For the low molalities we have given weight only to the freezing point depression measurements of Loomis [45,60].



Deviation Plot for Na_2HPO_4: ΔØ vs molality

- ▲ Husain [59], freezing point depression
- + Jones et al. [40], freezing point depression
- × Loomis [45,60], freezing point depression
- ◇ Platford [12], isopiestic vs NaCl
- ⧖ Scatchard and Breckenridge [61], isopiestic vs NaCl

Sodium Fumarate

Recommended Values for the mean activity and osmotic coefficient of sodium fumarate, $Na_2C_4H_2O_4$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8860	.9609	.999948	-1.
.002	.8462	.9467	.999898	-2.
.003	.8181	.9366	.999848	-3.
.004	.7959	.9285	.999799	-5.
.005	.7774	.9217	.999751	-6.
.006	.7615	.9158	.999703	-8.
.007	.7474	.9105	.999656	-10.
.008	.7349	.9058	.999608	-13.
.009	.7235	.9016	.999562	-15.
.010	.7131	.8976	.999515	-18.
.020	.6400	.8700	.999060	-47.
.030	.5948	.8529	.998618	-83.
.040	.5623	.8403	.998184	-124.
.050	.5372	.8316	.997755	-168.
.060	.5169	.8245	.997330	-216.
.070	.5000	.8188	.996907	-266.
.080	.4856	.8141	.996486	-319.
.090	.4732	.8102	.996067	-374.
.100	.4622	.8070	.995648	-430.
.200	.3969	.7938	.991457	-1068.
.300	.3655	.7950	.987192	-1788.
.400	.3471	.8016	.982820	-2557.
.500	.3354	.8107	.978330	-3358.
.600	.3278	.8212	.973722	-4179.
.700	.3227	.8325	.968996	-5015.
.800	.3196	.8443	.964154	-5860.
.900	.3178	.8564	.959199	-6711.
1.000	.3171	.8687	.954134	-7564.
1.250	.3189	.9001	.941006	-9696.
1.500	.3241	.9317	.927253	-11808.
1.750	.3318	.9633	.912918	-13882.
2.000	.3414	.9948	.898046	-15907.
2.077	.3447	1.0045	.893363	-16520.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0000	.0001	.0001
.010	.0003	.0007	.0005
.100	.0014	.0036	.0016
1.000	.0014	.0073	.0023
2.000	.0024	.0061	.0021
2.077	.0026	.0061	.0021

Coefficients of Correlating Equations

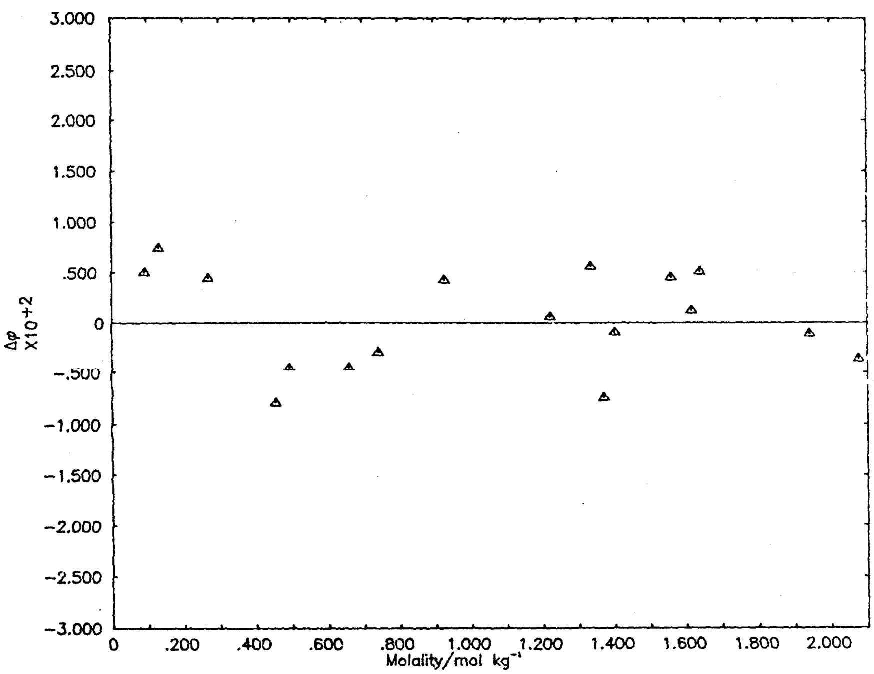
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1136905446+01	.152-01	-.5460588702+00	.323+00	.8028012197+01	.320+00
2	.2239277361+00	.551-02	.1157521448+02	.122+01	-.1152863413+02	.121+01
3			-.7727568763+01	.179+01	.1053636207+02	.178+01
4			.3330936780+01	.117+01	-.5087028746+01	.116+01
5			-.6156824597+00	.281+00	.9846260218+00	.278+00

σ(eqs 1) = .502-02
σ(eqs 2) = .436-02
σ(eqs 3) = .431-02

Experimental Data Employed in Generation of Correlating Equations

Robinson, Smith and Smith [62]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.093050	.8142
.132500	.8072
.269800	.7983
.455900	.7985
.493500	.8056
.659600	.8234
.741400	.8344
.928200	.8641
1.222000	.8971
1.336000	.9165
1.371000	.9079
1.402000	.9183
1.558000	.9435
1.615000	.9474
1.639000	.9543
1.941000	.9863
2.077000	1.0010



Deviation Plot for sodium fumarate: Δφ vs molality

▲ Robinson, Smith and Smith [62], isopiestic vs KCl

Sodium Maleate

Recommended Values for the mean activity and osmotic coefficient of solium maleate, $Na_2C_4H_2O_4$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8846	.9602	.999948	-1.
.002	.8437	.9453	.999898	-2.
.003	.8146	.9345	.999848	-3.
.004	.7916	.9258	.999800	-5.
.005	.7722	.9185	.999752	-7.
.006	.7555	.9120	.999704	-9.
.007	.7407	.9062	.999657	-11.
.008	.7274	.9010	.999611	-13.
.009	.7153	.8962	.999564	-15.
.010	.7043	.8918	.999518	-18.
.020	.6259	.8597	.999071	-49.
.030	.5767	.8388	.998641	-87.
.040	.5409	.8234	.998221	-130.
.050	.5131	.8113	.997810	-178.
.060	.4904	.8014	.997405	-229.
.070	.4714	.7931	.997004	-284.
.080	.4551	.7860	.996607	-341.
.090	.4409	.7799	.996214	-401.
.100	.4283	.7745	.995823	-463.
.200	.3514	.7439	.991991	-1175.
.300	.3121	.7320	.988202	-2000.
.400	.2875	.7275	.984395	-2898.
.500	.2703	.7270	.980547	-3849.
.600	.2577	.7287	.976647	-4840.
.700	.2480	.7319	.972690	-5863.
.800	.2404	.7362	.968671	-6912.
.900	.2343	.7412	.964588	-7982.
1.000	.2293	.7469	.960439	-9070.
1.250	.2205	.7627	.949776	-11847.
1.500	.2153	.7805	.938686	-14681.
1.750	.2125	.7996	.927164	-17550.
2.000	.2114	.8197	.915204	-20436.
2.250	.2116	.8408	.902803	-23325.
2.500	.2129	.8628	.889960	-26208.
2.750	.2152	.8856	.876673	-29074.
2.879	.2168	.8976	.869644	-30545.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0000	.0001	.0000
.010	.0002	.0004	.0003
.100	.0009	.0023	.0010
1.000	.0009	.0041	.0009
2.000	.0039	.0037	.0008
2.879	.0017	.0044	.0009

Coefficients of Correlating Equations

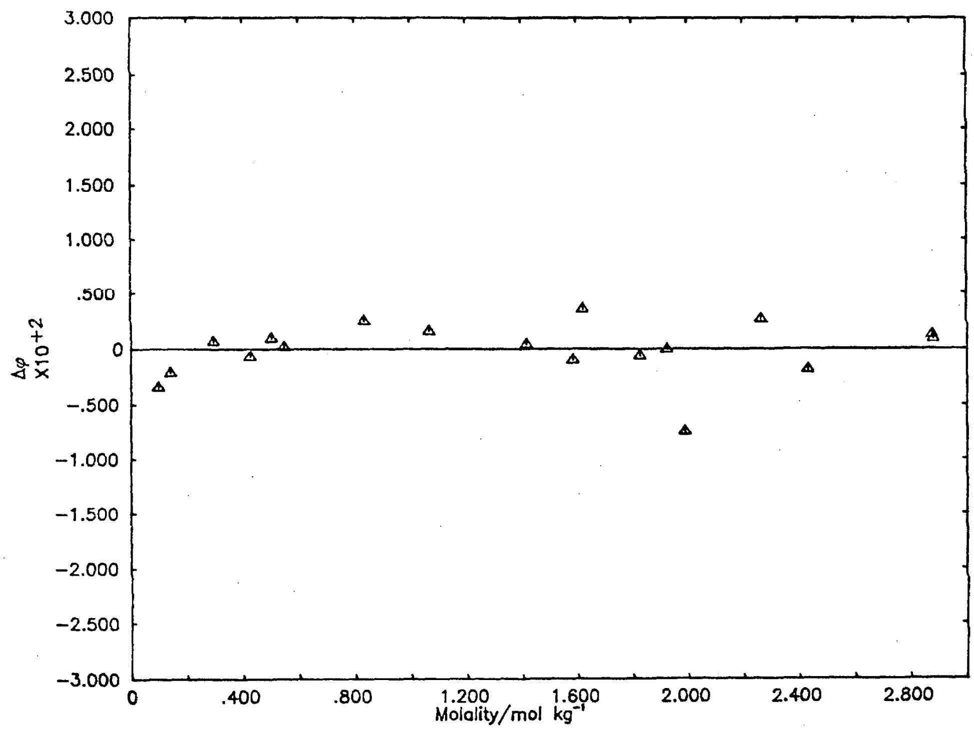
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.9200156885+00	.988-02	-.4713999633+01	.772+00	.5759564168+01	.127+00
2	.8832926287-01	.892-02	.2866716502+02	.448+01	-.5808164161+01	.401+00
3	.1005838387-01	.188-02	-.4245289484+02	.110+02	.3824565105+01	.492+00
4			.4248052125+02	.141+02	-.1402002198+01	.268+00
5			-.2554132905+02	.986+01	.2171639910+00	.542-01
6			.8364226330+01	.359+01		
7			-.1144436583+01	.531+00		

σ(eqs 1) = .270-02
σ(eqs 2) = .261-02
σ(eqs 3) = .254-02

[illegible] Equations

[illegible] measurements, reference electrolyte is KCl. Assigned weight

m/mol·kg^{-1}	$\phi_{298.15}$
.098140	.7720
.141500	.7558
.293800	.7331
.426100	.7264
.500100	.7279
.546300	.7277
.835600	.7404
1.066000	.7524
1.415000	.7747
1.584000	.7858
1.623000	.7933
1.826000	.8050
1.923000	.8134
1.988000	.8113
2.266000	.8449
2.432000	.8549
2.875000	.8985
2.879000	.8985



Deviation Plot for sodium maleate: $\Delta\phi$ vs molality

△ Robinson, Smith and Smith [62], isopiestic vs KCl

Na_2CO_3

Recommended Values for the *mean* activity and osmotic coefficient of Na_2CO_3 in H_2O at 298.15 K

/mol·kg^{-1}	γ	Ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8867	.9613	.999948	-1.
.002	.8474	.9474	.999898	-2.
.003	.8198	.9375	.999848	-3.
.004	.7979	.9296	.999799	-5.
.005	.7798	.9230	.999751	-6.
.006	.7641	.9173	.999703	-8.
.007	.7503	.9122	.999655	-10.
.008	.7380	.9076	.999608	-13.
.009	.7268	.9035	.999561	-15.
.010	.7165	.8997	.999514	-17.
.020	.6445	.8725	.999057	-46.
.030	.5995	.8552	.998614	-82.
.040	.5667	.8426	.998180	-122.
.050	.5411	.8326	.997753	-166.
.060	.5202	.8243	.997330	-213.
.070	.5025	.8174	.996912	-263.
.080	.4872	.8113	.996498	-316.
.090	.4738	.8059	.996087	-370.
.100	.4619	.8012	.995679	-427.
.200	.3855	.7692	.991720	-1074.
.300	.3429	.7496	.987920	-1829.
.400	.3137	.7349	.984238	-2660.
.500	.2918	.7230	.980653	-3549.
.600	.2744	.7129	.977146	-4489.
.700	.2602	.7044	.973703	-5471.
.800	.2482	.6971	.970308	-6490.
.900	.2379	.6910	.966948	-7542.
1.000	.2290	.6859	.963610	-8625.
1.250	.2115	.6772	.955282	-11442.
1.500	.1986	.6738	.946841	-14391.
1.750	.1892	.6752	.938133	-17444.
2.000	.1823	.6810	.929031	-20576.
2.250	.1773	.6908	.919432	-23767.
2.500	.1741	.7040	.909258	-27002.
2.750	.1722	.7205	.898455	-30264.
2.767 (sat)	.1721	.7217	.897697	-30486.
3.000	.1714	.7396	.880994	-33540.
2.115	.1714	.7492	.881498	-35048.

m/mol·kg^{-1}	σ(Ø)	σ(ℓnγ)	σ(γ)
.001	.0001	.0002	.0002
.010	.0006	.0013	.0009
.100	.0018	.0052	.0024
1.000	.0011	.0062	.0014
2.000	.0009	.0062	.0011
3.115	.0020	.0059	.0010

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1357610705+01	.320-01	-.1454965713+01	.381+00	.7087231263+01	.176+00
2	-.3431557008+00	.240-01	.1468303113+02	.146+01	-.8846628006+01	.504+00
3	.9114401308-01	.111-01	-.1392628385+02	.240+01	.6289353251+01	.565+00
4	-.6048231915-02	.184-02	.9096237236+01	.196+01	-.2297900103+01	.284+00
5			-.3191180875+01	.796+00	.3403665575+00	.533-01
6			.4563948583+00	.127+00		

σ(eqs 1) = .275-02
σ(eqs 2) = .287-02
σ(eqs 3) = .288-02

Experimental Data Employed in Generation of Correlating Equations

Ender [63]. Freezing point depression measurements. The Φ_L and Φ_C data for Na_2CO_3 given in the table of auxiliary data were used in treating these and the other freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.467820	.7696
.444420	.7714
.323840	.7646
.265920	.7633
.248050	.7631
.187530	.7683
.180480	.7668
.173620	.7699
.142070	.7760
.139450	.7766
.111330	.7849
.099061	.7903
.098283	.7905
.093565	.7929
.072222	.8053
.070755	.8065
.053574	.8214
.041759	.8352
.036074	.8436
.032088	.8506
.017936	.8878
.016516	.8931
.013148	.9539
.006781	.9405
.003601	.9477

Jones [64]. Freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.001520	1.0031
.004030	.9872
.006550	.9845
.009050	.9781
.010600	.9710
.024000	.9545
.038670	.8897
.047910	.8338
.075650	.8162
.102960	.8003

Jones et al. [40]. Freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.500000	.7150

Khvorostin, Filippov, and Reshetova [28]. Isopiestic measurements, reference electrolytes were NaOH and KCl. The authors did not report the isopiestic molalities. Assigned weight is 0.40.

m/mol·kg^{-1}	$\phi_{298.15}$
.045600	.7717 *
.104500	.8341 *
.394800	.7559 *
.782500	.6866
1.051700	.6871
1.397300	.6750
1.750300	.6710
1.759200	.6866
2.132600	.6839
2.263400	.6959
2.437200	.7068
2.591400	.7072
2.609300	.7157
2.728200	.7123

Loomis [44,65]. Freezing point depression measurements. Assigned weight is 0.20.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.9041
.020000	.8787
.050000	.8283
.100000	.7920
.200000	.7576

Perreu [46]. Vapor pressure measurements at 20°C. The Φ_L and Φ_C data given in the table of auxiliary data were used to adjust these measurements to 25°C. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.355800	.9900
.682700	.9820
1.093500	.9670
1.421000	.9590
1.693000	.9500
1.731900	.9480
1.854000	.9460
2.026000	.9410

Robinson and Macaskill [66]. Isopiestic measurements, reference electrolyte is NaCl. Their [66] Table I contains a typographical error: 2.2565 mol·kg^{-1} of NaCl in line two of column four should read 2.2965 mol·kg^{-1} [67]. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.306200	.7517
.515400	.7206
.522700	.7234
.628000	.7114
.715900	.7032
.878100	.6924
1.286700	.6761
1.377900	.6739
1.565300	.6727
1.724900	.6741
1.944900	.6799
2.175100	.6875
2.235300	.6855
2.385600	.6971
2.670900	.7156
2.671500	.7166
2.681900	.7147
2.766700	.7228
2.870800	.7286
2.939800	.7355
3.115000	.7487

Saegusa [68]. Emf measurements on the cell $Na(Hg)_x$; $Na_2CO_3(m)$; $Ag_2CO_3(s)$, Ag(s). m_{ref} = 0.00114 mol·kg^{-1}. Assigned weight is zero.

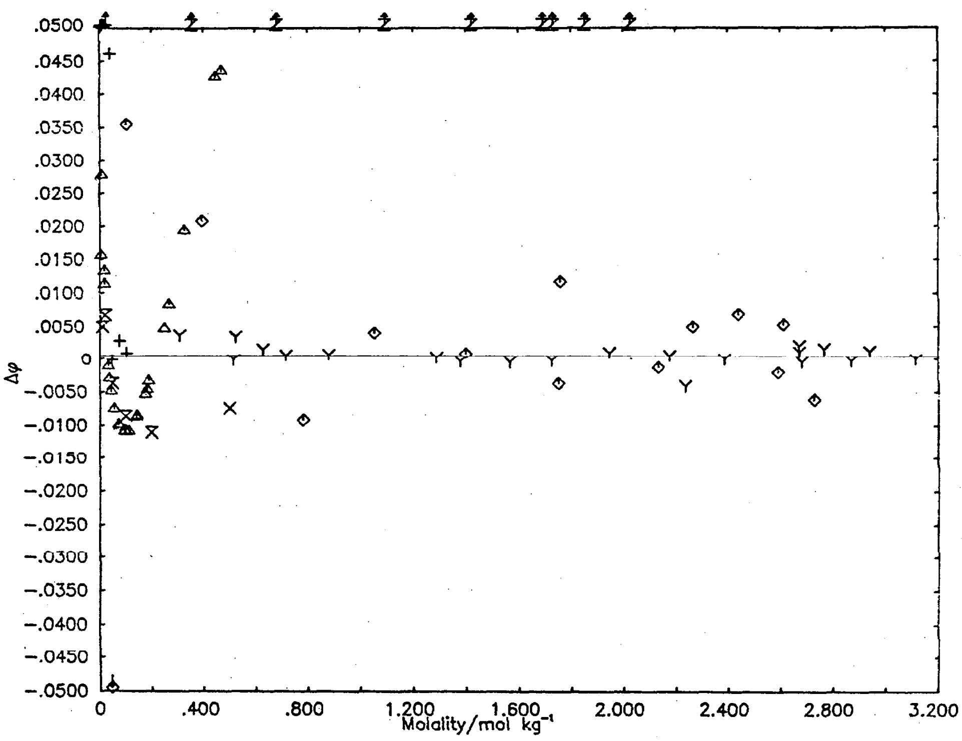
m/mol·kg^{-1}	γ/γ_{ref}
.002167	.9755
.005212	.9163
.010210	.8385
.020570	.4917
.057410	.3908
.106900	.3309
.505500	.2000
.977700	.1689

Taylor [69]. Emf measurements on the cell $Na(Hg)_x$; $Na_2CO_3(m)$; $Ag_2CO_2(s)$, Ag(s). m_{ref} = 0.1005 mol·kg^{-1}. Assigned weight is zero.

m/mol·kg^{-1}	γ/γ_{ref}
.200800	.8485
.400900	.7117
.601400	.6461
.847000	.5932
1.004700	.5664
1.535500	.5061

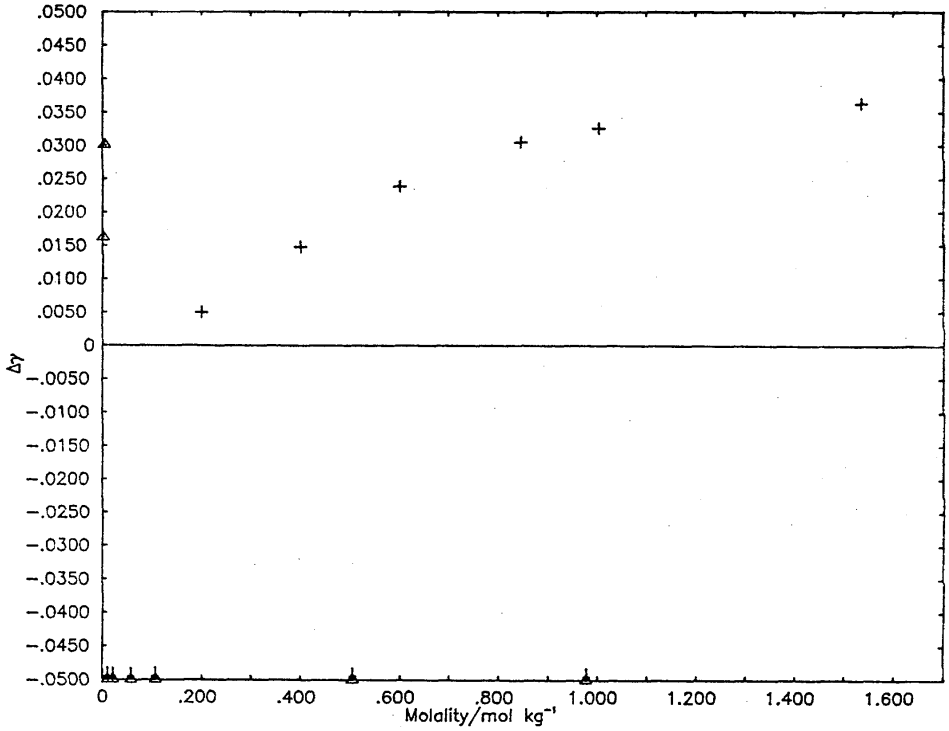
Comments

The recent measurements of Robinson and Macaskill [66] provide the most reliable data for this important system. The agreement with the earlier isopiestic measurements of Khvorostin et al. [28] is good [note that we have had to discard three data points at the lowest molalities where the measurements are most difficult]. The freezing point depression measurements of Loomis [44,65] were carefully done for their time and we have given some weight to these measurements. We have used the measured solubility of Robinson and Macaskill [66] in calculating the properties at saturation. These workers also noted that the solutions that they studied having molalities higher than saturation were sufficiently stable to permit meaningful isopiestic measurements. The cell measurements [68,69] are not in accord with the isopiestic measurements and we believe that they contain systematic errors.



Deviation Plot for Na_2CO_3: Δφ vs molality

- **Δ** Ender [63] - freezing point depression
- **+** Jones [64] - freezing point depression
- **X** Jones et al. [40] - freezing point depression
- **◇** Khvorostin, Filippov, and Reshetova [28] - isopiestic vs NaOH and KCl
- **Ӿ** Loomis [44,65] - freezing point depression
- **Z** Perreu [40] - vapor pressure
- **Y** Robinson and Macaskill [66] - isopiestic vs NaCl



Deviation Plot for Na_2CO_3: Δγ vs molality

Δ Saegusa [68] - emf

+ Taylor [69] - emf

Na_2HAsO_4

Recommended Values for the mean activity and osmotic coefficient of sodium orthoarsenate, Na_2HAsO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8885	.9622	.999948	-1.
.002	.8506	.9492	.999897	-2.
.003	.8241	.9400	.999848	-3.
.004	.8034	.9328	.999798	-5.
.005	.7862	.9268	.999750	-6.
.006	.7714	.9216	.999701	-8.
.007	.7584	.9171	.999653	-10.
.008	.7468	.9130	.999605	-12.
.009	.7363	.9093	.999558	-14.
.010	.7267	.9060	.999510	-17.
.020	.6597	.8824	.999047	-44.
.030	.6179	.8676	.998594	-78.
.040	.5874	.8567	.998150	-116.
.050	.5635	.8481	.997711	-157.
.060	.5439	.8410	.997277	-201.
.070	.5272	.8348	.996847	-247.
.080	.5127	.8293	.996421	-296.
.090	.4999	.8244	.995998	-347.
.100	.4884	.8199	.995579	-399.
.200	.4125	.7868	.991531	-1000.
.300	.3676	.7629	.987707	-1704.
.400	.3357	.7431	.984065	-2483.
.500	.3110	.7259	.980574	-3323.
.600	.2911	.7111	.977204	-4217.
.700	.2747	.6984	.973923	-5157.
.800	.2608	.6877	.970703	-6137.
.900	.2491	.6790	.967511	-7154.
1.000	.2391	.6723	.964319	-8203.
1.029	.2365	.6707	.963386	-8514.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0001	.0001	.0001
.010	.0004	.0009	.0007
.100	.0009	.0031	.0015
1.000	.0013	.0036	.0009
1.029	.0015	.0038	.0009

Coefficients of Correlating Equations

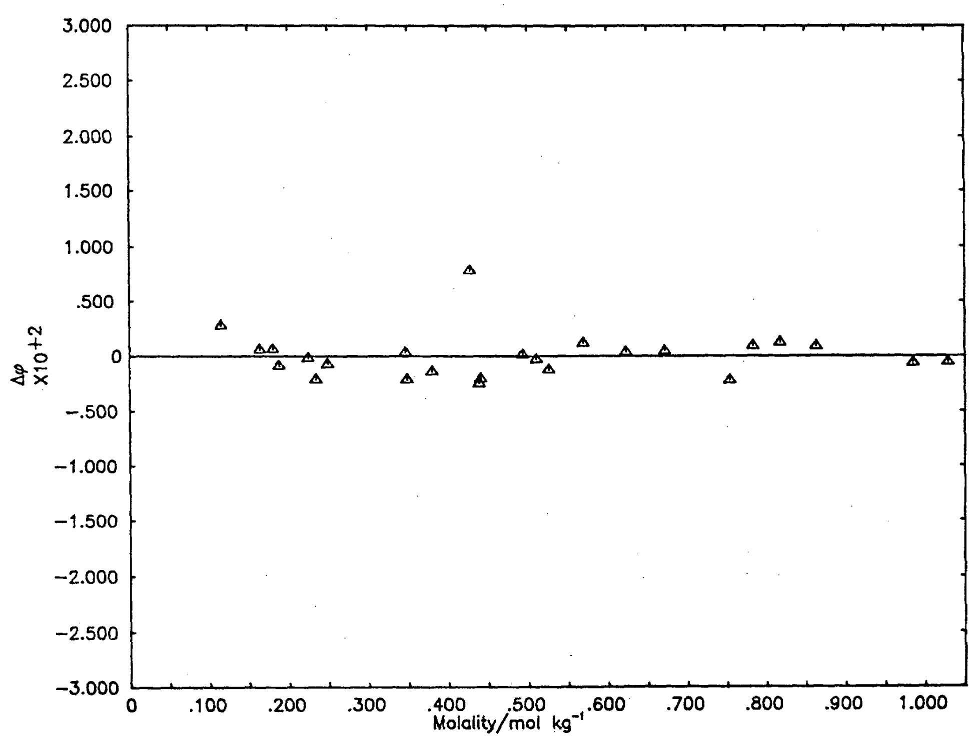
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1729061427+01	.264-01	.6611460751+00	.131+00	.1028057804+02	.556+00
2	-.5638367658+00	.201-01	.7484703740+01	.462+00	-.2109095084+02	.275+01
3	.1530013649+00	.121-01	-.3296024029+01	.569+00	.2566222872+02	.532+01
4			.8649703771+00	.236+00	-.1665998759+02	.462+01
5					.4448111559+01	.150+01

σ(eqs 1) = .218-02
σ(eqs 2) = .212-02
σ(eqs 3) = .226-02

Experimental Data Employed in Generation of Correlating Equations

Scatchard and Breckenridge [61]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
1.029100	.6701
.985170	.6725
.863360	.6829
.817800	.6873
.783410	.6903
.753850	.6902
.671670	.7023
.622950	.7084
.569570	.7166
.526130	.7206
.510410	.7240
.493630	.7271
.441030	.7337
.439500	.7335
.427550	.7459
.379760	.7454
.348780	.7507
.346660	.7536
.248920	.7737
.234490	.7758
.224630	.7802
.188030	.7892
.180300	.7929
.163580	.7978
.114810	.8166



Deviation Plot for Na_2HAsO_4: $\Delta\phi$ vs molality

△ Scatchard and Breckenridge [61], isopiestic vs NaCl

$Na_2C_2H_4S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of sodium 1,2-ethane disulfonate, $Na_2C_2H_4S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8856	.9607	.999948	-1.
.002	.8456	.9464	.999898	-2.
.003	.8174	.9362	.999848	-3.
.004	.7951	.9281	.999799	-5.
.005	.7766	.9213	.999751	-6.
.006	.7607	.9155	.999703	-8.
.007	.7466	.9103	.999656	-11.
.008	.7341	.9056	.999609	-13.
.009	.7228	.9015	.999562	-15.
.010	.7124	.8976	.999515	-18.
.020	.6407	.8714	.999058	-47.
.030	.5972	.8564	.998612	-83.
.040	.5666	.8465	.998172	-123.
.050	.5435	.8398	.997733	-167.
.060	.5251	.8352	.997295	-214.
.070	.5101	.8319	.996858	-263.
.080	.4976	.8296	.996419	-314.
.090	.4869	.8281	.995980	-367.
.100	.4777	.8271	.995540	-421.
.200	.4256	.8311	.991057	-1019.
.300	.4018	.8404	.986466	-1678.
.400	.3876	.8490	.981813	-2370.
.500	.3780	.8567	.977114	-3085.
.600	.3712	.8642	.972364	-3816.
.700	.3665	.8718	.967554	-4558.
.800	.3633	.8796	.962683	-5307.
.900	.3612	.8874	.957755	-6063.
1.000	.3597	.8949	.952783	-6822.
1.250	.3582	.9123	.940231	-8727.
1.500	.3590	.9289	.927463	-10635.
1.750	.3618	.9462	.914391	-12533.
1.800	.3622	.9490	.911811	-12911.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ell n\gamma)$	$\sigma(\gamma)$
.001	.0000	.0001	.0001
.010	.0003	.0007	.0005
.100	.0005	.0017	.0008
1.000	.0005	.0017	.0006
1.800	.0009	.0018	.0007

Coefficients of Correlating Equations

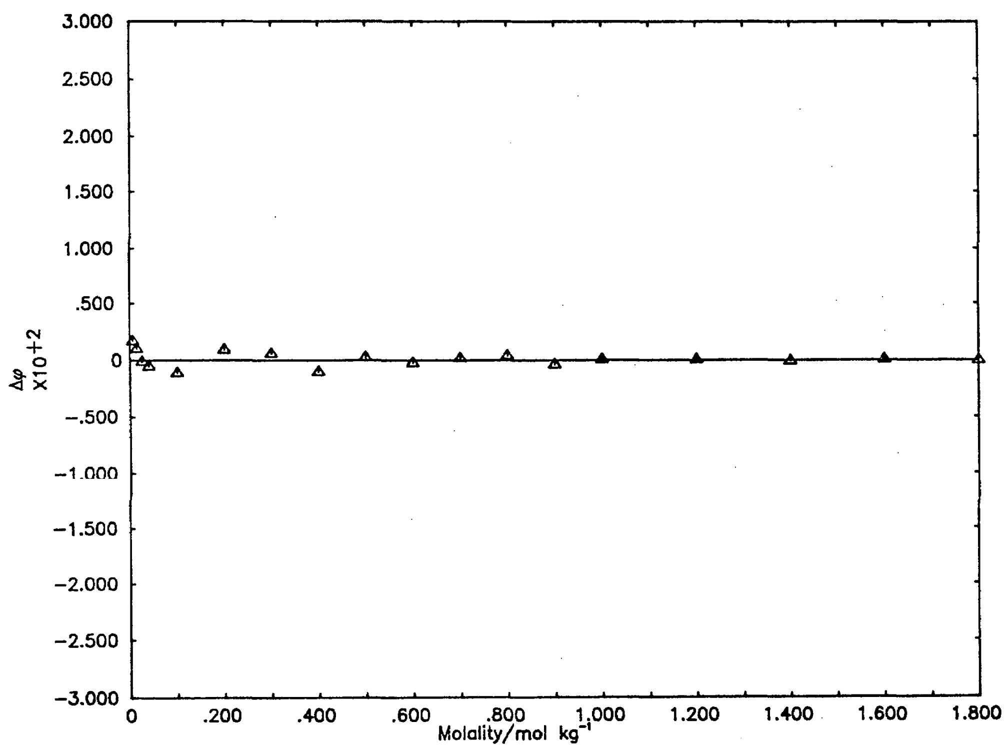
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.8521138579+00	.361-01	-.5391976395+01	.123+00	.7415091910+01	.134+00
2	.1625341953+01	.133+00	.4353632372+02	.957+00	-.6463108363+01	.771+00
3	-.2554486120+01	.298+00	-.9045128683+02	.312+01	.1452403907+00	.182+01
4	.2935704576+01	.459+00	.1156174645+03	.528+01	.4503271757+01	.212+01
5	-.2000657333+01	.398+00	-.8560193110+02	.486+01	-.3317619124+01	.120+01
6	.7244042175+00	.174+00	.3400676713+02	.231+01	.7686607075+00	.266+00
7	-.1069384303+00	.301-01	-.5615086779+01	.443+00		

σ(eqs 1) = .861-03
σ(eqs 2) = .531-03
σ(eqs 3) = .101-02

Experimental Data Employed in Generation of Correlating Equations

Bonner, Rushing and Torres [14]. Vapor pressure osmometry and isopiestic measurements. The reference electrolyte was NaCl [15]. *The authors did not report the isopiestic molalities. Assigned weight is 1.0.*

m/mol·kg^{-1}	$\phi_{298.15}$
.006400	.9150
.014400	.8850
.025600	.8620
.040000	.8460
.100000	.8260
.200000	.8320
.300000	.8410
.400000	.8480
.500000	.8570
.600000	.8640
.700000	.8720
.800000	.8800
.900000	.8870
1.000000	.8950
1.200000	.9090
1.400000	.9220
1.600000	.9360
1.800000	.9490



Deviation Plot for $Na_2C_2H_4S_2O_6$: $\Delta\phi$ vs molality

△ Bonner, Rushing and Torres [14], vapor pressure osmometry and isopiestic vs NaCl

$Na_2C_6H_4S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of sodium m-benzene disulfonate, $Na_2C_6H_4S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8899	.9630	.999948	-1.
.002	.8532	.9507	.999897	-2.
.003	.8278	.9421	.999847	-3.
.004	.8080	.9355	.999798	-4.
.005	.7917	.9301	.999749	-6.
.006	.7778	.9256	.999700	-8.
.007	.7656	.9216	.999651	-10.
.008	.7548	.9181	.999603	-12.
.009	.7451	.9149	.999555	-14.
.010	.7362	.9121	.999507	-16.
.020	.6755	.8935	.999035	-42.
.030	.6390	.8832	.998569	-74.
.040	.6132	.8766	.998107	-109.
.050	.5936	.8721	.997646	-146.
.060	.5778	.8688	.997187	-186.
.070	.5648	.8664	.996727	-228.
.080	.5538	.8647	.996268	-271.
.090	.5443	.8634	.995809	-316.
.100	.5360	.8625	.995349	-361.
.200	.4873	.8631	.990714	-865.
.300	.4648	.8700	.985993	-1419.
.400	.4523	.8790	.981177	-2000.
.500	.4451	.8889	.976265	-2597.
.600	.4412	.8994	.971257	-3202.
.700	.4395	.9102	.966152	-3813.
.800	.4394	.9213	.960948	-4424.
.900	.4406	.9327	.955647	-5035.
1.000	.4428	.9442	.950249	-5643.
1.250	.4519	.9737	.936338	-7140.
1.500	.4646	1.0036	.921861	-8592.
1.750	.4800	1.0335	.906877	-9987.
2.000	.4975	1.0628	.891470	-11319.
2.250	.5164	1.0911	.875746	-12583.
2.500	.5362	1.1177	.859832	-13776.
2.750	.5563	1.1421	.843876	-14901.
3.000	.5761	1.1638	.828039	-15958.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0001	.0001	.0001
.010	.0003	.0007	.0005
.100	.0008	.0025	.0014
1.000	.0009	.0031	.0014
2.000	.0013	.0034	.0017
3.000	.0023	.0039	.0023

Coefficients of Correlating Equations

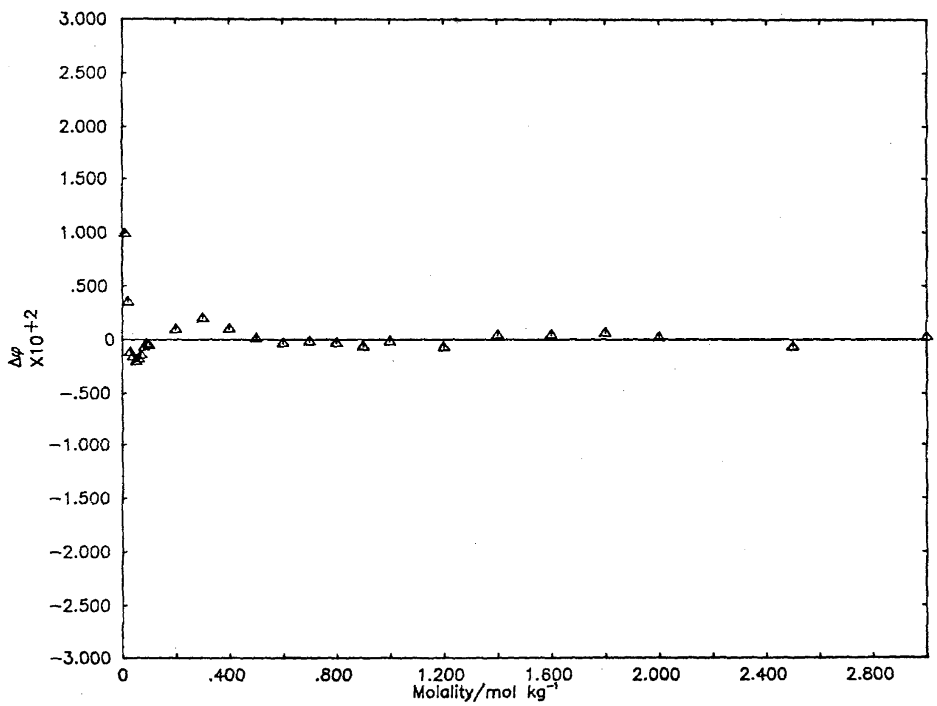
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1883939535+01	.202-01	.5222641691+00	.210+00	.1520843069+02	.843+00
2	.1013949755+00	.119-01	.1319293717+02	.136+01	-.5788339285+02	.822+01
3	.4837335076-01	.727-02	-.1734912424+02	.358+01	.1706499191+03	.350+02
4	-.8520232130-02	.143-02	.1759946157+02	.484+01	-.3343706980+03	.826+02
5			-.1062548387+02	.353+01	.4217199684+03	.117+03
6			.3427347721+01	.133+01	-.3374714899+03	.102+03
7			-.4563048353+00	.201+00	.1653245122+03	.534+02
8					-.4518400698+02	.154+02
9					.5273777768+01	.189+01

σ(eqs 1) = .246-02
σ(eqs 2) = .185-02
σ(eqs 3) = .231-02

Experimental Data Employed in Generation of Correlating Equations

Bonner and Rogers [17]. Vapor pressure osmometry measurements. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.9220
.020000	.8970
.030000	.8820
.040000	.8750
.050000	.8700
.060000	.8670
.070000	.8650
.080000	.8640
.090000	.8630
.100000	.8620
.200000	.8640
.300000	.8720
.400000	.8800
.500000	.8890
.600000	.8990
.700000	.9100
.800000	.9210
.900000	.9320
1.000000	.9440
1.200000	.9670
1.400000	.9920
1.600000	1.0160
1.800000	1.0400
2.000000	1.0630
2.500000	1.1170
3.000000	1.1640



Deviation Plot for $Na_2C_6H_4S_2O_6$: $\Delta\phi$ vs molality

△ Bonner and Rogers [17], vapor pressure osmometry

$Na_2C_{14}H_{12}S_2O_6$

Recommended Values for the mean activity and osmotic coefficient of sodium 4,4'-bibenzyl disulfonate, $Na_2C_{14}H_{12}S_2O_6$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8861	.9610	.999948	-1.
.002	.8465	.9469	.999898	-2.
.003	.8185	.9368	.999848	-3.
.004	.7964	.9288	.999799	-5.
.005	.7781	.9221	.999751	-6.
.006	.7622	.9163	.999703	-8.
.007	.7483	.9112	.999655	-10.
.008	.7359	.9065	.999608	-13.
.009	.7246	.9024	.999561	-15.
.010	.7143	.8985	.999514	-17.
.020	.6422	.8717	.999058	-47.
.030	.5978	.8553	.998614	-83.
.040	.5659	.8436	.998177	-123.
.050	.5413	.8352	.997746	-167.
.060	.5214	.8283	.997318	-214.
.070	.5047	.8227	.996892	-264.
.080	.4904	.8180	.996469	-316.
.090	.4780	.8140	.996048	-370.
.100	.4670	.8105	.995629	-425.
.200	.3957	.7846	.991555	-1059.
.300	.3507	.7562	.987813	-1794.
.400	.3124	.7159	.984642	-2616.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0002	.0005	.0005
.010	.0015	.0034	.0024
.100	.0023	.0062	.0033
.400	.0062	.0106	.0033

Coefficients of Correlating Equations

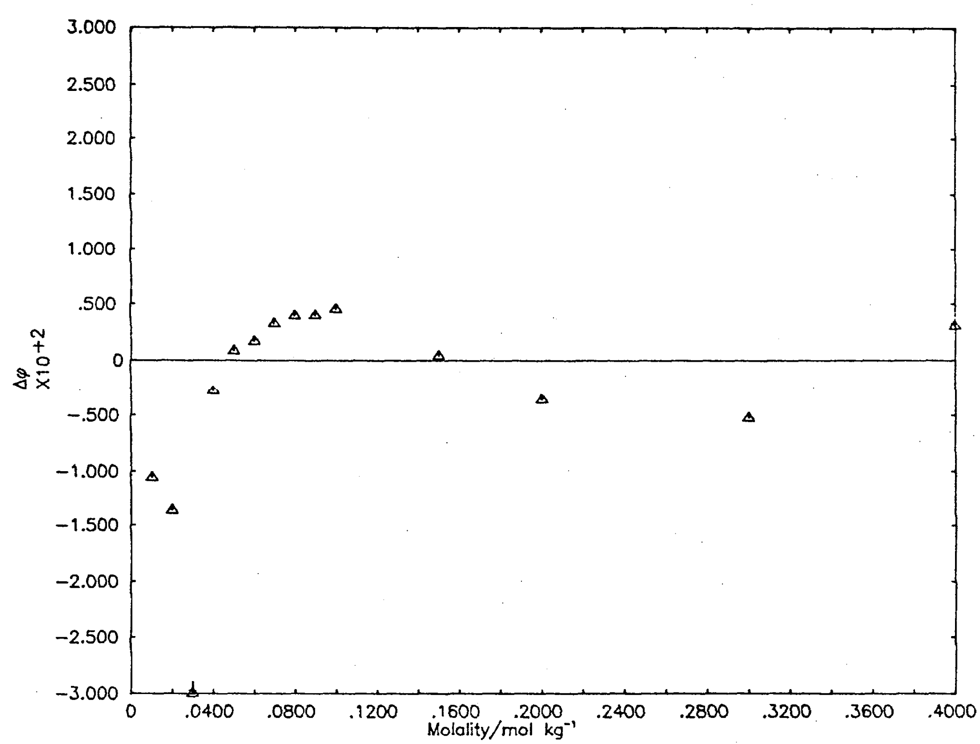
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1116448062+01	.135+00	-.1224068624+02	.920+00	.1409370378+01	.736+00
2	.5114286821+00	.350+00	.1012490406+03	.808+01	.4377180071+02	.647+00
3	-.1305024417+01	.440+00	-.2765208025+03	.276+02	-.1648940738+03	.221+02
4			.3623193926+03	.418+02	.2374755137+03	.355+02
5			-.1803764304+03	.233+02	-.1233221604+03	.186+02

σ(eqs 1) = .650-02
σ(eqs 2) = .231-02
σ(eqs 3) = .185-02

Experimental Data Employed in Generation of Correlating Equations

Bonner and Rogers [17]. Vapor pressure osmometry measurements. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.8880
.020000	.8680
.030000	.8170 *
.040000	.8410
.050000	.8360
.060000	.8300
.070000	.8260
.080000	.8220
.090000	.8180
.100000	.8150
.150000	.7970
.200000	.7810
.300000	.7510
.400000	.7190



Deviation Plot for $Na_2C_{14}H_{12}S_2O_6$: $\Delta\phi$ vs molality

△ Bonner and Rogers [17], vapor pressure osmometry

$Na_2C_{14}H_{12}S_2O_8$

Recommended Values for the mean activity and osmotic coefficient of sodium 2,7-anthraquinone disulfonate, $Na_2C_{14}H_{12}S_2O_8$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8936	.9648	.999948	-1.
.002	.8584	.9529	.999897	-2.
.003	.8334	.9442	.999847	-3.
.004	.8135	.9371	.999797	-4.
.005	.7966	.9308	.999748	-6.
.006	.7818	.9252	.999700	-8.
.007	.7686	.9200	.999652	-10.
.008	.7565	.9152	.999604	-12.
.009	.7454	.9106	.999557	-14.
.010	.7350	.9062	.999510	-16.
.020	.6564	.8698	.999060	-43.
.030	.6012	.8406	.998638	-78.
.040	.5582	.8157	.998238	-119.
.050	.5229	.7939	.997857	-164.
.060	.4932	.7748	.997491	-215.
.070	.4678	.7578	.997137	-269.
.080	.4456	.7426	.996795	-328.
.090	.4260	.7288	.996461	-390.
.100	.4086	.7162	.996137	-455.
.200	.2929	.6125	.993401	-1250.
.300	.2194	.5018	.991897	-2273.
.400	.1848	.4810	.989655	-3480.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0005	.0011	.0010
.010	.0013	.0040	.0030
.100	.0018	.0046	.0019
.400	.0022	.0051	.0009

Coefficients of Correlating Equations

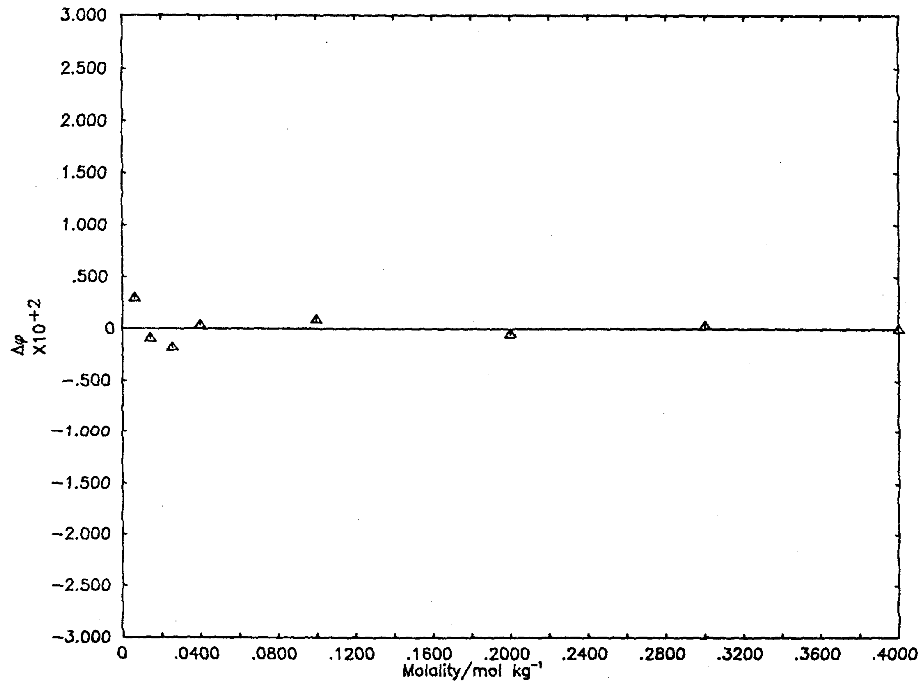
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.4098725747+01	.302+00	.4042491218+01	.745+00	.1788721115+02	.108+01
2	-.7264764590+01	.382+00	-.5414090670+02	.702+01	-.1132082250+03	.101+02
3	.3135949532+02	.277+01	.2394878804+03	.249+02	.3559561834+03	.360+02
4	-.9620218146+02	.891+01	-.3985015005+03	.384+02	-.5297942754+03	.555+02
5	.1103923609+03	.992+01	.2372024031+03	.216+02	.2973257463+03	.312+02

σ(eqs 1) = .216-02
σ(eqs 2) = .176-02
σ(eqs 3) = .254-02

Experimental Data Employed in Generation of Correlating Equations

Bonner, Rushing and Torres [14]. Isopiestic and vapor pressure osmometry measurements. The reference electrolyte was NaCl [15]. The authors did not report the isopiestic molalities. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.006400	.9260
.014400	.8880
.025600	.8510
.040000	.8160
.100000	.7170
.200000	.6120
.300000	.5020
.400000	.4810



Deviation Plot for $Na_2C_{14}H_{10}S_2O_8$: ΔØ vs molality

Δ Bonner, Rushing and Torres [14], vapor pressure osmometry and isopiestic vs NaCl

$Na_2B_{12}H_{12}$

Recommended Values for the mean activity and osmotic coefficient of sodium dodecahydrododecaborate, $Na_2B_{12}H_{12}$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8898	.9630	.999948	-1.
.002	.8532	.9507	.999897	-2.
.003	.8279	.9423	.999847	-3.
.004	.8082	.9358	.999798	-4.
.005	.7921	.9305	.999749	-6.
.006	.7783	.9261	.999700	-8.
.007	.7664	.9223	.999651	-10.
.008	.7557	.9189	.999603	-12.
.009	.7462	.9159	.999555	-14.
.010	.7376	.9133	.999507	-16.
.020	.6792	.8968	.999031	-42.
.030	.6452	.8890	.998560	-73.
.040	.6221	.8851	.998088	-107.
.050	.6052	.8834	.997616	-143.
.060	.5922	.8830	.997141	-182.
.070	.5820	.8837	.996663	-221.
.080	.5739	.8850	.996181	-262.
.090	.5673	.8868	.995696	-304.
.100	.5618	.8890	.995207	-346.
.200	.5429	.9223	.990080	-793.
.300	.5522	.9631	.984505	-1243.
.400	.5740	1.0066	.978474	-1671.
.500	.6041	1.0514	.971987	-2065.
.600	.6410	1.0972	.965044	-2418.
.700	.6841	1.1438	.957650	-2725.
.800	.7333	1.1911	.949805	-2982.
.900	.7890	1.2390	.941513	-3186.
1.000	.8515	1.2876	.932778	-3334.
1.250	1.0418	1.4118	.909029	-3447.
1.500	1.2912	1.5401	.882626	-3174.
1.729	1.5869	1.6612	.856216	-2564.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0001	.0002	.0001
.010	.0005	.0011	.0008
.100	.0013	.0041	.0023
1.000	.0013	.0046	.0039
1.729	.0019	.0053	.0084

Coefficients of Correlating Equations

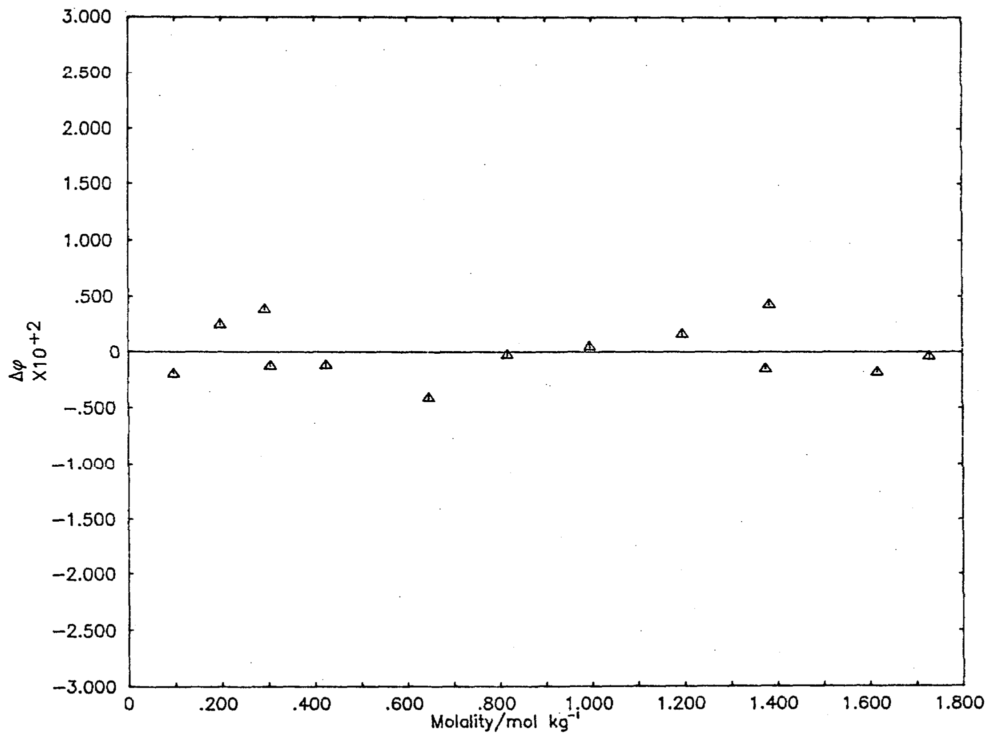
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.17592563180+01	.294-01	.5540101442-01	.630+00	.1068919937+02	.242+00
2	.79131126216+00	.155-01	.1868055722+02	.345+01	-.1586339284+02	.972+00
3	.54777684415-01	.594-02	-.2885735827+02	.786+01	.1497286991+02	.152+01
4			.2909627751+02	.891+01	-.7370931754+01	.105+01
5			-.1516036077+02	.497+01	.1470342624+01	.270+00
6			.3147357993+01	.109+01		

σ(eqs 1) = .267-02
σ(eqs 2) = .229-02
σ(eqs 3) - .213 02

Experimental Data Employed in Generation of Correlating Equations

Wen and Chen [18]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.097200	.8864
.197000	.9236
.293000	.9640
.305000	.9640
.425000	1.0165
.648000	1.1154
.817000	1.1989
.995000	1.2856
1.197000	1.3867
1.376000	1.4744
1.384000	1.4843
1.617000	1.5997
1.729000	1.6608



Deviation Plot for $Na_2B_{12}H_{12}$: $\Delta\phi$ vs molality

△ Wen and Chen [18], isopiestic vs KCl

Na_2CrO_4

Recommended Values for the mean activity and osmotic coefficient of sodium chromate, Na_2CrO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	Ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8875	.9618	.999948	-1.
.002	.8490	.9483	.999898	-2.
.003	.8219	.9388	.999848	-3.
.004	.8007	.9312	.999799	-5.
.005	.7830	.9250	.999750	-6.
.006	.7678	.9195	.999702	-8.
.007	.7544	.9147	.999654	-10.
.008	.7425	.9135	.999606	-12.
.009	.7317	.9066	.999559	-15.
.010	.7218	.9330	.999512	-17.
.020	.6526	.8780	.999051	-45.
.030	.6096	.8624	.998603	-80.
.040	.5784	.8511	.998162	-119.
.050	.5540	.8423	.997727	-161.
.060	.5341	.8351	.997296	-206.
.070	.5173	.8290	.996869	-254.
.080	.5028	.8238	.996445	-304.
.090	.4901	.8192	.996023	-356.
.100	.4788	.8150	.995605	-410.
.200	.4062	.7881	.991517	-1025.
.300	.3657	.7723	.987556	-1736.
.400	.3381	.7611	.983602	-2515.
.500	.3176	.7526	.979867	-3345.
.600	.3015	.7463	.976090	-4218.
.700	.2885	.7417	.972330	-5127.
.800	.2778	.7386	.968571	-6066.
.900	.2688	.7368	.964795	-7031.
1.000	.2613	.7363	.960988	-8018.
1.250	.2474	.7398	.951247	-10567.
1.500	.2384	.7495	.941044	-13201.
1.750	.2331	.7646	.930233	-15890.
2.000	.2307	.7846	.918693	-18609.
2.250	.2308	.8088	.906325	-21337.
2.500	.2330	.8372	.893039	-24056.
2.750	.2373	.8697	.878749	-26748.
3.000	.2438	.9061	.863363	-29399.
3.250	.2524	.9468	.846780	-31992.
3.500	.2635	.9921	.828883	-34513.
3.750	.2774	1.0425	.809539	-36946.
4.000	.2947	1.0986	.788592	-39275.
4.250	.3163	1.1613	.765873	-41483.
4.363	.3276	1.1920	.754973	-42436.

m/mol·kg^{-1}]	σ(Ø)	$\sigma(\ell n\gamma)$	$\sigma(\gamma)$
.001	.0001	.0003	.0002
.010	.0008	.0019	.0013
.100	.0024	.0072	.0035
1.000	.0020	.0086	.0023
2.000	.0019	.0087	.0020
4.363	.0035	.0094	.0031

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1521281253+01	.498-01	-.2490769557+00	.248+00	.7494636812+01	.176+00
2	-.3518642820+00	.380-01	.1087083995+02	.920+00	-.9297149038+01	.447+00
3	.1519398273+00	.239-01	-.8231604860+01	.138+01	.6425181609+01	.445+00
4	-.2308277403-01	.682-02	.4705429377+01	.102+01	-.2227319589+01	.197+00
5	.2077345276-02	.690-03	-.1485809754+01	.365+00	.3088351363+00	.324-01
6			.1930572245+00	.509-01		

σ(eqs 1) = .360-02
σ(eqs 2) = .320-02
σ(eqs 3) = .510-02

Experimental Data Employed in Generation of Correlating Equations

Carr and Harris [70]. These workers report the vapor pressure over the saturated solution. We have assumed that this pertains to a molality of 5.413 $mol \cdot kg^{-1}$ and we have adjusted the data to 25°C using the Φ_L data for $K_2Cr_2O_7$ and the Φ_C data for $K_2Cr_2O_4$ given in the table of auxiliary data. Assigned weight is zero.

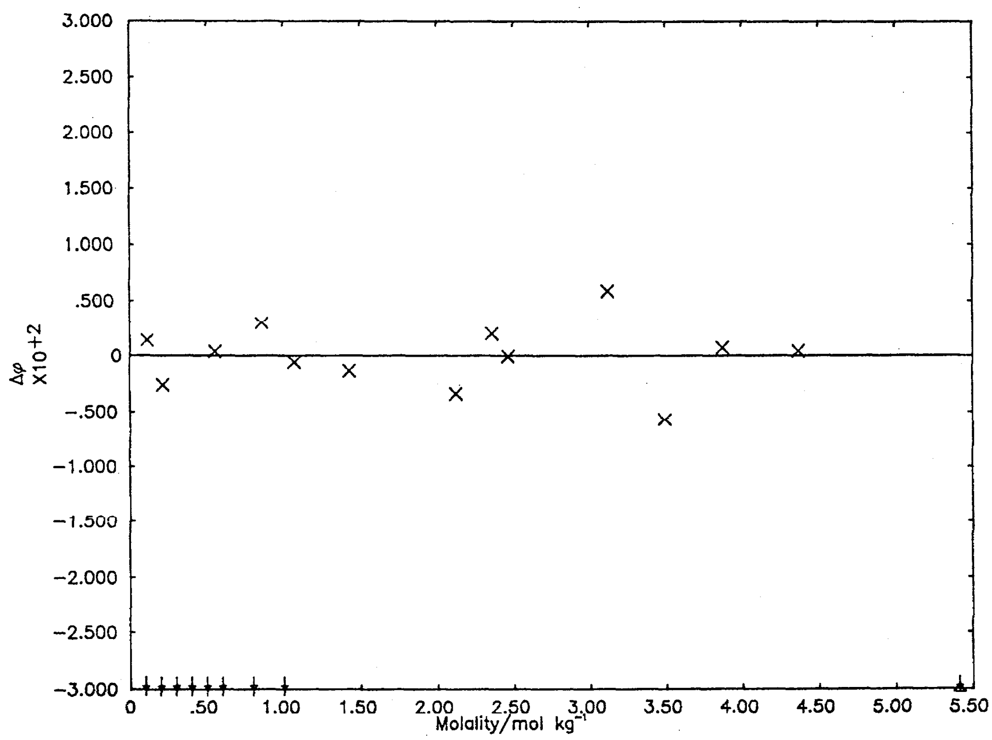
$m/mol \cdot kg^{-1}$	$\phi_{298.15}$
5.413000	1.4850

Jones et al. [40]. Freezing point depression measurements. These measurements were treated using the Φ_L data for $K_2Cr_2O_7$ and the Φ_C data for $K_2Cr_2O_4$ given in the table of auxiliary data. Assigned weight is zero.

$m/mol \cdot kg^{-1}$	$\phi_{298.15}$
.100000	.7677
.200000	.7118
.300000	.6800
.400000	.6614
.500000	.6436
.600000	.6397
.800000	.6206
1.000000	.6081

Stokes [71]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

$m/mol \cdot kg^{-1}$	$\phi_{298.15}$
.112700	.8118
.215800	.7826
.553300	.7494
.856400	.7404
1.070000	.7360
1.428000	.7448
2.121000	.7924
2.357000	.8225
2.462000	.8326
3.118000	.9307
3.489000	.9843
3.866000	1.0685
4.363000	1.1924



Deviation Plot for Na_2CrO_4: $\Delta\phi$ vs molality

▲ Carr and Harris [70], vapor pressure

+ Jones et al. [40], freezing point depression

× Stokes [71], isopiestic vs NaCl

Na_2WO_4

Recommended Values for the mean activity and osmotic coefficient of sodium tungstate, Na_2WO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8858	.9608	.999948	-1.
.002	.8459	.9466	.999898	-2.
.003	.8177	.9363	.999848	-3.
.004	.7954	.9282	.999799	-5.
.005	.7768	.9213	.999751	-6.
.006	.7607	.9153	.999703	-8.
.007	.7466	.9100	.999656	-11.
.008	.7339	.9052	.999609	-13.
.009	.7224	.9009	.999562	-15.
.010	.7119	.8969	.999515	-18.
.020	.6382	.8686	.999062	-47.
.030	.5923	.8509	.998621	-84.
.040	.5593	.8382	.998190	-125.
.050	.5337	.8286	.997763	-170.
.060	.5130	.8209	.997341	-218.
.070	.4957	.8147	.996922	-269.
.080	.4809	.8096	.996506	-322.
.090	.4681	.8052	.996091	-378.
.100	.4568	.8016	.995677	-435.
.200	.3885	.7840	.991561	-1085.
.300	.3547	.7813	.987412	-1825.
.400	.3341	.7840	.983195	-2619.
.500	.3202	.7893	.978897	-3451.
.600	.3104	.7960	.974517	-4310.
.700	.3033	.8036	.970055	-5189.
.800	.2980	.8117	.965512	-6083.
.900	.2941	.8202	.960889	-6989.
1.000	.2912	.8289	.956189	-7903.
1.250	.2873	.8512	.944118	-10212.
1.500	.2866	.8738	.931613	-12534.
1.750	.2880	.8965	.918708	-14854.
2.000	.2909	.9190	.905433	-17160.
2.250	.2951	.9415	.891819	-19443.
2.500	.3003	.9639	.877892	-21696.
2.523 (sat)	.3008	.9659	.876596	-21902.
2.558	.3016	.9690	.874619	-22214.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0003	.0006	.0005
.010	.0021	.0045	.0032
.100	.0093	.0234	.0107
1.000	.0114	.0541	.0158
2.000	.0057	.0495	.0144
2.558	.0093	.0435	.0131

Coefficients of Correlating Equations

Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1119588272+01	.951-01	.3284014925+01	.492-01
2	.1525394837+00	.245-01	-.8409229267+00	.279-01

σ(eqs 1) = .976-02
σ(eqs 3) = .942-02

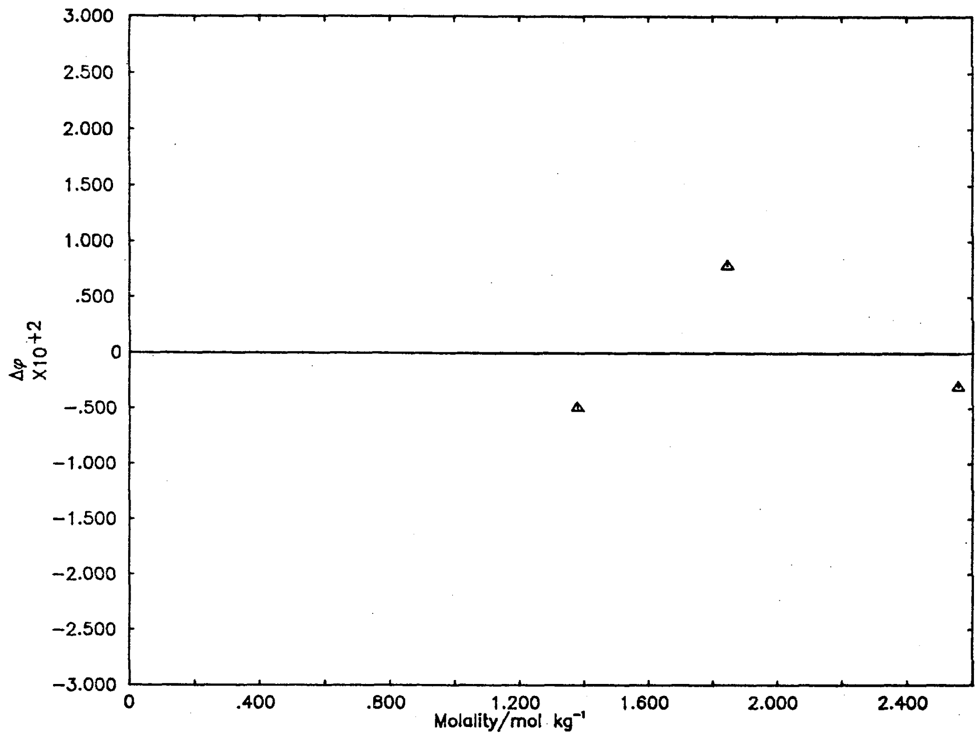
Experimental Data Employed in Generation of Correlating Equations

Dellien [72]. Isopiestic measurements, reference electrolyte is H_2SO_4. This worker did not report the isopiestic molalities. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
1.380000	.8580
1.846000	.9130
2.558000	.9660

Comments

The fit for this system is based on only three isopiestic measurements. Additional data would be desirable. It was not possible to obtain a satisfactory fit using eqs. 2.



Deviation Plot for Na_2WO_4: $\Delta\phi$ vs molality

▲ Dellien [72], isopiestic vs H_2SO_4

K_2SO_4

Recommended Values for the mean activity and osmotic coefficient of potassium sulfate, K_2SO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8846	.9601	.999948	-1.
.002	.8437	.9453	.999898	-2.
.003	.8146	.9345	.999848	-3.
.004	.7914	.9258	.999800	-5.
.005	.7720	.9183	.999752	-7.
.006	.7553	.9118	.999704	-9.
.007	.7404	.9060	.999657	-11.
.008	.7271	.9008	.999611	-13.
.009	.7150	.8960	.999564	-15.
.010	.7029	.8915	.999518	-18.
.020	.6251	.8590	.999072	-49.
.030	.5754	.8376	.998643	-87.
.040	.5392	.8216	.998225	-131.
.050	.5109	.8088	.997817	-179.
.060	.4877	.7983	.997415	-230.
.070	.4682	.7893	.997018	-285.
.080	.4515	.7816	.996626	-343.
.090	.4369	.7747	.996239	-404.
.100	.4239	.7687	.995854	-466.
.200	.3429	.7304	.992136	-1191.
.300	.3000	.7102	.988551	-2040.
.400	.2719	.6971	.985044	-2973.
.500	.2514	.6875	.981593	-3972.
.600	.2355	.6800	.978190	-5024.
.692 (sat)	.2237	.6743	.975097	-6031.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0000	.0001	.0001
.010	.0003	.0007	.0005
.100	.0012	.0033	.0014
.692	.0033	.0046	.0010

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.9438300725+00	.179-01	-.2100728296+02	.193+01	.5104692996+01	.133+00
2	-.8859857747-01	.231-01	.1529132612+03	.196+02	-.3673183129+01	.370+00
3			-.4442337141+03	.784+02	.9209181712+00	.268+00
4			.7015640009+03	.151+03		
5			-.5658857765+03	.141+03		
6			.1831688027+03	.512+02		

σ(eqs 1) = .719-02
σ(eqs 2) = .113-01
σ(eqs 3) = .774-02

Experimental Data Employed in Generation of Correlating Equations

Abegg [73]. Freezing point depression measurements. The Φ_L and Φ_C data for K_2SO_4 given in the table of auxiliary data were used in treating these and the other freezing point depression measurements on K_2SO_4. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.004381	.9943
.006532	.9258
.008673	.8798
.010804	.8661
.012906	.8547
.014958	.8505

Archibald [31]. Freezing point depression measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.050070	.4199
.055090	.4175
.060110	.4156
.070140	.4127
.100290	.4059
.201180	.3856
.251870	.3789
.302720	.3735
.353740	.3711
.404940	.3694
.456310	.3697
.507860	.3699
.611530	.3753
.715970	.3873

Filippov et al. [74]. Vapor pressure measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.251500	.7552
.491100	.7083

Foote et al. [36]. Vapor pressure measurement. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.691200	.6813

Hall and Harkins [75]. Freezing point depression measurements. Assigned weight is 0.60.

m/mol·kg^{-1}	$\phi_{298.15}$
.002740	.9320
.004040	1.2827*
.006180	.9180
.010390	.8940
.017560	.8676
.026080	.8478
.045470	.8173
.088990	.7774
.120500	.7598

Hovorka and Rodebush [76]. Freezing point depression measurements. Assigned weight is 0.30.

m/mol·kg^{-1}	$\phi_{298.15}$
.001000	.9404
.002740	.3434*
.005000	.9154
.010000	.8923

Indelli [21]. Freezing point depression measurements. Assigned weight is 0.20.

m/mol·kg^{-1}	$\phi_{298.15}$
.003075	.9062
.003853	.9023
.007187	.8848
.013390	.8643
.016796	.8595
.020695	.8487
.030064	.8310
.046900	.8086
.047636	.8086
.061410	.7952
.089460	.7748
.090036	.7762
.115480	.7589
.141350	.7462
.145660	.7443
.172040	.7345
.209740	.7216
.240820	.7118
.277420	.6965
.311220	.6942
.319170	.6926
.355160	.6852
.366790	.6838
.396400	.6787
.407380	.6776

Jones [77]. Freezing point depression measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.001000	.9680
.001996	.9578
.003001	.9521
.003991	.9483
.004971	.9370
.006002	.9304
.006982	.9248
.007953	.9217
.008923	.9053
.009884	.8983
.020013	.8833
.029227	.8615
.038044	.8475
.050074	.8210
.058099	.8165
.065827	.7954
.073156	.7896
.080287	.7862
.087120	.7792
.093705	.7773

Jones et al. [40]. Freezing point depression measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.050000	.8219
.100000	.7646

Leopold and Johnston [43]. Vapor pressure measurement performed on saturated solutions at 24.73 and 25.58°C. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.691300	.8660

Loomis [44,65]. Freezing point depression measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.8771
.020000	.8480
.050000	.8097
.100000	.7713
.200000	.7296
.300000	.7016

Osaka [78]. Freezing point depression measurements. Assigned weight is 0.30.

m/mol·kg^{-1}	$\phi_{298.15}$
.001172	.9579
.002556	.9405
.003911	.9325
.005194	.9248
.006498	.9062
.007777	.8989
.001919	.9590
.003890	.9283
.005645	.9159
.007454	.9068
.009229	.8945
.010986	.8877

Pearce and Eckstrom [23]. Vapor pressure measurements. Assigned weight is 0.40.

m/mol·kg^{-1}	$\phi_{298.15}$
.100000	.7500*
.200000	.7319
.400000	.6934
.600000	.6742
.688900	.6649

Ponsot [79]. Freezing point depression measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.036260	.8207
.037660	.8186
.114300	.7585
.117800	.7558
.208100	.7184

Rivett [80]. Freezing point depression measurements. Assigned weight is 0.10.

m/mol·kg^{-1}	$\phi_{298.15}$
.049600	.8267
.128000	.7658
.209400	.7276
.291900	.7045
.324700	.6987

Robinson, Wilson, and Stokes [24]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.095750	.7806
.129300	.7688
.146100	.7541
.181700	.7489
.185200	.7480
.205500	.7413
.230600	.7323
.238400	.7353
.240400	.7356
.307600	.7206
.316800	.7192
.383800	.7047
.393700	.7038
.399900	.7036
.411900	.6997
.426700	.7005
.494100	.6915
.499800	.6916
.577600	.6827
.622200	.6782
.689800	.6715

Wexler and Hasegawa [81]. Vapor pressure measurement performed over the saturated solution. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.691200	.8440

Åkerlof [25,25a]. Emf measurements on the cell Hg(l), Hg_2SO_4(s); K_2SO_4(m); K(Hg)$_x$(l); K_2SO_4(m_{ref}); Hg_2SO_4(s), Hg(l). m_{ref} = 0.05 mol·kg^{-1}. Assigned weight is 0.40.

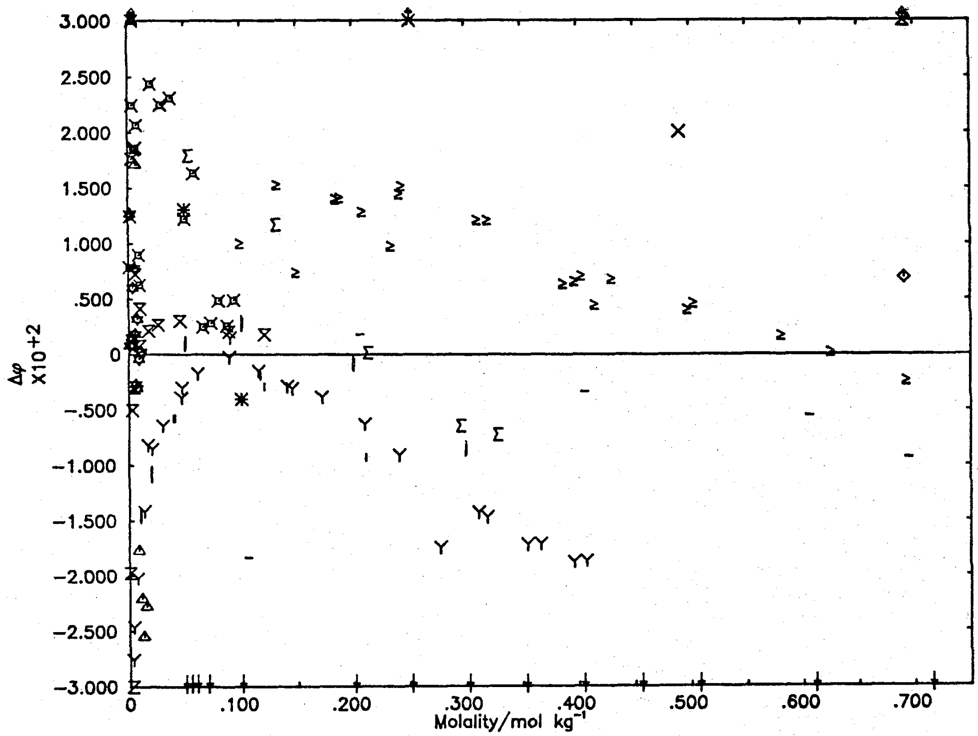
m/mol·kg^{-1}	γ/γ_{ref}
.025000	1.1947
.125000	.7471
.248000	.5999
.494000	.4815
.621000	.4395

Murata [82]. Emf measurements on the cell K(Hg)$_x$(l); K_2SO_4(m); Hg_2SO_4(s), Hg(l). m_{ref} = 0.01 mol·kg^{-1}. Assigned weight is zero.

m/mol·kg^{-1}	γ/γ_{ref}
.692000	.2778
.500000	.2690
.300000	.2995
.200000	.4213
.100000	.5242
.050000	.6327

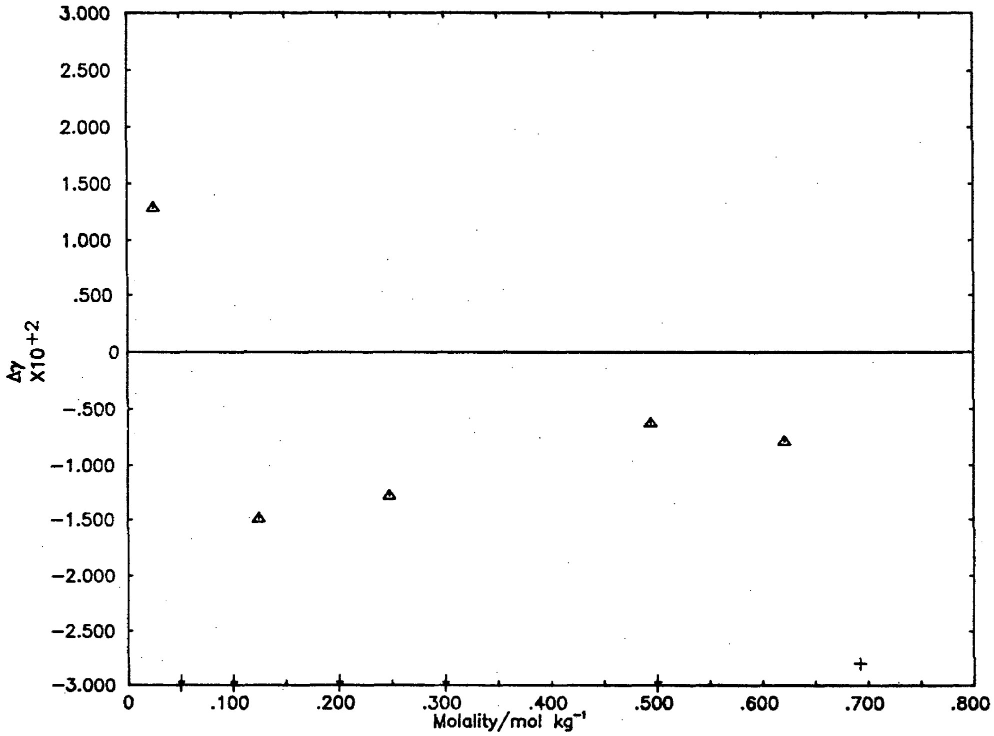
Comments

We have given the most weight to the careful isopiestic measurements of Robinson et al. [24], which are reasonably consistent with the cell measurements of Åkerlof [25,25a]. The vapor pressure measurements of Pearce and Eckstrom [23], with the exception of one data point at the lowest molality, are in excellent agreement with our final fit. Wexler and Hasegawa [81] report the vapor pressure over the saturated solution. Their result differs significantly from the bulk of the measurements and we have given it zero weight. A similar measurement by Foote et al. [36], however, is in good accord with our final fit. Two vapor pressure measurements reported by Filippov et al. [74] were given a low weight. The careful freezing point depression measurements of Hall and Harkins [75], Hovorka and Rodebush [76], and Osaka [78], with the exception of two data points contained in the former two investigations and which are probably typographical errors, are in good agreement with each other and merge well with the isopiestic measurements. We have given lower weights to the remainder of the freezing point depression data which appears to be of a lower quality than the aforementioned investigations. The emf measurements of Murata [82] appear to have large systematic errors associated with them. The cell measurements of Hass and Jellinek [83] and of Sircar et al. [84] involve unknown liquid junction potentials and we have chosen not to treat these data. Shibata, Oda, and Furukawa [85] report one measurement on the cell K(Hg)$_x$(l); $K_2SO_4(m)$; Hg_2SO_4(s), Hg(l) and, since it is only one measurement, it cannot be used to obtain any values of γ/γ_{ref} and hence any activity coefficients. Plake [86] reports some boiling point elevation data, which we have chosen not to treat due to the large and uncertain temperature corrections.



Deviation Plot for K_2SO_4: ΔØ vs molality

- ▲ Abegg [73], freezing point depression
- \+ Archibald [31], freezing point depression
- X Filippov, Makerevskii, and Yakimov [74], vapor pressure
- ◇ Foote et al. [36], vapor pressure
- ⪥ Hall and Harkins [75], freezing point depression
- Z Hovorka and Rodebush [76], freezing point depression
- Y Indelli [21], freezing point depression
- ⌘ Jones [77], freezing point depression
- ✱ Jones et al. [40], freezing point depression
- ⧗ Leopold and Johnston [43], vapor pressure
- | Loomis [44,65], freezing point depression
- ✡ Osaka [78], freezing point depression
- – Pearce and Eckstrom [23], vapor pressure
- ı Ponsot [79], freezing point depression
- Σ Rivett [80], freezing point depression
- ≥ Robinson, Wilson and Stokes [24], isopiestic vs KCl
- ≤ Wexler and Hasegawa [81], vapor pressure



Deviation Plot for K_2SO_4; Δγ vs molality

Δ Äkerlof [25,25a], emf

+ Murata [82], emf

K_2HPO_4

Recommended Values for the mean activity and osmotic coefficient of potassium orthophosphate, K_2HPO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8865	.9612	.999948	-1.
.002	.8471	.9472	.999898	-2.
.003	.8193	.9372	.999848	-3.
.004	.7973	.9293	.999799	-5.
.005	.7790	.9226	.999751	-6.
.006	.7633	.9168	.999703	-8.
.007	.7494	.9116	.999655	-10.
.008	.7369	.9070	.999608	-13.
.009	.7257	.9028	.999561	-15.
.010	.7153	.8989	.999514	-17.
.020	.6426	.8711	.999059	-47.
.030	.5969	.8533	.998617	-82.
.040	.5638	.8402	.998185	-123.
.050	.5378	.8298	.997760	-167.
.060	.5164	.8212	.997341	-215.
.070	.4984	.8138	.996926	-266.
.080	.4829	.8074	.996515	-319.
.090	.4692	.8017	.996108	-374.
.100	.4571	.7966	.995704	-431.
.200	.3789	.7620	.991797	-1089.
.300	.3352	.7404	.988068	-1859.
.400	.3054	.7241	.984468	-2708.
.500	.2830	.7109	.980971	-3619.
.600	.2653	.7001	.977553	-4583.
.700	.2509	.6911	.974191	-5591.
.800	.2389	.6839	.970865	-6637.
.873	.2313	.6795	.968452	-7422.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0001	.0001	.0001
.010	.0005	.0010	.0007
.100	.0012	.0037	.0017
.873	.0018	.0044	.0010

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1330082082+01	.299-01	-.1196806511+01	.207+00	.7486245576+01	.207+00
2	-.3854662891+00	.375-01	.1277618910+02	.800+00	-.1027288937+02	.799+00
3	.1052672337+00	.245-01	-.8994119524+01	.108+01	.7548955985+01	.108+01
4			.3060931796+01	.489+00	-.2215700645+01	.488+00

σ(eqs 1) = .324-02
σ(eqs 2) = .335-02
σ(eqs 3) = .334-02

Experimental Data Employed in Generation of Correlating Equations

Burge [32]. Vapor pressure osmometry measurements performed at 37°C. The Φ_L data for K_2HPO_4 and the Φ_C data for Na_2SO_4 given in the table of auxiliary data were used in adjusting these measurements to 25°C. We have given zero weight to the data for the lowest three molalities and unit weight to the highest four.

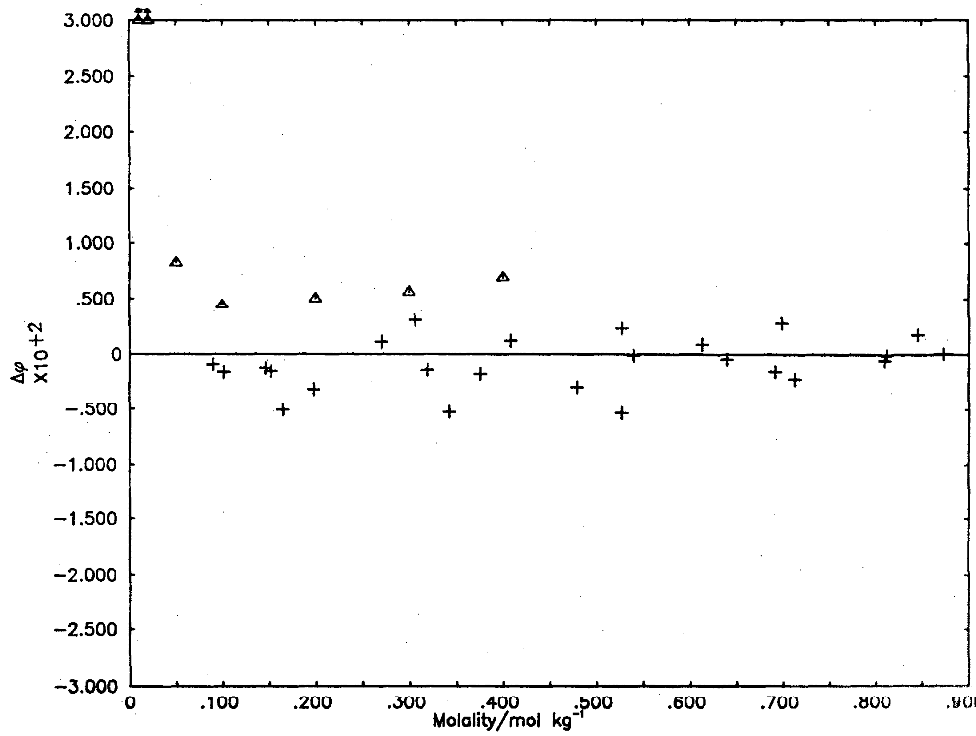
m/mol·kg^{-1}	$\phi_{298.15}$
.010000	.9520*
.020000	.9120*
.050000	.8380*
.100000	.8010
.200000	.7670
.300000	.7460
.400000	.7310

Scatchard and Breckenridge [61]. Isopiestic measurements, reference salt is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.872870	.6796
.844960	.6828
.811810	.6830
.809500	.6827
.713100	.6879
.698690	.6940
.691600	.6903
.639600	.6959
.612940	.6997
.539610	.7063
.526910	.7101
.526610	.7025
.479410	.7105
.407940	.7241
.375790	.7259
.341940	.7278
.319150	.7355
.305970	.7423
.269850	.7472
.197860	.7594
.164520	.7669
.151830	.7745
.146360	.7766
.101290	.7944
.089470	.8011

Comments

The vapor pressure osmometry results of Burge, with the exception of the data at the three lowest molalities, are in good agreement with the results of Scatchard and Breckenridge [61].



Deviation Plot for K_2HPO_4: $\Delta\phi$ vs molality

▲ Burge [32], vapor pressure osmometry

+ Scatchard and Breckenridge [61], isopiestic vs NaCl

$K_2H_2P_2O_7$

Recommended Values for the mean activity and osmotic coefficient of potassium dihydrogen pyrophosphate, $K_2H_2P_2O_7$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8871	.9615	.999948	-1.
.002	.8481	.9478	.999898	-2.
.003	.8206	.9380	.999848	-3.
.004	.7990	.9302	.999799	-5.
.005	.7810	.9237	.999750	-6.
.006	.7655	.9181	.999702	-8.
.007	.7518	.9131	.999655	-10.
.008	.7396	.9085	.999607	-13.
.009	.7285	.9044	.999560	-15.
.010	.7183	.9007	.999513	-17.
.020	.6467	.8737	.999056	-46.
.030	.6017	.8562	.998613	-81.
.040	.5687	.8431	.998179	-121.
.050	.5428	.8326	.997753	-165.
.060	.5214	.8238	.997332	-212.
.070	.5033	.8161	.996917	-262.
.080	.4875	.8093	.996507	-314.
.090	.4736	.8031	.996101	-368.
.100	.4611	.7975	.995699	-425.
.200	.3792	.7562	.991859	-1080.
.300	.3318	.7271	.988280	-1853.
.400	.2985	.7034	.984910	-2714.
.500	.2732	.6830	.981712	-3647.
.600	.2529	.6653	.978657	-4641.
.700	.2362	.6497	.975719	-5689.
.800	.2221	.6360	.972876	-6786.
.900	.2101	.6239	.970108	-7926.
1.000	.1997	.6133	.967396	-9105.
1.250	.1790	.5924	.960768	-12206.
1.500	.1636	.5782	.954211	-15491.
1.750	.1518	.5691	.947601	-18928.
2.000	.1425	.5639	.940869	-22494.
2.250	.1350	.5616	.933982	-26168.
2.500	.1289	.5615	.926937	-29934.
2.750	.1238	.5629	.919742	-33781.
3.000	.1195	.5654	.912409	-37699.
3.070	.1184	.5662	.910331	-38807.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0001	.0001	.0001
.010	.0004	.0010	.0007
.100	.0012	.0036	.0017
1.000	.0004	.0037	.0007
2.000	.0005	.0040	.0006
3.070	.0011	.0041	.0005

Coefficients of Correlating Equations

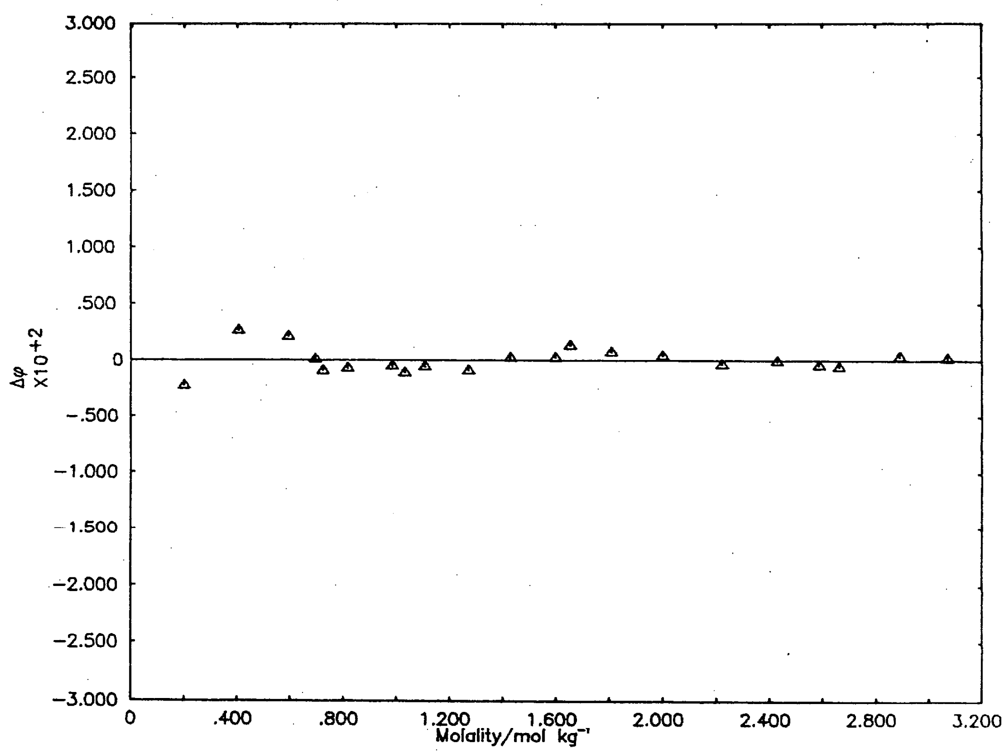
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1476275533+01	.266-01	-.2704897451+01	.240+00	.7225785434+01	.431-01
2	-.6368447433+00	.240-01	.2159131198+02	.120+01	-.9759974248+01	.125+00
3	.2046399849+00	.188-01	-.3111567765+02	.260+01	.7329352280+01	.143+00
4	-.3590390693-01	.707-02	.3066033166+02	.300+01	-.2784232255+01	.735-01
5	.2639688678-02	.973-03	-.1767450021+02	.192+01	.4213900955+00	.141-01
6			.5443605805+01	.644+00		
7			-.6934081902+00	.886-01		

σ(eqs 1) = .122-02
σ(eqs 2) = .520-03
σ(eqs 3) = .737-03

Experimental Data Employed in Generation of Correlating Equations

Bonner [120]. Isopiestic measurements, reference electrolyte is $Na_2S_2O_3$. The evaluated osmotic coefficients given for $Na_2S_2O_3$ in this paper were used in performing the calculations. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.201000	.7536
.406000	.7047
.594000	.6684
.696000	.6504
.725000	.6452
.818000	.6330
.985000	.6143
1.032000	.6091
1.107000	.6029
1.271000	.5901
1.428000	.5819
1.597000	.5743
1.652000	.5734
1.806000	.5683
1.998000	.5643
2.221000	.5614
2.428000	.5613
2.586000	.5614
2.662000	.5617
2.890000	.5645
3.070000	.5664



Deviation Plot for $K_2H_2P_2O_7$: $\Delta\phi$ vs molality

△ Bonner [120], isopiestic vs $Na_2S_2O_3$

K_2HAsO_4

Recommended Values for the mean activity and osmotic coefficient of potassium orthoarsenate, K_2HAsO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8891	.9626	.999948	-1.
.002	.8517	.9498	.999897	-2.
.003	.8258	.9410	.999847	-3.
.004	.8054	.9340	.999798	-4.
.005	.7886	.9282	.999749	-6.
.006	.7742	.9233	.999701	-8.
.007	.7615	.9190	.999652	-10.
.008	.7503	.9152	.999604	-12.
.009	.7401	.9117	.999557	-14.
.010	.7308	.9086	.999509	-17.
.020	.6662	.8868	.999042	-44.
.030	.6263	.8737	.998584	-76.
.040	.5975	.8643	.998133	-113.
.050	.5751	.8571	.997687	-153.
.060	.5567	.8512	.997244	-195.
.070	.5412	.8462	.996804	-240.
.080	.5278	.8420	.996366	-286.
.090	.5160	.8382	.995931	-335.
.100	.5055	.8349	.995498	-385.
.200	.4374	.8124	.991257	-951.
.300	.3988	.7987	.987133	-1602.
.400	.3722	.7891	.983085	-2313.
.500	.3525	.7824	.979078	-3069.
.600	.3372	.7783	.975077	-3861.
.700	.3253	.7766	.971048	-4683.
.800	.3159	.7771	.966957	-5530.
.886	.3095	.7795	.963343	-6278.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0001	.0002	.0002
.010	.0005	.0013	.0009
.100	.0012	.0041	.0021
.886	.0016	.0047	.0014

Coefficients of Correlating Equations

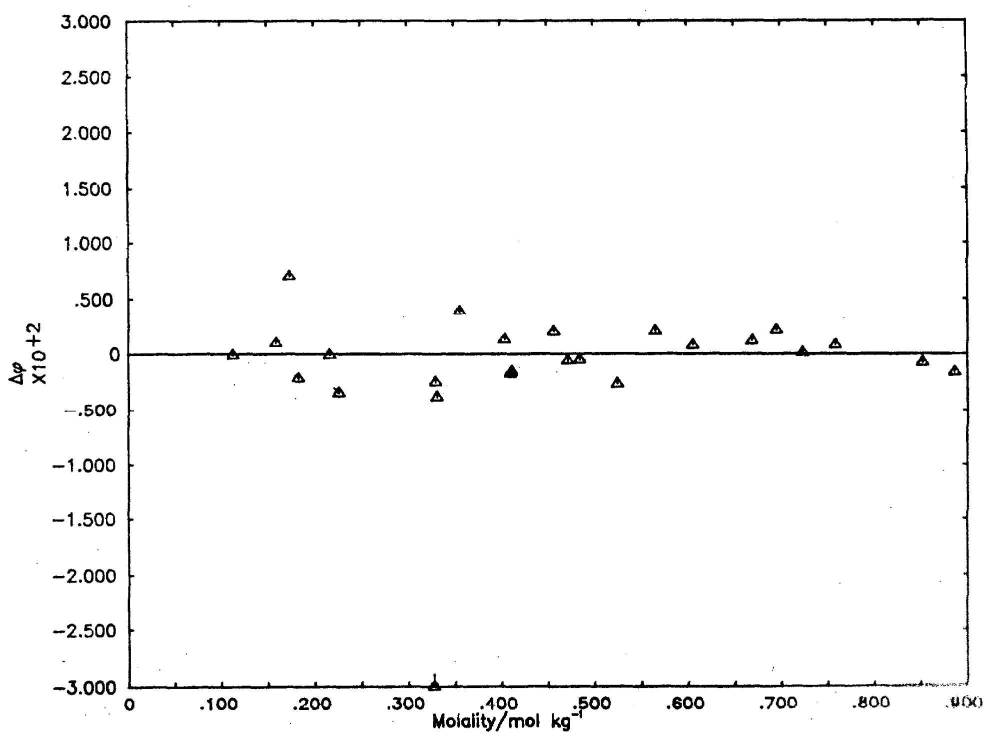
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1822615158+01	.378-01	.1401467296+01	.541-01	.9537221675+01	.205+00
2	-.3925113133+00	.288-01	.5755022906+01	.123+00	-.1525119966+02	.770+00
3	.1794377058+00	.196-01	-.1210801468+01	.747-01	.1267893612+02	.101+01
4					-.4118097390+01	.449+00

σ(eqs 1) = .253-02
σ(eqs 2) = .246-02
σ(eqs 3) = .257-02

Experimental Data Employed in Generation of Correlating Equations

Scatchard and Breckenridge [61]. Isopiestic measurements, reference electrolyte is NaCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.886460	.7779
.852010	.7776
.758370	.7774
.723680	.7766
.694470	.7787
.668780	.7780
.605580	.7789
.564730	.7815
.524170	.7786
.484340	.7828
.471610	.7835
.456040	.7870
.411300	.7867
.409820	.7866
.403620	.7901
.355220	.7969
.330760	.7916
.329420	.7931
.327400	.5882 *
.226010	.8049
.216450	.8097
.182470	.8133
.173470	.8241
.158980	.8209
.112830	.8309



Deviation Plot for K_2HAsO_4: $\Delta\phi$ vs molality

▲ Scatchard and Breckinridge [61], isopiestic vs NaCl

$K_2Pt(CN)_4$

Recommended Values for the mean activity and osmotic coefficient of potassium platinocyanide $K_2Pt(CN)_4$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8936	.9650	.999948	-1.
.002	.8596	.9541	.999897	-2.
.003	.8363	.9467	.999847	-3.
.004	.8183	.9411	.999797	-4.
.005	.8035	.9365	.999747	-6.
.006	.7909	.9326	.999698	-7.
.007	.7799	.9293	.999648	-9.
.008	.7702	.9263	.999600	-11.
.009	.7614	.9237	.999551	-13.
.010	.7533	.9212	.999502	-15.
.020	.6975	.9046	.999023	-39.
.030	.6626	.8941	.998551	-68.
.040	.6370	.8861	.998086	-100.
.050	.6165	.8796	.997626	-135.
.060	.5994	.8740	.997170	-172.
.070	.5848	.8691	.996718	-211.
.080	.5719	.8646	.996269	-252.
.090	.5605	.8605	.995823	-294.
.100	.5501	.8568	.995380	-338.
.200	.4809	.8306	.991062	-837.
.300	.4413	.8163	.986852	-1415.
.400	.4143	.8074	.982698	-2048.
.500	.3937	.8001	.978610	-2723.
.600	.3765	.7926	.974626	-3433.
.700	.3614	.7842	.970769	-4175.
.800	.3480	.7758	.967015	-4946.
.900	.3368	.7698	.963248	-5743.
.948	.3325	.7689	.961368	-6135.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0004	.0009	.0008
.010	.0019	.0049	.0037
.100	.0015	.0079	.0043
.948	.0022	.0074	.0024

Coefficients of Correlating Equations

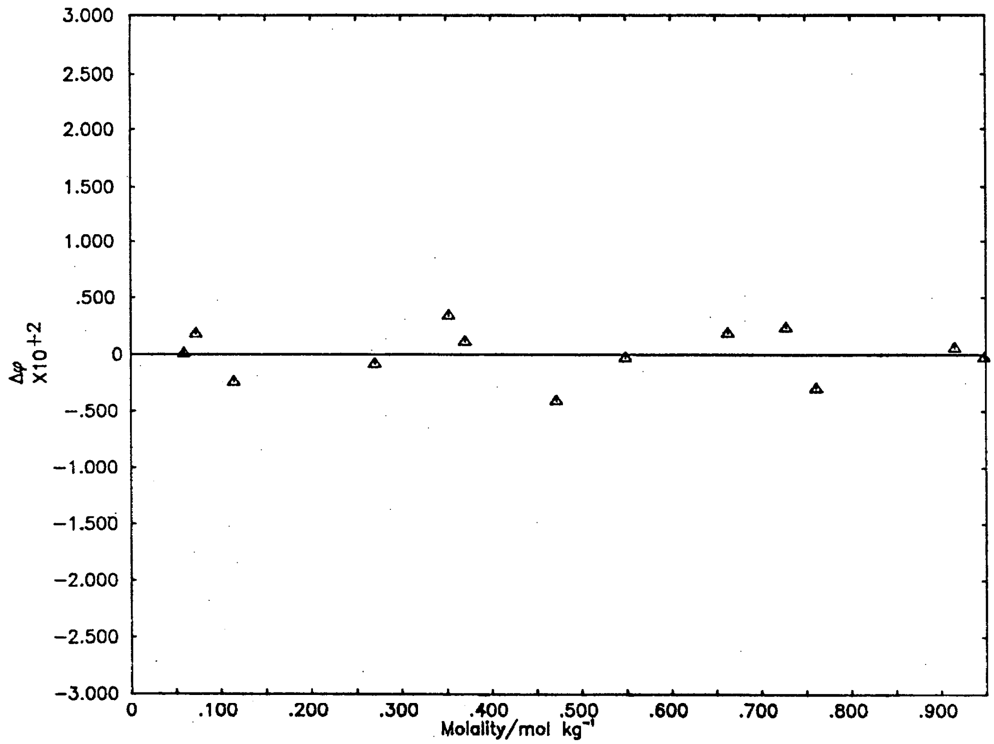
Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.2875863024+01	.220+00	.2067672371+01	.923-01	.1400001442+02	.629+00
2	-.1142306491+01	.222+00	.4711675542+01	.200+00	-.3615792196+02	.365+01
3	.1883235420+01	.623+00	-.7868910486+00	.115+00	.5327293899+02	.802+01
4	-.1941937772+01	.787+00			-.4019115215+02	.770+01
5	.7699942988+00	.352+00			.1202368153+02	.271+01

σ(eqs 1) = .269-02
σ(eqs 2) = .344-02
σ(eqs 3) = .300-02

Experimental Data Employed in Generation of Correlating Equations

Groves, Dye, and Brubaker [87]. Isopiestic measurements, reference electrolyte is KCl. The authors did not report the isopiestic molalities. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.059220	.8745
.072490	.8697
.114500	.8494
.270600	.8189
.352400	.8146
.370400	.8108
.472200	.7980
.549400	.7962
.663100	.7892
.727700	.7841
.761300	.7759
.915000	.7699
.948100	.7686



Deviation Plot for $K_2Pt(CN)_4$: $\Delta\phi$ vs molality

▲ Groves, Dye, and Brubaker [87], isopiestic vs KCl

K_2CrO_4

Recommended Values for the mean activity and osmotic coefficient of potassium chromate K_2CrO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8865	.9612	.999948	-1.
.002	.8470	.9472	.999898	-2.
.003	.8193	.9372	.999848	-3.
.004	.7973	.9293	.999799	-5.
.005	.7790	.9226	.999751	-6.
.006	.7633	.9168	.999703	-8.
.007	.7494	.9117	.999655	-10.
.008	.7370	.9070	.999608	-13.
.009	.7257	.9028	.999561	-15.
.010	.7154	.8990	.999514	-17.
.020	.6429	.8715	.999058	-47.
.030	.5976	.8540	.998616	-82.
.040	.5647	.8413	.998183	-123.
.050	.5391	.8313	.997756	-167.
.060	.5181	.8232	.997334	-214.
.070	.5005	.8163	.996917	-265.
.080	.4852	.8103	.996503	-317.
.090	.4719	.8051	.996091	-372.
.100	.4601	.8005	.995683	-429.
.200	.3850	.7709	.991702	-1079.
.300	.3439	.7543	.987844	-1833.
.400	.3162	.7428	.984070	-2660.
.500	.2957	.7341	.980357	-3542.
.600	.2797	.7274	.976690	-4469.
.700	.2666	.7220	.973054	-5435.
.800	.2558	.7178	.969439	-6434.
.900	.2466	.7147	.965833	-7462.
1.000	.2387	.7125	.962225	-8515.
1.250	.2234	.7105	.953134	-11243.
1.500	.2124	.7130	.943837	-14079.
1.750	.2046	.7194	.934225	-16996.
2.000	.1992	.7291	.924216	-19972.
2.250	.1955	.7417	.913751	-22991.
2.500	.1933	.7568	.902798	-26037.
2.750	.1923	.7739	.891350	-29098.
3.000	.1922	.7925	.879424	-32165.
3.250	.1929	.8121	.867057	-35228.
3.372	.1935	.8220	.860880	-36720.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0000	.0000	.0000
.010	.0002	.0004	.0003
.100	.0005	.0015	.0007
1.000	.0004	.0019	.0004
2.000	.0003	.0018	.0004
3.372	.0008	.0019	.0004

Coefficients of Correlating Equations

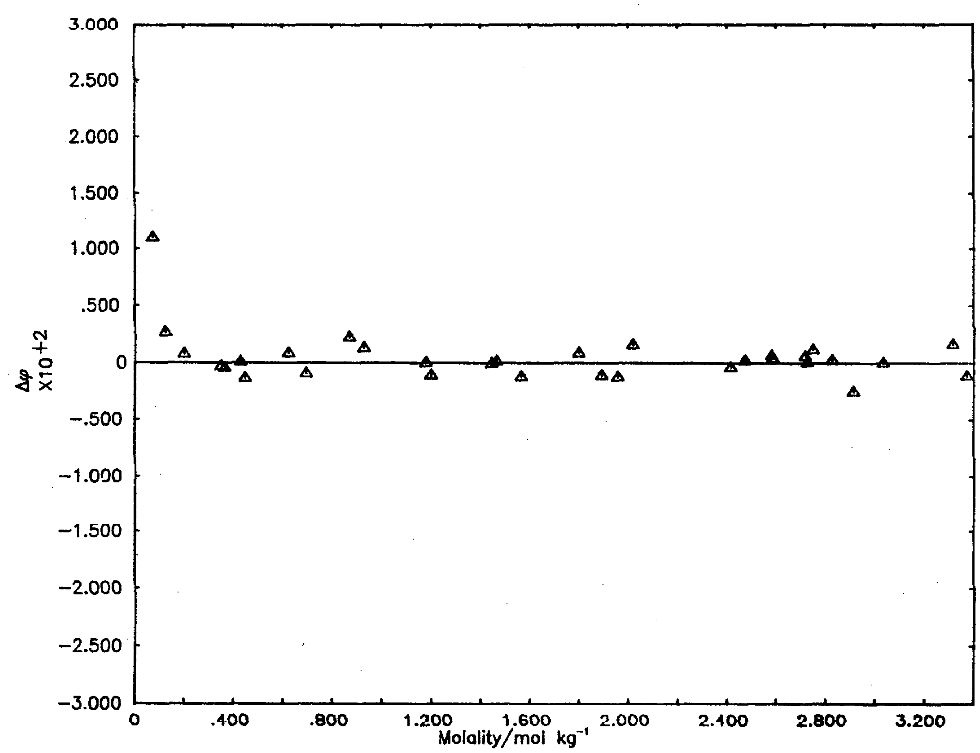
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1305648847+01	.889-02	-.6909635204+00	.137+00	.8557298349+01	.360+00
2	-.2592248082+00	.691-02	.1173938648+02	.520+00	-.1586988346+02	.171+01
3	.8275231636-01	.302-02	-.9031948667+01	.817+00	.2066923279+02	.354+01
4	-.6703584350-02	.470-03	.5101185772+01	.643+00	-.1757731181+02	.391+01
5			-.1597948603+01	.250+00	.9207740329+01	.241+01
6			.2069410985+00	.382-01	-.2669473078+01	.776+00
7					.3260363049+00	.103+00

σ(eqs 1) = .112-02
σ(eqs 2) = .108-02
σ(eqs 3) = .112-02

Experimental Data Employed in Generation of Correlating Equations

Stokes, Wilson, and Robinson [88]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.072550	.8256*
.124200	.7937*
.199800	.7717
.350000	.7478
.364700	.7460
.428200	.7402
.446700	.7371
.623300	.7268
.694200	.7213
.867800	.7178
.926500	.7153
1.177000	.7106
1.198000	.7094
1.443000	.7120
1.464000	.7125
1.564000	.7130
1.798000	.7218
1.891000	.7233
1.957000	.7259
2.017000	.7314
2.415000	.7510
2.472000	.7552
2.580000	.7627
2.585000	.7628
2.717000	.7721
2.725000	.7721
2.747000	.7748
2.826000	.7796
2.913000	.7833
3.032000	.7949
3.314000	.8189
3.372000	.8208



Deviation Plot for K_2CrO_4: $\Delta\phi$ vs molality

▲ Stokes, Wilson, and Robinson [88], isopiestic vs KCl

$K_2Cr_2O_7$

Recommended Values for the mean activity and osmotic coefficient of potassium dichromate $K_2Cr_2O_7$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.9329	.9831	.999947	-0.
.002	.9192	.9808	.999894	-1.
.003	.9104	.9793	.999841	-2.
.004	.9036	.9779	.999789	-2.
.005	.8979	.9767	.999736	-3.
.006	.8929	.9754	.999684	-4.
.007	.8884	.9742	.999632	-5.
.008	.8842	.9730	.999579	-6.
.009	.8802	.9718	.999527	-7.
.010	.8765	.9706	.999476	-8.
.020	.8453	.9584	.998965	-19.
.030	.8193	.9464	.998467	-32.
.040	.7961	.9347	.997981	-48.
.050	.7749	.9234	.997508	-66.
.060	.7552	.9127	.997045	-86.
.070	.7369	.9024	.996592	-108.
.080	.7198	.8926	.996148	-132.
.090	.7038	.8833	.995713	-157.
.100	.6888	.8745	.995285	-184.
.200	.5792	.8102	.991281	-530.
.300	.5154	.7773	.987475	-982.
.400	.4730	.7583	.983740	-1508.
.500	.4368	.7330	.980334	-2094.
.507 (sat)	.4342	.7327	.980116	-2139.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0053	.0143	.0133
.010	.0075	.0326	.0285
.100	.0020	.0354	.0244
.507	.0041	.0336	.0146

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1713606332+02	.774+01	.2133058726+02	.211+01	.3306332104+02	.217+01
2	-.2963070051+01	.234+00	-.1150305447+03	.154+02	-.1568206848+03	.159+02
3	.5164708245+01	.810+00	.2960489807+03	.442+02	.3577937461+03	.455+02
4	-.4054472278+01	.883+00	-.3376626001+03	.566+02	-.3920070783+03	.582+02
5			.1459889109+03	.269+02	.1660068668+03	.277+02

σ(eqs 1) = .514-02
σ(eqs 2) = .369-02
σ(eqs 3) = .379-02

Experimental Data Employed in Generation of Correlating Equations

Bedford [89]. Freezing point depression measurements. The Φ_L data for $K_2Cr_2O_7$ and the Φ_C data for K_2CrO_4 given in the table of auxiliary data were used in treating these measurements. Assigned weight is zero.

m/mol·kg^{-1}	$\phi_{298.15}$
.000500	2.5965
.001000	1.2622
.002000	.5087
.004000	.2793

Leopold and Johnston [43]. Vapor pressure measurements performed on the saturated solution at 23.66 and 26.40°C. Assigned weight is zero.

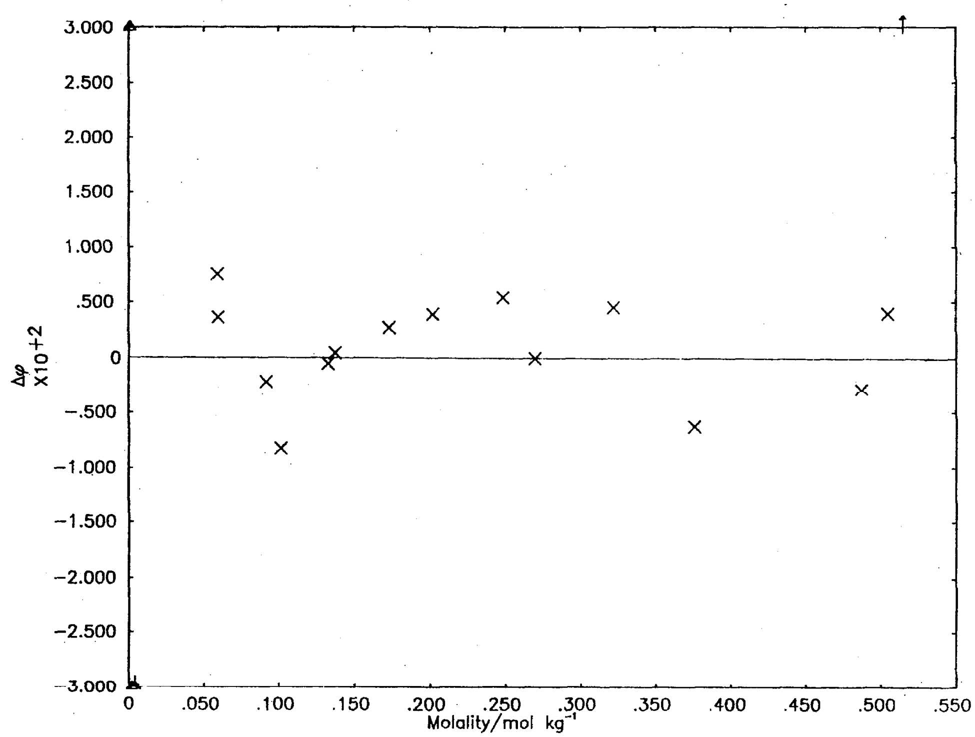
m/mol·kg^{-1}	$\phi_{298.15}$
.507	.8518

Stokes, Wilson, and Robinson [88]. Isopiestic measurements, reference electrolyte is KCl. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.061330	.9173
.062050	.9127
.094080	.8763
.103500	.8621
.135000	.8458
.139600	.8436
.175600	.8241
.204500	.8112
.250800	.7953
.271800	.7837
.324500	.7760
.377800	.7555
.489500	.7352
.507200	.7366

Comments

We have based the fit for this system entirely on the results of Stokes, Wilson, and Robinson [88].



Deviation Plot for $K_2Cr_2O_7$: $\Delta\phi$ vs molality

▲ Bedford [89], freezing point depression

+ Leopold and Johnston [43], vapor pressure

× Stokes, Wilson, and Robinson [88], isopiestic vs KCl

Rb_2SO_4

Recommended Values for the mean activity and osmotic coefficient of rubidium sulfate Rb_2SO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ϕ	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8856	.9607	.999948	-1.
.002	.8455	.9463	.999898	-2.
.003	.8171	.9360	.999848	-3.
.004	.7946	.9277	.999799	-5.
.005	.7758	.9206	.999751	-6.
.006	.7596	.9145	.999703	-8.
.007	.7453	.9091	.999656	-11.
.008	.7324	.9042	.999609	-13.
.009	.7208	.8997	.999562	-15.
.010	.7101	.8956	.999516	-18.
.020	.6347	.8658	.999065	-48.
.030	.5874	.8466	.998628	-84.
.040	.5530	.8324	.998202	-126.
.050	.5261	.8212	.997783	-172.
.060	.5041	.8119	.997371	-222.
.070	.4856	.8041	.996962	-274.
.080	.4697	.7974	.996558	-329.
.090	.4557	.7914	.996158	-386.
.100	.4433	.7861	.995760	-446.
.200	.3652	.7524	.991900	-1130.
.300	.3231	.7338	.988172	-1927.
.400	.2949	.7212	.984530	-2803.
.500	.2742	.7117	.980952	-3739.
.600	.2581	.7042	.977423	-4724.
.700	.2450	.6982	.973931	-5751.
.800	.2341	.6934	.970466	-6815.
.900	.2249	.6895	.967019	-7910.
1.000	.2169	.6865	.963579	-9033.
1.250	.2013	.6823	.954952	-11947.
1.500	.1900	.6825	.946175	-14983.
1.707	.1830	.6858	.938695	-17569.

m/mol·kg^{-1}	$\sigma(\phi)$	$\sigma(\ln\gamma)$	$\sigma(\gamma)$
.001	.0002	.0004	.0004
.010	.0015	.0033	.0024
.100	.0056	.0152	.0068
1.000	.0026	.0181	.0039
1.707	.0035	.0202	.0037

Coefficients of Correlating Equations

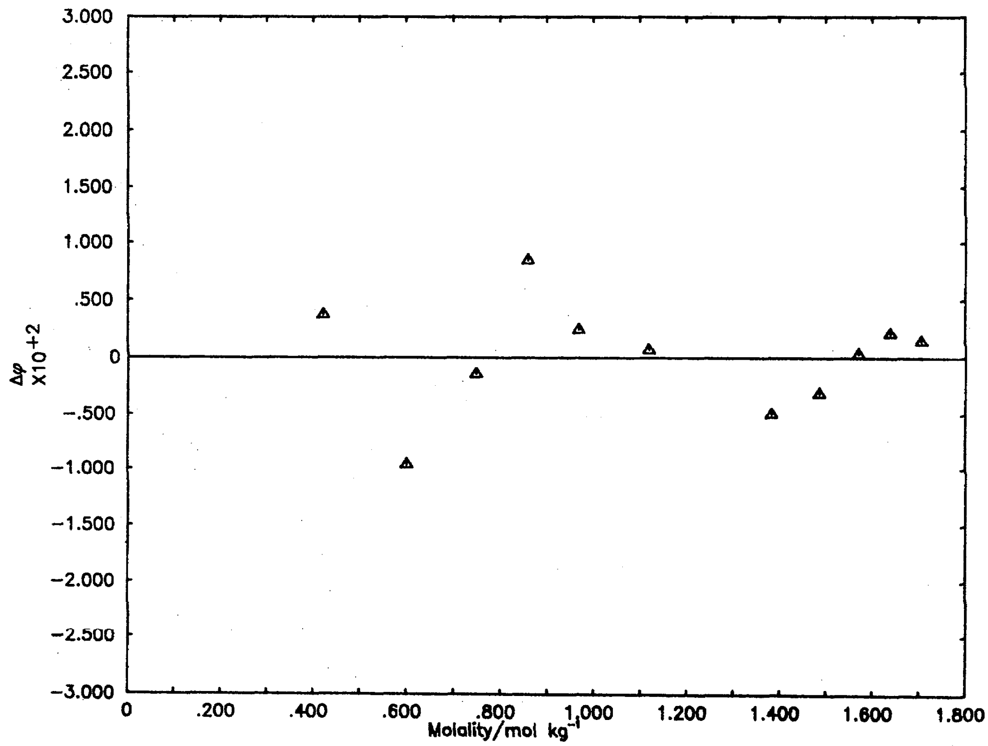
	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.1140270820+01	.817-01	-.3617460548+00	.541+00	.5040928252+01	.133+00
2	-.2076659164+00	.697-01	.9302008933+01	.136+01	-.3557113316+01	.210+00
3	.4912397283-01	.215-01	-.4232341992+01	.122+01	.9890503561+00	.882-01
4			.9501169853+00	.369+00		

σ(eqs 1) = .535-02
σ(eqs 2) = .520-02
σ(eqs 3) = .585-02

Experimental Data Employed in Generation of Correlating Equations

Cudd and Felsing [90]. Isopiestic measurements, reference electrolyte is Na_2SO_4. We have used our table of recommended values for the osmotic coefficient of Na_2SO_4 in treating these data. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.422000	.7226
.601000	.6945
.748000	.6943
.858000	.6995
.968000	.6898
1.118000	.6846
1.383000	.6769
1.486000	.6792
1.570000	.6836
1.640000	.6865
1.707000	.6872



Deviation Plot for Rb_2SO_4: $\Delta\phi$ vs molality

▲ Cudd and Felsing [90], isopiestic vs Na_2SO_4

$Rb_2S_2O_8$

Recommended Values for the mean activity and osmotic coefficient of rubidium persulfate, $Rb_2S_2O_8$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8837	.9596	.999948	-1.
.002	.8420	.9443	.999898	-2.
.003	.8122	.9331	.999849	-3.
.004	.7884	.9240	.999800	-5.
.005	.7685	.9162	.999752	-7.
.006	.7512	.9093	.999705	-9.
.007	.7359	.9032	.999658	-11.
.008	.7221	.8976	.999612	-13.
.009	.7096	.8924	.999566	-16.
.010	.6981	.8877	.999520	-18.
.020	.6163	.8526	.999079	-50.
.030	.5646	.8294	.998656	-89.
.040	.5269	.8120	.998246	-135.
.050	.4976	.7982	.997845	-184.
.060	.4737	.7869	.997452	-238.
.070	.4537	.7773	.997063	-295.
.075	.4450	.7732	.996875	-325.

m/mol·kg^{-1}	σ(ø)	σ(lnγ)	σ(γ)
.001	.0001	.0002	.0001
.010	.0007	.0014	.0010
.100	.0040	.0091	.0037
.075	.0033	.0074	.0033

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.7176969436+00	.251-01	-.5008729539+01	.104+01	.3960405795+01	.769-01
2			.1899358295+02	.341+01		

σ(eqs 1) = .632-02
σ(eqs 2) = .604-02
σ(eqs 3) = .529-02

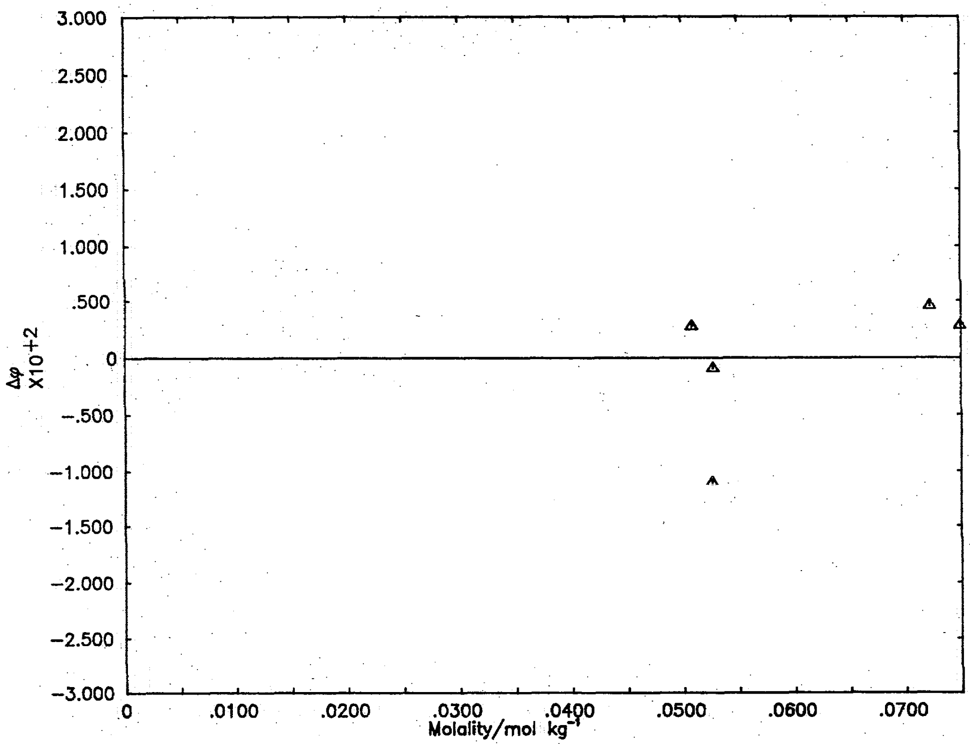
Experimental Data Employed in Generation of Correlating Equations

Chlebek and Lister [58]. Vapor pressure osmometry measurements. Assigned weight is unity.

m/mol·kg^{-1}	$ø_{298.15}$
.050800	.8000
.052600	.7840
.052700	.7940
.072200	.7800
.074900	.7760

Comments

Additional, careful measurements would be desirable here.



Deviation Plot for $Rb_2S_2O_8$: ΔØ vs molality

▲ Chlebek and Lister [58], vapor pressure osmometry

Cs_2SO_4

Recommended Values for the mean activity and osmotic coefficient of cesium sulfate, Cs_2SO_4, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	∅	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8855	.9606	.999948	-1.
.002	.8452	.9462	.999898	-2.
.003	.8168	.9358	.999848	-3.
.004	.7942	.9274	.999800	-5.
.005	.7754	.9204	.999751	-7.
.006	.7591	.9143	.999704	-8.
.007	.7447	.9088	.999656	-11.
.008	.7319	.9039	.999609	-13.
.009	.7202	.8994	.999563	-15.
.010	.7095	.8952	.999516	-18.
.020	.6340	.8654	.999065	-48.
.030	.5867	.8464	.998629	-85.
.040	.5525	.8324	.998202	-127.
.050	.5258	.8215	.997783	-173.
.060	.5040	.8126	.997368	-222.
.070	.4857	.8051	.996959	-274.
.080	.4701	.7988	.996552	-329.
.090	.4564	.7933	.996149	-387.
.100	.4443	.7884	.995748	-446.
.200	.3690	.7598	.991821	-1125.
.300	.3294	.7465	.987970	-1912.
.400	.3036	.7388	.984155	-2769.
.500	.2848	.7339	.980362	-3680.
.600	.2704	.7306	.976587	-4634.
.700	.2587	.7282	.972828	-5624.
.800	.2490	.7263	.969085	-6644.
.900	.2407	.7248	.965357	-7691.
1.000	.2335	.7236	.961646	-8761.
1.250	.2190	.7212	.952446	-11528.
1.500	.2077	.7192	.943363	-14402.
1.631	.2026	.7182	.938655	-15946.

m/mol·kg^{-1}	σ(∅)	σ(ℓnγ)	σ(γ)
.001	.0001	.0001	.0001
.010	.0004	.0010	.0007
.100	.0019	.0050	.0022
1.000	.0016	.0095	.0022
1.631	.0027	.0079	.0016

Coefficients of Correlating Equations

Par	Eqs 1 coefficient	Eqs 1 σ(coeff)	Eqs 2 coefficient	Eqs 2 σ(coeff)	Eqs 3 coefficient	Eqs 3 σ(coeff)
1	.1089562730+01	.211-01	-.6851551779+01	.432+00	.5256590788+01	.139+00
2	-.4320488862-01	.919-02	.3170955610+02	.163+01	-.3712715778+01	.225+00
3			-.3441634383+02	.257+01	.1020771032+01	.967-01
4			.1931503010+02	.185+01		
5			-.4213787710+01	.500+00		

σ(eqs 1) = .513-02
σ(eqs 2) = .421-02
σ(eqs 3) = .605-02

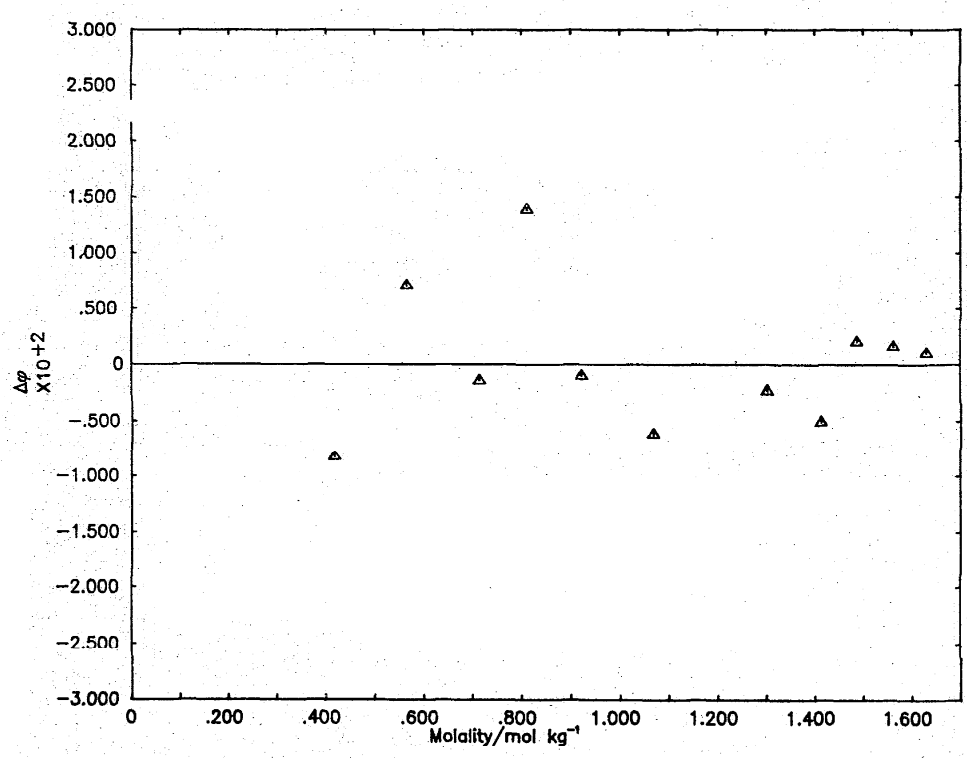
Experimental Data Employed in Generation of Correlating Equations

Cudd and Felsing [90]. Isopiestic measurements, reference electrolyte is Na_2SO_4. We have used our table of recommended values for the osmotic coefficient of Na_2SO_4 in treating these data. Assigned weight is 1.0.

m/mol·kg^{-1}	$\phi_{298.15}$
.418000	.7295
.565000	.7387
.715000	.7264
.811000	.7400
.923000	.7235
1.068000	.7167
1.303000	.7184
1.412000	.7148
1.488000	.7213
1.563000	.7203
1.631000	.7192

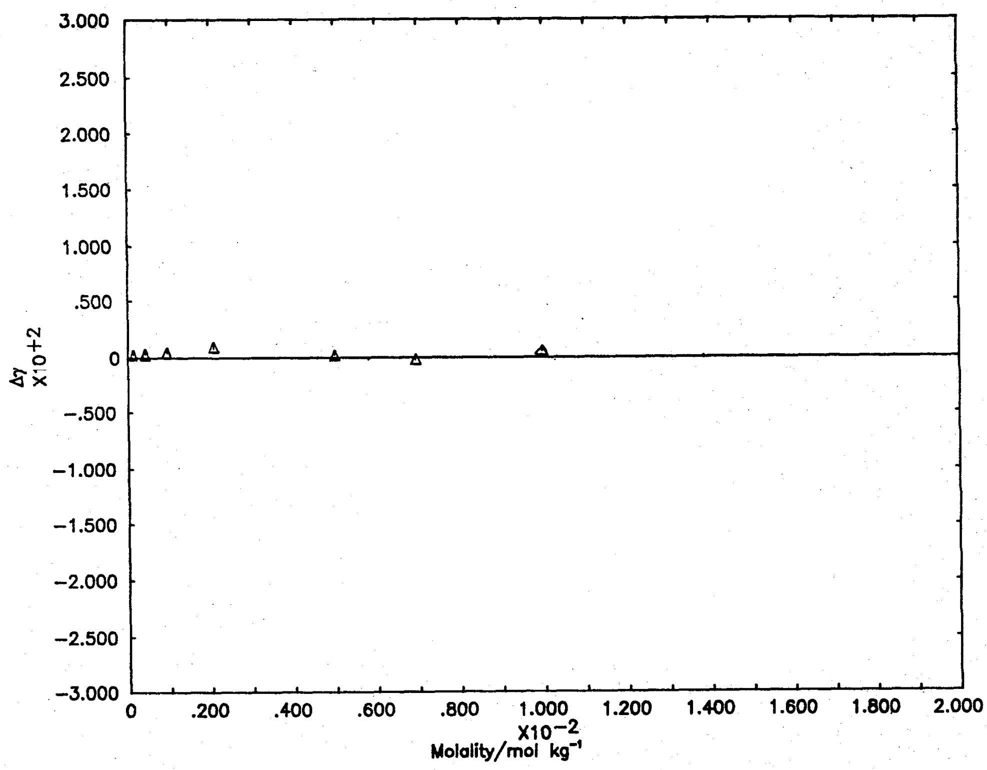
Harned [26]. Calculations based on the diffusion measurements of Harned and Blake [55]. Assigned weight is 1.0.

m/mol·kg^{-1}	γ
0.0001	0.961
0.0004	0.925
0.0010	0.886
0.0020	0.845
0.0050	0.774
0.0070	0.742
0.0100	0.707



Devi ion Plot for Cs_2SO_4: $\Delta\phi$ vs molality

▲ udd and Felsing [90], isopiestic vs Na_2SO_4



Deviation Plot for Cs_2SO_4: Δγ vs molality

Δ Harned [26], diffusion

$Cs_2S_2O_8$

Recommended Values for the mean activity and osmotic coefficient of cesium persulfate,

$Cs_2S_2O_8$, in H_2O at 298.15 K

m/mol·kg^{-1}	γ	ø	a_w	ΔG^{ex}/J·kg^{-1}
.001	.8827	.9591	.999948	-1.
.002	.8402	.9433	.999898	-2.
.003	.8097	.9316	.999849	-3.
.004	.7853	.9220	.999801	-5.
.005	.7647	.9138	.999753	-7.
.006	.7469	.9065	.999706	-9.
.007	.7310	.8999	.999660	-11.
.008	.7167	.8940	.999614	-14.
.009	.7037	.8884	.999568	-16.
.010	.6917	.8833	.999523	-19.
.020	.6059	.8446	.999087	-51.
.030	.5512	.8183	.998674	-92.
.040	.5111	.7980	.998276	-140.
.050	.4798	.7816	.997890	-192.
.060	.4542	.7678	.997513	-249.
.070	.4326	.7560	.997144	-309.
.080	.4142	.7457	.996781	-373.
.090	.3981	.7366	.996424	-440.
.100	.3839	.7284	.996071	-510.
.109	.3724	.7218	.995753	-576.

m/mol·kg^{-1}	σ(ø)	σ(ℓnγ)	σ(γ)
.001	.0001	.0002	.0001
.010	.0007	.0014	.0010
.100	.0044	.0099	.0033
.109	.0047	.0106	.0039

Coefficients of Correlating Equations

	Eqs 1		Eqs 2		Eqs 3	
Par	coefficient	σ(coeff)	coefficient	σ(coeff)	coefficient	σ(coeff)
1	.5569741764+00	.238-01	-.6234612791+01	.386+00	.2092816159+01	.358+00
2			.1954060695+02	.101+01	.2820932280+01	.934+00

σ(eqs 1) = .101-01
σ(eqs 2) = .421-02
σ(eqs 3) = .390-02

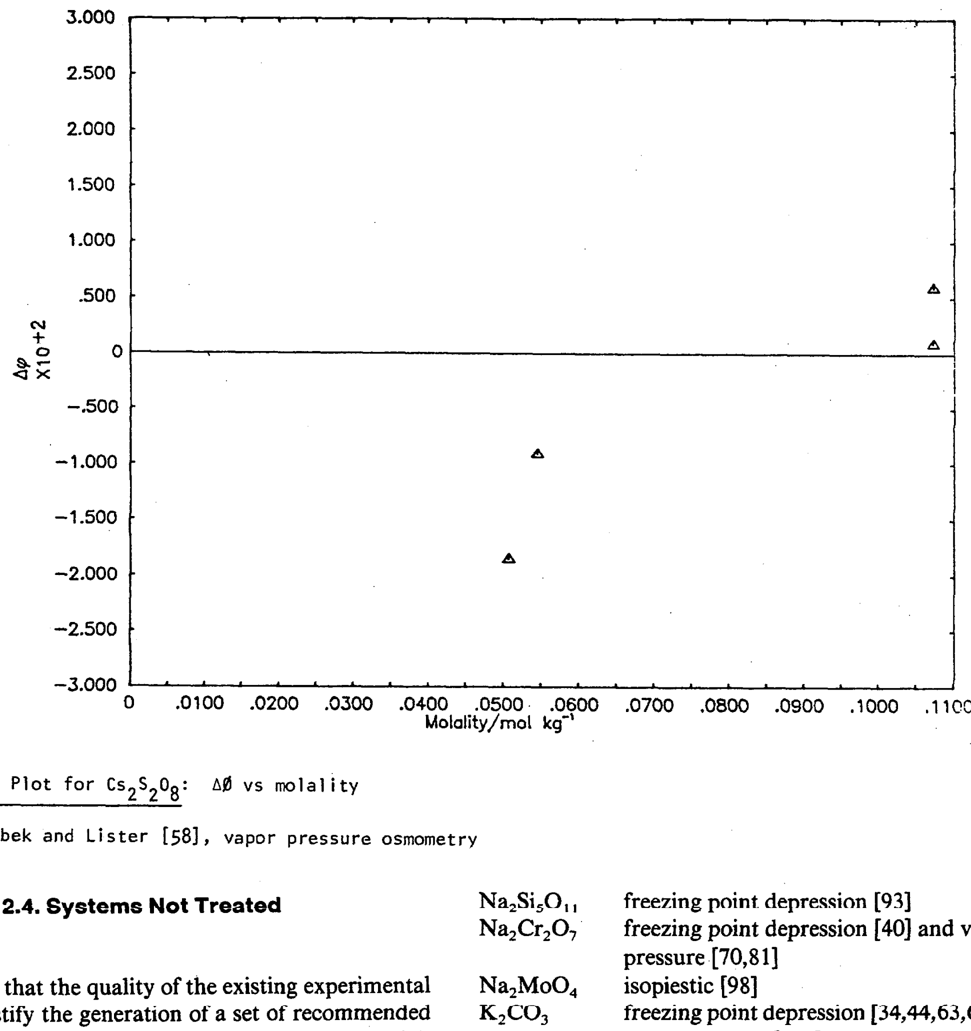
Experimental Data Employed in Generation of Correlating Equations

Chlebek and Lister [58]. Vapor pressure osmometry. Assigned weight is 1.0.

m/mol·kg^{-1}	$ø_{298.15}$
.060700	.7620
.054500	.7660
.107300	.7290
.107300	.7290
.107300	.7240
.109100	.7250

Comments

Additional, careful measurements would be desirable here.



Deviation Plot for $Cs_2S_2O_8$: Δφ vs molality

▲ Chlebek and Lister [58], vapor pressure osmometry

2.4. Systems Not Treated

It was felt that the quality of the existing experimental data do not justify the generation of a set of recommended values for the activity and osmotic coefficients for the following electrolytes of charge type 1–2:

Systems	Type of Measurement(s)
H_2PO_3	freezing point depression [91]
$H_2As_2O_4$	freezing point depression[92]
H_2GeO_3	freezing point depression[92]
Hg_2SO_4	electromotive force [83,84]
$H_2Cr_2O_7$	freezing point depression [40]
Li_2SiO_3	freezing point depression[93]
$Li_2Si_5O_{11}$	freezing point depression [93]
$Li_2B_4O_7$	freezing point depression [94]
Na_2S	freezing point depression [27] isopiestic[28]
$Na_2H_2P_2O_6$	freezing point depression [91]
Na_2SiO_3	freezing point depression [45,60,93,95], vapor pressure [95,96], and boiling poin elevation [97]
$Na_2Si_5O_{11}$	freezing point depression [93]
$Na_2Cr_2O_7$	freezing point depression [40] and vapor pressure [70,81]
Na_2MoO_4	isopiestic [98]
K_2CO_3	freezing point depression [34,44,63,64,65,99] vapor pressure [99a]
$K_2C_2O_4$	freezing point depression [41, 100], electromotive force [83], and boiling point elevation [86]
K_2SiO_3	freezing point depression [93]
Rb_2SiO_3	freezing point depression [93]
Cs_2SiO_3	freezing point depression [93]

Most of the above investigations involve imprecise freezing point depression measurements on which it would be difficult to base reliable values of ϕ and γ. The emf measurements of Hass and Jellinek [83] and of Sircar *et al.* [84] involve unknown liquid junction potentials and, in principle, cannot be used to calculate activity coefficients for Hg_2SO_4 and $K_2C_2O_4$. For Na_2MoO_4, Zhidikova *et al.* [98] report only three data points from 1 to 3.16 mol·kg^{-1}, and the results are given to only three significant figures; hence we have chosen not to treat their data. The few boiling point elevation measurements are not very precise and the adjustment of the osmotic coefficients from 100 to 25 °C is very uncertain. We

TABLE 1. Coefficients used to calculate relative apparent molar enthalpies

Systems	Range of validity molality/mol·kg^{-1}	α_1	α_2	α_3	α_4	α_5	α_6	α_7	α_8	Reference
Li_2SO_4	zero to 3.0	+ 10239.9	− 8338.13	+ 32671.89	− 116109.7	+ 162650.2	− 118389.4	+ 43936.9	− 6571.26	[109]
Na_2SO_4	zero to 3.0	+ 10239.9	− 34467.5	− 54221.6	− 69331.1	− 55790.4	− 23395.3	+ 3904.4		[109]
K_2SO_4	zero to 0.10	+ 10239.9	− 34168.9	+ 46711.5	− 24708.7					[110]
Rb_2SO_4	zero to 0.10	+ 10239.9	− 34866.3	+ 28919.2	+ 25750.8					[110]
Cs_2SO_4	zero to 0.10	+ 10239.9	− 59271.1	+ 224054.0	− 643195.0	+ 827071.0				[110]
$K_2Cr_2O_7$	zero to 2.0	+ 10239.9	+ 34565.9	− 65034.0	+ 46629.7	− 11574.2				[111]
K_2HPO_4	zero to 10.0	+ 10239.9	− 17760.7	+ 17775.3	− 8436.87	+ 1814.64	− 146.117			[112]
Na_2CO_3	zero to 1.4	+ 9357.82	− 22000.2	+ 13540.4	− 3275.37					[113]

note that the experimental data for $Na_2Cr_2O_7$ and for Na_2SiO_3 are very discordant and no tables of recommended values are given for these compounds. The vapor pressure measurements of Puchkov and Kurochkina [99a] on K_2CO_3 have an imprecision of $\pm$ 0.1 torr and are not very useful for obtaining precise osmotic coefficients for that system. Khvorostin *et al.* [28] report a set of osmotic coefficients for Na_2S based upon isopiestic measurements; they give little experimental detail and do not report the isopiestic molalities or the reference electrolyte. The values of the osmotic coefficients and the activity coefficients which may be calculated from their [28] data are unusually high ($\phi = 1.767$ and $\gamma = 4.037$ at $m = 3.00$ mol·kg^{-1}) for a 1–2 electrolyte. Earlier, not very precise freezing point depression data were reported by Jellinek and Czerwinski [27]. They are of little value for the confirmation of the results of Khvorostin *et al.* [28]. Accordingly, we have decided not to include a table of values for this compound. Careful measurements on the above systems would be of value.

Platford [101] reports a set of isopiestic data for $Na_2B_4O_7$ and for $K_2B_4O_7$. Earlier, not very precise freezing point depression measurements have been given by Menzel [94] for $Na_2B_4O_7$. Platford [101] finds that the osmotic coefficients of these two compounds are the same within his experimental error. These compounds apparently hydrolyze in water to form a solution consisting of an electrolyte, $NaB(OH)_4$, and a non-electrolyte, H_3BO_3:

$$Na_2B_4O_7 + 7H_2O \rightarrow 2Na^+ + 2B(OH)_4^- + 2H_3BO_3$$

We have not treated these data.

The correlating equations which have been used to date are not capable of giving an adequate representation of what is believed to be reliable experimental data for the following five electrolytes of charge type 1–2:

System	Type of Measurement(s)
$(NH_4)_2SO_4$	freezing point depression [34,99,102], vapor pressure [81,103], isopiestic [20,104], and electromotive force [34]
4,4′-bibenzyl disulfonic acid, $C_{14}H_{14}S_2O_6$	vapor pressure osmometry and isopiestic [16,17]
1,8-diphenyloctane disulfonic acid, $C_{20}H_{26}S_2O_6$	vapor pressure osmometry [17]
1,14-diphenyl tetradecane disulfonic acid, $C_{26}H_{38}S_2O_6$	vapor pressure osmometry [17]
lithium 1,8-diphenyloctane disulfonate, $Li_2C_{20}H_{24}S_2O_6$	vapor pressure osmometry [17]

We have chosen not to present evaluations for these systems at the present time.

The two data sets reported by Bonner *et al.* [16,17] for 4,4′-bibenzyl disulfonic acid are not in good agreement with each other. The latter data set [17] is to be preferred over the one published earlier [15]. Robinson and Stokes [106] and Pitzer and Mayorga [108] based their tables (or coefficients) for γ and ϕ for this compound on the results of the 1956 investigation of Bonner *et al.* [16].

For $(NH_4)_2SO_4$, we note that none of the earlier evaluations of activity and osmotic coefficients [71,105,106,107,108] took into account the freezing point depression measurements of Scatchard and Prentiss [102]. These freezing point depression measurements were very carefully done and they merge well with the isopiestic results of Wishaw and Stokes [104]. The osmotic coefficients which we have calculated for $(NH_4)_2SO_4$ from the freezing point

TABLE 2. Coefficients used to calculate apparent molar heat capacities

System	Range of validity molality/mol·kg^{-1}	Φ°_C	β_1	β_2	β_3	Reference
Na_2WO_4	zero to 0.3	− 110.4	150.4	7.8		[114]
Na_2MoO_4	zero to 0.3	− 122.8	150.4	31.1		[114]
$K_2Cr_2O_4$	zero to 0.3	− 235.0	150.4	36.6		[114]
$K_2S_2O_8$	zero to 0.3	− 84.0	150.4	160.0		[114]
$Na_2S_2O_8$	zero to 0.3	− 29.3	150.4	50.9		[114]
$Na_2S_2O_3$	zero to 0.3	− 163.6	150.4	106.0		[114]
K_2SO_4	zero to 0.3	− 251.0	150.4	73.6		[114]
Na_2SO_4	zero to 0.3	− 190.1	150.4	133.0		[114]
Na_2CO_3	zero to 1.0	− 176.3	150.2	100.9	− 11.2	[115]

depression data are lower than the values predicted by Debye-Hückel theory up to 0.007 mol·kg^{-1} and are indicative of a fair degree of association for this system.

2.5. Previous Compilations and Evaluations

Previous compilations and evaluations of the activity and osmotic coefficients for many of the systems dealt with herein may be found in the book by Harned and Owen [105], the tables of Stokes [71] and Robinson and Stokes [106], and in the papers of Wu and Hamer [107] and Pitzer and Mayorga [108]. The tables of Robinson and Stokes [106] appear to be largely based upon their own isopiestic measurements; Harned and Owen [105] also based their tables upon earlier calculations performed by Stokes [71] which were also largely based upon these same isopiestic measurements. For these compounds, the coefficients of the equation of Pitzer and Mayorga [108] are, with the exception of some results from Groves *et al.* [87] and Bonner and Rogers [17], also based upon the tables of Robinson and Stokes [106]. Wu and Hamer [107] utilized a larger data base than the other evaluations [105,106,108], but did not state how the various data sets were weighted to obtain their final tables of recommended values. None of the above evaluations have considered data for 1,2-ethane disulfonic acid, ammonium decahydroborate, sodium thionate, sodium 1,2-ethane disulfonate, sodium 2,7-anthraquinone disulfonate, sodium dodecahydroborate, sodium tungstate, and rubidium and cesium persulfate.

We have examined the difference at the maximum molality for which comparisons may be made between the activity coefficients which we have calculated and those which have appeared in the earlier evaluations (note that for K_2CrO_4, $K_2Pt(CN)_4$, K_2HPO_4, K_2HAsO_4, Rb_2SO_4, Cs_2SO_4, and sodium maleate, several of the earlier evaluations give values for γ and ϕ which have been extrapolated beyond the maximum molality for which data exist). The most significant difference is for Na_2CO_3 which is explained by our inclusion of the recent results of Robinson and Macaskill [66]. The remainder of the differences are on the order of only a few percent.

3. Auxiliary Data

Osmotic Coefficient Data

Evaluated data for several reference systems were needed in treating the isopiestic data. These systems and the sources of the evaluated data are: KCl[1], NaCl[1], H_2SO_4[4], and $CaCl_2$[2].

Relative Apparent Molar Enthaply Data

The coefficients for the equation

$$\Phi_L/\text{J·mol}^{-1} = \sum_{i=1}^{N} \alpha_i m^{i/2}$$

are given in table 1. Our calculated ϕ_L values for K_2HPO_4 differ significantly from the Φ_L values tabulated by Luff and Reed [112]. We have assumed that their tabulated values were erroneously calculated and we have relied upon their reported measurement data.

Apparent Molar Heat Capacity Data

The coefficients for the equations

$$\Phi_C/\text{J·mol}^{-1}\text{·K}^{-1} = \Phi^{\circ}_C + \sum_{i=1}^{N} \beta_i m^{i/2}$$

are given in table 2.

Additional Auxiliary Data

$\Delta H^{\circ}_{\text{fus}} = 6008$ J·mol^{-1} [116]
$\Delta C^{\circ}_{\text{fus}} = 38.1$ J·mol^{-1}·K^{-1} [116]
$\Delta b = -0.197$ J·K^{-2}·mol^{-1} [116]
$T_{\text{fus}} = 273.15$ K for water [10]
$R = 8.31441$ J·K^{-1}·mol^{-1} [117]
$F = 96484.56$ C·mol^{-1} [117]
$A = 0.51084 \log_e 10$ kg$^{1/2}$·mol$^{-1/2}$ [2]
$P^{\circ} = 3168.6$ Pa (23.7627 torr) for water at 25 °C [118]
$B_T = -992$ cm^3·mol^{-1} at 25 °C [119]

4. Acknowledgments

The author thanks Mrs. Donna Whitworth and Mrs. Joyce Grimes for their efforts in the preparation of the tables and Drs. J. Rard and D. Miller for making available their results on Na_2SO_4 prior to publication. The support of this research by the Division of Energy Storage Systems and the Morgantown Energy Technology Center of the United States Department of Energy and by the Office of Standard Reference Data of the National Bureau of Standards is gratefully acknowledged.

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6. Glossary of Symbols

a_w	activity of water
Δb	$(\partial \Delta \overline{C}_p / \partial T)_p$
c_B or c	concentration of solute substance B
m_B or m	molality of solute substance B
z_B	charge number of an ion B
A	constant in Debye-Hückel limiting law
A_1	$\lvert z_+ z_- \rvert A$
A_2	$\frac{(\Sigma_i \nu_i z_i^3)^2}{3\nu \Sigma_i(\nu_i z_i^2)} A^2$
A_i	coefficients in a specified equation
$B,C,D,E..$	coefficients in eqs (1)
B_i	coefficients in a specified equation
B_T	the second virial coefficient for water vapor
ΔC°_{fus}	the heat capacity change accompanying the fusion of the pure solvent at the freezing temperature of the pure solvent
$\Delta \overline{C}_p$	the difference between the partial mola heat capacity of the solvent in a solution and the molar heat capacity of the solid solvent at the freezing temperature of the solution
F	the Faraday constant
ΔG^{ex}	the excess Gibbs energy of a solution containing one kilogram of solvent
ΔH°_{fus}	the enthalpy of fusion of the pure solvent at the freezing temperature of the pure solvent
I_m or I	ionic strength: $(I_m = \frac{1}{2}\Sigma_i m_i z_i^2)$
P	vapor pressure of a solution
P°	vapor pressure of pure solvent
R	molar gas constant
T	thermodynamic or absolute temperature
T_{fus}	absolute temperature of fusion of pure solvent
α_i	coefficients in a specified equation
β_i	coefficients in a specified equation
$\gamma_\pm$ or γ	activity coefficient, molality basis
γ_{ref}	activity coefficient evaluated at a specified reference molality (m_{ref})
ν_i	number of ions of species i formed from one molecule of solute assuming complete dissociation
ν	total number of ions formed from one molecule of solute assuming complete dissociation: $[\nu = \Sigma_i \nu_i]$
σ	standard deviation
ϕ or φ	osmotic coefficient
Φ_c	apparent molar heat capacity
Φ_L	relative apparent molar enthalpy