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VOLUMETRIC PROPERTIES AND VISCOSITY OF DIETHYL SULFOXIDE IN ACETONITRILE AT DIFFERENT TEMPERATURES

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Densities and viscosities of diethyl sulfoxide–acetonitrile binary mixtures have been measured over the full range of compositions at temperatures from 298.15 to 323.15 *K*. Excess molar volumes, apparent molar volumes, partial molar volumes, excess partial molar volumes, partial molar volumes at infinite dilution and thermal expansion coefficients for binary liquid mixtures were calculated. The excess molar volumes are negative over the whole range of composition and become more negative with increasing temperatures from 298.15 to 323.15 *K*. Viscosity deviations and excess Gibbs energy of viscous flow activation were calculated. The viscosity deviations are negative, but contrary to the excess molar volumes deviations in viscosity become less negative with increasing temperatures. The excess molar volumes and viscosity deviations were correlated by Redlich–Kister equation. Results are discussed in terms of molecular interactions and molecular size and shape in these binary mixtures. The obtained results were interpreted on the basis of dipole-dipole interaction between polar groups of diethyl sulfoxide and acetonitrile.

Keywords: DMSO, volumetric properties, viscosity, intermolecular interactions.

Introduction. In our earlier works it was shown that diethyl sulfoxide (DESO) like dimethyl sulfoxide (DMSO) has unique physicochemical properties and could find biomedical applications [1–3]. Particularly, DESO compared with DMSO is more effective for preservation of membrane potential after freezing-thawing. Besides that, DESO exhibits more pronounced effect on the anaerobic growth, survival and ionic exchange of *E. coli* than DMSO [1]. DESO–water mixtures form an amorphous, glassy state and exhibit cryoprotective abilities [2]. The relaxation times show the typical signatures of glassy dynamics [4]. Also, molecular dynamic simulations and density functional theory based on electronic-structure calculations of DESO–water mixtures conform with the peculiarities of this system [5].

Several important physicochemical characteristics of DESO including aqueous solutions have been verified and first reported: melting point of pure substance, density, dielectric relaxation data, vapor pressure, surface tension, volumetric properties and some results were presented in Landolt–Bornstein handbook (2008).

This work reports densities and viscosities for binary mixtures of DESO with acetonitrile (ACN) from 298.15 to 323.15 *K* over the entire composition range. A Redlich–Kister type equation correlates excess molar volume and viscosity deviations. The apparent molar volumes and partial molar volumes, their limiting values at

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infinite dilution and thermal expansion coefficients have been calculated as a function of composition. It should be noted that although thermodynamic studies of binary mixtures of ACN with DMSO have been done by several authors [6–10], but to our knowledge there are no literature data for density and viscosity for the investigated DESO–ACN binary system.

The results obtained confirm that a deviation from ideality like that DMSO–ACN solutions, but to greater extent arises from competitive intermolecular interactions occurring in DESO–ACN system.

Materials and Methods. DESO was prepared and purified according to procedure in [11]. Its purity tested by gas chromatography was greater than 99.5 mass %; the water content, after drying on molecular sieves, was lower than 0.01 mass %. Acetonitrile (>99% purity) and DMSO (99.9% purity) were purchased from "Aldrich Chemical Co" and were used without further purification.

The densities of solutions were measured on Anton Paar DMA 4500 vibrating-tube densimeter at the temperature range 298.15–318.15 *K*. The accuracy of the density and temperature measurements were $\pm 1 \cdot 10^{-5}$ g/cm^3 and ±0.01 *K* respectively. The densimeter was calibrated with dry air and doubly-distilled water.

For viscosity measurements was used the Ubbelohde suspended level viscometer, thermostated in water bath with a glass contact thermometer, with a temperature precision of ±0.05 *K*. The viscometer calibrated with doubly-distilled water using literature data: viscometer constants are obtained by measuring the flow times of water at temperatures from 298.15 to 323.15 *K*, at which the values of density and viscosity are known [12]. The flow time of pure liquids and liquid mixtures are repeated for five times. A stop watch reading up to ± 0.1 *s* was used to record the time of flow. The viscosity of pure liquids and binary liquid mixtures was calculated by

$$\eta/\eta_w = \rho \cdot t/\rho_w \cdot t_w, \quad (1)$$

where ρ, ρ_w and t, t_w are the density and flow times of the experimental liquids and water respectively.

All solutions were prepared gravimetrically using a Sartorius CPA6235 balance with uncertainty of $\pm 1 \cdot 10^{-3}$ *g*.

Results and Discussion. The experimental values of densities excess molar volumes, viscosities and viscosity deviations for the binary mixtures DESO(1)–ACN(2) at temperatures from 298.15 to 323.15 *K* are given in Tab. 1.

Table 1

Experimental densities (ρ, kg/m³), excess volumes ($10^6 \cdot V^E$, m³/mol), viscosities (η, mPa·s) and viscosity deviations (η^E, mPa·s) for binary mixtures of DESO(1)–ACN(2) at temperatures from 298.15 to 323.15 K

x_1	ρ	V^E	η	η^E	ρ	V^E	η	η^E
	T=298.15 *K*				T=303.15 *K*			
0.0000	776.62	0.000	0.346	0.000	771.18	0.000	0.332	0.000
0.1009	821.67	–0.133	0.462	–0.068	816.34	–0.135	0.443	–0.055
0.1993	858.08	–0.226	0.557	–0.153	852.93	–0.234	0.538	–0.123
0.3146	893.23	–0.276	0.701	–0.220	888.33	–0.293	0.671	–0.179
0.3994	915.47	–0.314	0.827	–0.250	910.58	–0.325	0.779	–0.211
0.4937	935.94	–0.345	0.991	–0.258	931.13	–0.353	0.926	–0.220
0.5908	956.21	–0.325	1.171	–0.256	951.53	–0.334	1.081	–0.224
0.6982	974.71	–0.296	1.398	–0.225	970.10	–0.301	1.284	–0.198
0.7968	989.61	–0.257	1.640	–0.164	985.08	–0.259	1.501	–0.144
0.9003	1003.36	–0.193	1.892	–0.101	999.00	–0.202	1.722	–0.094
1.0000	1013.98	0.000	2.176	0.000	1009.64	0.000	1.980	0.000

	T=308.15 *K*				*T*=313.15 *K*			
0.0000	765.72	0.000	0.313	0.000	760.23	0.000	0.305	0.000
0.1009	811.05	–0.142	0.417	–0.046	805.73	–0.149	0.409	–0.033
0.1993	847.80	–0.246	0.505	–0.105	842.64	–0.257	0.475	–0.100
0.3146	883.35	–0.306	0.635	–0.146	878.35	–0.320	0.595	–0.137
0.3994	905.70	–0.338	0.736	–0.172	900.81	–0.352	0.694	–0.153
0.4937	926.35	–0.366	0.851	–0.197	921.55	–0.378	0.815	–0.160
0.5908	946.85	–0.346	0.998	–0.194	942.16	–0.358	0.939	–0.168
0.6982	965.51	–0.310	1.173	–0.179	960.91	–0.319	1.096	–0.157
0.7968	980.57	–0.266	1.368	–0.131	976.05	–0.272	1.260	–0.126
0.9003	994.57	–0.206	1.560	–0.093	990.14	–0.210	1.440	–0.087
1.0000	1005.28	0.000	1.801	0.000	1000.92	0.000	1.663	0.000
	T=318.15 *K*				*T*=323.15 *K*			
0.0000	754.71	0.000	0.296	0.000	749.15	0.000	0.258	0.000
0.1009	800.38	–0.156	0.396	–0.025	795.00	–0.163	0.343	–0.018
0.1993	837.46	–0.270	0.451	–0.090	832.24	–0.282	0.392	–0.068
0.3146	873.33	–0.335	0.570	–0.112	868.28	–0.349	0.489	–0.088
0.3994	895.90	–0.368	0.658	–0.127	890.97	–0.384	0.558	–0.105
0.4937	916.74	–0.393	0.768	–0.134	913.11	–0.408	0.656	–0.103
0.5908	937.45	–0.371	0.879	–0.141	932.73	–0.385	0.746	–0.112
0.6982	956.30	–0.330	1.030	–0.122	951.68	–0.341	0.876	–0.091
0.7968	971.52	–0.280	1.176	–0.097	966.98	–0.288	0.990	–0.077
0.9003	985.69	–0.215	1.330	–0.069	981.23	–0.219	1.117	–0.054
1.0000	996.54	0.000	1.522	0.000	992.16	0.000	1.272	0.000

Densities and Excess Molar Volumes. Excess molar volumes (V^E) of the mixtures were calculated from experimental densities at each temperature using the following equation:

$$V^E=(x_1M_1+ x_2M_2)/\rho-(x_1M_1/\rho_1+ x_2M_2/\rho_2), \quad (2)$$

where M_1 and M_2 represent the molar masses of DESO and ACN respectively; x_1 and x_2 are molar fractions of DESO and ACN having densities ρ_1 and ρ_2 respectively.

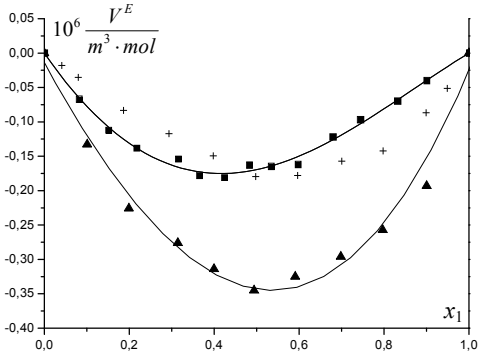
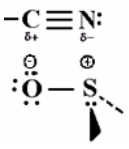


Fig. 1. Excess molar volumes, V^E, at 298.15 *K*.
▲ DESO(1)–ACN(2);
■ DMSO(1)–ACN(2) (current work);
\+ DMSO(1)–ACN(2) [6].

As it follows from these data, the excess molar volumes are negative over the whole range of composition and temperature for mentioned binary mixtures and increase with increasing temperatures from 298.15 to 323.15 *K*, implying that the intermolecular forces between different molecules becomes more strong (Tab. 1). It should be noted that according to [6, 7] excess molar volumes for DMSO–ACN binary mixtures are negative and become more negative with increasing temperature [7]. These results are in agreement with those we have obtained for DESO–ACN and DMSO–ACN mixtures. Earlier on the basis of FT IR and Raman spectroscopic measurements of DESO solutions in ACN [13] was shown that the formation of intermolecular associate as the antiparallel dipolar conformation takes place as it was discussed for DMSO–ACN interaction [14] (see Scheme).



Scheme.

In the polar solvent ACN the frequencies of vibration of S=O polar group of DESO shifts in IR spectra [13] and dilution in ACN leads to displacement of 1068 cm^{-1} band to 1061 cm^{-1} and simultaneously an increase of intensity in IR spectra. This shift was attributed to the formation of intermolecular associates as it also was discussed for DMSO–ACN interaction [14]. However, it should be noted that the small value of the shift in the infrared spectrum of DMSO solutions [14] indicates that these interactions are weak.

For comparison, the corresponding literature data for DMSO–ACN are depicted in Fig. 1 as well, obviously the comparison with DMSO–ACN binary system deviation from ideality is more pronounced for DESO–ACN. One consider a role of electron donor power of ethyl groups in DESO and hence S=O bond becomes more polar.

Apparent and Partial Molar Volumes. In a binary liquid mixture, the apparent molar volumes $V_{\phi,1}$ and $V_{\phi,2}$ of components 1 (DESO) and 2 (ACN) are calculated by the following equations [15, 16]:

$$V_{\phi,1} = V_1^* + V_m^E / x_1 \quad \text{and} \quad V_{\phi,2} = V_2^* + V_m^E / x_2, \tag{3}$$

where V_1^* and V_2^* are the molar volumes of pure DESO and ACN respectively. The data for (DESO–ACN) mixtures at temperature from 298.15 to 323.15 K are presented in Tab. 2. As it follows from presented data with the increase of both mole fractions, the apparent molar volumes increase, but the temperature increasing leads to the decreasing apparent molar volumes. The same behavior is observed for partial molar volumes as well.

Table 2

Apparent molar volumes ($10^6 \cdot V_{\phi,i}$, m^3/mol), partial molar volumes ($10^6 \cdot \bar{V}_i$, m^3/mol) and excess partial molar volumes ($10^6 \cdot \bar{V}_i^E$, m^3/mol) for DESO and ACN in DESO(1)–ACN(2) binary solutions at temperatures from 298.15 to 323.15 K

x_1	$V_{\phi,1}$	$V_{\phi,2}$	$\bar{V}_1$	$\bar{V}_2$	$\bar{V}_1^E$	$\bar{V}_2^E$
T=298.15 K						
0.1009	106.349	31.733	106.656	33.062	1.008	–1.182
0.1993	106.530	31.598	107.041	33.655	0.623	–1.775
0.3146	106.787	31.477	107.470	33.848	0.194	–1.968
0.3994	106.877	31.357	107.661	33.690	0.003	–1.809
0.4937	106.966	31.199	107.841	33.308	–0.176	–1.427
0.5908	107.115	31.087	108.052	32.838	–0.387	–0.958
0.6982	107.240	30.898	108.177	32.180	–0.512	–0.300
0.7968	107.342	30.616	108.171	31.452	–0.506	0.428
0.9003	107.450	29.944	107.986	30.335	–0.322	1.545
T=303.15 K						
0.1009	105.866	31.507	106.188	32.865	1.016	–1.208
0.1993	106.029	31.365	106.563	33.468	0.640	–1.811
0.3146	106.271	31.229	106.983	33.656	0.220	–1.999
0.3994	106.390	31.116	107.204	33.507	–0.001	–1.850
0.4937	106.489	30.960	107.393	33.125	–0.190	–1.468
0.5908	106.638	30.841	107.603	32.642	–0.399	–0.986
0.6982	106.772	30.659	107.733	31.982	–0.530	–0.325
0.7968	106.878	30.380	107.726	31.247	–0.522	0.410
0.9003	106.979	29.632	107.527	30.039	–0.324	1.618

			T=308.15 *K*			
0.1009	105.336	31.275	105.674	32.672	1.066	–1.239
0.1993	105.508	31.126	106.070	33.290	0.671	–1.857
0.3146	105.767	30.986	106.512	33.487	0.228	–2.054
0.3994	105.894	30.870	106.744	33.336	–0.003	–1.904
0.4937	106.000	30.711	106.941	32.947	–0.200	–1.515
0.5908	106.155	30.588	107.155	32.454	–0.414	–1.021
0.6982	106.296	30.405	107.289	31.779	–0.548	–0.346
0.7968	106.407	30.124	107.280	31.027	–0.540	0.406
0.9003	106.512	29.368	107.075	29.794	–0.334	1.639
			T=313.15 *K*			
0.1009	104.805	31.042	105.159	32.465	1.119	–1.257
0.1993	104.988	30.886	105.573	33.092	0.704	–1.884
0.3146	105.261	30.741	106.036	33.293	0.242	–2.085
0.3994	105.395	30.621	106.276	33.141	0.002	–1.933
0.4937	105.511	30.460	106.483	32.750	–0.205	–1.542
0.5908	105.672	30.333	106.700	32.247	–0.422	–1.040
0.6982	105.820	30.149	106.837	31.564	–0.559	–0.356
0.7968	105.936	29.867	106.828	30.801	–0.550	0.407
0.9003	106.044	29.099	106.618	29.542	–0.340	1.666
			T=318.15 *K*			
0.1009	104.270	30.808	104.640	32.260	1.173	–1.279
0.1993	104.460	30.644	105.071	32.898	0.741	–1.917
0.3146	104.749	30.493	105.556	33.104	0.256	–2.124
0.3994	104.892	30.368	105.806	32.951	0.007	–1.970
0.4937	105.017	30.205	106.022	32.555	–0.209	–1.574
0.5908	105.185	30.075	106.245	32.043	–0.432	–1.063
0.6982	105.340	29.887	106.385	31.347	–0.572	–0.366
0.7968	105.461	29.602	106.375	30.569	–0.563	0.412
0.9003	105.574	28.826	106.161	29.286	–0.348	1.694
			T=323.15 *K*			
0.1009	103.728	30.571	104.109	32.030	1.239	–1.277
0.1993	103.933	30.401	104.562	32.667	0.786	–1.915
0.3146	104.237	30.243	105.066	32.873	0.282	–2.120
0.3994	104.386	30.113	105.323	32.717	0.025	–1.964
0.4937	104.522	29.948	105.549	32.321	–0.201	–1.569
0.5908	104.697	29.813	105.775	31.806	–0.428	–1.053
0.6982	104.859	29.622	105.919	31.104	–0.571	–0.352
0.7968	104.986	29.337	105.911	30.321	–0.564	0.431
0.9003	105.104	28.557	105.696	29.028	–0.349	1.724

The partial molar volumes $(\bar{V}_i)$ can be determined by excess molar volumes data using the following equation:

$$\bar{V}_i = V_i^* + V^E / x_i + x_i(1-x_i)(\partial(V^E / x_i)/\partial x_i)_{T,P}, \quad (4)$$

where $(\partial(V^E/x_i)/\partial x_i)_{T,P}$ is calculated using Redlich–Kister polynomial equation (vide infra) and V_i^* represent the molar volumes of the component 1 or 2.

Partial molar volumes at infinite dilution (V_i^∞) are considered to be of particular interest, because of their usefulness in examining solute-solvent interactions, as solute-solute interactions can be assumed to be eliminated at infinite dilution. The limiting partial molar volumes (V_i^∞) were estimated by extrapolating the apparent molar volumes to infinite dilution. The limiting partial molar volumes of DESO and ACN in DESO–ACN mixtures at temperatures from 298.15 to 323.15 *K*

are given in Tab. 3. As seen from data the infinite dilution values decrease with increasing temperature. Noteworthy is the item that at infinite dilution the partial molar volumes and apparent molar volumes of both DESO and ACN are equal and smaller than for the corresponding pure solvents. This also indicates the existence of interaction between these molecules.

Table 3

Limiting partial molar volumes ($10^6 \cdot V_i^{\infty}$, m^3/mol) of DESO and ACN at temperatures from 298.15 to 323.15 K

T, *K*	V^{∞} (DESO)	V^{∞} (ACN)
298.15	106.285	29.937
303.15	105.780	29.630
308.15	105.249	29.360
313.15	104.718	29.085
318.15	104.179	28.805
323.15	103.638	28.528

The excess partial molar volumes ($\overline{V}_i^E$) of a component in a binary DESO–ACN mixture can be determined from the relation (5) and are given in Tab. 2:

$$\overline{V}_i^E = V_i^* - \overline{V}_i. \quad (5)$$

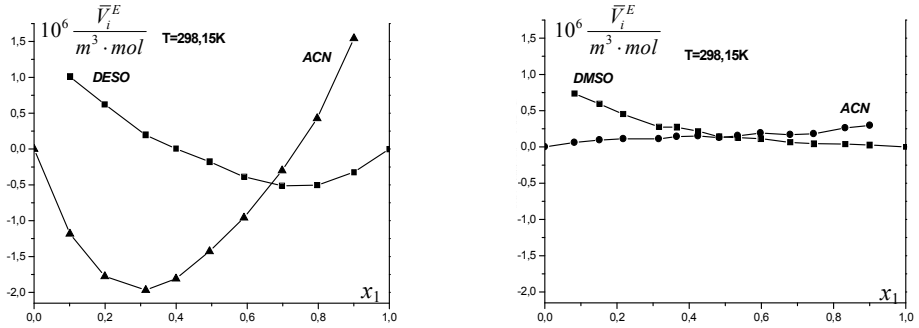


Fig. 2. Excess partial molar volumes, $\overline{V}_i^E$ of DESO and ACN in the DESO(1)–ACN(2) (a) and DMSO(1)–ACN(2) (b) mixtures at *T*=298.15 *K*.

For comparison, the corresponding data for DMSO–ACN at different temperatures calculated by us are presented in Fig. 2 as well. As seen from the data, the excess partial molar volumes of components in DESO–ACN mixtures are less dependent from temperature.

Thermal Expansion Coefficients. A commonly encountered derived value for mixtures is the temperature dependence of density that is expressed by thermal expansion coefficient. The thermal expansion coefficient (α_p) is given by the relation (6) and are presented in Tab. 4:

$$\alpha_p = (1/V)(\delta V/\delta T)_p = -(1/\rho)(\delta\rho/\delta T)_p. \quad (6)$$

As follows from these data, the dependence of the expansion coefficient against mole fraction of DESO reveals a maximum which also proves the existence of the relevant interactions between DESO and ACN.

Table 4

The thermal expansion coefficients ($10^4 \cdot \alpha$, K^{-1}) *of mixtures DESO(1)–ACN(2) at temperatures from 298.15 to 323.15 K*

x_1	298.15	303.15	308.15	313.15	318.15	323.15
0.0000	5.621	5.660	5.701	5.742	5.784	5.652
0.1009	8.300	8.354	8.409	8.464	8.521	8.436
0.1993	9.683	9.742	9.801	9.861	9.922	9.900
0.3146	11.307	11.370	11.434	11.499	11.565	11.638
0.3994	10.701	10.758	10.816	10.875	10.934	10.995
0.4937	10.265	10.318	10.371	10.425	10.480	10.535
0.5908	9.587	9.634	9.682	9.730	9.779	9.820
0.6982	10.362	10.411	10.461	10.511	10.562	10.650
0.7968	9.836	9.881	9.927	9.973	10.019	10.091
0.9003	9.312	9.352	9.394	9.436	9.479	9.538
1.0000	8.609	8.646	8.683	8.721	8.759	8.798

Viscosities and Deviations in Viscosity. The experimental values of viscosities (η) of pure ACN and DESO and those of their binary mixtures such as DESO–ACN at temperatures 298.15–323.15 *K* calculated by Eq. (1) are presented in Tab. 1.

The viscosity deviations (η^E) are obtained by

$$\eta^E = \eta - x_1\eta_1 - x_2\eta_2, \tag{7}$$

where η is the viscosity of mixtures; η_1 and η_2 are the viscosities of DESO and ACN respectively. The x_1 and x_2 are the mole fractions of DESO and ACN having densities ρ_1 and ρ_2 respectively.

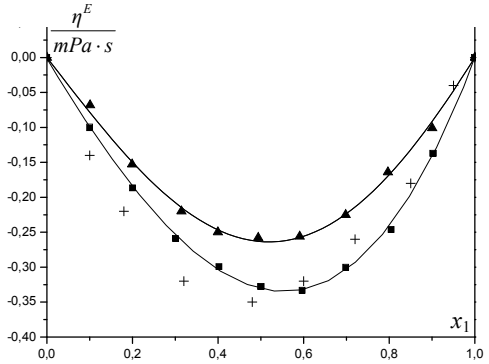


Fig. 3. Viscosity deviations η^E, at 298.15 *K*.
▲ DESO(1)–ACN(2);
■ DMSO(1)–ACN(2) (current work);
\+ DMSO(1)–ACN(2) [10].

The calculated values of viscosity deviations are given in Tab. 1. As it is seen from these results, derivations in viscosity are negative over the entire range of composition and become less negative as temperature is increased. It is interesting to mention, that both excess properties (volume and viscosity) are negative and this type of behavior conforms with the results presented in [17–19], suggesting that the strength of specific or dispersion forces is not the only factor influencing the η^E, but the molecular size and shape of the components are also equally important.

For comparison, the corresponding literature data for DMSO–ACN are depicted in Fig. 3 as well.

On the basis of the theory of absolute reaction rates, the excess Gibbs energies (ΔG^{*E}) of activation of viscous flow were calculated by Eq. (8):

$$\frac{\Delta G^{*E}}{RT} = \left[\ln\left(\frac{\eta V}{\eta_2 V_2^*}\right) - x_1 \ln\left(\frac{\eta_1 V_1^*}{\eta_2 V_2^*}\right) \right], \tag{8}$$

where V, V_1^* and V_2^* are the molar volumes of the binary mixture and pure components. Calculated values of ΔG^{*E} are presented in Tab. 5. The observed values of ΔG^{*E} are positive over the entire range of composition and indicate the specific

interaction leading to complex formation through intermolecular specific or van der Waals interaction between unlike molecules compared with like molecules [20, 21].

Table 5

Excess Gibbs energy of activation of viscous flow (ΔG^{*E}, J/mol) for DESO(1)–ACN(2) binary mixtures at temperatures from 298.15 to 323.15 K

x_1	298.15 *K*	303.15 *K*	308.15 *K*	313.15 *K*	318.15 *K*	323.15 *K*
0.0000	0	0	0	0	0	0
0.1009	318	331	340	377	384	385
0.1993	370	414	425	373	345	366
0.3146	443	481	526	474	493	493
0.3994	471	484	530	513	517	494
0.4937	490	494	481	515	515	524
0.5908	452	440	445	444	444	442
0.6982	382	369	357	352	378	393
0.7968	300	292	281	252	273	272
0.9003	147	135	117	105	115	117
1.0000	0	0	0	0	0	0

Redlich–Kister Equation. Excess molar volumes and viscosity deviations were described by the Redlich–Kister polynomial equation [7, 15]

$$Y^E = x_1(1-x_1)\sum_{i=0}^{m} A_i(2x_1-1)^i. \quad (9)$$

The Redlich–Kister coefficients (A_i) and standard deviations (σ) are summarized in Tab. 6 σ is evaluated from the equation

$$\sigma = \left[\sum\left(Y^E_{\text{expt}} - Y^E_{\text{calc}}\right)^2 \Big/ (m-n)\right]^{1/2}, \quad (10)$$

where m is the number of results and n is the number of parameters retained in Eq. (10).

Table 6

Redlich–Kister fitting coefficients (A_i) and standard deviations (σ) of the excess molar volumes and viscosity deviations for the DESO(1)–ACN(2) binary mixtures at temperatures from 298.15 to 323.15 K

Y^E	T, K	A_0	A_1	A_2	σ
$10^6 \cdot V^E$, m^3/mol	298.15	–1.30805	–0.20398	–0.60421	0.0140
	303.15	–1.30805	–0.20398	–0.60421	0.0160
	308.15	–1.39886	–0.15678	–0.63519	0.0160
	313.05	–1.45028	–0.13120	–0.64630	0.0160
	318.15	–1.50986	–0.10791	–0.65942	0.0160
	323.15	–1.57044	–0.08788	–0.66056	0.0160
η^E, $mPa \cdot s$	298.15	–1.05376	–0.09329	0.17095	0.0002
	303.15	–0.89940	–0.15385	0.14528	0.0003
	308.15	–0.77030	–0.20910	0.05366	0.0002
	313.05	–0.66469	–0.19038	–0.06699	0.0003
	318.15	–0.55108	–0.11618	–0.01466	0.0003
	323.15	–0.43521	–0.08806	0.01596	0.0003

Conclusion. The excess molar volumes and viscosity deviations for DESO–ACN binary mixtures exhibit negative deviations from the ideal behavior over the entire range. However, contrary to the excess molar volumes, the viscosity deviations become less negative with increasing temperature. Results are discussed in terms of molecular interactions and molecular size and shape in these binary

mixtures and interpreted on the basis of dipole-dipole interaction between polar groups of diethylsulfoxide and acetonitrile.

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