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Densities and Viscosities for Binary Mixtures of Poly(ethylene glycol) 400 + Dimethyl Sulfoxide and Poly(ethylene glycol) 600 + Water at Different Temperatures

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ABSTRACT: We report herein the density, viscosity, and excess properties of poly(ethylene glycol) 400 (PEG 400) + dimethyl sulfoxide (DMSO) and 600 (PEG 600) + water binary mixtures at temperatures from (298.15 to 323.15) K and (298.15 to 308.15) K, respectively, covering the whole composition range at atmospheric pressure. The excess molar volumes (V_m^E) and viscosity deviation ($\Delta\eta$) were calculated using the measured density and viscosity of the binary systems. They were correlated as a function of temperature and composition and fitted by the Redlich−Kister polynomial equation. The results of pure PEG 400 and 600 were also obtained and were compared with the data reported in previous literature.

INTRODUCTION

The physical and transport properties of liquid mixtures are very important in understanding the nature of molecular interactions between the molecules of liquid mixtures. Such properties of liquid mixtures are useful in designing various transport and process equipments in the chemical industry.[1] Physical and transport properties of liquid mixtures also affect most separation procedures, such as liquid−liquid extraction, gas absorption, and distillation.[2]

Sulfur dioxide (SO_2) is the major source of flue gas from burning fuels with high sulfur content in industrial processes, which is one of the main air pollutants to be dealt with in consideration of environmental protection.[3−6] However, the development of new efficient processes for SO_2 control of power-plant flue gas is still a challenge to environment protection. Because of the lowering of admissible environment emission standards and the fact that numerous desulfurization processes, such as limestone scrubbing, can produce a large volume of solid waste,[7] there is a growing interest in using organic liquids to remove SO_2. Actually, organic liquids have been applied in the SO_2 regenerative processes.[8−12] In the study of flue gas desulfurization processes, we have developed methods of absorbing acid gases in industrial processes which involves introducing organic solvents to the desulfurization system.[7] Among these organic absorbents, alcohols show favorable properties in the absorption and desorption of acid gases in industrial processes.[13]

Poly(ethylene glycol) (PEG), owing to its high water solubility and low toxicity, has wide applications in such fields as cosmetic, medical, and textile industries. Recently, we found that PEG has potential applications in acid gas removal, for example, in flue gas desulfurization of the chemical industry. Such binary mixtures can lower the energy for the absorption and regeneration processes which have received considerable attention in desulfurization technology. Measurements on the densities and viscosity have been partly studied previously. Trivedi et al.[14] have studied densities of PEG 600 + water at temperatures from (283.15 to 363.15) K, and Kirinčič et al.[15,16] have studied volumetric properties and the viscosity of PEG 600 + water at 298.15 K. However, the physicochemical data of these binary mixtures have not been reported previously.

In this work, we report the density and viscosity of the binary mixtures of PEG 400 + DMSO and PEG 600 + H_2O solutions, which are considered as candidates for the study of SO_2 removal processes, at a temperature range that covers the partly industrial applications.

EXPERIMENTAL SECTION

Materials. The PEGs with nominal molecular weights of (400 and 600) $g\cdot mol^{-1}$ as well as dimethyl sulfoxide (DMSO) were purchased from Beijing Reagent Company. They were used after drying over molecular sieves (type 4 A) and decompression filtration by vacuum pump. The ethanol (HPLC grade) with a purity of minimum mass fraction of 0.998 was purchased from Tjshield Company. Double-distilled, deionized, and degassed water was used.

Measurements. The solutions were prepared with ± 0.0001 g mass accuracy using an analytical balance (224S, Sartorius BS). The uncertainty in the mole fraction of each mixture is less than ± 0.0001. Density measurements of pure liquids as well as the mixtures were carried out by means of a bicapillary pycnometer with a bulb volume of 10 cm^{-3} which was carefully calibrated using double-distilled, deionized, and degassed water. The temperatures of liquids were controlled at the desired value (± 0.01 K) by immersing the pycnometer in a thermostatically controlled, well-stirred water bath for a sufficient length of time. Measurements were carried out at temperatures of (298.15,

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Table 1. Calculated A and B Values in the Kinetic Viscosity Equation

T/K	298.15	303.15	308.15	313.15	318.15	323.15
$A\cdot 10^{-5}$	6.85461	6.90639	6.29677	7.01464	7.66456	7.00486
$B\cdot 10^{-3}$	2.36150	2.65694	0.54702	2.84091	3.82689	2.89906

Table 2. Comparison of Experimental Density (ρ), Viscosity (η), and Kinematic Viscosity (ν) of PEG 400 and 600 and DMSO with Literature Values at Different Temperatures

	$\rho/(\mathrm{g\cdot cm^{-3}})$		$\eta/(\mathrm{mPa\cdot s})$		$10^6\ \nu/(\mathrm{m^2\cdot s^{-1}})$	
T/K	exptl.	lit.	exptl.	lit.	exptl.	lit.
			PEG 400			
298.15	1.1226	1.1218[7] 1.12310[1]	89.73	94.4[7] 84.71[1]	79.93	84.1[7]
303.15	1.1185	1.1180[7] 1.1181[14]	69.89	69.1[7]	62.48	61.8[7]
308.15	1.1139	1.1142[7] 1.11489[1]	49.54	55.6[7] 51.66[1]	44.47	49.9[7]
313.15	1.1088	1.1097[7] 1.1098[14]	44.77	44.4[7]	40.38	40.0[7]
318.15	1.1048	1.1057[7] 1.10671[1]	39.90	34.2[7] 33.81[1]	36.12	30.9[7]
323.15	1.1015	1.1017[7] 1.1015[14]	29.82	25.7[7]	27.07	23.3[7]
			PEG 600			
298.15	1.1235		135.8		120.85	
303.15	1.1186	1.1186[14]	101.4		90.68	
308.15	1.1145	1.1144[18]	72.45		65.01	
			DMSO			
298.15	1.0958	1.0954[19]	1.964	1.984[19]	1.79	
303.15	1.0900	1.0908[19]	1.787	1.801[19]	1.64	
308.15	1.0839	1.0862[19]	1.566	1.651[19]	1.45	
313.15	1.0783		1.490		1.38	
318.15	1.0731		1.469		1.37	
323.15	1.0693		1.285		1.20	

Table 3. Experimental Densities (ρ) of PEG 400 (1) + DMSO (2) and PEG 600 (1) + H_2O (2)

	$\rho/(\mathrm{g\cdot cm^{-3}})$					
x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15	T/K = 313.15	T/K = 318.15	T/K = 323.15
			PEG 400 + DMSO			
0.0000	1.0957	1.0900	1.0840	1.0783	1.0731	1.0693
0.0102	1.0979	1.0925	1.0867	1.0813	1.0763	1.0725
0.0213	1.0999	1.0947	1.0889	1.0833	1.0782	1.0748
0.0333	1.1019	1.0967	1.0911	1.0857	1.0806	1.0769
0.0466	1.1033	1.0981	1.0927	1.0874	1.0824	1.0788
0.0611	1.1050	1.1000	1.0949	1.0895	1.0845	1.0807
0.0773	1.1067	1.1018	1.0966	1.0912	1.0866	1.0830
0.0952	1.1086	1.1038	1.0985	1.0931	1.0884	1.0848
0.1152	1.1099	1.1052	1.1001	1.0947	1.0900	1.0867
0.1378	1.1117	1.1071	1.1015	1.0966	1.0916	1.0884
0.1633	1.1131	1.1085	1.1035	1.0982	1.0936	1.0900
0.1927	1.1145	1.1099	1.1047	1.0997	1.0950	1.0916
0.2266	1.1157	1.1114	1.1063	1.1010	1.0967	1.0932
0.2662	1.1171	1.1126	1.1076	1.1024	1.0980	1.0945
0.3130	1.1184	1.1140	1.1088	1.1038	1.0993	1.0960
0.3691	1.1194	1.1150	1.1100	1.1049	1.1006	1.0972
0.4382	1.1204	1.1161	1.1110	1.1059	1.1018	1.0984
0.5253	1.1211	1.1169	1.1120	1.1070	1.1028	1.0995
0.6370	1.1218	1.1177	1.1128	1.1077	1.1037	1.1004
0.7870	1.1222	1.1181	1.1133	1.1083	1.1042	1.1010
1.0000	1.1226	1.1185	1.1139	1.1088	1.1048	1.1015

			PEG 600 + H_2O				
x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15	x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15
0.0000	0.9970	0.9957	0.9940	0.3001	1.1225	1.1187	1.1139
0.0075	1.0309	1.0287	1.0259	0.3994	1.1226	1.1189	1.1140
0.0196	1.0662	1.0629	1.0598	0.4983	1.1228	1.1190	1.1141
0.0431	1.0995	1.0951	1.0906	0.6977	1.1230	1.1192	1.1144
0.1001	1.1156	1.1120	1.1070	0.8849	1.1232	1.1194	1.1145
0.1998	1.1217	1.1179	1.1133	1.0000	1.1233	1.1195	1.1147

303.15, 308.15, 313.15, 318.15, and 323.15) K. Each experimental density value was an average from at least three measurements. The relative uncertainty of the density measurement was estimated to be less than ± 0.02 %.

An Ubbelohde glass viscometer carefully adjusted to the desired temperature (± 0.01 K) was used for measuring the kinematic viscosity of pure liquids and the mixtures. The kinematic viscosity measurement was performed in a transparent glass-walled water bath with the thermal stability of 0.01 K. While conducting experiments, care was taken to avoid the introduction of any air bubbles or particulate matter into the apparatus. The apparatus was filled exactly to the same level in all of the experiments to meet the requirements of constant pressure and volumetric flow as far as possible.[17] The duration for the liquid to flow between two fixed marks was recorded by a digital stopwatch, the precision of which is controlled at ± 0.01 s.

First, experiments were conducted at each temperature using water and ethanol. The data obtained from water and ethanol as well as from pure liquids and mixtures were used to calculate the kinematic viscosity of the samples by

$$\nu = At - \frac{B}{t} \tag{1}$$

where ν is the kinematic viscosity, t is its flow time in the viscometer, and A and B are viscometer constants, respectively. A and B are determined from the known viscosity and measured flow time using high pure water and high-performance liquid chromatography (HPLC) grade ethanol as calibration liquids.[7] The calculated A and B values are listed in Table 1. The absolute viscosity (η) was obtained from the relation $\eta = \rho\nu$, where ρ is the measured density and ν the determined kinematic viscosity. The relative uncertainty in the dynamic viscosity determination was estimated to be less than ± 0.9 %. Each measurement was repeated five times.

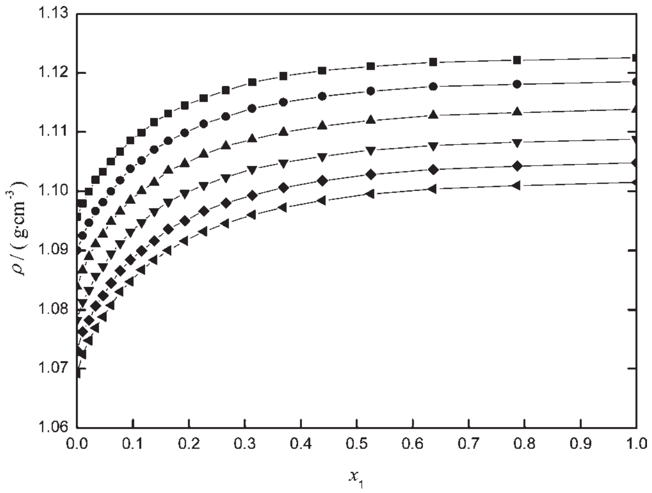

Figure 1. Experimental densities as a function of mole fraction and temperature for PEG 400 (1) + DMSO (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K; ▼, 313.15 K; ♦, 318.15 K; left-pointing triangle, 323.15 K.

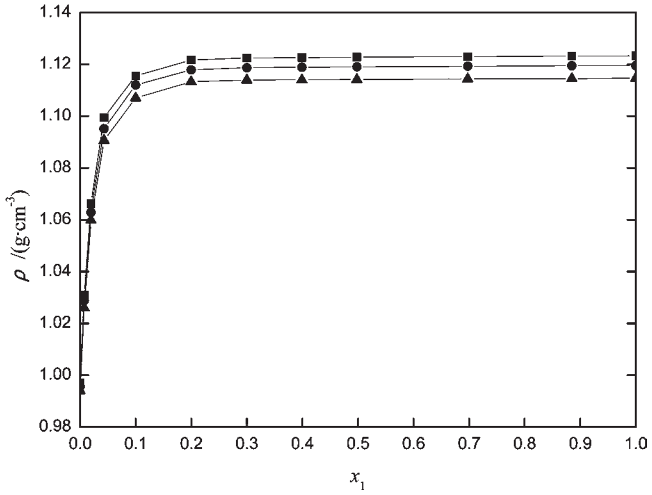

Figure 2. Experimental densities as a function of mole fraction and temperature for PEG 600 (1) + H_2O (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K.

Density, viscosity, and kinematic viscosity values of pure components at different temperatures given in Table 2 are compared with literature values.

■ RESULTS AND DISCUSSION

The experimental densities of PEG 600 which were measured at 303.15 K and 308.15 K to be 1.1186 g·cm^{-3} and 1.1145 g·cm^{-3}, respectively, were in good agreement with the literature values cited in Table 2. Experimental densities of binary solutions of PEG 400 + DMSO and PEG 600 + H_2O at different temperatures over the whole concentration range are summarized in Table 3. The data of densities at different temperatures are also plotted as curves and shown in Figures 1 and 2.

It can be seen from the figures that the density values increase with the molar fraction of PEG in binary solutions over the whole concentration range, but the values increase more quickly between x_1 = 0.0 and x_1 = 0.2. On the other hand, the density decreases when temperature rises under the condition of constant composition.

Table 4. Excess Molar Volumes (V_m^E) of PEG 400 (1) + DMSO (2) and PEG 600 (1) + H_2O (2)

	$V_m^E/(cm^3\cdot mol^{-1})$					
x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15	T/K = 313.15	T/K = 318.15	T/K = 323.15
			PEG 400 + DMSO			
0.0000	0.000	0.000	0.000	0.000	0.000	0.000
0.0102	−0.066	−0.075	−0.089	−0.110	−0.117	−0.115
0.0213	−0.115	−0.133	−0.149	−0.150	−0.148	−0.175
0.0333	−0.168	−0.183	−0.205	−0.226	−0.222	−0.226
0.0466	−0.179	−0.194	−0.229	−0.246	−0.247	−0.260
0.0611	−0.219	−0.242	−0.295	−0.308	−0.308	−0.300
0.0773	−0.262	−0.291	−0.330	−0.340	−0.364	−0.378
0.0952	−0.329	−0.354	−0.386	−0.396	−0.413	−0.411
0.1152	−0.343	−0.375	−0.418	−0.426	−0.431	−0.470
0.1378	−0.408	−0.441	−0.434	−0.488	−0.461	−0.506
0.1633	−0.444	−0.474	−0.515	−0.529	−0.537	−0.534
0.1927	−0.478	−0.499	−0.517	−0.560	−0.554	−0.571
0.2266	−0.498	−0.547	−0.566	−0.582	−0.605	−0.609
0.2662	−0.536	−0.561	−0.594	−0.605	−0.616	−0.622
0.3130	−0.581	−0.601	−0.596	−0.631	−0.631	−0.651
0.3691	−0.586	−0.603	−0.602	−0.626	−0.638	−0.651
0.4382	−0.585	−0.594	−0.584	−0.603	−0.629	−0.640
0.5253	−0.525	−0.546	−0.547	−0.580	−0.595	−0.610
0.6370	−0.451	−0.472	−0.462	−0.475	−0.499	−0.516
0.7870	−0.255	−0.272	−0.267	−0.286	−0.297	−0.307
1.0000	0.000	0.000	0.000	0.000	0.000	0.000

			PEG 600 + H_2O				
x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15	x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15
0.0000	0.000	0.000	0.000	0.3001	−1.269	−1.274	−1.259
0.0075	−0.230	−0.223	−0.210	0.3994	−1.047	−1.072	−1.046
0.0196	−0.585	−0.562	−0.555	0.4983	−0.907	−1.874	−0.852
0.0431	−1.107	−1.056	−1.024	0.6977	−0.490	−0.503	−0.497
0.1001	−1.349	−1.340	−1.291	0.8849	−0.149	−0.183	−0.161
0.1998	−1.436	−1.422	−1.412	1.0000	0.000	0.000	0.000

The excess molar volume, V_m^E, was calculated from density data according to the following equation,

$$V_m^E = \frac{x_1M_1 + x_2M_2}{\rho_m} - \left(x_1\frac{M_1}{\rho_1} + x_2\frac{M_2}{\rho_2}\right) \qquad (2)$$

where ρ_m is the density of the mixture and x_1, ρ_1, M_1, x_2, ρ_2, and M_2 are the mole fraction, densities, and molecular masses of pure PEG and DMSO or H_2O, respectively. The values of V_m^E are listed in Table 4, and the dependence of V_m^E on temperatures is shown in Figures 3 and 4.

The V_m^E experimental values, as shown in Figures 3 and 4, are negative over the whole composition range for all mixtures at each temperature. The V_m^E values of the PEG 400 + DMSO system become less negative with lowering temperatures, and the minimum was reached at about x_1 = 0.35. Otherwise, the V_m^E

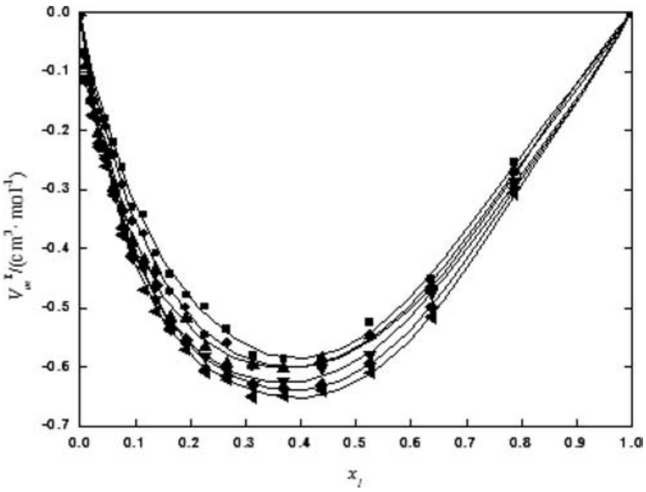

Figure 3. Excess molar volumes as a function of mole fraction and temperature for PEG 400 (1) + DMSO (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K; ▼, 313.15 K; ♦, 318.15 K; left-pointing triangle, 323.15 K.

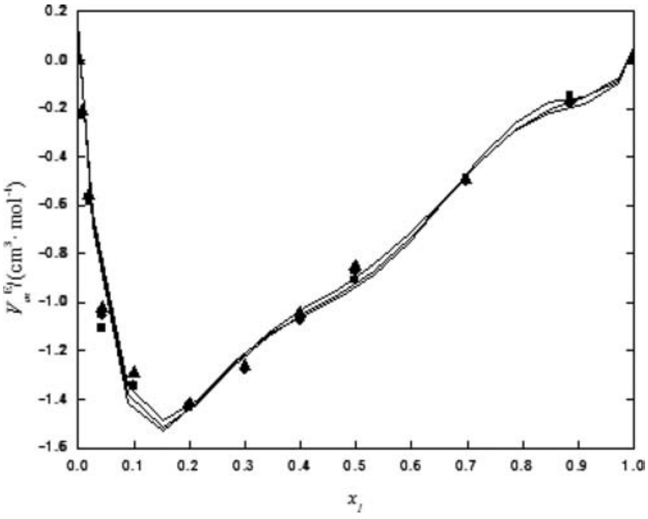

Figure 4. Excess molar volumes as a function of mole fraction for PEG 600 (1) + H_2O (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K.

values of the PEG 600 + water system become more negative with lowering temperatures, and the minimum was reached at about $x_1 = 0.20$.

A Redlich–Kister relation as follows was used to correlate the excess volume data,

$$V_m^E/cm^3 \cdot mol^{-1} = x_1 x_2 \sum_{i=0}^{n} A_i (2x_1 - 1)^i \qquad (3)$$

where x_1 and x_2 are the mole fractions of PEG and DMSO or H_2O, respectively, A_i is polynomial coefficient, and n is the polynomial degree.

The standard deviation values, σ, among the calculated and experimental data points are obtained by the following equation

$$\sigma_{V_m^E} = [\sum (V_{calc}^E - V_m^E)^2/(N - m)]^{1/2} \qquad (4)$$

where N is the total number of experimental points and m is the number of A_i coefficients considered. The coefficients

Table 5. Coefficients and Standard Deviations of Excess Molar Volumes (V_m^E) for PEG 400 (1) + DMSO (2) and PEG 600 (1) + H_2O (2)

T/K	A_0	A_1	A_2	A_3	A_4	$\sigma/(cm^3 \cdot mol^{-1})$
			PEG 400 + DMSO			
298.15	−2.182	1.056	0.280	0.431	−0.921	0.014
303.15	−2.230	0.961	−0.129	0.911	−0.429	0.014
308.15	−2.205	1.023	−0.020	1.048	−1.247	0.015
313.15	−2.280	1.060	−0.081	0.997	−1.351	0.015
318.15	−2.367	0.999	0.133	1.068	−1.609	0.017
323.15	−2.422	0.931	0.093	1.330	−1.610	0.015
			PEG 600 + H_2O			
298.15	3.619	2.779	0.987	9.388	−13.868	0.094
303.15	−3.563	2.957	0.059	8.412	−12.605	0.085
308.15	−3.448	2.933	−0.701	8.313	−10.812	0.087

Table 6. Experimental Viscosities (η) of PEG 400 (1) + DMSO (2) and PEG 600 (1) + H_2O (2)

	η/(mPa·s)					
x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15	T/K = 313.15	T/K = 318.15	T/K = 323.15
			PEG 400 + DMSO			
0.0000	1.964	1.787	1.566	1.490	1.469	1.285
0.0102	2.427	2.191	1.875	1.829	1.788	1.523
0.0213	2.907	2.610	2.199	2.151	2.099	1.791
0.0333	3.495	3.126	2.584	2.543	2.481	2.092
0.0466	4.253	3.772	3.086	3.019	2.950	2.469
0.0611	5.114	4.502	3.646	3.571	3.466	2.898
0.0773	6.273	5.481	4.383	4.291	4.135	3.422
0.0952	7.567	6.561	5.245	5.065	4.894	3.965
0.1152	9.297	7.961	6.254	6.088	5.816	4.743
0.1378	11.34	9.630	7.502	7.231	6.899	5.585
0.1633	13.82	11.67	9.018	8.640	8.158	6.590
0.1927	16.88	14.15	10.83	10.30	9.661	7.757
0.2266	20.69	17.13	13.00	12.24	11.44	9.157
0.2662	25.09	20.70	15.58	14.60	13.49	10.69
0.3130	31.29	25.56	19.02	17.68	16.31	12.61
0.3691	37.65	30.39	22.51	20.73	18.96	14.84
0.4382	45.75	36.63	26.86	24.58	22.35	17.39
0.5253	55.43	43.94	31.86	28.96	26.19	20.19
0.6370	65.93	51.97	37.39	33.91	30.49	23.34
0.7870	78.29	61.51	43.78	39.71	35.42	26.99
1.0000	89.73	69.88	49.54	44.77	39.90	29.82

			PEG 600 + H_2O				
x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15	x_1	T/K = 298.15	T/K = 303.15	T/K = 308.15
0.0000	0.895	0.800	0.549	0.3001	125.8	96.67	68.26
0.0075	2.421	2.136	1.782	0.3994	132.0	101.1	71.82
0.0196	7.572	6.414	5.009	0.4983	133.4	103.5	73.33
0.0431	26.11	20.98	15.47	0.6977	135.5	105.6	75.35
0.1001	74.73	57.31	40.56	0.8849	135.7	105.7	75.50
0.1998	112.5	86.00	60.78	1.0000	135.8	106.2	75.97

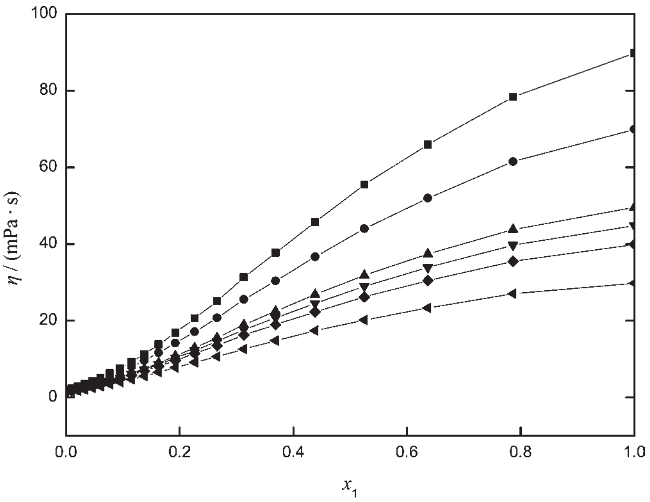

Figure 5. Experimental viscosity (η) of of PEG 400 (1) + DMSO (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K; ▼, 313.15 K; ♦, 318.15 K; left-pointing triangle, 323.15 K.

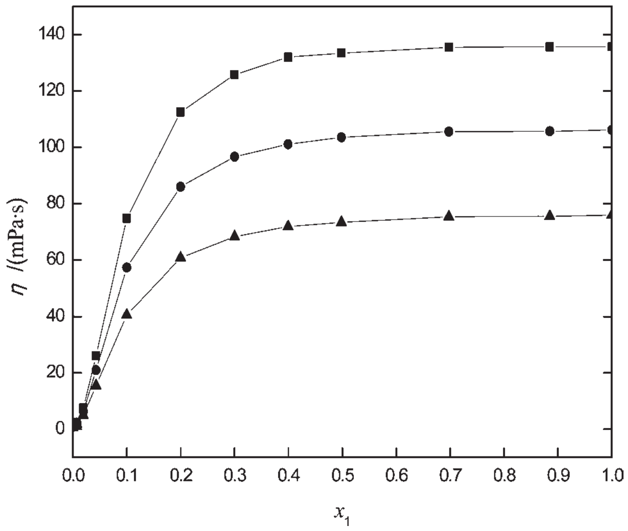

Figure 6. Experimental viscosity (η) of of PEG 600 (1) + H_2O (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K.

A_i and corresponding standard deviations, σ, are listed in Table 5.

Experimental viscosity values of the binary mixtures of PEG 400 + DMSO and PEG 600 + H_2O at varied temperatures are listed in Table 6 and shown in Figures 5 and 6. From these results, it can be seen that the viscosity of the solutions changes with the molar fraction of PEG. They increase with the concentration of PEG and decrease with temperature. Also, the viscosity of PEG 600 + H_2O system increases rapidly in the composition range between $x_1 = 0.0$ and $x_1 = 0.2$.

The experimental viscosity values of the two binary mixtures were used to calculate the viscosity deviation defined by

$$\Delta\eta = \eta - (x_1\eta_1 + x_2\eta_2) \tag{5}$$

where η is the viscosity of the mixture, η_1 and η_2 are viscosities of pure PEG and DMSO or H_2O, respectively, and x_1 and x_2 are the

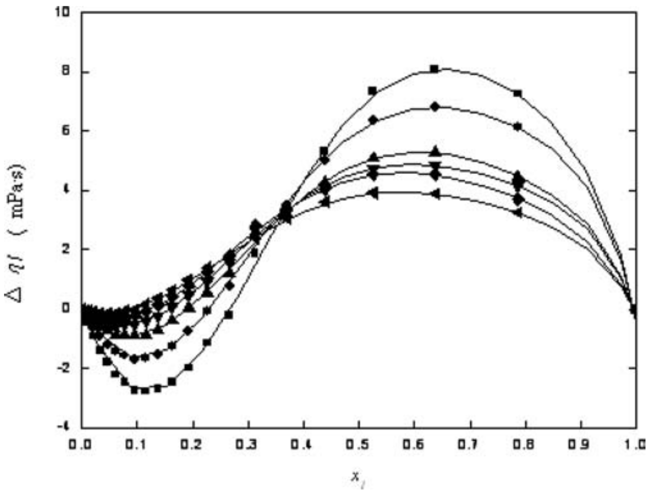

Figure 7. Viscosity deviations as a function of mole fraction and temperature for PEG 400 (1) + DMSO (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K; ▼, 313.15 K; ♦, 318.15 K; left-pointing triangle, 323.15 K.

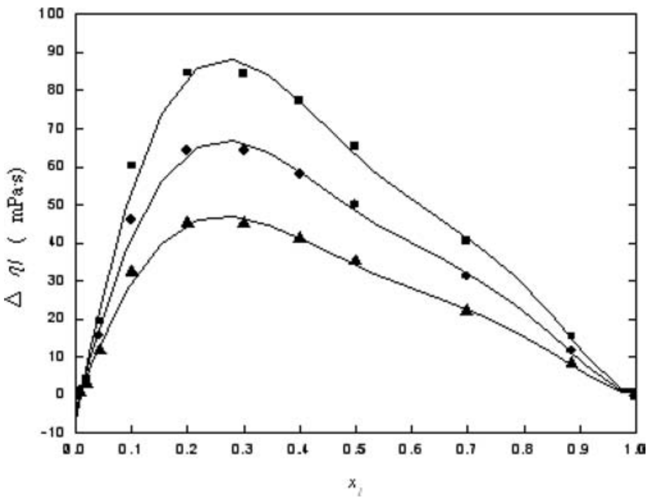

Figure 8. Viscosity deviations as a function of mole fraction and temperature for PEG 600 (1) + H_2O (2); ■, 298.15 K; ●, 303.15 K; ▲, 308.15 K.

mole fractions of the pure components. The results of the viscosity deviations, $\Delta\eta$, are plotted in Figures 7 and 8.

Figure 7 shows the dependence of $\Delta\eta$ on composition and temperature. It can be seen from each viscosity deviation curve of the PEG 400 + DMSO that the value of $\Delta\eta$ is not always negative but shows a positive maximum and negative minimum at around $x_1 = 0.65$ and $x_1 = 0.15$, respectively. The curves became more and more flat, and the absolute values decrease with elevated temperatures. However, the viscosity deviations of the other system, PEG 600 + H_2O as shown in Figure 8, are all positive, and the maximum appears at $x_1 = 0.20$.

The viscosity deviations, $\Delta\eta$, were also represented by the Redlich–Kister equation as follows

$$\Delta\eta/\text{mPa}\cdot\text{s} = x_1x_2\sum_{i=0}^{n} B_i(2x_1 - 1)^i \tag{6}$$

Table 7. Coefficients and Standard Deviations of Viscosity Deviations ($\Delta\eta$) for PEG 400 (1) + DMSO (2) and PEG 600 (1) + H_2O (2)

T/K	B_0	B_1	B_2	B_3	B_4	σ/(mPa·s)
			PEG 400 + DMSO			
298.15	27.21	36.71	−39.55	27.12	25.97	0.12
303.15	24.08	24.71	−27.86	27.49	20.75	0.01
308.15	19.64	15.01	−20.25	19.37	12.49	0.06
313.15	18.41	11.27	−14.70	19.36	9.86	0.06
318.15	17.75	8.73	−12.66	14.98	6.25	0.07
323.15	15.41	6.33	−8.26	13.05	5.32	0.03
			PEG 600 + H_2O			
298.15	264.68	−275.08	400.23	−74.53	−290.36	4.86
303.15	202.34	−201.17	294.08	−74.22	−205.48	3.47
308.15	142.31	−138.82	201.51	−57.77	−133.18	2.23

The coefficients B_i and the standard deviation σ are presented in Table 7.

■ CONCLUSION

In this work, we reported the experimental data for density and viscosity of the two binary mixture solutions, PEG 400 + DMSO and PEG 600 + H_2O, over a temperature range from (298.15 to 323.15) K. By measuring density and viscosity, the values of excess molar volume and viscosity deviations were obtained. In the whole composition range and at all work temperatures, excess molar volume was illustrated to be negative values. But viscosity deviation values were not always negative. This simple fluid system can be used to understand the mechanism of acidic gas absorption process and can be used to analyze the effective factors of absorption and desorption processes.

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