

Short Communication

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VISCOSITY AND THERMODYNAMIC PROPERTIES DATA FOR METHANOL AND BENZENE MIXTURES AT ELEVATED TEMPERATURES (FOR TWO EXTREME CONCENTRATIONS)

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The non-ideality in viscosities of liquid mixtures is usually represented by the excess function of viscosities. A number of theories for the structure of liquid has been proposed whereby viscosity and excess function can be computed from molecular data. Vapour Liquid Equilibrium data also provide a means for understanding physical state of molecule in solution. The non-ideality of the equilibrium data is also expressed in the terms of excess-function.

An attempt was made to measure both the quantities i.e. viscosity of liquid mixture and its vapour liquid equilibrium data under identical conditions so that these data could be tested against proposed theories for the structure of liquid. A rolling ball viscometer and a static equilibrium cell, in a closed system, was designed, constructed and operated to obtain data for binary mixture of *n*-hexane-benzene and methanol-benzene systems when the data for the mixture of *n*-hexane and benzene have were obtained [1-2]. The data of mixture of methanol-benzene obtained for two extreme conditions from the same instrument are now being reported here. In this study the same apparatus and liquid sampling procedure was used as reported earlier [3-4].

Benzene and methanol used were of B.D.H. (Analar grade) and tested with Pye 104 Chromatograph and till no further purification needed. The reliability of measurement system and the purity of materials was further confirmed by measuring the vapour pressure and viscosity of liquids of the pure substances at different temperature and comparing them with values reported in the literature. The data on liquid viscosities from this measurement system have been published [2-3]. The measured data of vapour pressure for methanol and benzene alongwith the values reported in the literature are given in Table 1. An attempt was also made to express the dependency of vapour pressure on the temperature by means of mathematical correlations. The experimental vapour pressure data were fitted to Antoine equation, Rankine-Kirschhoff's equation and Frost-Kalkwarf equation.

Results of the comparison of these equations are shown in Table 2 expressed as the percentage root mean square deviation (RMSD %).

The total vapour pressure-liquid composition method is applied in the present work in calculating the vapour

Table 1. Vapour pressures of pure components at different temperatures ($P = P_1 \times 6894.8 \text{ N/m}^2$).

Temperature °K	Methanol P_1			Benzene P_1			Toluene P_1	
	Experimental	Ref. [6]	Ref. [5]	Experimental	Ref. [6]	Ref. [7]	Experimental	Ref. [7]
353.15	26.1	25.93	26.11					
363.15	36.7	36.68	36.89	20.1	19.49	19.75		
373.15	50.4	50.68	51.04	26.6	25.81	26.12		
383.15	69.0	68.86	69.31	34.6	33.63	33.97		
393.15	91.05	91.87	92.48	43.4	43.12	43.50	19.4	19.04
403.15	120.2	120.7	121.51	55.3	54.55	54.94	24.8	24.71
413.15	155.7	156.06	157.81	69.1	68.06	68.51	31.5	31.6
423.15	199.3	199.87	201.89	83.6	83.82	84.45	39.4	39.9
433.15	250.9	251.9	255.01	101.8	102.48	103.01	49.2	49.76
443.15	314.1	315.03	318.32	123.4	123.48	124.44	60.6	61.38
453.15	387.1	388.46	393.27	147.6	147.29	149.0	74.4	74.95
463.15	474.3	475.93	481.44	175.6	174.9	176.97	90.2	90.67

P = Total pressure

Table 2. Comparison of the vapour pressure equations RMSD (%)

	Antoine	R-Kirschhoff	F-Kalkwarf
Methanol	0.202	30.49	0.264
Benzene	0.537	20.81	0.538
Toluene	0.948	8.23	0.952

tion while analysing their own data and by Chemists and Engineers in the design of heat transfer, fluid flow and mass transfer equipments, needed in industry for such or similar systems of mixtures.

Key words: Viscosity, Thermodynamic, Methanol, Benzene.

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Table 3. Vapour-liquid equilibrium and liquid viscosities data for methanol benzene system.

Temperature °K	Mole fraction methanol X_1	Viscosity (in 10^3Ns/m^2)	Pressure (experimental) $\times 10^{-5} \text{N/m}^2$	Calculated from virial equation of state				
				Pressure $\times 10^{-5} \text{N/m}^2$	Y_1	G^E KJ/K mole	γ_1	γ_2
363.15	0.1563	0.268	2.654	2.655	0.5167	758.44	3.5479	1.0657
	0.7833	0.245	2.999	2.999	0.7178	856.64	1.0808	2.8028
383.15	0.1496	0.219	4.509	4.509	0.5137	714.15	3.3910	1.0504
	0.7836	0.195	5.461	5.461	0.7439	889.10	1.0842	2.7155
403.15	0.1536	0.181	7.136	7.136	0.5091	689.95	3.0247	1.0436
	0.7861	0.151	9.178	9.170	0.7705	876.34	1.0804	2.5605
423.15	0.1304	0.150	10.018	10.018	0.4591	550.04	2.8277	1.0245
	0.7853	0.113	14.658	14.658	0.7953	857.53	1.0795	2.3568
443.15	0.1236	0.124	14.389	14.389	0.4318	507.05	2.6583	1.0196
	0.7846	0.084	22.532	22.532	0.8083	841.56	1.0749	2.2235
463.15	0.1311	0.105	19.698	19.701	0.4076	455.97	2.2438	1.0147
	0.7846	0.060	33.398	33.398	0.8244	820.65	1.0797	2.0376

x = Mole fraction in the liquid phase, y = Mole fraction in the vapour phase

G^E = Gibbs excess free energy of mixing, γ = Activity coefficient.

composition. The deviation of the vapour phase from the ideal was calculated using the virial equation of state from the experimental volumetric data from Eubank [5] and Young [6] while the deviation of the liquid phase from ideal solutions were evaluated with the help of Van Laar equation.

The vapour-liquid equilibrium and liquid viscosities data for methanol-benzene system obtained for the two extreme conditions at six different temperatures are given in Table 3. The availability of present two sets of data for the viscosity and thermodynamic properties appears to be too small to be used for any meaningful analysis of the proposed correlations, based on different theories of liquid. However, it is hoped that such data may be found useful by research workers who may take advantage of this informa-

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