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PVTx Property Measurements for 2-Methyl-2-propanamine + Water from 278 to 313 K

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The effect of pressure on the volume of liquid 2-methyl-2-propanamine and six of its mixtures with water has been measured with a bellows volumometer at 278.15, 288.15, 298.14, and 313.14 K. These data have been represented by equations which enable interpolation and extrapolation of the volumetric properties. Isothermal compressibilities evaluated from one of the equations are given. Densities have been evaluated at 0.1 MPa for the pure amine at those temperatures and at 298.14 and 313.14 K for 17 and 9 mixtures, respectively. The effect of pressure on the excess molar volume is illustrated at 298.14 K.

Introduction

The densities of mixtures of 2-methyl-2-propanamine (1) + water (2) were studied over a range of temperatures, pressures, and compositions to see if the intermolecular interactions due to the competing effects of the hydrophobic hydrocarbon head group and the hydrogen-bonding amine tail had an unusual effect on the volumetric properties. Measurements were also made for pure 2-methyl-2-propanamine up to its freezing pressure. The results also extend the temperature range of the atmospheric pressure density measurements of Kipkemboi and Easteal (1994) and enable their use to calculate densities at high pressures.

Experimental Section

The water used in the measurements was distilled and deionized; the 2-methyl-2-propanamine was Fluka puriss grade of stated purity >99.5% which was fractionally distilled from a molecular sieve under argon before use; the purity was not independently determined. A bellows volumometer was used for the high-pressure measurements; the experimental method has been described elsewhere (Easteal and Woolf, 1985, 1993). Temperatures in the volumometer bath were maintained constant to ±0.005 K and had an accuracy of ±0.01 K. Pressures were measured with a calibrated (by a dead weight gauge) pressure transducer for pressures above 25 MPa; between 5 and 25 MPa, a calibrated (dead weight gauge) Heise−Bourdon gauge was used; at 2.5 and 5 MPa, a dead weight gauge generated the pressure (Easteal and Woolf, 1993). The overall accuracy in pressure was estimated to be ±0.05%. Densities at atmospheric pressure were measured with an Anton Paar Model DMA60 digital densimeter using a DMA602HT external cell frequently calibrated with distilled, deionized, and degassed water and dry nitrogen gas. The procedures used for operating the densimeter and corrections of the standard solution compositions for vapor space, etc., closely followed those of Malhotra and Woolf (1994). The temperatures in the densimeter had a precision of ±0.002 K and an accuracy of ±0.01 K. Ambient pressures approximated 950 hPa so that the densities were adjusted to 0.1 MPa using the low pressure data from the volumometer experiments (the correction was less than 10 ppm). They were reproducible to ±0.003 $kg \cdot m^{-3}$ and had an estimated accuracy of ±(0.01−0.02) $kg \cdot m^{-3}$.

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Results

Because the volumometer cell is evacuated before it is filled with the sample liquid, the density of each solution used for the volumometer measurements was determined at ambient pressure and 298.14 K (ITS-90) after the completion of the complete set of experiments for that mixture. The composition of the samples from the experiments was established from the measured densities at compositions estimated to be known to ±0.02% given in Table 1 which were used to obtain the coefficients of a Redlich−Kister equation of the fourth order fitted to the excess molar volumes. The estimated accuracy in the mole fraction of the volumometer sample, x_1, is ±0.1%. Densities were also measured at 0.1 MPa for the pure amine at 278.15 K and for a number of compositions at 313.14 K to extend the range of the literature data (Kipkemboi and Easteal, 1994). The volumetric properties were measured as volume ratios for pure 2-methyl-2-propanamine and six of its mixtures with water at temperatures from 278.15 to 313.14 K and pressures up to about 200 MPa; the volume ratios $k = V_P/V(0.1\ \mathrm{MPa})$, where V_P denotes the volume of a fixed mass of liquid at pressure P, are given in Table 2. The accuracy in the volume ratios is estimated to be ±(0.02−0.04)% for pressures of 50 MPa or greater and about ±0.1% at lower pressures. The pressure range was limited by the low freezing pressure of the amine.

Discussion

The 0.1 MPa densities, $\varrho(0.1\ \mathrm{MPa})$, of the pure amine are generally lower, but not by a consistent amount, than those of Kipkemboi and Easteal (1994) which were based on a different set of calibrating fluids. The difference seems to increase as the temperature decreases below 298.14 K. The combined data with temperatures, t, expressed on the

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Table 1. Densities, ϱ, for 2-Methyl-2-propanamine (1) + Water (2) at 0.1 MPa[a,b]

		T = 298.14 K		volumometer samples[c]		T = 313.14 K	
x_1	ϱ/(kg·m^{-3})	x_1	ϱ/(kg·m^{-3})	x_1	ϱ/(kg·m^{-3})	x_1	ϱ/(kg·m^{-3})
0	997.044	0.540978	761.036	0.04897	958.843	0	992.215
0.008964	988.883	0.592459	750.678	0.09878	921.011	0.028214	967.481
0.019373	980.836	0.703154	730.728	0.29285	825.948	0.139010	883.359
0.042342	964.145	0.795189	715.597	0.51609	766.321	0.238201	832.928
0.065592	945.719	0.895967	700.973	0.71205	729.149	0.395705	781.211
0.099195	920.754	0.945343	694.210	0.89705	700.805	0.507113	753.391
0.190548	866.721	0.987707	688.428			0.591789	735.526
0.290960	826.595	1	686.729			0.735605	709.403
0.388707	797.185					0.893371	685.225
0.444188	782.822					0.941003	678.348
0.491832	771.759					1	670.243

[a] Densities for $x_1 = 1$ were also measured at 278.15 K, 708.10$_1$ kg·m^{-3}, and 288.15 K, 697.59$_9$ kg·m^{-3}. [b] More than the correct number of significant figures are given to assist calculations. [c] Density in column 6 used to determine composition in column 5.

Celsius scale can be represented with a root mean square deviation of 4.7×10^{-2} by

$$\varrho(0.1\ \mathrm{MPa})/(\mathrm{kg{\cdot}m^{-3}}) = 713.210 - 1.0062(t/°\mathrm{C}) - 2.915 \times 10^{-3}(t/°\mathrm{C})^2\ 3.08 \times 10^{-5}(t/°\mathrm{C})^3 \quad (1)$$

The volume ratios $k = V_P/V(0.1\ \mathrm{MPa})$ in Table 2 are conveniently expressed by either of two equations

$$K = P/(1-k) = a_0 + a_1P + a_2P^2 + a_3P^3 \quad (2)$$

$$1 - k = C \log[(B + P)/(B + 0.1)] \quad (3)$$

Eq 1 provides the most accurate representation of the k, while eq 2 generally is the more suitable for

Table 2. Volume Ratios, $k = V_P/V$ (0.1 MPa), for 2-Methyl-2-propanamine (1) + Water (2)

x_1	T/K	P/MPa	k	P/MPa	k	P/MPa	k	P/MPa	k
0.04897	278.15	2.547	0.9989	23.83	0.9904	67.85	0.9747	136.82	0.9536
		4.996	0.9979	27.99	0.9888	76.70	0.9718	157.19	0.9480
		9.675	0.9960	37.79	0.9851	87.73	0.9682	178.76	0.9423
		14.563	0.9940	46.95	0.9818	97.25	0.9653	197.09	0.9376
		19.741	0.9920	58.09	0.9780	117.51	0.9592		
	288.15	2.547	0.9989	23.60	0.9901	67.54	0.9738	137.94	0.9518
		4.996	0.9978	27.49	0.9885	76.28	0.9709	158.23	0.9461
		9.459	0.9959	37.03	0.9849	87.11	0.9673	182.24	0.9397
		14.427	0.9938	47.19	0.9811	96.43	0.9643	208.57	0.9331
		19.592	0.9917	57.81	0.9772	116.41	0.9582		
	298.14	2.547	0.9989	23.71	0.9897	66.78	0.9732	136.43	0.9508
		4.996	0.9978	27.26	0.9882	77.18	0.9696	156.61	0.9450
		9.662	0.9957	37.99	0.9840	86.34	0.9665	180.51	0.9385
		14.691	0.9935	46.77	0.9806	97.57	0.9628	204.46	0.9323
		19.600	0.9914	57.27	0.9766	117.43	0.9565		
	313.14	2.547	0.9988	24.01	0.9891	66.49	0.9721	136.88	0.9486
		4.996	0.9976	27.28	0.9877	76.69	0.9684	156.65	0.9428
		9.666	0.9955	37.99	0.9832	87.45	0.9646	182.19	0.9356
		14.607	0.9932	47.88	0.9792	98.50	0.9608	208.57	0.9287
		19.667	0.9910	57.23	0.9756	118.15	0.9544		
0.09878	278.15	2.547	0.9987	23.95	0.9887	66.88	0.9709	137.93	0.9469
		4.996	0.9976	28.20	0.9868	77.23	0.9671	157.86	0.9409
		9.666	0.9953	37.64	0.9827	87.97	0.9632	181.56	0.9340
		14.541	0.9930	48.06	0.9784	97.26	0.9600	202.34	0.9281
		19.720	0.9906	57.26	0.9747	116.96	0.9534		
	288.15	2.546	0.9987	23.79	0.9884	67.80	0.9699	136.84	0.9463
		4.996	0.9975	27.92	0.9865	76.96	0.9665	158.35	0.9398
		9.666	0.9951	37.77	0.9822	87.75	0.9626	181.07	0.9334
		14.575	0.9927	48.11	0.9778	97.63	0.9591	202.96	0.9275
		19.624	0.9903	57.78	0.9738	118.25	0.9522		
	298.14	2.547	0.9986	23.67	0.9879	66.54	0.9691	136.66	0.9446
		4.996	0.9973	27.27	0.9862	76.93	0.9651	156.37	0.9387
		9.799	0.9948	36.47	0.9819	85.61	0.9619	180.85	0.9317
		14.541	0.9924	46.31	0.9775	96.56	0.9579	204.07	0.9256
		19.509	0.9899	57.14	0.9730	115.97	0.9513		
	313.14	2.547	0.9985	23.75	0.9869	66.20	0.9677	138.46	0.9418
		4.996	0.9971	26.56	0.9855	77.35	0.9633	158.16	0.9356
		9.738	0.9944	36.93	0.9804	87.73	0.9593	183.45	0.9281
		14.734	0.9916	46.57	0.9760	98.56	0.9554	206.38	0.9218
		19.717	0.9890	56.69	0.9716	117.84	0.9487		
0.29285	278.15	2.547	0.9982	23.99	0.9846	67.57	0.9620	137.64	0.9345
		4.996	0.9966	28.24	0.9821	77.43	0.9576	157.27	0.9281
		9.721	0.9934	37.18	0.9771	87.69	0.9533	180.21	0.9210
		14.823	0.9901	48.21	0.9713	98.38	0.9490	201.24	0.9149
		19.821	0.9871	58.17	0.9664	117.40	0.9417		

Table 2 (Continued)

x_1	T/K	P/MPa	k	P/MPa	k	P/MPa	k	P/MPa	k
0.29285	288.15	2.547	0.9981	24.12	0.9836	66.84	0.9604	138.72	0.9312
		4.996	0.9963	27.89	0.9812	78.01	0.9553	158.15	0.9246
		9.550	0.9931	37.74	0.9755	87.97	0.9509	180.99	0.9174
		14.925	0.9895	48.27	0.9697	98.42	0.9465	200.84	0.9115
		19.339	0.9866	58.06	0.9647	118.76	0.9385		
	298.14	2.547	0.9980	24.24	0.9825	67.66	0.9579	138.25	0.9283
		4.996	0.9961	28.15	0.9800	76.98	0.9534	157.11	0.9217
		9.867	0.9924	37.76	0.9741	86.70	0.9490	184.31	0.9129
		14.964	0.9888	47.94	0.9682	98.60	0.9438	209.95	0.9052
		19.774	0.9855	57.56	0.9631	118.62	0.9356		
	313.14	2.547	0.9978	24.34	0.9809	67.99	0.9543	138.74	0.9230
		4.996	0.9958	28.17	0.9782	77.09	0.9496	157.24	0.9162
		9.855	0.9918	38.62	0.9713	88.37	0.9441	181.28	0.9080
		14.861	0.9879	48.51	0.9651	98.35	0.9396	202.55	0.9015
		19.994	0.9840	58.18	0.9596	117.80	0.9313		
0.51609	278.15	2.547	0.9977	24.07	0.9804	68.41	0.9529	137.51	0.9219
		4.996	0.9956	28.07	0.9775	77.69	0.9481	158.37	0.9142
		10.040	0.9913	37.51	0.9711	87.64	0.9432	182.94	0.9059
		14.972	0.9873	48.01	0.9645	97.85	0.9384	205.19	0.8990
		19.685	0.9837	57.95	0.9586	118.01	0.9296		
	288.15	2.547	0.9975	24.21	0.9789	68.01	0.9502	137.70	0.9176
		4.996	0.9952	28.12	0.9759	77.17	0.9452	158.35	0.9098
		9.833	0.9908	38.60	0.9684	88.54	0.9394	180.63	0.9021
		14.774	0.9866	48.46	0.9619	98.62	0.9345	202.66	0.8949
		19.871	0.9823	57.69	0.9562	118.39	0.9256		
	298.14	2.547	0.9973	24.09	0.9775	67.72	0.9473	137.66	0.9132
		4.996	0.9949	28.36	0.9740	78.27	0.9413	158.06	0.9053
		9.819	0.9901	37.48	0.9670	87.67	0.9363	181.96	0.8967
		14.712	0.9856	47.14	0.9602	97.58	0.9312	203.83	0.8894
		19.819	0.9811	57.75	0.9533	118.62	0.9214		
	313.14	2.547	0.9970	24.20	0.9748	67.70	0.9420	137.74	0.9059
		4.996	0.9942	28.55	0.9709	78.08	0.9357	157.58	0.8978
		9.815	0.9889	38.41	0.9627	87.21	0.9305	183.36	0.8882
		15.142	0.9834	48.13	0.9553	98.52	0.9245	206.77	0.8802
		20.141	0.9785	58.35	0.9481	117.43	0.9151		
0.71205	278.15	2.547	0.9973	19.71	0.9808	47.55	0.9593	88.37	0.9350
		4.996	0.9948	24.04	0.9771	58.30	0.9522	98.27	0.9299
		9.985	0.9898	28.39	0.9735	68.31	0.9461	119.30	0.9200
		14.882	0.9852	37.67	0.9663	77.32	0.9410		
	288.15	2.547	0.9971	24.30	0.9750	57.80	0.9491	97.76	0.9257
		4.996	0.9943	28.63	0.9712	67.52	0.9429	117.36	0.9160
		9.890	0.9890	37.74	0.9637	78.34	0.9364	138.28	0.9066
		14.944	0.9839	47.47	0.9563	87.82	0.9310	147.53	0.9029
		20.028	0.9789						
	298.14	2.547	0.9968	23.81	0.9733	57.57	0.9455	98.45	0.9204
		4.996	0.9937	28.94	0.9685	67.37	0.9389	117.63	0.9106
		9.889	0.9880	38.90	0.9598	77.78	0.9323	140.11	0.9004
		14.908	0.9824	48.54	0.9521	87.04	0.9268	157.26	0.8932
		19.806	0.9773						
	313.14	2.547	0.9962	24.30	0.9693	68.03	0.9319	118.51	0.9019
		4.996	0.9928	28.19	0.9653	78.06	0.9251	137.11	0.8929
		9.780	0.9863	37.78	0.9560	87.15	0.9193	160.74	0.8826
		14.810	0.9800	48.36	0.9469	98.22	0.9128	178.89	0.8754
		19.627	0.9744	58.60	0.9388				
0.89705	278.15	2.547	0.9968	19.73	0.9779	38.89	0.9607	67.52	0.9399
		4.996	0.9939	23.95	0.9738	48.64	0.9530	78.05	0.9333
		9.919	0.9883	28.58	0.9695	57.83	0.9464	89.12	0.9268
		14.779	0.9830						
	288.15	2.547	0.9965	20.05	0.9756	48.15	0.9499	87.17	0.9232
		4.996	0.9933	24.30	0.9712	57.56	0.9427	100.47	0.9157
		9.768	0.9873	28.37	0.9672	67.12	0.9359	115.52	0.9078
		14.983	0.9812	38.32	0.9581	77.61	0.9290		
	298.14	2.547	0.9962	19.54	0.9740	48.73	0.9455	87.59	0.9177
		4.996	0.9926	24.60	0.9684	57.51	0.9384	98.90	0.9110
		10.005	0.9858	28.51	0.9642	68.20	0.9305	119.64	0.8998
		14.652	0.9799	38.20	0.9548	78.43	0.9235	137.36	0.8912
	313.14	2.547	0.9956	24.15	0.9646	58.03	0.9307	97.54	0.9026
		4.996	0.9915	28.44	0.9595	68.02	0.9228	117.47	0.8911
		10.118	0.9835	38.53	0.9486	77.82	0.9156	138.80	0.8802
		15.147	0.9762	48.56	0.9390	88.20	0.9085	157.93	0.8716
		19.686	0.9702						
1	278.15	2.547	0.9967	19.78	0.9764	47.81	0.9506	88.16	0.9234
		4.996	0.9936	23.92	0.9721	57.81	0.9431	99.29	0.9169
		9.662	0.9878	28.54	0.9675	67.01	0.9367	123.32	0.9027
		14.956	0.9817	37.58	0.9592	77.43	0.9300		
	288.15	2.547	0.9962	19.94	0.9735	27.78	0.9649	78.80	0.9230
		4.996	0.9926	23.79	0.9692	38.09	0.9548	97.88	0.9111

Table 2 (Continued)

x_1	T/K	P/MPa	k	P/MPa	k	P/MPa	k	P/MPa	k
1	288.15	9.782	0.9861	14.76	0.9797	58.48	0.9376	118.63	0.9001
	298.14	2.547	0.9958	19.79	0.9713	38.14	0.9511	97.90	0.9052
		4.996	0.9918	24.19	0.9660	58.40	0.9331	116.90	0.8946
		9.299	0.9853	28.36	0.9613	77.68	0.9185	139.23	0.8847
		14.701	0.9778						
	313.14	2.547	0.9950	19.67	0.9671	57.70	0.9252	117.74	0.8830
		4.975	0.9905	23.93	0.9613	77.79	0.9088	137.77	0.8723
		9.723	0.9822	27.48	0.9568	97.82	0.8950	157.82	0.8627
		14.738	0.9743	38.58	0.9439				

Table 3. Coefficients of Eqs 2 and 3 and Standard Deviation of Their Fit to the Volume Ratio $k = V_P/V(0.1\ \mathrm{MPa})$ for 2-Methyl-2-propanamine (1) + Water (2)

T/K	a_0/MPa	a_1	$-a_2$/GPa^{-1}	a_3/GPa^{-2}	$10^2\ \langle\Delta k/k\rangle$	B/MPa	C	$10^2\ \langle\Delta k/k\rangle$
				$x_1 = 0.04897$				
278.15	2350.16	5.4480	10.1877	17.166	0.001	278.08	0.2678	0.009
288.15	2263.55	5.1552	7.2482	10.183	0.001	260.61	0.2618	0.008
298.14	2196.79	4.5496	1.9945	−2.700	0.001	246.22	0.2575	0.005
313.14	2087.13	4.5636	2.4679	−1.054	0.001	234.26	0.2578	0.006
				$x_1 = 0.09878$				
278.15	2015.37	4.1909	−2.7212	−19.223	0.001	225.55	0.2576	0.012
288.15	1932.25	5.0318	4.2500	2.537	0.001	202.59	0.2402	0.007
298.14	1835.39	5.0229	3.1217	1.413	0.001	178.92	0.2251	0.003
313.14	1666.85	6.4589	11.3486	13.715	0.005	166.08	0.2222	0.023
				$x_1 = 0.29285$				
278.15	1421.23	5.6546	5.6577	4.212	0.002	129.42	0.2086	0.010
288.15	1331.86	5.7631	6.9359	7.458	0.001	121.67	0.2087	0.012
298.14	1249.77	5.7134	6.8565	7.323	0.001	114.40	0.2091	0.013
313.14	1154.02	5.0079	1.4910	−6.533	0.006	104.37	0.2103	0.010
				$x_1 = 0.51609$				
278.15	1100.74	5.4786	5.6005	4.846	0.002	98.81	0.2068	0.010
288.15	1019.41	5.5054	6.7107	8.241	0.003	92.14	0.2080	0.010
298.14	942.08	5.4291	6.2643	6.451	0.003	85.15	0.2082	0.012
313.14	836.39	5.2356	5.5055	4.672	0.004	75.51	0.2091	0.012
				$x_1 = 0.71205$				
278.15	925.24	5.2871	3.3942	−9.812	0.002	80.92	0.2033	0.006
288.15	849.83	5.1342	3.0803	−7.171	0.006	75.27	0.2062	0.009
298.14	769.57	5.3164	6.3024	5.814	0.003	68.15	0.2055	0.008
313.14	661.75	5.5872	10.6559	20.239	0.004	59.76	0.2072	0.014
				$x_1 = 0.89705$				
278.15	793.02	5.1780	3.4613	−13.633	0.001	69.37	0.2043	0.004
288.15	715.81	5.5536	10.8367	26.047	0.001	63.15	0.2043	0.006
298.14	650.82	5.3594	8.5028	13.832	0.002	57.64	0.2056	0.008
313.14	558.90	5.3014	9.7483	19.492	0.002	49.89	0.2075	0.008
				$x_1 = 1$				
278.15	755.11	3.9183	−17.8107	−128.413	0.003	70.96	0.2204	0.043
288.15	651.68	5.2869	8.6685	17.929	0.009	57.63	0.2062	0.011
298.14	582.88	5.7563	17.9186	62.882	0.012	50.94	0.2029	0.033
313.14	495.08	5.4204	12.6531	29.242	0.007	45.21	0.2106	0.014

extrapolation of them; the coefficients of eq 2 and the B and C of eq 3 are given in Table 3. The isothermal compressibilities given in Table 4 have been calculated from eq 2 using the relation

$$\kappa_T = -[1/(P-K)][1-(P/K)(\partial K/\partial P)_T] \qquad (4)$$

with the derivatives calculated analytically. The κ_T for pure 2-methyl-2-propanamine shows that it is a very compressible liquid, indicating that the amino group contributes to the volumetric properties in much the same way as a methyl group. The κ_T's at $x_1 = 0.0489_7$ at the three lower temperatures are similar in some respects to those for a similar composition of acetonitrile + water (Easteal and Woolf, 1988). Within the expected error of ±(1−2)%, they are lower than those of pure water throughout the pressure range. This behavior persisted in the acetonitrile + water system up to a mole fraction of acetonitrile of 0.0998 for the two lower temperatures. Unlike the latter system,, the κ_T's for the present one do not decrease with increasing temperature at the lower compositions. The decrease in κ_T with increase in composition of the nonaqueous component is present to a much greater extent in methanol + water (Easteal and Woolf, 1985). Hydrogen bonding is present in the methanol + water system but is not thought to be of any significance in acetonitrile + water. Because of the similarity with the acetonitrile + water system, it does not seem that the extent of hydrogen bonding between the two components in 2-methyl-2-propanamine + water has a significant influence on the *PVTx* properties of their solutions. However, this similarity may indicate that the destructive effects of the hydrophobic hydrocarbon head group on the water structure substantially counterbalance the constructive ones of the hydrogen-bonding amine tail.

Excess molar volumes calculated at 0.1 MPa from the density data of Table 1 are in good agreement with those of Kipkemboi and Easteal (1994). The density of solutions at elevated pressures can be calculated from $\varrho(0.1\ \mathrm{MPa})$ by dividing by the corresponding $V_P/V(0.1\mathrm{MPa})$ obtained

Table 4. Isothermal Compressibility, κ_T/(10^{-4}·MPa^{-1}), for 2-Methyl-2-propanamine (1) + Water (2)

	P/MPa								
T/K	0.1	10	20	40	60	80	100	150	200
				x_1 = 0.04897					
278.15	4.25	4.09	3.94	3.69	3.48	3.32	3.17	2.89	
288.15	4.42	4.25	4.09	3.82	3.60	3.42	3.26	2.94	2.68
298.14	4.55	4.39	4.24	3.97	3.73	3.52	3.34	2.99	2.75
313.14	4.79	4.61	4.45	4.15	3.89	3.67	3.47	3.09	2.83
				x_1 = 0.09878					
278.15	4.96	4.78	4.61	4.29	4.01	3.76	3.54	3.17	3.02
288.15	5.17	4.94	4.73	4.37	4.06	3.80	3.58	3.16	2.86
298.14	5.45	5.19	4.96	4.55	4.20	3.91	3.66	3.17	2.81
313.14	6.00	5.60	5.27	4.72	4.31	4.00	3.75	3.31	3.01
				x_1 = 0.29285					
278.15	7.03	6.56	6.14	5.46	4.92	4.49	4.14	3.51	3.10
288.15	7.50	6.96	6.49	5.72	5.13	4.67	4.30	3.63	3.18
298.14	7.99	7.39	6.86	6.01	5.37	4.86	4.46	3.75	3.27
313.14	8.66	8.03	7.47	6.53	5.78	5.19	4.72	3.92	3.50
				x_1 = 0.51609					
278.15	9.08	8.33	7.68	6.65	5.87	5.27	4.80	3.96	3.42
288.15	9.80	8.93	8.19	7.04	6.18	5.53	5.02	4.12	3.51
298.14	10.60	9.60	8.76	7.46	6.50	5.78	5.22	4.27	3.66
313.14	11.94	10.73	9.72	8.16	7.04	6.21	5.57	4.50	3.85
				x_1 = 0.71205					
278.15	10.80	9.78	8.92	7.56	6.56	5.83	5.30	3.96	
288.15	11.75	10.59	9.61	8.07	6.95	6.13	5.51	4.12	
298.14	12.98	11.54	10.36	8.59	7.35	6.45	5.77	4.66	
313.14	15.09	13.09	11.55	9.38	7.95	6.95	6.21	4.89	
				x_1 = 0.89705					
278.15	12.60	11.26	10.14	8.44	7.25	6.41	5.30	3.96	
288.15	13.95	12.24	10.90	8.97	7.66	6.71	5.96	4.12	
298.14	15.34	13.35	11.79	9.57	8.08	7.03	6.25	4.66	
313.14	17.86	15.25	13.27	10.55	8.80	7.60	6.70	5.13	
				x_1 = 1					
278.15	13.23	12.05	10.90	8.94	7.52	6.67	6.35		
288.15	15.32	13.37	11.83	9.62	8.13	7.06	6.25		
298.14	17.13	14.56	12.69	10.23	8.65	7.48	6.48		
313.14	20.16	16.83	14.42	11.29	9.37	8.09	7.13	5.34	

from eq 2. This enables the determination of corresponding excess molar volumes, V^E. For the present system, the V_P/V(0.1 MPa)'s used for water were those listed by Easteal and Woolf (1985) in their Table 5; they were represented by a third-order equation, eq 2. Table 5 gives V^E's at 298.14 K which show the usual result that increase in pressure causes a rapid decrease in their absolute magnitude.

Table 5. Excess Molar Volume, V^E/(cm^3·mol^{-1}), for Mixtures of 2-Methyl-2-propanamine (1) + Water (2) at 298.14 K

	P/(MPa)				
X_1	0.1	10.0	20.0	50.0	100.0
0.0490	−0.795	−0.734	−0.684	−0.568	−0.438
0.0988	−1.331	−1.230	−1.149	−0.971	−0.783
0.2928	−2.610	−2.382	−2.204	−1.833	−1.463
0.5161	−3.076	−2.786	−2.567	−2.125	−1.701
0.7121	−2.500	−2.245	−2.060	−1.692	−1.332
0.8970	−1.133	−0.997	−0.904	−0.717	−0.522

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