Journal of Physical and Chemical Reference Data

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Cite as: Journal of Physical and Chemical Reference Data **9**, 513 (1980); https://doi.org/10.1063/1.555621
Published Online: 15 October 2009

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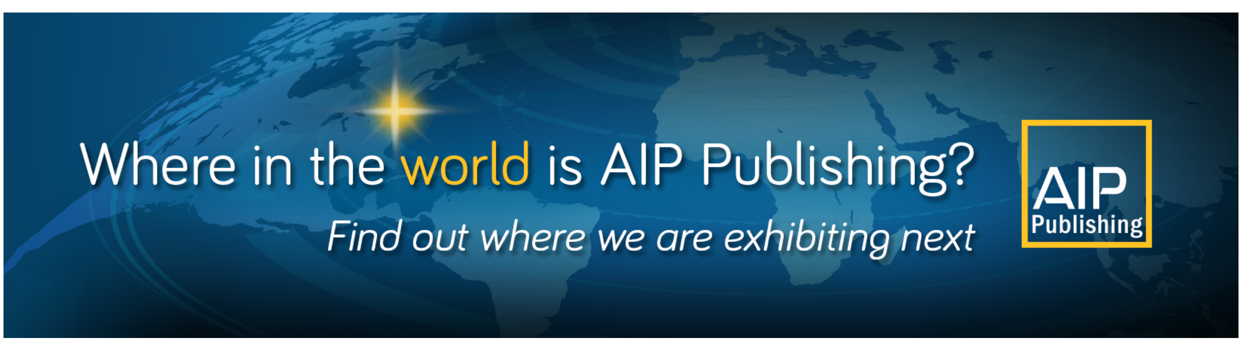

## Comments

# Revised Values of the Osmotic Coefficients and Mean Activity Coefficients of Sodium Nitrate in Water at 25°C

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A paper entitled "Osmotic Coefficients and Mean Activity Coefficients of Uni-univalent Electrolytes in Water at 25° C" appeared in Vol. 1 on pages 1047 to 1100 of this Journal in 1972. Values for $NaNO_3$ listed in table 23, p. 1071, omitted the data for "Freezing point depression measurements" by Scatchard et al. [10][1] due to lack of adequate information concerning the apparent molal heat capacity $\Phi_c$. Only recently, Roux et al. [5] have provided values for $\Phi_c$. It is therefore now appropriate to calculate meaningful values for the osmotic coefficients and mean activity coefficients of $NaNO_3$ in $H_2O$ at 25° C. This Comment also provides corrected values for the molality higher than 6 in response to an informal communication from A.W. Stelson of the California Institute of Technology. The revised values and the parameters are listed in table 1. The original data used for the computations are listed in tables 2 A, B, C, D, and E.

The notation and format for the presentation of the data are those employed previously [1-3].

The auxiliary thermal data used for treating the freezing point depression data are as follows:

$$\Phi_L/\mathrm{J\cdot mol^{-1}} = 1919.1\ m^{1/2} - 5033.76\ m - 407.671\ m^{3/2} + 6585.0\ m^2 - 7985.75\ m^{5/2} + 4232.12\ m^3 - 843.745\ m^{7/2} \quad \text{ref. [4]},$$

and

$$\Phi_c/\mathrm{J\cdot mol^{-1}\cdot K^{-1}} = 30.15 + 38.95\ m^{1/2} + 58.5\ m - 23.5\ m^{3/2} \quad \text{ref. [5]}.$$

Pearce and Hopson [6] reported a solubility of 10.83 mol • kg$^{-1}$ for $NaNO_3$ in $H_2O$ at 25° C. This value is in good agreement with those values which may be calculated from the data compiled by Linke and Seidell [7].

[1] Figures in brackets indicate literature references at the end of this paper.

TABLE 1.

Recommended Values for the mean activity and osmotic coefficient of sodium nitrate, $NaNO_3$, in $H_2O$ at 298.15 K.

| $m$/mol·kg$^{-1}$ | γ | ø | $a_w$ | $\Delta G^{ex}$/J·kg$^{-1}$ |
|---|---|---|---|---|
| .001 | .9647 | .9882 | .999964 | -0. |
| .002 | .9512 | .9837 | .999929 | -[illegible]. |
| .003 | .9412 | .9804 | .999894 | -1. |
| .004 | .9330 | .9777 | .999859 | -1. |
| .005 | .9259 | .9753 | .999824 | -1. |
| .006 | .9197 | .9732 | .999790 | -2. |
| .007 | .9140 | .9714 | .999755 | -2. |
| .008 | .9089 | .9697 | .999721 | -3. |
| .009 | .9041 | .9681 | .999686 | -3. |
| .010 | .8997 | .9666 | .999652 | -4. |
| .020 | .8663 | .9556 | .999312 | -10. |
| .030 | .8431 | .9480 | .998976 | -18. |
| .040 | .8250 | .9421 | .998643 | -27. |
| .050 | .8100 | .9372 | .998313 | -37. |
| .060 | .7972 | .9331 | .997985 | -48. |
| .070 | .7860 | .9295 | .997658 | -59. |
| .080 | .7759 | .9263 | .997334 | -71. |
| .090 | .7669 | .9234 | .997010 | -84. |
| .100 | .7586 | .9207 | .996688 | -98. |
| .200 | .7008 | .9026 | .993517 | -256. |
| .300 | .6646 | .8913 | .990412 | -446. |
| .400 | .6381 | .8831 | .987353 | -659. |
| .500 | .6171 | .8765 | .984334 | -890. |
| .600 | .5997 | .8709 | .981348 | -1137. |
| .700 | .5849 | .8661 | .978393 | -1397. |
| .800 | .5719 | .8618 | .975466 | -1668. |
| .900 | .5603 | .8579 | .972565 | -1951. |
| 1.000 | .5499 | .8542 | .969690 | -2243. |
| 1.250 | .5276 | .8463 | .962603 | -3010. |
| 1.500 | .5091 | .8394 | .955650 | -3825. |
| 1.750 | .4934 | .8332 | .948818 | -4682. |
| 2.000 | .4797 | .8277 | .942096 | -5575. |
| 2.250 | .4676 | .8228 | .935475 | -6502. |
| 2.500 | .4568 | .8182 | .928946 | -7458. |
| 2.750 | .4470 | .8141 | .922500 | -8443. |
| 3.000 | .4381 | .8104 | .916132 | -9454. |
| 3.250 | .4300 | .8069 | .909834 | -10488. |
| 3.500 | .4225 | .8038 | .903599 | -11545. |
| 3.750 | .4156 | .8010 | .897423 | -12623. |
| 4.000 | .4092 | .7984 | .891301 | -13721. |
| 4.250 | .4033 | .7961 | .885228 | -14838. |
| 4.500 | .3978 | .7940 | .879200 | -15972. |
| 4.750 | .3926 | .7922 | .873214 | -17123. |
| 5.000 | .3878 | .7905 | .867266 | -18289. |
| 5.250 | .3833 | .7890 | .861355 | -19471. |
| 5.500 | .3790 | .7877 | .855479 | -20667. |
| 5.750 | .3750 | .7865 | .849635 | -21876. |
| 6.000 | .3712 | .7855 | .843823 | -23098. |
| 6.250 | .3676 | .7846 | .838041 | -24332. |
| 6.500 | .3643 | .7838 | .832291 | -25578. |
| 6.750 | .3611 | .7832 | .826571 | -26835. |
| 7.000 | .3580 | .7826 | .820882 | -28103. |
| 7.250 | .3551 | .7821 | .815225 | -29382. |
| 7.750 | .3497 | .7812 | .804012 | -31967. |
| 8.000 | .3471 | .7808 | .798459 | -33274. |
| 8.250 | .3447 | .7805 | .792945 | -34590. |
| 8.500 | .3423 | .7801 | .787472 | -35915. |
| 8.750 | .3400 | .7798 | .782043 | -37248. |
| 9.000 | .3378 | .7794 | .776662 | -38589. |
| 9.250 | .3356 | .7790 | .771330 | -39939. |
| 9.500 | .3335 | .7786 | .766053 | -41296. |
| 9.750 | .3314 | .7781 | .760834 | -42661. |
| 10.000 | .3293 | .7775 | .755677 | -44034. |
| 10.250 | .3273 | .7768 | .750586 | -45414. |
| 10.500 | .3253 | .7761 | .745567 | -46802. |
| 10.750 | .3233 | .7752 | .740623 | -48198. |
| 10.830 (sat) | .3227 | .7749 | .739058 | -48646. |

Estimated Standard Deviations of Values in TABLE 1.

| $m$/mol·kg$^{-1}$ | σ(Ø) | σ(ℓnγ) | σ(γ) |
|---|---|---|---|
| .001 | .0000 | .0000 | .0000 |
| .010 | .0001 | .0002 | .0001 |
| .100 | .0004 | .0009 | .0007 |
| 1.000 | .0006 | .0024 | .0013 |
| 2.000 | .0006 | .0024 | .0011 |
| 5.000 | .0006 | .0022 | .0009 |
| 10.000 | .0014 | .0027 | .0009 |
| 10.830 | .0022 | .0031 | .0010 |

Coefficients of Correlating Equations

| Par | Eqs 4.1 [1][a] coefficient | Eqs 4.1 [1][a] σ(coeff) | Eqs 3 [2,3] coefficient | Eqs 3 [2,3] σ(coeff) |
|---|---|---|---|---|
| 1 | .1205287009+01 | .199-01 | .1198540545+01 | .325-01 |
| 2 | -.7005454845-01 | .323-02 | -.1028638450+01 | .771-01 |
| 3 | .5551911790-02 | .514-03 | .5560513704+00 | .751-01 |
| 4 | -.1922143722-03 | .278-04 | -.1785647276+00 | .362-01 |
| 5 | | | .3132636790-01 | .851-02 |
| | | | -.2313089135-02 | .780-03 |

[a] The equation used here is based on natural logarithum. See refs. [2,3].

σ(eqs 1) = .304-02
σ(eqs 3) = .310-02

TABLES 2 A, B, C, D AND E

Experimental Data Employed in Generation of Correlating Equations

TABLE 2A.

Kangro and Groeneveld [8]. Vapor pressure measurements. Assigned weight is 1.0.

| $m$/mol·kg$^{-1}$ | $Ø_{298.15}$ |
|---|---|
| 1.000000 | .8777 [a] |
| 2.000000 | .8355 |
| 3.000000 | .8155 |
| 4.000000 | .8006 |
| 5.000000 | .7927 |
| 6.000000 | .7856 |
| 7.000000 | .7811 |
| 8.000000 | .7804 |
| 9.000000 | .7786 |
| 10.000000 | .7773 |

[a] Zero weight.

TABLE 2B.

Pearce and Hopson [6]. Vapor pressure measurements. The data for the highest five molalities were weighted unity and the remainder zero.

| $m$/mol·kg$^{-1}$ | $Ø_{298.15}$ |
|---|---|
| .100000 | .9186 [a] |
| .200000 | .9201 [a] |
| .400000 | .9020 [a] |
| .600000 | .8932 [a] |
| .800000 | .8901 [a] |
| 1.000000 | .8866 [a] |
| 1.500000 | .8841 [a] |
| 2.000000 | .8567 [a] |
| 2.500000 | .8533 [a] |
| 3.000000 | .8410 [a] |
| 4.000000 | .8252 [a] |
| 5.000000 | .8092 [a] |
| 6.000000 | .7964 [a] |
| 7.000000 | .7863 |
| 8.000000 | .7776 |
| 9.000000 | .7801 |
| 10.000000 | .7772 |
| 10.830000 | .7756 |

[a] Zero weight.

TABLE 2C.

Robinson [9], Isopiestic measurements, reference salt is KCl. Assigned weight is 1.0.

| $m$/mol·kg$^{-1}$ | $\phi_{298.15}$ |
|---|---|
| .105200 | .9153 |
| .205900 | .9027 |
| .207700 | .9018 |
| .343100 | .8874 |
| .442800 | .8770 |
| .523600 | .8748 |
| .593500 | .8682 |
| .735700 | .8619 |
| .877400 | .8597 |
| .915900 | .8550 |
| 1.175000 | .8484 |
| 1.181000 | .8456 |
| 1.205000 | .8446 |
| 1.293000 | .8428 |
| 1.317000 | .8440 |
| 1.441000 | .8394 |
| 1.529000 | .8374 |
| 1.569000 | .8378 |
| 1.674000 | .8333 |
| 1.798000 | .8296 |
| 1.845000 | .8287 |
| 2.060000 | .8248 |
| 2.596000 | .8153 |
| 2.738000 | .8135 |
| 2.814000 | .8138 |
| 2.912000 | .8126 |
| 2.956000 | .8124 |
| 3.127000 | .8112 |
| 3.138000 | .8093 |
| 3.237000 | .8077 |
| 3.506000 | .8008 |
| 3.672000 | .8007 |
| 3.719000 | .8008 |
| 3.840000 | .7997 |
| 3.863000 | .7990 |
| 4.038000 | .7950 |
| 4.087000 | .7965 |
| 4.315000 | .7912 |
| 4.467000 | .7912 |
| 4.735000 | .7895 |
| 5.000000 | .7885 |
| 5.016000 | .7901 |
| 5.072000 | .7898 |
| 5.194000 | .7912 |
| 5.505000 | .7875 |
| 5.628000 | .7873 |
| 5.671000 | .7865 |
| 5.759000 | .7890 |
| 6.025000 | .7908 |

TABLE 2D.

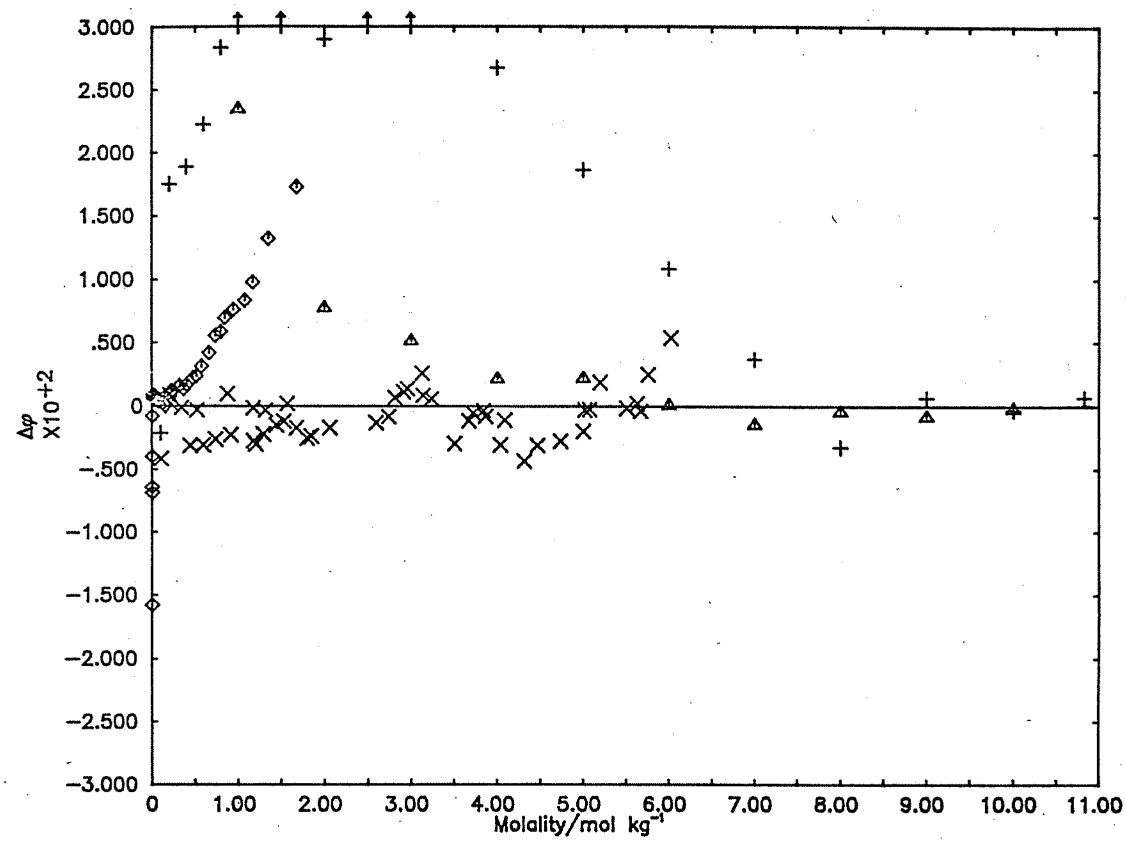
Scatchard Prentiss and Jones [10]. Freezing point depression measurements. $\Phi_L$ data from Parker's evaluation [4] and $\Phi_c$ data from Roux et al. [5] were used in treating these data. The data from 0.000803 to 0.19565 mol·kg$^{-1}$ were weighted 1.0, those from 0.22017 to 0.57485 mol·kg$^{-1}$ were weighted 0.5, and the remainder were weighted 0.2.

| $m$/mol·kg$^{-1}$ | $\phi_{298.15}$ |
|---|---|
| .000803 | .9736 |
| .000985 | .9819 |
| .002096 | .9765 |
| .003101 | .9761 |
| .006389 | .9717 |
| .010875 | .9663 |
| .017605 | .9585 |
| .021100 | .9552 |
| .036710 | .9447 |
| .055233 | .9357 |
| .073695 | .9286 |
| .093962 | .9227 |
| .141630 | .9125 |
| .153590 | .9097 |
| .195650 | .9036 |
| .220170 | .9019 |
| .223840 | .9007 |
| .249410 | .8977 |
| .318100 | .8913 |
| .368800 | .8868 |
| .404140 | .8845 |
| .473850 | .8803 |
| .512690 | .8781 |
| .574850 | .8754 |
| .663380 | .8720 |
| .735210 | .8701 |
| .796370 | .8678 |
| .843710 | .8670 |
| .942820 | .8639 |
| 1.074200 | .8601 |
| 1.166200 | .8586 |
| 1.351400 | .8566 |
| 1.676500 | .8523 |

TABLE 2E.

Harned and Shropshire [11, 12]. Activity coefficients based on diffusion measurements. Note that there is an obvious typographical error in ref. [12] for the value of $\gamma$ at 0.015 mol·kg$^{-1}$. The value for $\gamma$ at 0.001 mol·kg$^{-1}$ given in ref. [11] differs by 0.005 from the value given in ref. [12]. Assigned weight is 1.0.

| $m$/mol·kg$^{-1}$ | $\gamma$ |
|---|---|
| .000500 | .9746 |
| .001000 | .9696 |
| .002000 | .9508 |
| .005000 | .9251 |
| .010000 | .8983 |
| .015000 | .8793 |
| .020000 | .8643 |



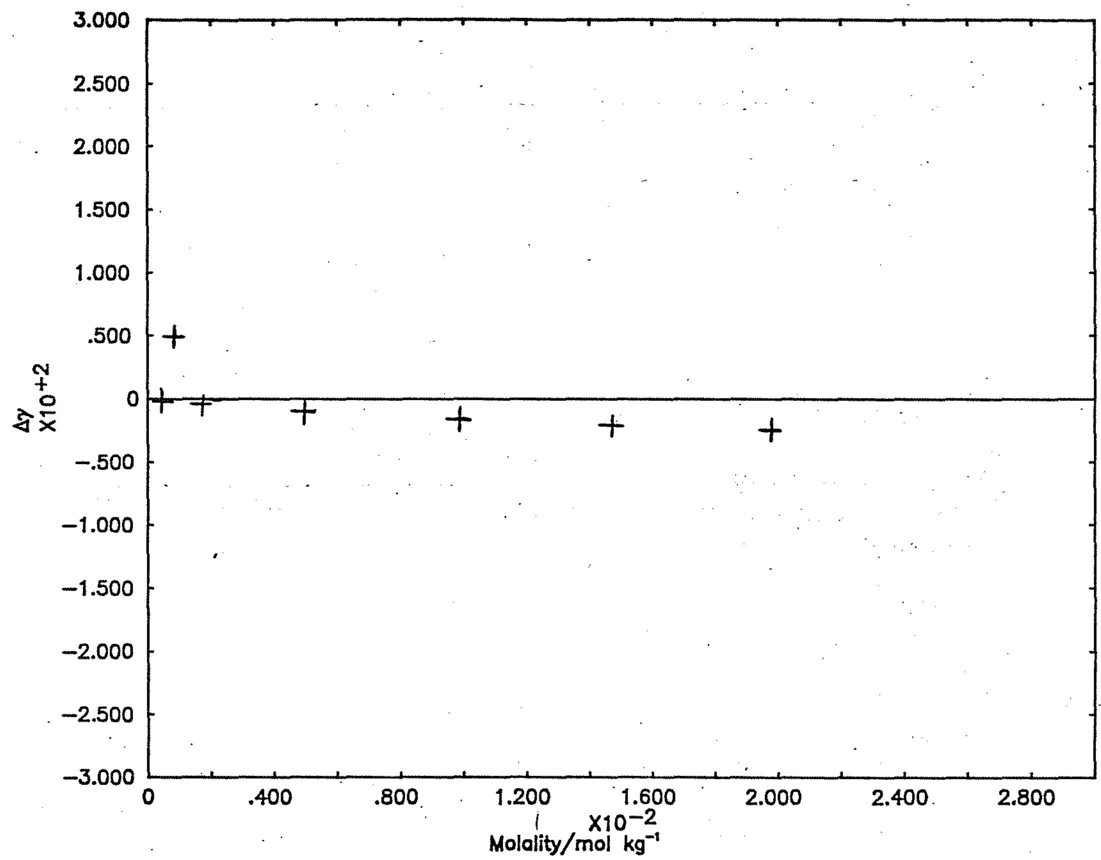

Deviation Plot for $NaNO_3$: ΔØ vs molality

▲ Kangro and Groeneveld [ 8 ].

+ Pearce and Hopson [ 6 ].

× Robinson [ 9 ].

◇ Scatchard, Prentiss, and Jones [10].




Deviation Plot for $NaNO_3$: Δγ vs molality

+ Harned and Schropshire [11,12]


## Acknowledgement

Revised values were calculated by R. Goldberg, whose efforts are greatly appreciated.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