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DENSITY OF SODIUM CHLORIDE SOLUTIONS AT HIGH TEMPERATURES AND PRESSURES

S.L. Phillips, H. Ozbek, and L.F. Silvester

June 1983

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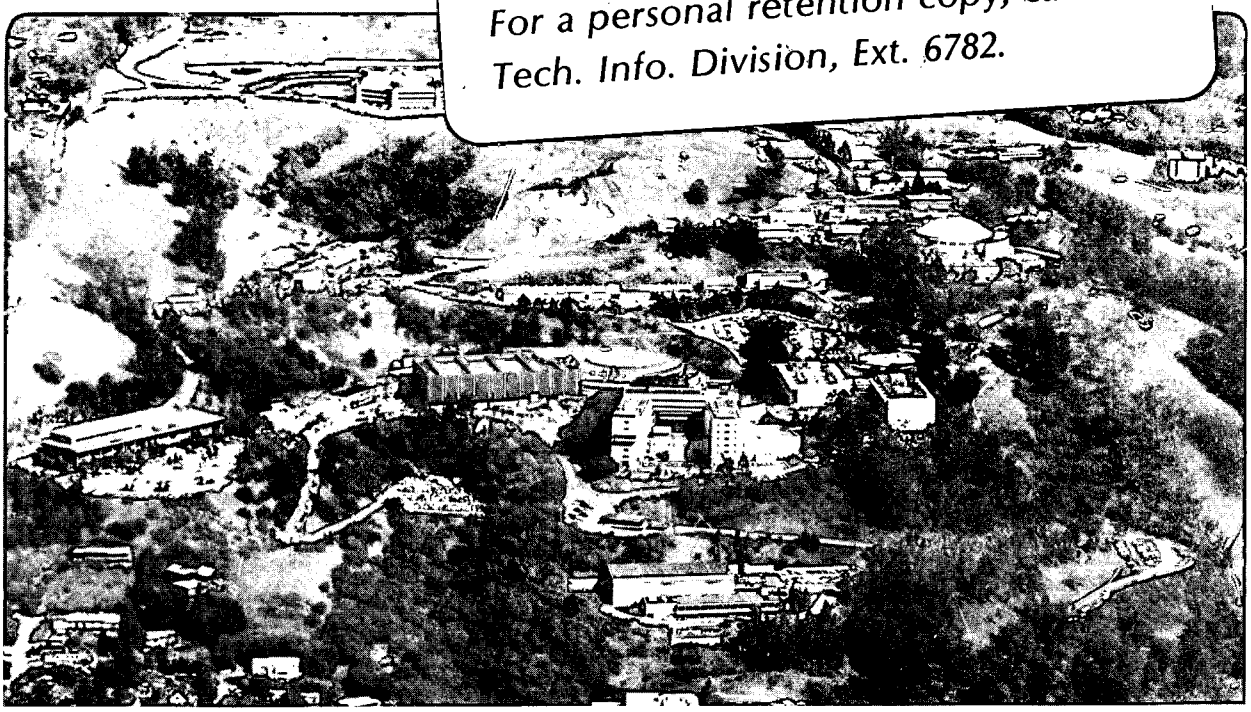

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DENSITY OF SODIUM CHLORIDE SOLUTIONS AT HIGH TEMPERATURES AND PRESSURES*

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A correlation equation is given which reproduces the density of sodium chloride solutions to ± 4% over the ranges 0-5 molal, 0-350° C and 1-1000 bars. Data generated from the equation are compared with selected experimental and smoothed values at typical temperatures, pressures and concentrations. Data are included for the density of sea water concentrates up to 150° C and 150 g/kg salinity at saturation vapor pressures based on a fit to a Chebyshev polynomial.

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Introduction

The development of new energy resources and advanced chemical processes requires sound thermophysical data on aqueous solutions to high temperatures. The combined need is for modern data in a quickly useful form. This paper gives a correlating equation used to generate tables of data on the density of sodium chloride solutions up to 350° C, 1-1000 bars and 0-5 molal concentrations. Such data are used to predict characteristics of brines for geothermal energy (1-3), sea water desalination (4), and for the origin of subsurface brines (5). The equations were developed by fitting critically evaluated experimental data (1).

The critical evaluation and selection of experimental data was based on the following criteria: details given on the experimental procedure; purity of materials; uncertainty assigned by the investigator; number of replicate measurements; temperature, pressure and concentration range covered; publication in refereed journals; and, prior publications by the researcher. Interpolated values from these correlating equations were then compared to both experimental and calculated data.

This work reports correlation equations and tables of data on the density of water, sodium chloride solutions and sea water concentrates. The larger aqueous solutions database consists of other thermophysical properties such as viscosity; and, thermochemical data, e.g., equilibrium constants (1).

Density of Sodium Chloride Solutions

Experimental data on the density of sodium chloride solutions were selected and fit earlier (1) to the following empirical equation:

$$d = A + Bx + Cx^2 + Dx^3 \quad . \tag{1}$$

where

$$x = c_1 \, exp(a_1 m) + c_2 \, exp\,(a_2 T) + c_3 \, exp\,(a_3 P) \tag{2}$$

d = *density*, g/cm^3; m = *molality*; T = °C; P = *bars*

A = -3.033405; B = 10.128163;

C = -8.750567; D = 2.663107

c_1 = -9.9559; c_2 = 7.0845; c_3 = 3.9093

$$a_1 = -4.539\,E-003; \quad a_2 = -1.638\,E-004; \quad a_3 = 2.551\,E-005$$
$$0 < T < 350°\ C; \quad 1 < P < 1000\ bars$$
$$0 < m < 5\ molal$$

Some features of eq 1 are the following: calculation of temperature and pressure derivatives is straightforward; the equation is easily programmed; and the equation reproduces experimental data with sufficient accuracy for many application. Equation 1 interpolates the density of water to ± 4% deviation for m=0, 1-1000 bars, and 0-350° C. Figure 1 shows % deviation versus temperature between density calculated by eq 1, and 79 values selected from the recent publications by Rogers, Bradley and Pitzer (6), Out and Los (7), Nagashima (8), and from the Steam Tables (9). Comparison of data for the density of water from eq 1 when m=0 in eq 2 with values calculated from Rowe and Chou (10) for 0-100° C, and from Isdale and Morris (11) for 70-160° C were also ± 4% difference. Figure 2 is a plot of % deviation for water density versus pressure, covering 1-1000 bars.

Similarly, the density of NaCl solutions is reproduced to ± 4% by eq 1. Figure 3 plots 200 points selected from the following: Out and Los (7); Rogers, Bradley and Pitzer (6); Grant-Taylor (14); Zarembo and Fedorov (15); Gorbachev, Kondrat'ev, Androsov and Kolupaev (16); and Ellis (17). We do not include data from Zarembo et al. for 350° C at 24% (5.404m) concentration because of the comparatively larger error (-5.7% to -7.8%). Similarly, the last six values for 1.000 m solutions for Table 1 of Grant-Taylor are erroneous and, therefore, not included here. The density values published by Khaibullin and Novikov (18) for 100-417° C, 1-338 kg/cm^2, 1% and 5% of NaCl (0.1728 and 0.9006 m) gave the largest errors (up to 15%), and consequently are not included in these comparisons.

Figure 4 plots % deviation in density for 112 points over the pressure range 20-1000 bars using data from Rogers et al., Zarembo and Fedorov, Gorbachev et al., and Grant-Taylor. Beyond 500 bars, values interpolated by eq 1 are 0-3% higher than e.g., Zarembo and Fedorov. Figure 5 shows % deviation for 107 points for 0.1-4 m concentrations in comparing eq 1 with the recent publications by Out and Los (7), Rogers et al. (6) and Grant-Taylor (14). There is a noticeable trend of zero to about 3% lower results as the concentration increases from 2-4 m. A comparable plot of 117 points

of data from Ellis (17), Gorbachev et al. (16) and Zarembo and Fedorov (15) indicates a similar trend (Fig. 6).

Our values for NaCl solutions were compared with specific volumes calculated by the equation for volumetric properties published recently by Rogers and Pitzer covering temperatures to 300° C and pressures to 1000 bars (19). Figures 7, 8 and 9 plot density versus temperature for 1 molal NaCl solutions at pressures of 200, 600 and 1000 bars. Agreement is quite good generally, with the largest difference of about ± 1.5% apparently at 1000 bars. Figures 10 and 11 compare the two sets of data as a function of concentration with the pressure fixed at 200 bars, and temperatures of 100° C and 300° C. At 100° C, the two sets begin to diverge near 1 molal NaCl to a maximum difference of 2.6% at 5 m. For 300° C, the two curves merge at about 2m NaCl, with maximum differences of 2.9% at 0.1 m, and 0.8% at 5 m. A comparison for 0-5 m, 1 bar and 100° C gives two curves with a difference of 0.5% at 0.1 m, which increases to 3% at 5 m (Fig. 12). The agreement is considered satisfactory, given the different databases used to develop the correlations.

Comparison of our data for NaCl solutions with selected densities from Rowe and Chou indicates at any constant pressure and molal concentration, % deviation is usually positive for temperatures from 0-150° C (Fig. 13).

Table 1 lists selected sources of experimental data on density of NaCl solutions; Table 2 gives density values generated from eq 1 and eq 2 for 0-350° C; 1-1000 bars; 0-5 molal.

Sea Water Density

As a companion study to developing eq 1, an interpolating equation for the density of sea water concentrates was developed as the difference in density of sea water and pure water, $d-d_w$. The limited range of temperature (0-150° C) simplifies obtaining an expression for water to predict density values to better than the ± 4% obtained from eq 1, which covers much wider ranges of temperature and pressure.

More accurate interpolating equations for reproducing the density of water were developed at saturated vapor pressures for the temperature ranges 0-100° C, and for 0-150° C. Both were obtained by fitting published experimental and smoothed data from selected sources to a Chebyshev

polynomial. For purposes of interpolation, the Chebyshev polynomial has several advantages as discussed by Ambrose, Counsell and Davenport (22), and recently by Brewer (23). Isdale and Morris fit their density data for sea water concentrates to a Chebyshev polynomial in the form of a double summation (11).

A caution in fitting Chebyshev polynomials is not to include an excessive number of coefficients with the expectation of obtaining continually improved accuracy on interpolation (22). Instead, the reproducibility of data may actually worsen. For example, we fit data on the specific volume of water taken from the Steam Tables for 0-100° C to polynomials of order 2-8. A comparison of the order with the square of the sum of residuals gave the following results.

Order:	2	3	4	5	6	7	8
$\Sigma(Residuals)^2$:	0.105	0.252	3.6×10^{-5}	0.0001	0.029	5.75	31,258

Order 6 gives increasingly negative % deviations; orders 7 and 8 increasingly positive erroneous densities.

Data on the density of water to six and seven decimal places from Kell and Whalley (24) and Kell (25) at one bar for 0-100° C were fit to Chebyshev polynomials as log (density, g/cm^3) versus T/K. Coefficients of the resulting fits relate water density (d_W) to specific volume (V) by $\log d_W = -\log V$ (25). Fits were made for orders 4, 5 and 6; Table 3 compares the resulting correlations as % deviations with densities given in Kell and Whalley (24). From Table 3, order 5 is the best choice.

Our fitting was done using a program obtained from Hewlett-Packard and run on an HP-85 microcomputer. This program fits data to a polynomial which is the best polynomial approximation in the Chebyshev sense:

$$P = \Sigma A_i X^i \text{ , } \quad \text{for } i = 0 \text{ to } n$$

The number of coefficients is not reduced by developing the polynomial with T = ° C, where the first term is then log d_w at 0 °C. For example, the % difference for order 4 and 5 when fitting to Chebyshev polynomials as log d_w versus T/C gave the following results:

% Deviation with Data in Kell (25)

T (C)	Order 4	Order 5
0	-0.00122	-0.00022
10	.00449	.00153
20	.00122	.00022
30	-.00133	-.00022
40	-.00122	.00008
50	.00024	.00022
60	.00122	-.00003
80	-.00122	.00022
90	-.00234	.00095
100	.00122	-.00022
	av. ± 0.0015%	av. ± 0.0004%

From the above comparison, order 5 is the best choice; the data in Table 3 shows order 5 is also the best choice for T/K.

A more accurate correlation for the density of water at 0-100° C and saturation vapor pressures other than eq 1 is the following Chebyshev polynomial:

$$\log d_w = A_0 + A_1T + A_2T^2 + A_3T^3 + A_4T^4 + A_5T^5 \qquad (3)$$

$$T = 273.15 + {}^\circ C$$

$$A_0 = -2.45724246 \; E \; +000$$

$$A_1 = 3.44563271 \; E \; -002$$

$$A_2 = -1.93976798 \; E \; -004$$

$$A_3 = 5.50708349 \; E \; -007$$

$$A_4 = -7.89829871 \; E \; -010$$

$$A_5 = 4.54837241 \; E \; -013$$

Table 4 lists dw interpolated from eq 3. The following equation covers the range 0-150°C, and was developed by fitting data from the Steam Tables, and References 7, 9 and 24.

$$\log d_w = A_0 + A_1T + A_2T^2 + A_3T^3 + A_4T^4 + A_5T^5 \quad (4)$$

$$T = 273.15 + {}^\circ C$$

$$A_0 = -1.4001218E\ -001$$

$$A_1 = -1.4671353E\ -004$$

$$A_2 = 1.1845275E\ -005$$

$$A_3 = -5.9008320E\ -008$$

$$A_4 = 1.0998292E\ -010$$

$$A_5 = -7.4573506E\ -014$$

Figure 14 compares density values for water from eq 4 with the following: the elegant correlation developed by Rowe and Chou which is based on data published in 1935 (10); experimental data published by Out and Los (7); highly accurate densities from the correlation by Millero et al. (12, 13); values from Isdale and Morris and the Steam Tables (9); and, Kell and Whalley for 1 bar (24). Water densities are reproduced to an average of ± 0.03% at saturated vapor pressures from 0-150° C.

For sea water density, we used eq 4 and data in Isdale and Morris (11) to fit the following Chebyshev polynomial.

$$(d_s - d_w) = A_0 + A_1T + A_2T^2 + A_3T^3,\ g/cm^3 \quad (5)$$

for which

$$A_0 = 1.6263604\,E\,-003 + 7.912403\,E\,-004S$$

$$A_1 = -1.311896\,E\,-004 - 4.247298E\,-006\,S + 2.506863\,E\,-008\,S^2$$

$$A_2 = 1.670632\,E\,-006 + 4.959969\,E\,-008\,S - 3.430183\,E\,-010S^2$$

$$A_3 = -5.974604\,E\,-009 - 1.407165\,E\,-010S + 1.140085\,E\,-012\,S^2$$

$$T = {}^\circ C;\quad d_s = \textit{density of sea water}, g/cm^3$$

$$S = \textit{salinity}, g/kg$$

The quantity (d_s - d_w) is the relative density; d_s is recovered by adding d_w. Equation 5 reproduces sea water data in both Isdale and Morris and Fabuss and Korosi (20, 21) to about ± 0.2%. Table 5 is the density of sea water concentrates from 5-150° C, 10-150 g/kg salinity and saturation vapor pressures.

Empirical equations such as eq 3 and eq 4 for water are intended for purposes of interpolation so that extrapolation outside the range where data were fit is risky. For example, Fig. 15 plots the highly accurate eq 3 to 150° C, representing extrapolation of 50° C beyond the region where data were fit (0-100° C). Comparison with data from Kell and Whalley shows a fit within ± 0.0005% deviation from 0-100° C; however, extrapolated results predicted by eq 3 are consistently lower: from -0.006% at 100° C to -0.35% at 150° C. However, within the temperature, pressure and concentration domain covered, eq 1-4 are very useful in predicting density and specific volume. In addition, variation in density with other parameters are faithfully reproduced; for example, increase in density with pressure isotherms such as that for water and 5m NaCl solution at 350° C are shown in Figure 16.

Ion Product of Water

The ion product of water, $H_2O = H^+ + OH^-$, is reproduced by the following equation recently published by Marshall and Franck (26).

$$\log K_w = -4.098 - \frac{3245.2}{T} + \frac{2.2362\,E+005}{T^2} - \frac{3.984\,E+007}{T^3}$$

$$+\left(13.957 - \frac{1262.3}{T} + \frac{8.5641\,E+005}{T^2}\right)\log d_w \qquad (6)$$

$$\text{where } T = 273.15 + {}^\circ C$$

Note that in eq 6 the pressure dependence for log K_W is contained in the density term. We have calculated values of log K_W using eq 1 for water density, at representative pressures of 1, 500 and 1000 bars. Figure 17 shows agreement between the results from eq 1 and eq 6, with those tabulated by Marshall and Franck. The percentage deviation varies with temperature, and is within ± 3%. See Figure 18. Equation 1 for density is only valid up to 350° C, so that log K_W calculated with these equations is valid only up to 350° C and 1000 bars.

Units and Conversions

$$1\ bar = 1.019716\ kg/cm^2$$

$$1\ atm = 1.01325\ bar = 1.03323\ kg/cm^2$$

$$\%\ weight\ NaCl = (100)(molality)(58.44)/(1000 + (molality)(58.44))$$

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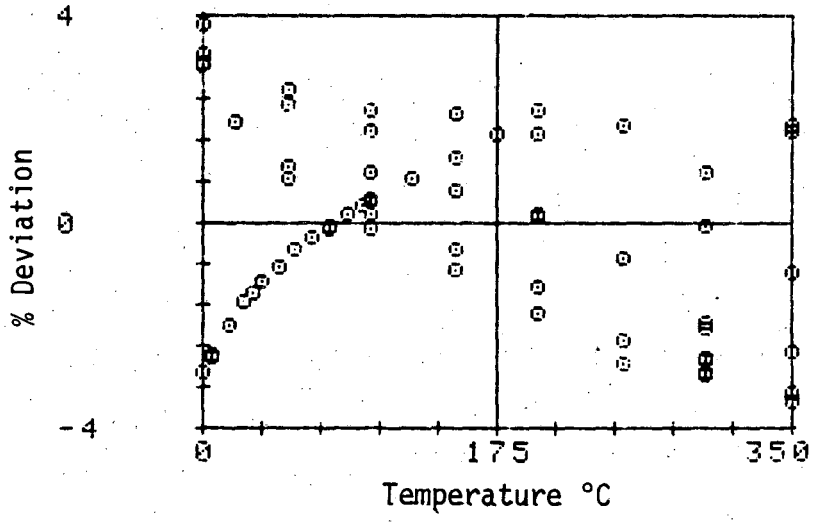

Figure 1. Density of water. Percentage difference in data from eq 1 and eq 2 with data from Out and Los;Rogers et al.; Nagashima;and, Steam Tables. Pressure is 1 - 1000 bar ; 79 data points.

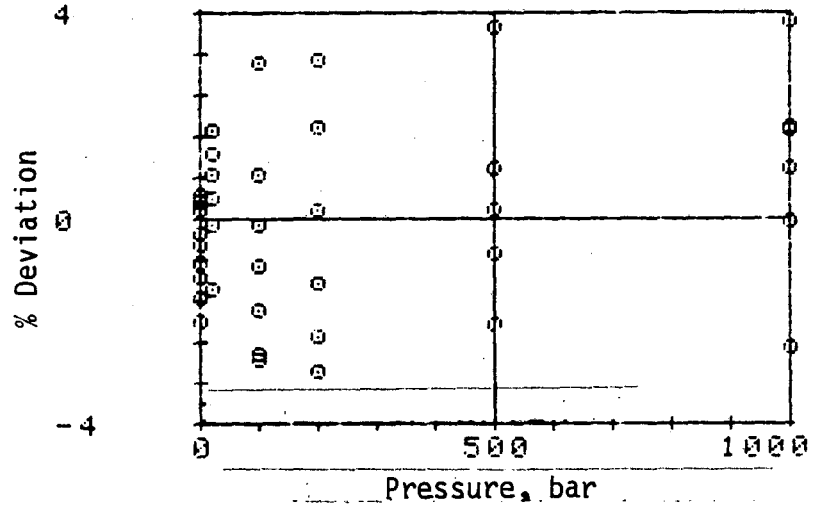

Figure 2. Density of water. Percentage difference in data from eq 1 and eq 2 with data from Out and Los;Rogers et al.; Nagashima;and, Steam Tables. Temperature is 0 - 350°C; 40 data points.

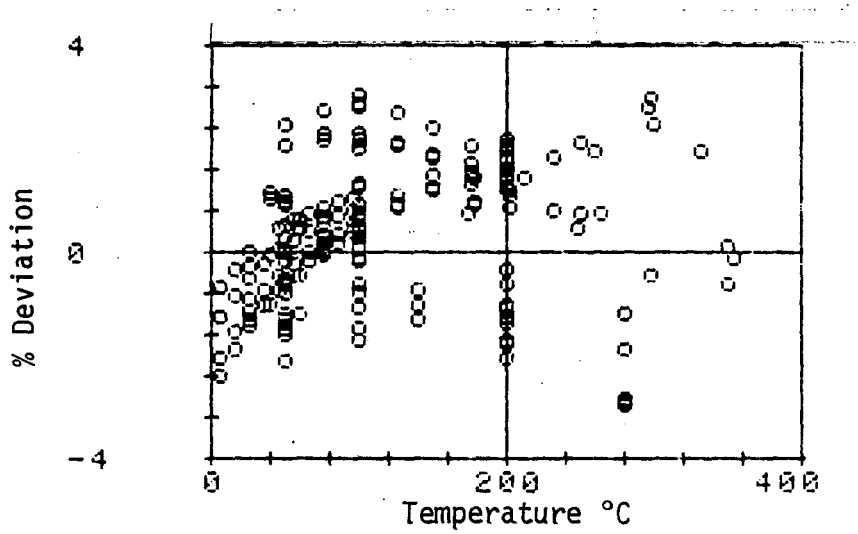

Figure 3. Density of sodium chloride solutions. Percentage difference in data from eq 1 and eq 1 with data from Out and Los;Zarembo and Fedorov;Gorbachev et al.;Rogers et al.; Grant-Taylor; and, Ellis. Pressure is 1 - 1000 bar ; concentration is 0.001 - 5.4 m; 200 data points.

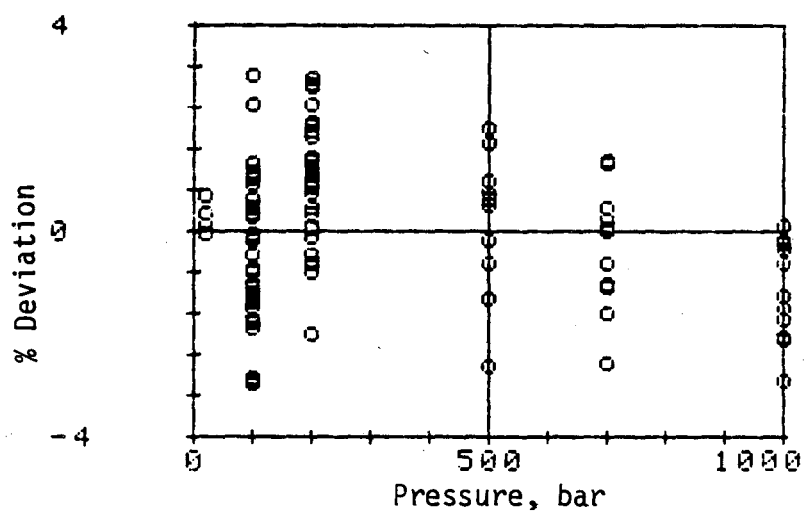

Figure 4. Density of sodium chloride solutions. Percentage difference in data from eq 1 and eq 2 with data from Grant-Taylor;Rogers et al.;Gorbachev et al.; and, Zarembo and Fedorov. Temperature is 20 - 350°C; concentration is 0.001 - 5.4m; 112 data points.

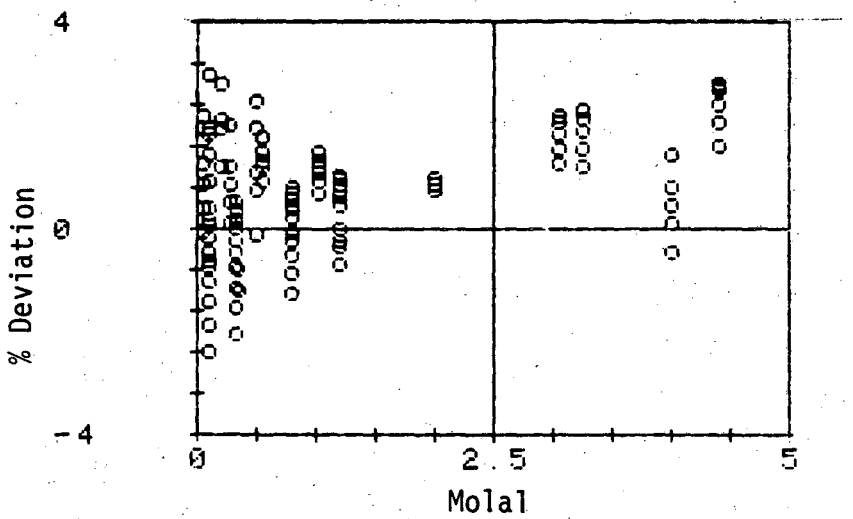

Figure 5. Density of NaCl solutions. Percentage difference in data from eq 1 and eq 2, and data from Out and Los; Rogers et al.; Grant-Taylor; and, Zarembo and Fedorov. Temperature 5 - 350°C; pressure 1 - 200 bar ; 107 data points.

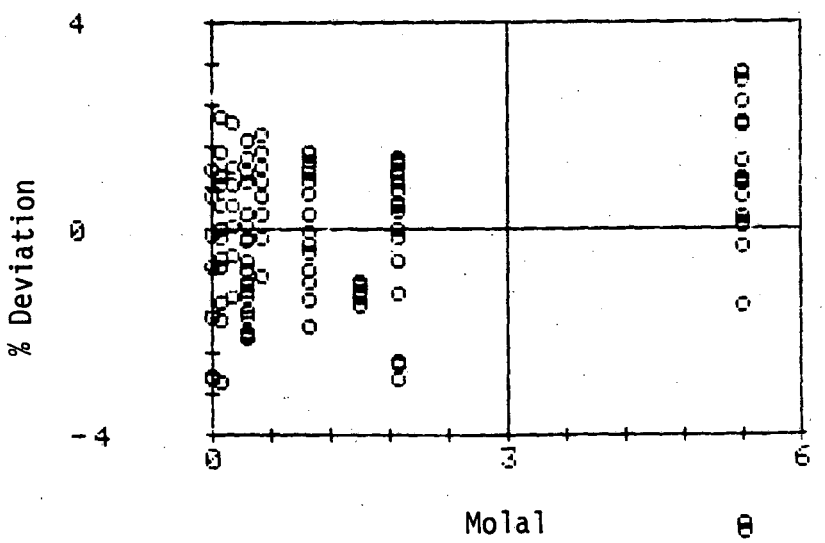

Figure 6. Density of NaCl solutions. Percentage difference in data from eq 1 and eq 2, and data from Ellis; Gorbachev et al.; and, Zarembo and Fedorov. Temperature 25 - 350°C; pressure 20-1000 bar ; 117 data points.

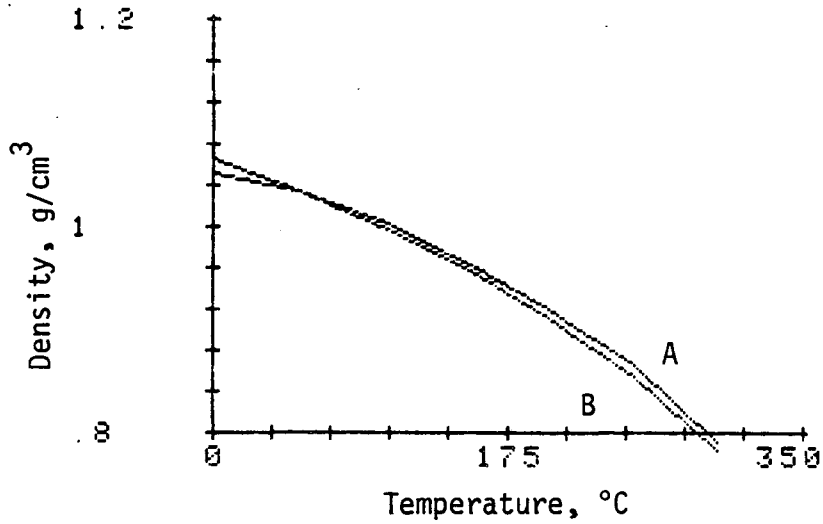

Figure 7. Comparison of density data (A) Rogers and Pitzer with (B) this work. Pressure is 200 bar ; concentration is 1m NaCl.

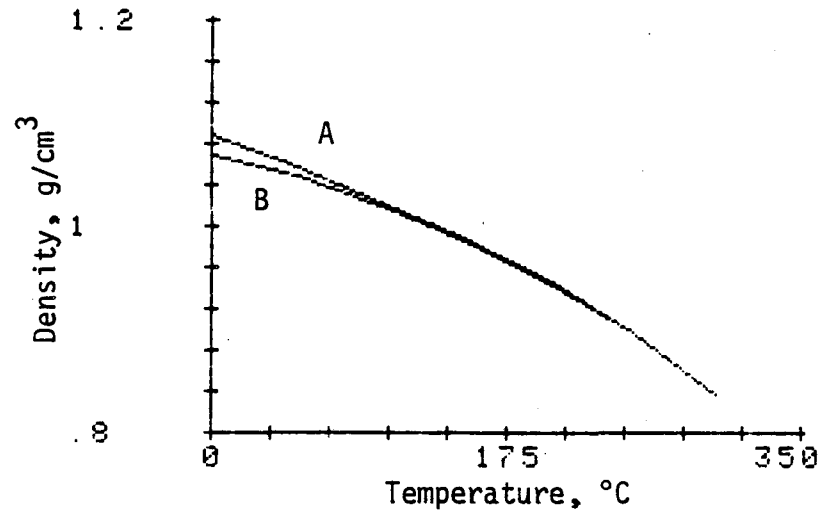

Figure 8. Comparison of density data (A) from this work with (B) Rogers and Pitzer. Pressure is 600 bar ;concentration is 1m NaCl.

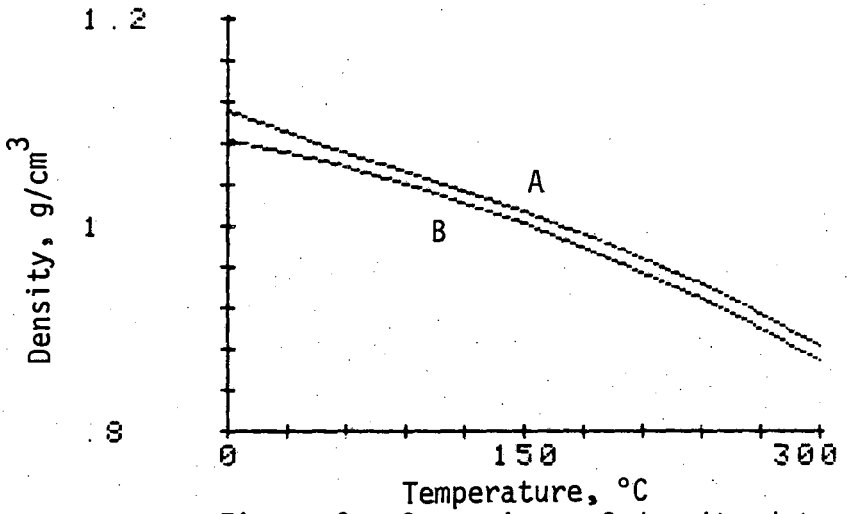

Figure 9. Comparison of density data from (A) Rogers and Pitzer with (B) this work. Pressure is 1000 bar ; concentration is 1m NaCl.

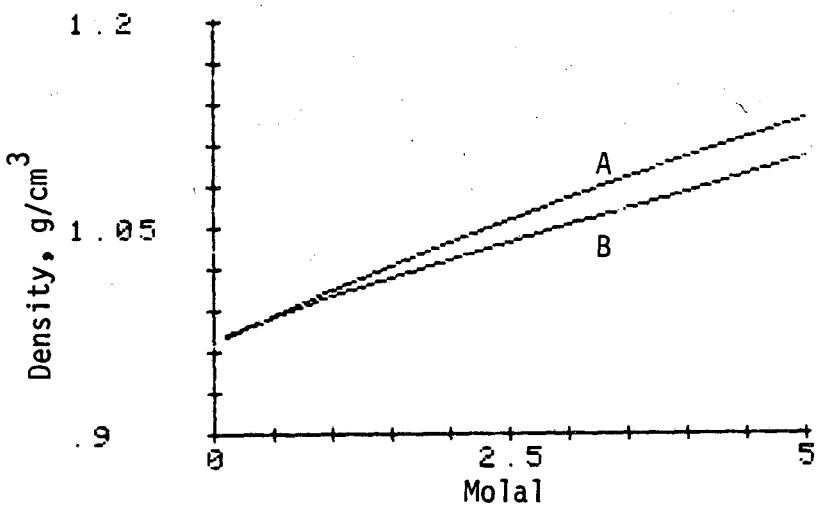

Figure 10. Comparison of density data from (A) Rogers and Pitzer with (B) this work. Temperature is 100°C; pressure is 200 bar .

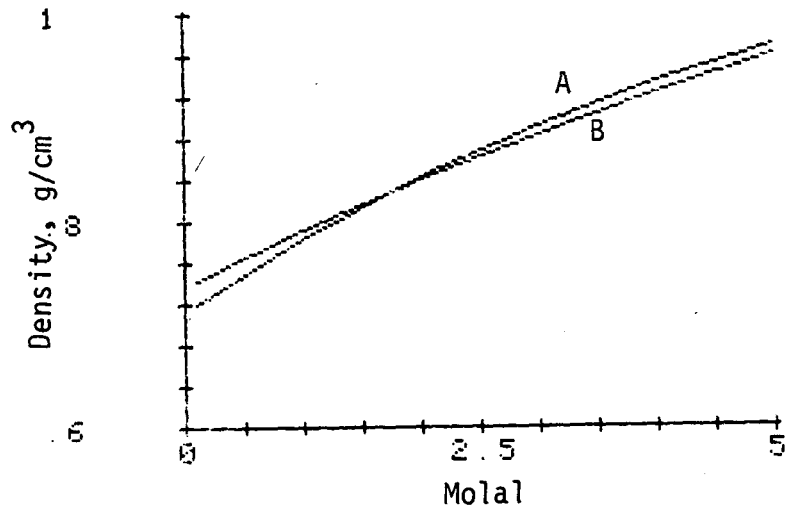

Figure 11. Comparison of density data from (A) this work with (B) Rogers and Pitzer. Temperature is 300°C; pressure is 200 bar.

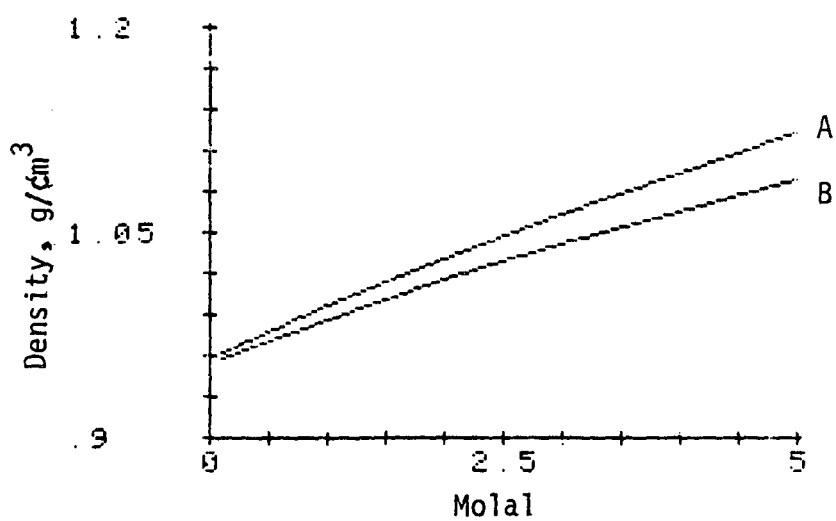

Figure 12. Comparison of density data from (A) Rogers and Pitzer with (B) this work. Temperature is 100°C; pressure is 1 bar.

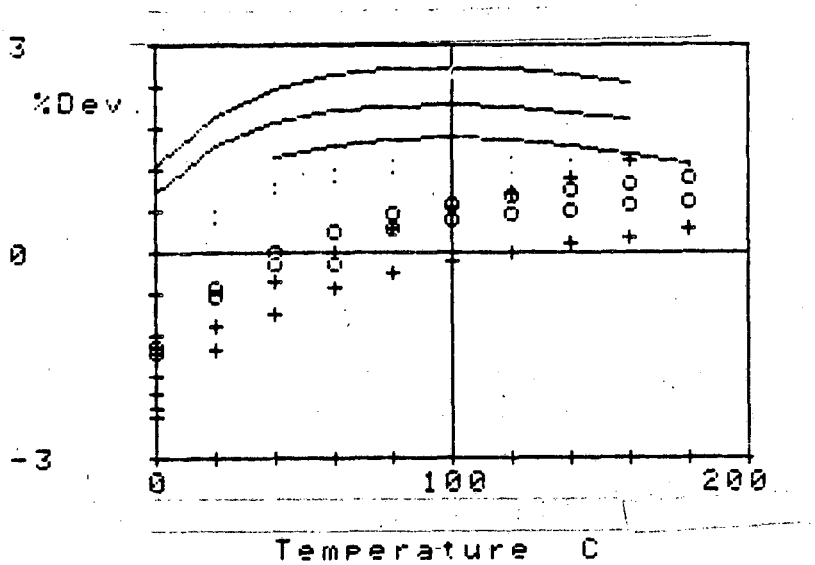

Figure 13. Comparison of densities of NaCl solutions predicted by eq 1, compared with Rowe and Chou correlation. Concentration and pressure: 0.5m (10 and 100 bar): +++; 1m (100 and 200 bar): ooo; 2m (100 and 200 bar): ...; 3m (20 and 300 bar): ___; 4m (10 bar): ___(uppermost curve).

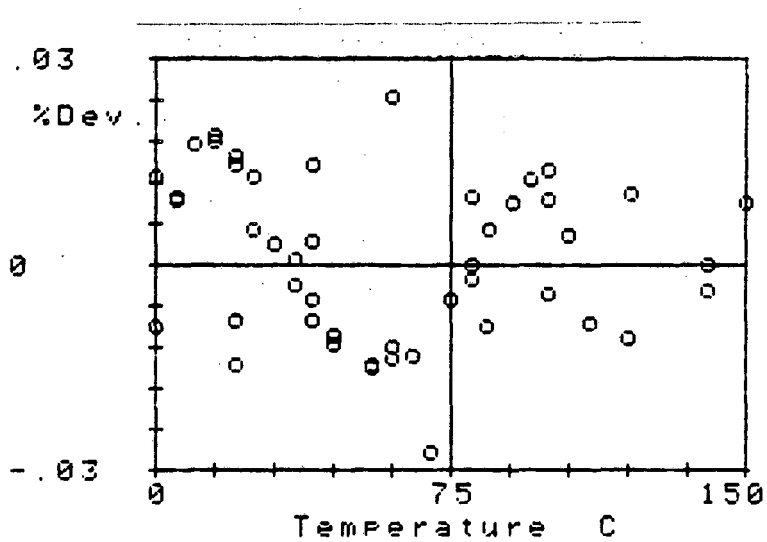

Figure 14. Percentage deviation in density of water using data from eq 4, with data from Kell and Whalley (0 - 100°C);Out and Los (5-95°C); Rowe and Chou (0 - 100°C); Isdale and Morris (70 - 160°C); Chen,Chen and Millero (0 - 55°C); Steam Tables (0 - 150°C). Saturated vapor pressures; 49 data points.

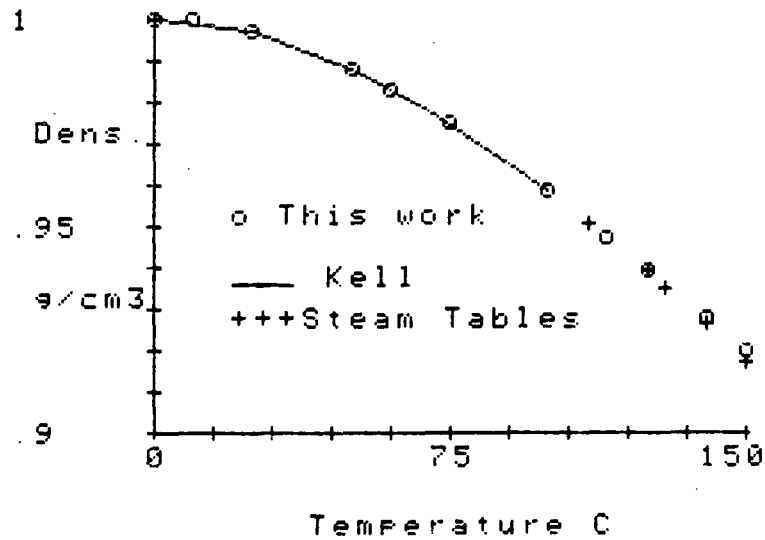

Figure 15. Plot of eq 3 showing extrapolation from 100 - 150°C.

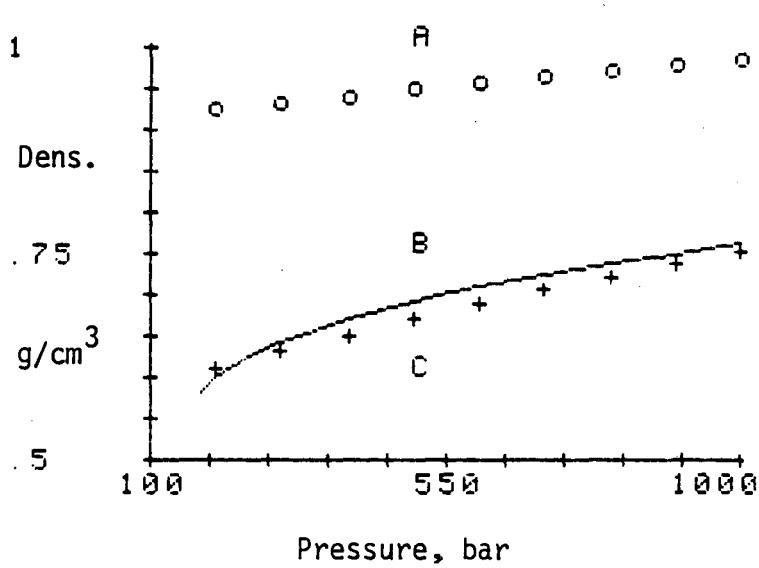

Figure 16. Plot of density of water versus pressure for 350°C. A. 5m NaCl. B. Water, data from Nagashima (___). C. Water, data from this work (+++).

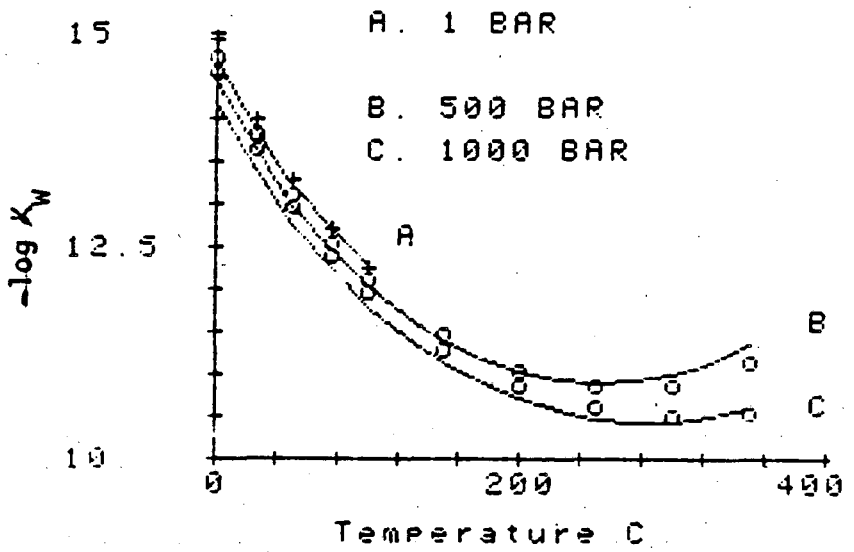

Figure 17. Ion product of water (-log K_W) calculated from eq 6, using densities calculated by eq 1, eq 2 (solid lines). Values are compared with data from Marshall and Franck (26).

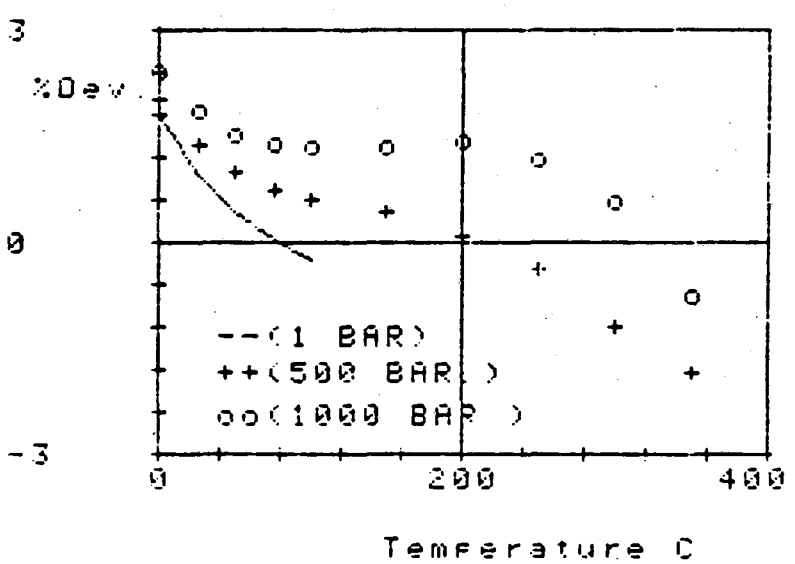

Figure 18. Percentage deviation between ion product of water calculated from eq 6, using densities calculated by eq 1, eq 2 and data from Marshall and Franck (26), at pressures indicated.

Table 1. Selected experimental data for density of water and sodium chloride solutions to high temperatures and pressures. Some data are published in the form of a correlation equation.

Ranges	Measurement	Reference
25-45;1;1-5	Oscillating tube	Romankiw;Chou(1983)
5-34;1;0.37802-5.99684	Vibrating tube	LoSurdo;Alzola;Millero(1982)
30-200;20.3;0-4.39	Dilatometer	Rogers;Bradley;Pitzer(1982)
173-354;200;0.100-4.000	Mercury displacement	Grant-Taylor(1981)
0-100;1;0	Calculated	Kell(1981)
5-95;1;0-1.2000	Calculated	Out;Los(1980)
0-35;1;0.00992-1.49986	Vibrating flow densimeter	Chen;Chen;Millero(1980)
25-50;1;0.00784-5.8267	Pycnometer	Goncalves;Kestin(1977)
25-350;0-980.7;0.35-5.4	Hydrostatic weighing	Zarembo;Fedorov(1976)
0-150;0-1000;0	Calculated	Kell;Whalley(1975)
40-280;100.1;0.001-1.5		Gorbachev;Kondrat'ev;Androsov;Kolupaev(1974)
70-160;SVP;0	Dilatometer	Isdale;Morris(1972)
0-175;1-303;0-5.7	Compressibility	Rowe;Chou(1972)
25-200;20.3;0.1-1	Mercury displacement	Ellis(1966)
25-175;SVP;0.1-2.5	Pycnometer;dilatometer	Fabuss;Korosi;Huq(1966)
0-40;0-1000;0-1	Equation of state	Chen;Millero(1981)

Romankiw, L. A.; Chou, I-M; J. Chem. Eng. Data 1983, 28, 300.

Goncalves, F. A.; Kestin, J; Berich. Bunsege Physik.Chem. 1977, 81, 1156.

Chen, C.-T.; Millero, F. J.; J. Chem. Eng. Data 1981, 26, 270.

Table 2. Density of NaCl solutions g/cm3,at molal concentration shown

TEMP (C)	PRES BAR	MOLAL CONCENTRATION 0	.5	1	2	3	4	5
20	10	1.01681	1.02993	1.04256	1.06708	1.09182	1.11820	1.14757
20	100	1.02211	1.03502	1.04752	1.07199	1.09697	1.12386	1.15404
20	200	1.02789	1.04061	1.05300	1.07748			
20	500	1.04483	1.05717	1.06943	1.09439			
20	1000	1.07256	1.08503	1.09781	1.12506			
50	10	.99537	1.00956	1.02297	1.04822	1.07258	1.09747	1.12429
50	100	1.00112	1.01499	1.02816	1.05314	1.07751	1.10271	1.13011
50	200	1.00737	1.02092	1.03385	1.05859	1.08305	1.10865	1.13677
50	500	1.02535	1.03815	1.05058	1.07505	1.10020	1.12745	1.15816
50	1000	1.05371	1.06599	1.07832	1.10381	1.13160	1.16309	1.19961
70	10	.97996	.99510	1.00927	1.03548	1.06006	1.08444	1.11003
70	100	.98611	1.00086	1.01471	1.04050	1.06495	1.08949	1.11551
70	200	.99277	1.00711	1.02064	1.04603	1.07040	1.09518	1.12176
70	500	1.01177	1.02511	1.03789	1.06251	1.08708	1.11301	1.14169
70	1000	1.04108	1.05349	1.06574	1.09054	1.11691	1.14626	1.17992
100	10	.95473	.97164	.98730	1.01565	1.04125	1.06558	1.09003
100	100	.96162	.97803	.99326	1.02096	1.04622	1.07048	1.09514
100	200	.96905	.98493	.99971	1.02677	1.05170	1.07596	1.10093
100	500	.99004	1.00454	1.01820	1.04375	1.06814	1.09281	1.11915
100	1000	1.02158	1.03451	1.04702	1.07149	1.09645	1.12329	1.15338
150	10	.90555	.92632	.94538	.97912	1.00828	1.03434	1.05874
150	100	.91403	.93412	.95256	.98530	1.01374	1.03938	1.06363
150	200	.92315	.94251	.96030	.99189	1.01970	1.04492	1.06908
150	500	.94868	.96605	.98210	1.01103	1.03699	1.06141	1.08572
150	1000	.98601	1.00076	1.01462	1.04041	1.06486	1.08940	1.11542
200	100	.85565	.88054	.90332	.94333	.97722	1.00649	1.03258
200	200	.86696	.89091	.91284	.95139	.98415	1.01260	1.03821
200	500	.89854	.91989	.93946	.97405	1.00383	1.03027	1.05482
200	1000	.94419	.96190	.97825	1.00764	1.03387	1.05839	1.08262
250	100	.78392	.81470	.84291	.89240	.93393	.96903	.99918
250	200	.79790	.82754	.85470	.90232	.94232	.97621	1.00547
250	500	.83699	.86343	.88762	.93007	.96588	.99656	1.02357
250	1000	.89346	.91522	.93517	.97038	1.00062	1.02736	1.05204
300	100	.69641	.73416	.76886	.82996	.88127	.92435	.96071
300	200	.71353	.74994	.78339	.84223	.89161	.93309	.96816
300	500	.76157	.79416	.82405	.87651	.92051	.95759	.98923
300	1000	.83127	.85818	.88280	.92601	.96242	.99355	1.02087
350	200	.61155	.65576	.69655	.76869	.82955	.88072	.92370
350	500	.66992	.70972	.74635	.81092	.86522	.91080	.94918
350	1000	.75522	.78832	.81868	.87199	.91670	.95435	.98643

Table 3. Comparison of Densities of Water from Chebyshev Polynomials, with Kell and Whalley Values.

Order	Σ (% Deviations)^2
4	0.0104
5	0.0001
6	0.0047

Table 4. Density of water, eq 3 and eq 4, at saturated vapor pressures

TEMPERATURE	DENSITY(g/cm3)	
DEG C	eq 3	eq 4
0	0.9998420	0.99993
5	0.9999478	0.99986
10	0.9996847	0.99952
15	0.9990914	0.99892
20	0.9982021	0.99806
25	0.9970462	0.99696
30	0.9956493	0.99562
35	0.9940330	0.99406
40	0.9922155	0.99230
45	0.9902119	0.99033
50	0.9880349	0.98817
55	0.9856946	0.98584
60	0.9831996	0.98333
65	0.9805566	0.98067
70	0.9777716	0.97786
75	0.9748497	0.97490
80	0.9717957	0.97182
85	0.9686146	0.96860
90	0.9653118	0.96527
95	0.9618934	0.96183
100	0.9583668	0.95827
105		0.95461
110		0.95085
115		0.94699
120		0.94303
125		0.93897
130		0.93481
135		0.93054
140		0.92617
145		0.92169
150		0.91709

Table 5. Density of sea water, g/cm 3; at salinity (g/kg) shown

TEMP	SALINITY						
DEG C	10	30	35	50	70	110	150
5	1.0086	1.0241	1.0280	1.0397	1.0554	1.0871	1.1192
10	1.0076	1.0228	1.0266	1.0382	1.0538	1.0855	1.1179
15	1.0063	1.0214	1.0251	1.0366	1.0521	1.0838	1.1165
20	1.0050	1.0198	1.0235	1.0349	1.0503	1.0819	1.1148
25	1.0034	1.0181	1.0218	1.0330	1.0483	1.0800	1.1130
30	1.0017	1.0162	1.0199	1.0311	1.0463	1.0779	1.1110
35	.9999	1.0143	1.0179	1.0290	1.0442	1.0757	1.1089
40	.9979	1.0122	1.0158	1.0269	1.0420	1.0734	1.1066
45	.9958	1.0100	1.0136	1.0246	1.0397	1.0710	1.1041
50	.9936	1.0077	1.0113	1.0223	1.0373	1.0686	1.1016
55	.9912	1.0053	1.0089	1.0198	1.0348	1.0660	1.0989
60	.9887	1.0028	1.0064	1.0173	1.0323	1.0634	1.0961
65	.9861	1.0002	1.0038	1.0147	1.0296	1.0606	1.0932
70	.9834	.9975	1.0011	1.0120	1.0269	1.0578	1.0902
75	.9805	.9947	.9983	1.0093	1.0241	1.0549	1.0871
80	.9776	.9918	.9955	1.0064	1.0213	1.0520	1.0840
85	.9745	.9889	.9925	1.0035	1.0184	1.0490	1.0807
90	.9714	.9858	.9894	1.0004	1.0154	1.0459	1.0774
95	.9681	.9826	.9863	.9973	1.0123	1.0428	1.0741
100	.9648	.9794	.9830	.9941	1.0091	1.0395	1.0707
105	.9613	.9760	.9797	.9909	1.0058	1.0362	1.0672
110	.9577	.9725	.9763	.9875	1.0025	1.0329	1.0636
115	.9540	.9690	.9727	.9840	.9991	1.0294	1.0601
120	.9502	.9653	.9690	.9804	.9955	1.0259	1.0564
125	.9462	.9614	.9652	.9767	.9919	1.0223	1.0527
130	.9422	.9575	.9613	.9728	.9881	1.0186	1.0490
135	.9380	.9534	.9573	.9688	.9842	1.0148	1.0451
140	.9336	.9492	.9531	.9647	.9802	1.0108	1.0413
145	.9291	.9448	.9487	.9604	.9760	1.0068	1.0373
150	.9244	.9402	.9442	.9560	.9716	1.0026	1.0333

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

The appendix which follows consists of values for the density of NaCl solutions

Density of NaCl solutions,g/cm 3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	1	1.02977	1.03233	1.03488	1.03741	1.03993	1.04243
5	1	1.02644	1.02903	1.03160	1.03416	1.03669	1.03921
10	1	1.02309	1.02571	1.02830	1.03088	1.03343	1.03597
15	1	1.01970	1.02235	1.02497	1.02757	1.03015	1.03271
20	1	1.01628	1.01896	1.02161	1.02424	1.02684	1.02942
25	1	1.01281	1.01553	1.01821	1.02087	1.02350	1.02611
30	1	1.00931	1.01205	1.01477	1.01746	1.02013	1.02276
35	1	1.00575	1.00854	1.01129	1.01402	1.01671	1.01938
40	1	1.00215	1.00498	1.00777	1.01053	1.01326	1.01597
45	1	.99849	1.00137	1.00420	1.00700	1.00977	1.01251
50	1	.99478	.99770	1.00058	1.00342	1.00623	1.00901
55	1	.99102	.99398	.99691	.99979	1.00265	1.00546
60	1	.98719	.99020	.99318	.99611	.99901	1.00187
65	1	.98330	.98636	.98939	.99237	.99531	.99822
70	1	.97934	.98246	.98554	.98857	.99156	.99452
75	1	.97531	.97849	.98162	.98471	.98775	.99076
80	1	.97121	.97445	.97764	.98078	.98388	.98694
85	1	.96703	.97034	.97359	.97679	.97994	.98305
90	1	.96278	.96615	.96946	.97272	.97594	.97910
95	1	.95845	.96188	.96526	.96859	.97186	.97508
100	1	.95403	.95753	.96098	.96437	.96771	.97099

Density of NaCl solutions,g/cm 3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	10	1.03028	1.03284	1.03538	1.03791	1.04043	1.04293
5	10	1.02696	1.02955	1.03211	1.03466	1.03719	1.03971
10	10	1.02361	1.02623	1.02882	1.03139	1.03394	1.03647
15	10	1.02023	1.02287	1.02549	1.02809	1.03066	1.03322
20	10	1.01681	1.01949	1.02213	1.02476	1.02736	1.02993
25	10	1.01336	1.01606	1.01874	1.02139	1.02402	1.02663
30	10	1.00985	1.01260	1.01531	1.01799	1.02065	1.02329
35	10	1.00631	1.00909	1.01184	1.01456	1.01725	1.01991
40	10	1.00271	1.00553	1.00832	1.01108	1.01380	1.01650
45	10	.99907	1.00193	1.00476	1.00756	1.01032	1.01305
50	10	.99537	.99828	1.00115	1.00398	1.00679	1.00956
55	10	.99161	.99457	.99748	1.00036	1.00321	1.00602
60	10	.98779	.99080	.99376	.99669	.99958	1.00243
65	10	.98391	.98697	.98998	.99296	.99590	.99879
70	10	.97996	.98308	.98614	.98917	.99216	.99510
75	10	.97595	.97912	.98224	.98532	.98836	.99135
80	10	.97186	.97509	.97827	.98140	.98449	.98754
85	10	.96769	.97099	.97423	.97742	.98057	.98367
90	10	.96346	.96681	.97011	.97337	.97657	.97973
95	10	.95914	.96256	.96593	.96924	.97251	.97572
100	10	.95473	.95822	.96166	.96504	.96837	.97164
105	10	.95024	.95381	.95731	.96076	.96415	.96749
110	10	.94567	.94930	.95288	.95639	.95985	.96326
115	10	.94100	.94471	.94836	.95195	.95548	.95895
120	10	.93624	.94003	.94375	.94741	.95101	.95456
125	10	.93138	.93525	.93905	.94279	.94646	.95008
130	10	.92642	.93037	.93426	.93807	.94182	.94552
135	10	.92136	.92540	.92936	.93326	.93709	.94086
140	10	.91620	.92032	.92437	.92835	.93226	.93611
145	10	.91093	.91514	.91928	.92334	.92734	.93127
150	10	.90555	.90985	.91408	.91823	.92231	.92632
155	10	.90005	.90445	.90877	.91301	.91718	.92128
160	10	.89444	.89894	.90335	.90768	.91194	.91613
165	10	.88872	.89331	.89782	.90225	.90660	.91087
170	10	.88287	.88756	.89217	.89669	.90114	.90551
175	10	.87690	.88169	.88640	.89103	.89557	.90003

Density of NaCl solutions,g/cm 3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	20	1.03084	1.03340	1.03594	1.03847	1.04098	1.04348
5	20	1.02753	1.03012	1.03268	1.03522	1.03775	1.04026
10	20	1.02419	1.02680	1.02939	1.03195	1.03450	1.03703
15	20	1.02082	1.02345	1.02607	1.02866	1.03123	1.03378
20	20	1.01741	1.02007	1.02271	1.02533	1.02793	1.03050
25	20	1.01396	1.01666	1.01933	1.02198	1.02460	1.02720
30	20	1.01046	1.01320	1.01590	1.01858	1.02124	1.02386
35	20	1.00693	1.00970	1.01244	1.01515	1.01784	1.02050
40	20	1.00334	1.00615	1.00893	1.01168	1.01440	1.01709
45	20	.99970	1.00256	1.00538	1.00817	1.01092	1.01365
50	20	.99601	.99891	1.00178	1.00461	1.00740	1.01017
55	20	.99227	.99521	.99812	1.00100	1.00383	1.00664
60	20	.98846	.99146	.99441	.99733	1.00021	1.00306
65	20	.98459	.98764	.99065	.99361	.99654	.99943
70	20	.98065	.98376	.98682	.98983	.99281	.99575
75	20	.97665	.97981	.98292	.98599	.98902	.99201
80	20	.97257	.97579	.97897	.98209	.98517	.98821
85	20	.96843	.97171	.97494	.97812	.98126	.98435
90	20	.96420	.96755	.97084	.97408	.97727	.98042
95	20	.95990	.96331	.96666	.96997	.97322	.97642
100	20	.95551	.95899	.96241	.96578	.96909	.97236
105	20	.95104	.95458	.95808	.96151	.96489	.96822
110	20	.94648	.95010	.95366	.95716	.96061	.96400
115	20	.94182	.94552	.94916	.95273	.95625	.95971
120	20	.93708	.94085	.94456	.94821	.95180	.95533
125	20	.93224	.93609	.93988	.94361	.94727	.95087
130	20	.92730	.93124	.93510	.93891	.94265	.94632
135	20	.92226	.92628	.93023	.93411	.93793	.94168
140	20	.91711	.92122	.92526	.92922	.93312	.93695
145	20	.91186	.91606	.92018	.92423	.92821	.93213
150	20	.90650	.91079	.91500	.91914	.92320	.92720
155	20	.90103	.90541	.90971	.91394	.91809	.92217
160	20	.89544	.89992	.90431	.90863	.91287	.91705
165	20	.88974	.89431	.89880	.90321	.90755	.91181
170	20	.88391	.88859	.89317	.89768	.90211	.90647
175	20	.87797	.88274	.88743	.89204	.89656	.90101
180	20	.87190	.87677	.88157	.88627	.89090	.89544
185	20	.86570	.87068	.87558	.88039	.88511	.88975
190	20	.85937	.86446	.86946	.87438	.87921	.88395
195	20	.85291	.85811	.86322	.86824	.87318	.87802
200	20	.84631	.85163	.85685	.86198	.86702	.87197

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	100	1.03536	1.03789	1.04040	1.04291	1.04540	1.04788
10	100	1.02879	1.03136	1.03392	1.03645	1.03898	1.04148
20	100	1.02211	1.02473	1.02733	1.02992	1.03248	1.03502
30	100	1.01528	1.01797	1.02063	1.02327	1.02588	1.02847
40	100	1.00829	1.01105	1.01378	1.01648	1.01915	1.02180
50	100	1.00112	1.00396	1.00676	1.00954	1.01228	1.01499
60	100	.99373	.99666	.99955	1.00241	1.00523	1.00802
70	100	.98611	.98914	.99213	.99508	.99799	1.00086
80	100	.97824	.98138	.98447	.98752	.99052	.99349
90	100	.97008	.97334	.97654	.97970	.98282	.98589
100	100	.96162	.96501	.96834	.97162	.97485	.97803
110	100	.95284	.95636	.95983	.96323	.96659	.96989
120	100	.94371	.94738	.95098	.95453	.95802	.96145
130	100	.93422	.93804	.94179	.94549	.94912	.95269
140	100	.92433	.92831	.93223	.93608	.93987	.94359
150	100	.91403	.91819	.92228	.92629	.93024	.93412
160	100	.90330	.90764	.91191	.91610	.92022	.92426
170	100	.89212	.89665	.90110	.90548	.90977	.91400
180	100	.88047	.88520	.88984	.89441	.89889	.90330
190	100	.86832	.87325	.87811	.88287	.88756	.89216
200	100	.85565	.86081	.86587	.87085	.87574	.88054
210	100	.84245	.84783	.85312	.85832	.86342	.86843
220	100	.82870	.83432	.83983	.84526	.85058	.85582
230	100	.81437	.82023	.82599	.83165	.83721	.84267
240	100	.79945	.80556	.81157	.81747	.82327	.82897
250	100	.78392	.79029	.79655	.80271	.80876	.81470
260	100	.76775	.77440	.78092	.78734	.79365	.79985
270	100	.75094	.75786	.76466	.77135	.77792	.78438
280	100	.73345	.74066	.74775	.75471	.76156	.76829
290	100	.71528	.72278	.73016	.73741	.74454	.75156
300	100	.69641	.70421	.71188	.71943	.72686	.73416
310	100	.67681	.68492	.69290	.70075	.70848	.71607

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	200	1.04095	1.04345	1.04594	1.04842	1.05089	1.05335
10	200	1.03447	1.03700	1.03952	1.04203	1.04452	1.04701
20	200	1.02789	1.03047	1.03303	1.03558	1.03810	1.04061
30	200	1.02120	1.02384	1.02645	1.02903	1.03160	1.03415
40	200	1.01437	1.01706	1.01973	1.02238	1.02500	1.02759
50	200	1.00737	1.01014	1.01287	1.01558	1.01826	1.02092
60	200	1.00018	1.00303	1.00584	1.00862	1.01138	1.01410
70	200	.99277	.99571	.99862	1.00148	1.00431	1.00711
80	200	.98513	.98817	.99117	.99413	.99705	.99994
90	200	.97723	.98038	.98349	.98655	.98957	.99255
100	200	.96905	.97232	.97555	.97872	.98185	.98493
110	200	.96057	.96397	.96731	.97061	.97385	.97705
120	200	.95176	.95529	.95877	.96220	.96557	.96889
130	200	.94260	.94628	.94991	.95347	.95698	.96042
140	200	.93307	.93691	.94069	.94440	.94805	.95164
150	200	.92315	.92716	.93109	.93496	.93877	.94251
160	200	.91282	.91700	.92111	.92514	.92911	.93301
170	200	.90206	.90642	.91070	.91491	.91905	.92312
180	200	.89084	.89539	.89986	.90426	.90858	.91282
190	200	.87914	.88390	.88857	.89315	.89766	.90209
200	200	.86696	.87192	.87679	.88158	.88629	.89091
210	200	.85425	.85943	.86452	.86952	.87443	.87926
220	200	.84102	.84642	.85173	.85695	.86208	.86712
230	200	.82722	.83287	.83841	.84386	.84921	.85446
240	200	.81286	.81874	.82453	.83021	.83579	.84128
250	200	.79790	.80403	.81007	.81600	.82182	.82754
260	200	.78232	.78872	.79501	.80119	.80727	.81324
270	200	.76612	.77279	.77934	.78579	.79212	.79834
280	200	.74926	.75621	.76304	.76975	.77636	.78284
290	200	.73174	.73897	.74609	.75308	.75995	.76671
300	200	.71353	.72106	.72846	.73574	.74290	.74994
310	200	.69461	.70244	.71015	.71772	.72518	.73250
320	200	.67497	.68312	.69113	.69901	.70676	.71438
330	200	.65460	.66306	.67139	.67958	.68764	.69557
340	200	.63346	.64225	.65090	.65941	.66779	.67603
350	200	.61155	.62067	.62966	.63850	.64720	.65576

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	300	1.04649	1.04897	1.05144	1.05391	1.05636	1.05882
10	300	1.04008	1.04259	1.04508	1.04756	1.05004	1.05250
20	300	1.03360	1.03614	1.03867	1.04118	1.04367	1.04616
30	300	1.02702	1.02961	1.03217	1.03472	1.03725	1.03977
40	300	1.02032	1.02296	1.02558	1.02817	1.03075	1.03330
50	300	1.01348	1.01618	1.01886	1.02151	1.02414	1.02674
60	300	1.00646	1.00924	1.01199	1.01471	1.01740	1.02006
70	300	.99926	1.00212	1.00494	1.00774	1.01050	1.01323
80	300	.99183	.99479	.99770	1.00058	1.00342	1.00623
90	300	.98418	.98723	.99024	.99322	.99615	.99904
100	300	.97625	.97942	.98254	.98562	.98865	.99164
110	300	.96805	.97134	.97457	.97776	.98090	.98400
120	300	.95954	.96296	.96632	.96963	.97289	.97610
130	300	.95070	.95426	.95775	.96119	.96458	.96791
140	300	.94152	.94522	.94886	.95244	.95596	.95943
150	300	.93196	.93582	.93961	.94334	.94701	.95061
160	300	.92201	.92603	.92999	.93387	.93770	.94145
170	300	.91164	.91584	.91997	.92402	.92801	.93192
180	300	.90085	.90523	.90953	.91376	.91792	.92201
190	300	.88959	.89417	.89866	.90308	.90741	.91168
200	300	.87787	.88264	.88733	.89194	.89647	.90092
210	300	.86564	.87063	.87552	.88033	.88506	.88970
220	300	.85290	.85811	.86322	.86824	.87317	.87802
230	300	.83963	.84506	.85039	.85563	.86078	.86584
240	300	.82580	.83146	.83703	.84250	.84788	.85316
250	300	.81139	.81730	.82311	.82882	.83443	.83994
260	300	.79639	.80256	.80862	.81457	.82042	.82617
270	300	.78078	.78721	.79352	.79973	.80583	.81183
280	300	.76454	.77124	.77782	.78429	.79065	.79690
290	300	.74765	.75462	.76148	.76822	.77485	.78136
300	300	.73009	.73735	.74449	.75151	.75841	.76519
310	300	.71184	.71940	.72683	.73414	.74132	.74839
320	300	.69289	.70075	.70848	.71608	.72356	.73091
330	300	.67322	.68139	.68943	.69733	.70511	.71276
340	300	.65280	.66129	.66965	.67787	.68595	.69391
350	300	.63163	.64045	.64913	.65767	.66607	.67434

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	400	1.05200	1.05447	1.05693	1.05938	1.06184	1.06429
10	400	1.04565	1.04813	1.05060	1.05307	1.05553	1.05798
20	400	1.03924	1.04175	1.04425	1.04673	1.04921	1.05167
30	400	1.03276	1.03530	1.03783	1.04035	1.04285	1.04534
40	400	1.02617	1.02877	1.03134	1.03389	1.03643	1.03895
50	400	1.01947	1.02211	1.02474	1.02734	1.02992	1.03248
60	400	1.01261	1.01532	1.01801	1.02067	1.02330	1.02591
70	400	1.00558	1.00837	1.01113	1.01385	1.01655	1.01922
80	400	.99836	1.00123	1.00407	1.00687	1.00964	1.01238
90	400	.99092	.99389	.99682	.99970	1.00256	1.00537
100	400	.98324	.98631	.98934	.99232	.99527	.99817
110	400	.97530	.97848	.98162	.98470	.98775	.99075
120	400	.96708	.97038	.97363	.97683	.97998	.98309
130	400	.95854	.96197	.96535	.96867	.97195	.97517
140	400	.94968	.95325	.95676	.96022	.96362	.96697
150	400	.94046	.94418	.94784	.95144	.95497	.95845
160	400	.93088	.93475	.93856	.94231	.94599	.94962
170	400	.92090	.92494	.92891	.93282	.93666	.94043
180	400	.91050	.91472	.91887	.92294	.92694	.93088
190	400	.89967	.90408	.90840	.91265	.91683	.92093
200	400	.88839	.89298	.89750	.90193	.90629	.91057
210	400	.87663	.88142	.88613	.89076	.89531	.89978
220	400	.86437	.86938	.87429	.87913	.88387	.88854
230	400	.85160	.85682	.86195	.86700	.87195	.87682
240	400	.83829	.84374	.84910	.85436	.85953	.86461
250	400	.82442	.83011	.83570	.84119	.84659	.85189
260	400	.80998	.81592	.82175	.82748	.83311	.83864
270	400	.79495	.80114	.80722	.81319	.81907	.82484
280	400	.77930	.78575	.79209	.79832	.80445	.81046
290	400	.76302	.76975	.77635	.78285	.78923	.79550
300	400	.74610	.75310	.75998	.76674	.77339	.77993
310	400	.72850	.73579	.74295	.75000	.75693	.76373
320	400	.71022	.71780	.72526	.73259	.73980	.74689
330	400	.69124	.69912	.70688	.71451	.72201	.72939
340	400	.67153	.67973	.68779	.69573	.70353	.71121
350	400	.65109	.65960	.66798	.67623	.68434	.69232

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	500	1.05750	1.05996	1.06242	1.06487	1.06733	1.06979
10	500	1.05118	1.05365	1.05611	1.05856	1.06102	1.06347
20	500	1.04483	1.04731	1.04979	1.05226	1.05472	1.05717
30	500	1.03842	1.04093	1.04343	1.04592	1.04840	1.05087
40	500	1.03194	1.03449	1.03702	1.03954	1.04205	1.04454
50	500	1.02535	1.02795	1.03052	1.03308	1.03562	1.03815
60	500	1.01863	1.02129	1.02392	1.02653	1.02911	1.03168
70	500	1.01177	1.01449	1.01718	1.01985	1.02249	1.02511
80	500	1.00473	1.00753	1.01029	1.01303	1.01573	1.01841
90	500	.99749	1.00038	1.00322	1.00604	1.00881	1.01156
100	500	.99004	.99302	.99595	.99885	1.00171	1.00454
110	500	.98234	.98542	.98846	.99145	.99441	.99732
120	500	.97438	.97757	.98072	.98382	.98688	.98989
130	500	.96613	.96945	.97271	.97592	.97909	.98221
140	500	.95757	.96102	.96441	.96775	.97104	.97427
150	500	.94868	.95227	.95580	.95927	.96269	.96605
160	500	.93944	.94318	.94685	.95047	.95402	.95751
170	500	.92983	.93372	.93755	.94131	.94501	.94865
180	500	.91982	.92388	.92787	.93180	.93565	.93944
190	500	.90940	.91364	.91780	.92189	.92591	.92986
200	500	.89854	.90296	.90730	.91157	.91577	.91989
210	500	.88722	.89184	.89637	.90083	.90520	.90950
220	500	.87543	.88025	.88498	.88963	.89420	.89868
230	500	.86314	.86817	.87311	.87796	.88273	.88741
240	500	.85033	.85558	.86074	.86580	.87078	.87566
250	500	.83699	.84247	.84785	.85313	.85833	.86343
260	500	.82309	.82881	.83442	.83993	.84535	.85068
270	500	.80862	.81458	.82043	.82619	.83184	.83739
280	500	.79356	.79977	.80587	.81187	.81777	.82356
290	500	.77788	.78435	.79071	.79697	.80311	.80915
300	500	.76157	.76831	.77494	.78146	.78787	.79416
310	500	.74461	.75163	.75854	.76533	.77200	.77856
320	500	.72698	.73429	.74148	.74855	.75550	.76233
330	500	.70867	.71628	.72376	.73112	.73835	.74546
340	500	.68966	.69757	.70535	.71300	.72053	.72793
350	500	.66992	.67814	.68623	.69419	.70202	.70972

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	600	1.06300	1.06546	1.06792	1.07038	1.07285	1.07532
10	600	1.05670	1.05915	1.06161	1.06406	1.06652	1.06898
20	600	1.05038	1.05285	1.05531	1.05777	1.06022	1.06268
30	600	1.04403	1.04652	1.04900	1.05147	1.05393	1.05639
40	600	1.03763	1.04014	1.04265	1.04514	1.04762	1.05009
50	600	1.03114	1.03369	1.03623	1.03876	1.04127	1.04376
60	600	1.02455	1.02715	1.02973	1.03230	1.03484	1.03737
70	600	1.01782	1.02049	1.02312	1.02574	1.02833	1.03090
80	600	1.01095	1.01368	1.01638	1.01906	1.02170	1.02433
90	600	1.00390	1.00671	1.00948	1.01222	1.01494	1.01762
100	600	.99665	.99954	1.00240	1.00522	1.00801	1.01077
110	600	.98918	.99217	.99512	.99803	1.00090	1.00373
120	600	.98146	.98456	.98761	.99061	.99358	.99650
130	600	.97348	.97669	.97985	.98296	.98603	.98905
140	600	.96521	.96854	.97182	.97505	.97823	.98136
150	600	.95663	.96010	.96350	.96685	.97015	.97340
160	600	.94772	.95132	.95487	.95835	.96178	.96516
170	600	.93846	.94221	.94590	.94953	.95309	.95660
180	600	.92882	.93273	.93657	.94035	.94407	.94772
190	600	.91878	.92286	.92687	.93081	.93468	.93849
200	600	.90833	.91259	.91677	.92087	.92491	.92888
210	600	.89744	.90188	.90625	.91053	.91474	.91888
220	600	.88610	.89073	.89528	.89976	.90415	.90847
230	600	.87428	.87911	.88386	.88853	.89312	.89762
240	600	.86196	.86700	.87196	.87684	.88162	.88632
250	600	.84912	.85439	.85956	.86465	.86964	.87455
260	600	.83575	.84124	.84665	.85195	.85716	.86228
270	600	.82182	.82755	.83319	.83872	.84416	.84951
280	600	.80732	.81330	.81917	.82495	.83062	.83619
290	600	.79222	.79845	.80458	.81060	.81652	.82233
300	600	.77651	.78301	.78939	.79567	.80184	.80790
310	600	.76017	.76694	.77359	.78013	.78656	.79288
320	600	.74318	.75023	.75716	.76397	.77067	.77725
330	600	.72553	.73286	.74008	.74717	.75414	.76100
340	600	.70719	.71482	.72233	.72971	.73696	.74410
350	600	.68815	.69608	.70389	.71156	.71911	.72654

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	700	1.06852	1.07099	1.07346	1.07593	1.07842	1.08091
10	700	1.06221	1.06467	1.06713	1.06959	1.07205	1.07452
20	700	1.05591	1.05837	1.06083	1.06328	1.06574	1.06819
30	700	1.04960	1.05207	1.05454	1.05700	1.05945	1.06190
40	700	1.04326	1.04575	1.04823	1.05070	1.05317	1.05563
50	700	1.03685	1.03938	1.04188	1.04438	1.04686	1.04934
60	700	1.03036	1.03293	1.03547	1.03800	1.04051	1.04301
70	700	1.02377	1.02638	1.02897	1.03154	1.03409	1.03662
80	700	1.01704	1.01971	1.02235	1.02497	1.02757	1.03015
90	700	1.01015	1.01289	1.01560	1.01829	1.02094	1.02357
100	700	1.00309	1.00591	1.00869	1.01145	1.01417	1.01686
110	700	.99583	.99873	1.00160	1.00443	1.00723	1.00999
120	700	.98835	.99135	.99430	.99722	1.00011	1.00295
130	700	.98061	.98372	.98678	.98980	.99277	.99571
140	700	.97262	.97583	.97901	.98213	.98521	.98825
150	700	.96433	.96767	.97096	.97420	.97739	.98054
160	700	.95573	.95920	.96262	.96599	.96930	.97256
170	700	.94679	.95041	.95397	.95747	.96091	.96430
180	700	.93750	.94127	.94497	.94862	.95220	.95572
190	700	.92784	.93177	.93563	.93942	.94315	.94682
200	700	.91778	.92187	.92590	.92985	.93374	.93756
210	700	.90730	.91157	.91577	.91990	.92395	.92793
220	700	.89639	.90084	.90522	.90953	.91376	.91791
230	700	.88501	.88967	.89424	.89873	.90314	.90748
240	700	.87316	.87802	.88279	.88748	.89208	.89660
250	700	.86082	.86589	.87086	.87575	.88056	.88528
260	700	.84795	.85324	.85844	.86354	.86855	.87348
270	700	.83455	.84007	.84549	.85082	.85605	.86119
280	700	.82060	.82635	.83201	.83756	.84302	.84838
290	700	.80607	.81207	.81796	.82376	.82945	.83505
300	700	.79094	.79720	.80334	.80939	.81532	.82116
310	700	.77521	.78172	.78813	.79443	.80062	.80670
320	700	.75884	.76563	.77230	.77886	.78531	.79165
330	700	.74182	.74889	.75584	.76268	.76940	.77600
340	700	.72414	.73150	.73874	.74585	.75284	.75972
350	700	.70578	.71343	.72096	.72836	.73564	.74280

Appendix. Density of NaCl solutions, g/cm3, at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	800	1.07408	1.07656	1.07905	1.08154	1.08405	1.08657
10	800	1.06774	1.07021	1.07268	1.07515	1.07763	1.08012
20	800	1.06144	1.06390	1.06636	1.06882	1.07128	1.07375
30	800	1.05515	1.05761	1.06007	1.06253	1.06498	1.06744
40	800	1.04885	1.05132	1.05379	1.05625	1.05870	1.06116
50	800	1.04251	1.04500	1.04749	1.04996	1.05243	1.05489
60	800	1.03611	1.03863	1.04114	1.04364	1.04613	1.04860
70	800	1.02961	1.03218	1.03473	1.03726	1.03978	1.04228
80	800	1.02301	1.02563	1.02823	1.03080	1.03336	1.03590
90	800	1.01628	1.01896	1.02161	1.02423	1.02684	1.02942
100	800	1.00939	1.01213	1.01485	1.01754	1.02020	1.02284
110	800	1.00231	1.00514	1.00793	1.01069	1.01342	1.01612
120	800	.99504	.99795	1.00083	1.00367	1.00647	1.00925
130	800	.98754	.99055	.99352	.99645	.99934	1.00220
140	800	.97979	.98291	.98598	.98901	.99200	.99494
150	800	.97178	.97501	.97819	.98133	.98442	.98746
160	800	.96347	.96682	.97013	.97338	.97658	.97974
170	800	.95485	.95834	.96177	.96515	.96847	.97175
180	800	.94589	.94952	.95310	.95661	.96007	.96347
190	800	.93658	.94037	.94408	.94774	.95134	.95488
200	800	.92690	.93084	.93471	.93852	.94227	.94595
210	800	.91681	.92092	.92496	.92893	.93284	.93667
220	800	.90631	.91060	.91481	.91895	.92302	.92702
230	800	.89537	.89985	.90424	.90856	.91281	.91698
240	800	.88397	.88864	.89323	.89774	.90217	.90652
250	800	.87210	.87697	.88176	.88646	.89109	.89563
260	800	.85972	.86481	.86981	.87472	.87954	.88428
270	800	.84683	.85214	.85736	.86248	.86751	.87245
280	800	.83341	.83894	.84438	.84973	.85498	.86014
290	800	.81942	.82520	.83087	.83645	.84193	.84731
300	800	.80487	.81089	.81681	.82262	.82833	.83395
310	800	.78972	.79600	.80216	.80822	.81418	.82003
320	800	.77396	.78050	.78693	.79324	.79945	.80555
330	800	.75757	.76438	.77107	.77766	.78412	.79048
340	800	.74053	.74762	.75459	.76145	.76818	.77481
350	800	.72283	.73020	.73746	.74459	.75161	.75851

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	900	1.07969	1.08219	1.08470	1.08723	1.08977	1.09233
10	900	1.07331	1.07579	1.07827	1.08077	1.08327	1.08579
20	900	1.06699	1.06945	1.07192	1.07439	1.07687	1.07935
30	900	1.06070	1.06316	1.06561	1.06807	1.07053	1.07300
40	900	1.05442	1.05688	1.05934	1.06179	1.06425	1.06670
50	900	1.04812	1.05060	1.05307	1.05553	1.05798	1.06044
60	900	1.04178	1.04428	1.04677	1.04925	1.05171	1.05418
70	900	1.03538	1.03791	1.04043	1.04293	1.04542	1.04790
80	900	1.02889	1.03146	1.03401	1.03655	1.03907	1.04158
90	900	1.02228	1.02491	1.02751	1.03009	1.03265	1.03519
100	900	1.01554	1.01823	1.02089	1.02352	1.02613	1.02872
110	900	1.00864	1.01140	1.01412	1.01682	1.01949	1.02213
120	900	1.00156	1.00439	1.00719	1.00996	1.01270	1.01541
130	900	.99427	.99720	1.00008	1.00293	1.00575	1.00853
140	900	.98676	.98978	.99276	.99570	.99860	1.00147
150	900	.97900	.98213	.98521	.98825	.99124	.99420
160	900	.97097	.97421	.97740	.98055	.98365	.98671
170	900	.96264	.96601	.96933	.97259	.97580	.97897
180	900	.95400	.95750	.96095	.96434	.96768	.97096
190	900	.94503	.94867	.95226	.95578	.95925	.96267
200	900	.93570	.93949	.94323	.94690	.95051	.95406
210	900	.92599	.92995	.93384	.93766	.94142	.94512
220	900	.91588	.92001	.92406	.92805	.93197	.93582
230	900	.90536	.90966	.91389	.91805	.92213	.92615
240	900	.89439	.89889	.90330	.90764	.91190	.91608
250	900	.88297	.88766	.89227	.89679	.90124	.90560
260	900	.87107	.87597	.88077	.88549	.89013	.89469
270	900	.85868	.86378	.86880	.87372	.87856	.88332
280	900	.84576	.85109	.85632	.86146	.86651	.87147
290	900	.83231	.83787	.84333	.84869	.85396	.85913
300	900	.81831	.82410	.82979	.83539	.84088	.84628
310	900	.80373	.80977	.81570	.82154	.82727	.83290
320	900	.78856	.79485	.80104	.80712	.81309	.81897
330	900	.77277	.77933	.78578	.79211	.79834	.80446
340	900	.75636	.76319	.76991	.77651	.78299	.78937
350	900	.73930	.74641	.75340	.76028	.76703	.77368

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	.1	.2	.3	.4	.5
0	1000	1.08536	1.08790	1.09044	1.09301	1.09559	1.09819
10	1000	1.07892	1.08142	1.08393	1.08646	1.08899	1.09154
20	1000	1.07256	1.07504	1.07752	1.08001	1.08252	1.08503
30	1000	1.06626	1.06872	1.07119	1.07365	1.07613	1.07861
40	1000	1.05998	1.06244	1.06490	1.06735	1.06981	1.07228
50	1000	1.05371	1.05617	1.05863	1.06109	1.06354	1.06599
60	1000	1.04742	1.04990	1.05236	1.05483	1.05728	1.05974
70	1000	1.04108	1.04358	1.04607	1.04855	1.05102	1.05349
80	1000	1.03468	1.03722	1.03973	1.04224	1.04473	1.04721
90	1000	1.02819	1.03076	1.03332	1.03586	1.03839	1.04090
100	1000	1.02158	1.02421	1.02681	1.02940	1.03197	1.03451
110	1000	1.01483	1.01752	1.02019	1.02283	1.02544	1.02804
120	1000	1.00792	1.01069	1.01342	1.01612	1.01880	1.02145
130	1000	1.00083	1.00367	1.00648	1.00926	1.01200	1.01472
140	1000	.99353	.99647	.99936	1.00222	1.00504	1.00783
150	1000	.98601	.98904	.99203	.99498	.99789	1.00076
160	1000	.97823	.98137	.98446	.98751	.99052	.99349
170	1000	.97019	.97344	.97665	.97980	.98292	.98598
180	1000	.96184	.96522	.96855	.97183	.97505	.97823
190	1000	.95319	.95670	.96016	.96356	.96691	.97021
200	1000	.94419	.94785	.95145	.95499	.95847	.96190
210	1000	.93484	.93865	.94240	.94609	.94971	.95327
220	1000	.92512	.92909	.93299	.93683	.94060	.94431
230	1000	.91499	.91913	.92320	.92720	.93113	.93500
240	1000	.90444	.90876	.91301	.91718	.92128	.92531
250	1000	.89346	.89797	.90240	.90675	.91102	.91522
260	1000	.88202	.88672	.89134	.89588	.90034	.90473
270	1000	.87010	.87500	.87983	.88456	.88922	.89379
280	1000	.85768	.86280	.86783	.87277	.87763	.88240
290	1000	.84474	.85008	.85533	.86049	.86556	.87054
300	1000	.83127	.83684	.84232	.84770	.85298	.85818
310	1000	.81724	.82305	.82877	.83438	.83989	.84531
320	1000	.80264	.80870	.81465	.82051	.82625	.83190
330	1000	.78745	.79376	.79997	.80607	.81206	.81795
340	1000	.77165	.77822	.78469	.79104	.79729	.80343
350	1000	.75522	.76207	.76880	.77542	.78192	.78832

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##############
# Aqueous    #
# Solutions  #
# Database   #
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April 1983
NaCl Solutions

Density of NaCl solutions,g/cm 3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	1	1.02977	1.05478	1.07929	1.10473	1.13250	1.16397
5	1	1.02644	1.05162	1.07609	1.10131	1.12869	1.15958
10	1	1.02309	1.04844	1.07291	1.09794	1.12494	1.15528
15	1	1.01970	1.04526	1.06975	1.09461	1.12126	1.15107
20	1	1.01628	1.04207	1.06660	1.09132	1.11764	1.14694
25	1	1.01281	1.03886	1.06345	1.08805	1.11407	1.14289
30	1	1.00931	1.03563	1.06031	1.08481	1.11055	1.13891
35	1	1.00575	1.03237	1.05717	1.08160	1.10709	1.13501
40	1	1.00215	1.02909	1.05403	1.07841	1.10367	1.13118
45	1	.99849	1.02579	1.05088	1.07524	1.10029	1.12742
50	1	.99478	1.02245	1.04773	1.07209	1.09696	1.12372
55	1	.99102	1.01908	1.04456	1.06895	1.09365	1.12008
60	1	.98719	1.01567	1.04139	1.06581	1.09039	1.11650
65	1	.98330	1.01222	1.03819	1.06269	1.08715	1.11297
70	1	.97934	1.00872	1.03498	1.05957	1.08394	1.10949
75	1	.97531	1.00519	1.03174	1.05645	1.08076	1.10606
80	1	.97121	1.00160	1.02848	1.05333	1.07759	1.10268
85	1	.96703	.99796	1.02518	1.05020	1.07445	1.09933
90	1	.96278	.99426	1.02186	1.04706	1.07132	1.09603
95	1	.95845	.99051	1.01851	1.04392	1.06820	1.09276
100	1	.95403	.98670	1.01511	1.04076	1.06509	1.08952

Density of NaCl solutions,g/cm 3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	10	1.03028	1.05527	1.07978	1.10526	1.13309	1.16465
5	10	1.02696	1.05211	1.07659	1.10184	1.12927	1.16025
10	10	1.02361	1.04894	1.07341	1.09846	1.12552	1.15594
15	10	1.02023	1.04576	1.07024	1.09513	1.12183	1.15171
20	10	1.01681	1.04256	1.06708	1.09182	1.11820	1.14757
25	10	1.01336	1.03936	1.06394	1.08855	1.11462	1.14351
30	10	1.00985	1.03613	1.06080	1.08531	1.11110	1.13953
35	10	1.00631	1.03288	1.05766	1.08210	1.10762	1.13562
40	10	1.00271	1.02961	1.05452	1.07891	1.10420	1.13177
45	10	.99907	1.02630	1.05137	1.07573	1.10082	1.12800
50	10	.99537	1.02297	1.04822	1.07258	1.09747	1.12429
55	10	.99161	1.01961	1.04506	1.06944	1.09417	1.12064
60	10	.98779	1.01620	1.04188	1.06630	1.09090	1.11705
65	10	.98391	1.01276	1.03869	1.06318	1.08766	1.11352
70	10	.97996	1.00927	1.03548	1.06006	1.08444	1.11003
75	10	.97595	1.00574	1.03225	1.05694	1.08125	1.10660
80	10	.97186	1.00216	1.02899	1.05382	1.07809	1.10320
85	10	.96769	.99853	1.02570	1.05069	1.07494	1.09985
90	10	.96346	.99485	1.02239	1.04756	1.07181	1.09654
95	10	.95914	.99111	1.01903	1.04441	1.06869	1.09327
100	10	.95473	.98730	1.01565	1.04125	1.06558	1.09003
105	10	.95024	.98344	1.01222	1.03808	1.06247	1.08681
110	10	.94567	.97951	1.00875	1.03489	1.05937	1.08363
115	10	.94100	.97551	1.00523	1.03167	1.05627	1.08046
120	10	.93624	.97144	1.00167	1.02843	1.05317	1.07732
125	10	.93138	.96730	.99806	1.02516	1.05006	1.07420
130	10	.92642	.96308	.99439	1.02186	1.04695	1.07109
135	10	.92136	.95878	.99066	1.01852	1.04382	1.06799
140	10	.91620	.95440	.98688	1.01515	1.04068	1.06490
145	10	.91093	.94993	.98303	1.01174	1.03752	1.06182
150	10	.90555	.94538	.97912	1.00828	1.03434	1.05874
155	10	.90005	.94074	.97514	1.00479	1.03114	1.05566
160	10	.89444	.93600	.97109	1.00124	1.02792	1.05258
165	10	.88872	.93117	.96697	.99764	1.02466	1.04949
170	10	.88287	.92624	.96277	.99399	1.02138	1.04639
175	10	.87690	.92121	.95850	.99028	1.01806	1.04328

.Density of NaCl solutions,g/cm 3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	20	1.03084	1.05581	1.08033	1.10585	1.13376	1.16542
5	20	1.02753	1.05265	1.07713	1.10242	1.12993	1.16100
10	20	1.02419	1.04948	1.07395	1.09904	1.12616	1.15668
15	20	1.02082	1.04631	1.07078	1.09570	1.12246	1.15244
20	20	1.01741	1.04312	1.06763	1.09239	1.11882	1.14828
25	20	1.01396	1.03991	1.06448	1.08912	1.11523	1.14421
30	20	1.01046	1.03669	1.06134	1.08587	1.11170	1.14021
35	20	1.00693	1.03344	1.05820	1.08265	1.10822	1.13629
40	20	1.00334	1.03017	1.05506	1.07946	1.10479	1.13243
45	20	.99970	1.02688	1.05192	1.07628	1.10140	1.12865
50	20	.99601	1.02355	1.04877	1.07312	1.09805	1.12493
55	20	.99227	1.02019	1.04561	1.06998	1.09474	1.12127
60	20	.98846	1.01680	1.04243	1.06685	1.09146	1.11767
65	20	.98459	1.01336	1.03925	1.06372	1.08822	1.11413
70	20	.98065	1.00988	1.03604	1.06060	1.08500	1.11063
75	20	.97665	1.00636	1.03281	1.05748	1.08181	1.10719
80	20	.97257	1.00279	1.02956	1.05436	1.07864	1.10379
85	20	.96843	.99917	1.02628	1.05124	1.07549	1.10044
90	20	.96420	.99549	1.02297	1.04810	1.07235	1.09712
95	20	.95990	.99176	1.01962	1.04496	1.06923	1.09384
100	20	.95551	.98797	1.01624	1.04181	1.06612	1.09059
105	20	.95104	.98412	1.01282	1.03864	1.06301	1.08737
110	20	.94648	.98020	1.00936	1.03545	1.05991	1.08418
115	20	.94182	.97622	1.00585	1.03223	1.05682	1.08102
120	20	.93708	.97216	1.00230	1.02900	1.05371	1.07787
125	20	.93224	.96803	.99870	1.02573	1.05061	1.07475
130	20	.92730	.96383	.99504	1.02244	1.04749	1.07163
135	20	.92226	.95954	.99132	1.01911	1.04437	1.06854
140	20	.91711	.95518	.98755	1.01574	1.04123	1.06545
145	20	.91186	.95073	.98372	1.01234	1.03808	1.06236
150	20	.90650	.94619	.97982	1.00890	1.03491	1.05928
155	20	.90103	.94156	.97585	1.00541	1.03171	1.05620
160	20	.89544	.93685	.97181	1.00187	1.02849	1.05312
165	20	.88974	.93203	.96771	.99828	1.02524	1.05003
170	20	.88391	.92712	.96352	.99464	1.02196	1.04694
175	20	.87797	.92211	.95926	.99094	1.01865	1.04383

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	100	1.03536	1.06016	1.08478	1.11064	1.13914	1.17165
10	100	1.02879	1.05385	1.07834	1.10372	1.13137	1.16266
20	100	1.02211	1.04752	1.07199	1.09697	1.12386	1.15404
30	100	1.01528	1.04114	1.06569	1.09037	1.11660	1.14576
40	100	1.00829	1.03470	1.05941	1.08389	1.10956	1.13779
50	100	1.00112	1.02816	1.05314	1.07751	1.10271	1.13011
60	100	.99373	1.02151	1.04684	1.07120	1.09603	1.12269
70	100	.98611	1.01471	1.04050	1.06495	1.08949	1.11551
80	100	.97824	1.00776	1.03409	1.05871	1.08306	1.10854
90	100	.97008	1.00061	1.02758	1.05248	1.07673	1.10176
100	100	.96162	.99326	1.02096	1.04622	1.07048	1.09514
110	100	.95284	.98567	1.01420	1.03991	1.06426	1.08866
120	100	.94371	.97783	1.00728	1.03353	1.05807	1.08229
130	100	.93422	.96972	1.00016	1.02706	1.05187	1.07601
140	100	.92433	.96130	.99285	1.02047	1.04565	1.06980
150	100	.91403	.95256	.98530	1.01374	1.03938	1.06363
160	100	.90330	.94349	.97750	1.00685	1.03303	1.05747
170	100	.89212	.93404	.96942	.99978	1.02659	1.05132
180	100	.88047	.92421	.96105	.99249	1.02004	1.04513
190	100	.86832	.91398	.95236	.98498	1.01334	1.03889
200	100	.85565	.90332	.94333	.97722	1.00649	1.03258
210	100	.84245	.89221	.93395	.96919	.99945	1.02618
220	100	.82870	.88064	.92418	.96087	.99220	1.01966
230	100	.81437	.86858	.91401	.95223	.98473	1.01300
240	100	.79945	.85601	.90343	.94326	.97701	1.00618
250	100	.78392	.84291	.89240	.93393	.96903	.99918
260	100	.76775	.82927	.88091	.92423	.96075	.99197
270	100	.75094	.81507	.86894	.91413	.95217	.98454
280	100	.73345	.80028	.85647	.90362	.94325	.97687
290	100	.71528	.78488	.84348	.89267	.93399	.96893
300	100	.69641	.76886	.82996	.88127	.92435	.96071
310	100	.67681	.75221	.81587	.86940	.91433	.95218

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	200	1.04095	1.06561	1.09040			
10	200	1.03447	1.05930	1.08389			
20	200	1.02789	1.05300	1.07748			
30	200	1.02120	1.04667	1.07114	1.09608	1.12288	1.15291
40	200	1.01437	1.04029	1.06485	1.08950	1.11566	1.14469
50	200	1.00737	1.03385	1.05859	1.08305	1.10865	1.13677
60	200	1.00018	1.02731	1.05232	1.07669	1.10183	1.12914
70	200	.99277	1.02064	1.04603	1.07040	1.09518	1.12176
80	200	.98513	1.01384	1.03969	1.06416	1.08867	1.11462
90	200	.97723	1.00687	1.03328	1.05793	1.08227	1.10769
100	200	.96905	.99971	1.02677	1.05170	1.07596	1.10093
110	200	.96057	.99234	1.02014	1.04545	1.06971	1.09434
120	200	.95176	.98474	1.01337	1.03914	1.06351	1.08789
130	200	.94260	.97688	1.00644	1.03277	1.05733	1.08154
140	200	.93307	.96874	.99931	1.02629	1.05114	1.07528
150	200	.92315	.96030	.99198	1.01970	1.04492	1.06908
160	200	.91282	.95154	.98441	1.01296	1.03865	1.06292
170	200	.90206	.94243	.97659	1.00606	1.03231	1.05677
180	200	.89084	.93296	.96850	.99897	1.02586	1.05062
190	200	.87914	.92310	.96010	.99167	1.01930	1.04444
200	200	.86696	.91284	.95139	.98415	1.01260	1.03821
210	200	.85425	.90215	.94234	.97637	1.00574	1.03190
220	200	.84102	.89101	.93293	.96832	.99869	1.02549
230	200	.82722	.87940	.92313	.95997	.99143	1.01897
240	200	.81286	.86730	.91294	.95132	.98395	1.01230
250	200	.79790	.85470	.90232	.94232	.97621	1.00547
260	200	.78232	.84157	.89126	.93297	.96821	.99846
270	200	.76612	.82789	.87975	.92324	.95992	.99125
280	200	.74926	.81365	.86775	.91312	.95131	.98380
290	200	.73174	.79882	.85525	.90259	.94238	.97612
300	200	.71353	.78339	.84223	.89161	.93309	.96816
310	200	.69461	.76734	.82867	.88019	.92344	.95992
320	200	.67497	.75065	.81456	.86829	.91339	.95138
330	200	.65460	.73330	.79987	.85589	.90293	.94251
340	200	.63346	.71527	.78458	.84299	.89205	.93329
350	200	.61155	.69655	.76869	.82955	.88072	.92370

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	300	1.04649	1.07108	1.09613			
10	300	1.04008	1.06476	1.08952			
20	300	1.03360	1.05846	1.08303			
30	300	1.02702	1.05217	1.07664	1.10190	1.12934	1.16033
40	300	1.02032	1.04584	1.07032	1.09522	1.12193	1.15183
50	300	1.01348	1.03947	1.06405	1.08867	1.11474	1.14365
60	300	1.00646	1.03302	1.05779	1.08224	1.10777	1.13578
70	300	.99926	1.02647	1.05153	1.07590	1.10099	1.12819
80	300	.99183	1.01981	1.04525	1.06962	1.09436	1.12086
90	300	.98418	1.01299	1.03891	1.06339	1.08787	1.11376
100	300	.97625	1.00601	1.03249	1.05718	1.08150	1.10686
110	300	.96805	.99884	1.02598	1.05096	1.07520	1.10014
120	300	.95954	.99146	1.01935	1.04470	1.06898	1.09357
130	300	.95070	.98383	1.01257	1.03840	1.06279	1.08714
140	300	.94152	.97595	1.00562	1.03202	1.05661	1.08081
150	300	.93196	.96779	.99849	1.02554	1.05043	1.07457
160	300	.92201	.95933	.99114	1.01894	1.04422	1.06838
170	300	.91164	.95054	.98355	1.01220	1.03795	1.06223
180	300	.90085	.94141	.97572	1.00529	1.03160	1.05610
190	300	.88959	.93191	.96760	.99819	1.02516	1.04995
200	300	.87787	.92202	.95919	.99088	1.01859	1.04378
210	300	.86564	.91173	.95045	.98334	1.01189	1.03755
220	300	.85290	.90101	.94138	.97555	1.00501	1.03124
230	300	.83963	.88984	.93194	.96748	.99795	1.02483
240	300	.82580	.87820	.92212	.95911	.99068	1.01830
250	300	.81139	.86607	.91190	.95043	.98319	1.01163
260	300	.79639	.85343	.90126	.94142	.97544	1.00479
270	300	.78078	.84027	.89017	.93205	.96742	.99777
280	300	.76454	.82656	.87862	.92230	.95911	.99055
290	300	.74765	.81229	.86660	.91215	.95049	.98310
300	300	.73009	.79743	.85407	.90159	.94154	.97540
310	300	.71184	.78196	.84102	.89059	.93223	.96743
320	300	.69289	.76588	.82743	.87914	.92255	.95917
330	300	.67322	.74915	.81329	.86722	.91249	.95061
340	300	.65280	.73177	.79857	.85480	.90201	.94172
350	300	.63163	.71371	.78326	.84187	.89111	.93249

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	400	1.05200	1.07659	1.10197			
10	400	1.04565	1.07024	1.09525			
20	400	1.03924	1.06394	1.08867			
30	400	1.03276	1.05765	1.08220	1.10786	1.13601	1.16803
40	400	1.02617	1.05136	1.07583	1.10104	1.12838	1.15922
50	400	1.01947	1.04504	1.06953	1.09438	1.12101	1.15077
60	400	1.01261	1.03867	1.06327	1.08786	1.11386	1.14265
70	400	1.00558	1.03222	1.05702	1.08145	1.10693	1.13483
80	400	.99836	1.02567	1.05077	1.07513	1.10017	1.12729
90	400	.99092	1.01899	1.04449	1.06887	1.09357	1.11999
100	400	.98324	1.01217	1.03815	1.06265	1.08711	1.11292
110	400	.97530	1.00518	1.03173	1.05644	1.08075	1.10606
120	400	.96708	.99799	1.02522	1.05023	1.07448	1.09936
130	400	.95854	.99059	1.01858	1.04398	1.06826	1.09283
140	400	.94968	.98295	1.01179	1.03768	1.06209	1.08641
150	400	.94046	.97505	1.00483	1.03130	1.05592	1.08011
160	400	.93088	.96687	.99768	1.02482	1.04974	1.07388
170	400	.92090	.95839	.99032	1.01822	1.04353	1.06771
180	400	.91050	.94957	.98272	1.01146	1.03727	1.06157
190	400	.89967	.94042	.97487	1.00454	1.03092	1.05545
200	400	.88839	.93089	.96673	.99743	1.02448	1.04931
210	400	.87663	.92098	.95830	.99011	1.01791	1.04314
220	400	.86437	.91066	.94954	.98256	1.01119	1.03691
230	400	.85160	.89991	.94045	.97475	1.00431	1.03060
240	400	.83829	.88871	.93099	.96666	.99724	1.02419
250	400	.82442	.87704	.92114	.95828	.98996	1.01766
260	400	.80998	.86488	.91090	.94959	.98245	1.01098
270	400	.79495	.85222	.90023	.94055	.97469	1.00414
280	400	.77930	.83902	.88912	.93116	.96666	.99711
290	400	.76302	.82528	.87755	.92139	.95834	.98988
300	400	.74610	.81097	.86549	.91122	.94970	.98241
310	400	.72850	.79608	.85294	.90064	.94073	.97470
320	400	.71022	.78059	.83986	.88962	.93140	.96672
330	400	.69124	.76447	.82625	.87814	.92171	.95846
340	400	.67153	.74772	.81208	.86619	.91162	.94988
350	400	.65109	.73031	.79733	.85375	.90113	.94098

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	500	1.05750	1.08217	1.10794			
10	500	1.05118	1.07576	1.10108			
20	500	1.04483	1.06943	1.09439			
30	500	1.03842	1.06314	1.08784	1.11397	1.14291	1.17602
40	500	1.03194	1.05686	1.08140	1.10699	1.13504	1.16690
50	500	1.02535	1.05058	1.07505	1.10020	1.12745	1.15816
60	500	1.01863	1.04426	1.06876	1.09357	1.12012	1.14976
70	500	1.01177	1.03789	1.06251	1.08708	1.11301	1.14169
80	500	1.00473	1.03144	1.05627	1.08069	1.10611	1.13391
90	500	.99749	1.02488	1.05003	1.07438	1.09938	1.12641
100	500	.99004	1.01820	1.04375	1.06814	1.09281	1.11915
110	500	.98234	1.01137	1.03741	1.06193	1.08637	1.11212
120	500	.97438	1.00437	1.03100	1.05574	1.08003	1.10528
130	500	.96613	.99717	1.02448	1.04953	1.07377	1.09862
140	500	.95757	.98976	1.01783	1.04329	1.06758	1.09211
150	500	.94868	.98210	1.01103	1.03699	1.06141	1.08572
160	500	.93944	.97418	1.00407	1.03061	1.05525	1.07943
170	500	.92983	.96598	.99691	1.02412	1.04908	1.07322
180	500	.91982	.95747	.98953	1.01751	1.04288	1.06706
190	500	.90940	.94864	.98192	1.01075	1.03661	1.06094
200	500	.89854	.93946	.97405	1.00383	1.03027	1.05482
210	500	.88722	.92991	.96590	.99671	1.02382	1.04869
220	500	.87543	.91997	.95744	.98937	1.01725	1.04252
230	500	.86314	.90962	.94867	.98180	1.01053	1.03629
240	500	.85033	.89885	.93955	.97398	1.00364	1.02999
250	500	.83699	.88762	.93007	.96588	.99656	1.02357
260	500	.82309	.87592	.92020	.95748	.98927	1.01704
270	500	.80862	.86374	.90993	.94877	.98175	1.01036
280	500	.79356	.85104	.89924	.93971	.97398	1.00351
290	500	.77788	.83782	.88811	.93030	.96593	.99648
300	500	.76157	.82405	.87651	.92051	.95759	.98923
310	500	.74461	.80972	.86443	.91033	.94894	.98176
320	500	.72698	.79480	.85185	.89972	.93995	.97404
330	500	.70867	.77927	.83875	.88868	.93061	.96605
340	500	.68966	.76313	.82511	.87719	.92090	.95777
350	500	.66992	.74635	.81092	.86522	.91080	.94918

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	600	1.06300	1.08782	1.11406			
10	600	1.05670	1.08134	1.10705			
20	600	1.05038	1.07496	1.10023			
30	600	1.04403	1.06864	1.09357	1.12024	1.15004	1.18434
40	600	1.03763	1.06236	1.08704	1.11309	1.14192	1.17488
50	600	1.03114	1.05609	1.08062	1.10616	1.13410	1.16582
60	600	1.02455	1.04982	1.07429	1.09940	1.12655	1.15713
70	600	1.01782	1.04351	1.06801	1.09279	1.11926	1.14878
80	600	1.01095	1.03714	1.06177	1.08632	1.11219	1.14076
90	600	1.00390	1.03068	1.05555	1.07995	1.10532	1.13303
100	600	.99665	1.02412	1.04931	1.07367	1.09862	1.12556
110	600	.98918	1.01744	1.04303	1.06744	1.09208	1.11835
120	600	.98146	1.01060	1.03670	1.06124	1.08566	1.11135
130	600	.97348	1.00359	1.03028	1.05505	1.07934	1.10454
140	600	.96521	.99637	1.02376	1.04885	1.07310	1.09790
150	600	.95663	.98894	1.01711	1.04261	1.06691	1.09141
160	600	.94772	.98127	1.01031	1.03631	1.06076	1.08505
170	600	.93846	.97334	1.00333	1.02993	1.05461	1.07878
180	600	.92882	.96512	.99616	1.02345	1.04845	1.07258
190	600	.91878	.95659	.98877	1.01683	1.04224	1.06644
200	600	.90833	.94774	.98114	1.01007	1.03598	1.06032
210	600	.89744	.93853	.97326	1.00313	1.02964	1.05422
220	600	.88610	.92896	.96509	.99600	1.02319	1.04809
230	600	.87428	.91900	.95662	.98866	1.01661	1.04193
240	600	.86196	.90863	.94782	.98108	1.00989	1.03570
250	600	.84912	.89783	.93869	.97324	1.00299	1.02940
260	600	.83575	.88657	.92918	.96513	.99591	1.02298
270	600	.82182	.87485	.91930	.95671	.98861	1.01645
280	600	.80732	.86264	.90901	.94798	.98108	1.00976
290	600	.79222	.84992	.89829	.93891	.97329	1.00291
300	600	.77651	.83667	.88714	.92948	.96523	.99587
310	600	.76017	.82287	.87552	.91968	.95688	.98861
320	600	.74318	.80851	.86341	.90947	.94821	.98113
330	600	.72553	.79356	.85081	.89885	.93921	.97340
340	600	.70719	.77802	.83769	.88779	.92986	.96540
350	600	.68815	.76185	.82403	.87627	.92013	.95711

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	700	1.06852	1.09356	1.12036			
10	700	1.06221	1.08700	1.11317			
20	700	1.05591	1.08055	1.10620			
30	700	1.04960	1.07418	1.09941	1.12670	1.15744	1.19298
40	700	1.04326	1.06788	1.09277	1.11936	1.14904	1.18317
50	700	1.03685	1.06161	1.08627	1.11225	1.14097	1.17377
60	700	1.03036	1.05535	1.07987	1.10535	1.13319	1.16477
70	700	1.02377	1.04908	1.07355	1.09862	1.12569	1.15613
80	700	1.01704	1.04277	1.06729	1.09204	1.11843	1.14784
90	700	1.01015	1.03640	1.06106	1.08559	1.11140	1.13986
100	700	1.00309	1.02995	1.05485	1.07924	1.10456	1.13217
110	700	.99583	1.02339	1.04861	1.07297	1.09789	1.12475
120	700	.98835	1.01670	1.04234	1.06676	1.09137	1.11757
130	700	.98061	1.00985	1.03601	1.06057	1.08497	1.11060
140	700	.97262	1.00283	1.02959	1.05439	1.07867	1.10383
150	700	.96433	.99560	1.02307	1.04820	1.07244	1.09722
160	700	.95573	.98816	1.01641	1.04196	1.06627	1.09075
170	700	.94679	.98047	1.00960	1.03567	1.06013	1.08440
180	700	.93750	.97252	1.00262	1.02928	1.05399	1.07815
190	700	.92784	.96429	.99544	1.02280	1.04783	1.07197
200	700	.91778	.95574	.98804	1.01618	1.04164	1.06584
210	700	.90730	.94687	.98040	1.00941	1.03538	1.05974
220	700	.89639	.93764	.97249	1.00246	1.02903	1.05364
230	700	.88501	.92805	.96431	.99533	1.02258	1.04752
240	700	.87316	.91806	.95582	.98797	1.01600	1.04136
250	700	.86082	.90767	.94701	.98038	1.00927	1.03514
260	700	.84795	.89684	.93786	.97253	1.00237	1.02883
270	700	.83455	.88557	.92834	.96440	.99528	1.02242
280	700	.82060	.87382	.91843	.95598	.98797	1.01588
290	700	.80607	.86158	.90812	.94723	.98043	1.00919
300	700	.79094	.84884	.89739	.93814	.97263	1.00233
310	700	.77521	.83556	.88621	.92870	.96456	.99528
320	700	.75884	.82174	.87457	.91887	.95620	.98803
330	700	.74182	.80736	.86244	.90865	.94752	.98054
340	700	.72414	.79239	.84982	.89801	.93850	.97280
350	700	.70578	.77682	.83668	.88694	.92914	.96479

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	800	1.07408	1.09941	1.12683			
10	800	1.06774	1.09274	1.11946			
20	800	1.06144	1.08621	1.11231			
30	800	1.05515	1.07978	1.10537	1.13336	1.16511	1.20199
40	800	1.04885	1.07343	1.09861	1.12581	1.15642	1.19179
50	800	1.04251	1.06714	1.09200	1.11851	1.14808	1.18204
60	800	1.03611	1.06089	1.08552	1.11144	1.14005	1.17271
70	800	1.02961	1.05464	1.07914	1.10457	1.13232	1.16376
80	800	1.02301	1.04837	1.07284	1.09787	1.12486	1.15518
90	800	1.01628	1.04207	1.06659	1.09131	1.11764	1.14693
100	800	1.00939	1.03570	1.06038	1.08489	1.11063	1.13900
110	800	1.00231	1.02924	1.05417	1.07856	1.10382	1.13135
120	800	.99504	1.02268	1.04794	1.07230	1.09718	1.12397
130	800	.98754	1.01598	1.04168	1.06610	1.09068	1.11682
140	800	.97979	1.00912	1.03534	1.05993	1.08431	1.10989
150	800	.97178	1.00209	1.02893	1.05376	1.07803	1.10314
160	800	.96347	.99486	1.02240	1.04757	1.07182	1.09655
170	800	.95485	.98740	1.01574	1.04134	1.06566	1.09011
180	800	.94589	.97970	1.00892	1.03504	1.05952	1.08378
190	800	.93658	.97174	1.00193	1.02866	1.05339	1.07755
200	800	.92690	.96348	.99474	1.02217	1.04724	1.07138
210	800	.91681	.95492	.98733	1.01555	1.04105	1.06527
220	800	.90631	.94603	.97968	1.00877	1.03479	1.05917
230	800	.89537	.93678	.97176	1.00182	1.02845	1.05308
240	800	.88397	.92717	.96356	.99468	1.02200	1.04697
250	800	.87210	.91717	.95506	.98731	1.01541	1.04081
260	800	.85972	.90675	.94623	.97971	1.00868	1.03459
270	800	.84683	.89590	.93706	.97185	1.00177	1.02829
280	800	.83341	.88460	.92752	.96371	.99467	1.02188
290	800	.81942	.87283	.91760	.95527	.98736	1.01533
300	800	.80487	.86058	.90727	.94651	.97981	1.00864
310	800	.78972	.84781	.89652	.93741	.97201	1.00178
320	800	.77396	.83451	.88532	.92795	.96392	.99473
330	800	.75757	.82067	.87366	.91811	.95555	.98746
340	800	.74053	.80626	.86152	.90787	.94686	.97997
350	800	.72283	.79127	.84888	.89722	.93783	.97222

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	900	1.07969	1.10539	1.13352			
10	900	1.07331	1.09860	1.12593			
20	900	1.06699	1.09196	1.11859			
30	900	1.06070	1.08544	1.11148	1.14024	1.17308	1.21136
40	900	1.05442	1.07903	1.10458	1.13246	1.16408	1.20077
50	900	1.04812	1.07270	1.09784	1.12496	1.15544	1.19065
60	900	1.04178	1.06643	1.09126	1.11770	1.14715	1.18096
70	900	1.03538	1.06018	1.08480	1.11066	1.13917	1.17169
80	900	1.02889	1.05394	1.07844	1.10382	1.13148	1.16279
90	900	1.02228	1.04768	1.07215	1.09714	1.12406	1.15426
100	900	1.01554	1.04138	1.06592	1.09061	1.11687	1.14606
110	900	1.00864	1.03502	1.05972	1.08421	1.10990	1.13817
120	900	1.00156	1.02856	1.05352	1.07790	1.10312	1.13057
130	900	.99427	1.02199	1.04730	1.07166	1.09650	1.12322
140	900	.98676	1.01529	1.04103	1.06547	1.09003	1.11610
150	900	.97900	1.00843	1.03470	1.05930	1.08367	1.10920
160	900	.97097	1.00138	1.02828	1.05314	1.07741	1.10248
170	900	.96264	.99414	1.02175	1.04696	1.07121	1.09592
180	900	.95400	.98667	1.01509	1.04073	1.06507	1.08950
190	900	.94503	.97896	1.00827	1.03444	1.05894	1.08319
200	900	.93570	.97098	1.00127	1.02806	1.05282	1.07697
210	900	.92599	.96271	.99407	1.02157	1.04668	1.07082
220	900	.91588	.95413	.98665	1.01494	1.04049	1.06472
230	900	.90536	.94522	.97898	1.00816	1.03423	1.05863
240	900	.89439	.93596	.97106	1.00121	1.02789	1.05255
250	900	.88297	.92633	.96285	.99405	1.02144	1.04644
260	900	.87107	.91630	.95433	.98668	1.01485	1.04029
270	900	.85868	.90587	.94549	.97907	1.00812	1.03408
280	900	.84576	.89500	.93630	.97120	1.00120	1.02777
290	900	.83231	.88368	.92675	.96305	.99410	1.02136
300	900	.81831	.87189	.91681	.95460	.98678	1.01482
310	900	.80373	.85961	.90646	.94583	.97922	1.00812
320	900	.78856	.84683	.89569	.93671	.97141	1.00126
330	900	.77277	.83351	.88448	.92724	.96332	.99420
340	900	.75636	.81965	.87280	.91739	.95493	.98693
350	900	.73930	.80522	.86064	.90713	.94623	.97943

Appendix.Density of NaCl solutions,g/cm3,at molal concentration shown

TEMP DEG C	PRES BARS	MOLAL CONCENTRATION 0	1	2	3	4	5
0	1000	1.08536	1.11152	1.14042			
10	1000	1.07892	1.10458	1.13260			
20	1000	1.07256	1.09781	1.12506			
30	1000	1.06626	1.09120	1.11776	1.14736	1.18137	1.22113
40	1000	1.05998	1.08471	1.11068	1.13933	1.17204	1.21013
50	1000	1.05371	1.07832	1.10381	1.13160	1.16309	1.19961
60	1000	1.04742	1.07200	1.09710	1.12414	1.15450	1.18955
70	1000	1.04108	1.06574	1.09054	1.11691	1.14626	1.17992
80	1000	1.03468	1.05951	1.08410	1.10991	1.13832	1.17070
90	1000	1.02819	1.05327	1.07776	1.10309	1.13067	1.16186
100	1000	1.02158	1.04702	1.07149	1.09645	1.12329	1.15338
110	1000	1.01483	1.04072	1.06528	1.08994	1.11613	1.14523
120	1000	1.00792	1.03436	1.05908	1.08355	1.10919	1.13738
130	1000	1.00083	1.02790	1.05289	1.07726	1.10244	1.12981
140	1000	.99353	1.02133	1.04667	1.07104	1.09585	1.12250
150	1000	.98601	1.01462	1.04041	1.06486	1.08940	1.11542
160	1000	.97823	1.00775	1.03409	1.05871	1.08306	1.10854
170	1000	.97019	1.00070	1.02767	1.05256	1.07681	1.10185
180	1000	.96184	.99345	1.02113	1.04638	1.07063	1.09531
190	1000	.95319	.98597	1.01446	1.04016	1.06450	1.08891
200	1000	.94419	.97825	1.00764	1.03387	1.05839	1.08262
210	1000	.93484	.97025	1.00063	1.02748	1.05227	1.07642
220	1000	.92512	.96197	.99343	1.02099	1.04613	1.07028
230	1000	.91499	.95337	.98600	1.01436	1.03995	1.06419
240	1000	.90444	.94445	.97832	1.00758	1.03370	1.05812
250	1000	.89346	.93517	.97038	1.00062	1.02736	1.05204
260	1000	.88202	.92552	.96216	.99346	1.02090	1.04594
270	1000	.87010	.91548	.95363	.98608	1.01432	1.03979
280	1000	.85768	.90503	.94478	.97846	1.00758	1.03358
290	1000	.84474	.89414	.93557	.97058	1.00066	1.02728
300	1000	.83127	.88280	.92601	.96242	.99355	1.02087
310	1000	.81724	.87100	.91605	.95396	.98622	1.01432
320	1000	.80264	.85870	.90569	.94517	.97866	1.00763
330	1000	.78745	.84589	.89491	.93605	.97084	1.00076
340	1000	.77165	.83256	.88368	.92656	.96274	.99370
350	1000	.75522	.81868	.87199	.91670	.95435	.98643

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