

Supporting Information

Thermophysical Properties: Viscosity, Density, and Excess properties of 2-propanol and n-decane mixtures from 283.15K to 343.15K under atmospheric conditions.

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1. Literature comparison

We have compared our measured density data with literature data [1–3] for 2-propanol and n-decane binary system. Figure S1 shows the literature comparison with the experimental data. The measured densities were correlated using a second order polynomial expression.

$$\rho = AT^2 + BT + C \quad (\text{S1})$$

With parameters A, B, and C, and ρ the density in g/cm³. Table S1 shows the density parameters for each composition with their corresponding uncertainties.

We compared our excess molar volume with literature data, as shown in Figure S2, and detailed the deviations in Table S3. These comparisons were conducted at specific 2-propanol compositions and three temperatures: 298.15 K, 303.15 K, and 308.15 K. Although a visual discrepancy is noticeable in the graph, the average absolute relative deviation (AARD%) between our experimental data and the literature data is consistently below 5% across all analyzed datasets.

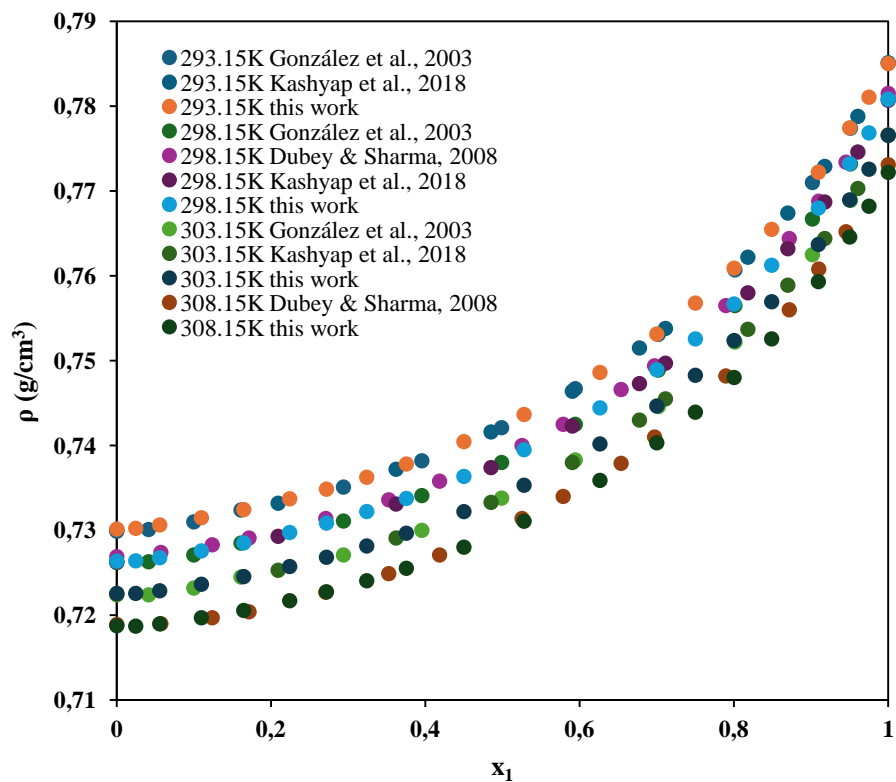


Figure S1. Experimental density data for 2-propanol and n-decane binary mixtures compared with literature data as a function of 2-propanol composition.

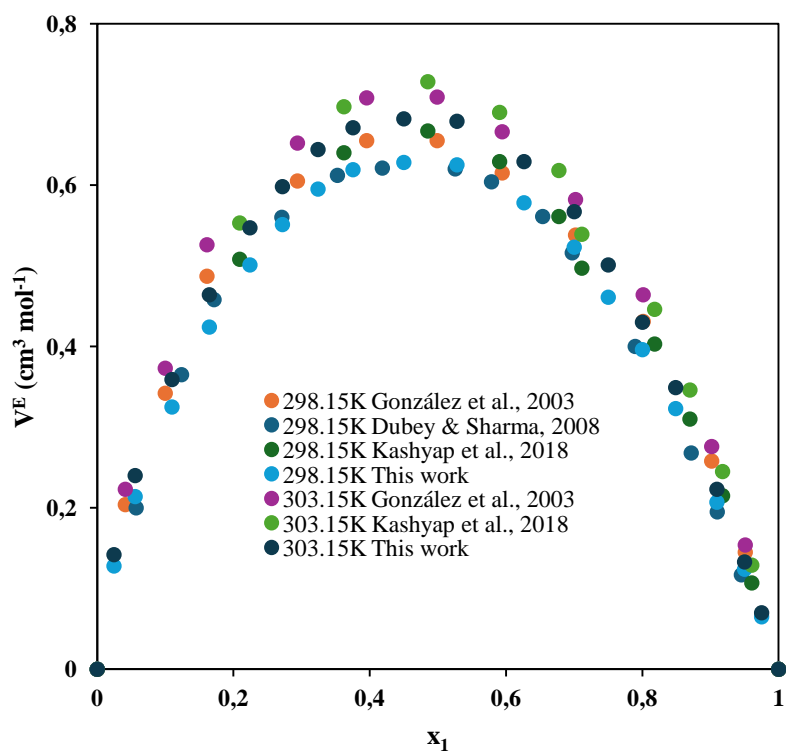


Figure S2. Excess molar volume for 2-propanol and n-decane binary mixtures compared with literature data as a function of 2-propanol composition.

Table S1. Parameters of density correlation for each composition

x_1	$A \times 10^{-7}$	$u(A) \times 10^{-9}$	$B \times 10^{-4}$	$u(B) \times 10^{-6}$	$C \times 10^{-1}$	$u(C) \times 10^{-4}$
0	-2.45	6.90	-6.11	4.32	9.30	6.75
0.0246	-2.14	2.45	-6.40	1.54	9.36	2.40
0.0556	-3.42	4.71	-5.71	2.95	9.27	4.61
0.1097	-4.96	2.32	-4.88	1.45	9.17	2.27
0.1645	-6.05	8.11	-4.29	5.08	9.10	7.94
0.2241	-6.95	12.6	-3.82	7.89	9.06	12.3
0.2718	-7.61	11.5	-3.49	7.20	9.03	11.3
0.3240	-8.16	16.2	-3.23	10.2	9.01	15.9
0.3753	-8.85	16.8	-2.88	10.5	8.98	16.4
0.4499	-9.69	17.3	-2.47	10.9	8.96	17.0
0.5279	-10.9	18.7	-1.85	11.7	8.91	18.3
0.6263	-12.6	21.7	-9.03	13.6	8.84	21.3
0.7000	-14.2	22.6	-2.30	14.1	8.75	22.1
0.7500	-15.1	28.7	0.50	18.0	8.72	28.1
0.8001	-16.1	33.2	1.10	20.8	8.67	32.5
0.8489	-17.0	35.6	1.59	22.3	8.65	34.8
0.9094	-18.0	44.2	2.24	27.7	8.62	43.2
0.9500	-18.8	46.9	2.69	29.4	8.60	45.9
0.9750	-18.8	51.3	2.72	32.2	8.63	50.2
1	-19.0	57.4	2.89	35.9	8.64	56.1

2. Molar volume correlation

The density data was used to calculate molar volume. We used this data to adjust the coefficient of the molar volume by the least squared method.

$$v = aT^2 + bT + c \quad (S2)$$

Table S2 presents the molar volume parameter for each composition

Table S2. Parameters of molar volume correlation for each composition

x_1	a	$u(a) \times 10^{-6}$	b	$u(b)$	c	$u(c)$
0	0.00030	3.81	0.0274	0.0024	161.36	0.3727
0.0246	0.00029	1.88	0.0315	0.0012	157.99	0.1843
0.0556	0.00032	1.60	0.0083	0.0010	158.12	0.1561
0.1097	0.00036	2.99	-0.0183	0.0019	156.51	0.2925
0.1645	0.00038	5.03	-0.0358	0.0031	153.51	0.4918
0.2241	0.00039	6.21	-0.0487	0.0039	149.38	0.6081
0.2718	0.00040	5.90	-0.0573	0.0037	145.81	0.5772
0.3240	0.00040	7.01	-0.0634	0.0044	141.39	0.6859
0.3753	0.00040	7.08	-0.0707	0.0044	137.26	0.6932
0.4499	0.00040	7.06	-0.0778	0.0044	130.72	0.6906
0.5279	0.00040	7.16	-0.0870	0.0045	124.24	0.7003
0.6263	0.00040	7.40	-0.0981	0.0046	116.02	0.7239
0.7000	0.00039	7.33	-0.1063	0.0046	109.92	0.7170
0.7500	0.00038	8.00	-0.1085	0.0050	105.28	0.7823
0.8001	0.00038	8.31	-0.1106	0.0052	100.64	0.8132
0.8489	0.00036	8.22	-0.1100	0.0052	95.75	0.8048
0.9094	0.00034	8.66	-0.1082	0.0054	89.53	0.8476
0.9500	0.00033	8.49	-0.1059	-0.1059	85.22	0.8308
0.9750	0.00032	8.62	0.0054	0.0054	82.10	0.8437
1	0.00030	8.86	-0.0982	0.0056	79.17	0.8674

Table S3. Literature comparison and average absolute relative deviation of excess molar volumes (v^E) for 2-propanol (1) + n-decane (2) binary system as a function of 2-propanol mole fraction at atmospheric pressure and 3 different temperatures: 298.15 K, 303.15 K, and 308.15 K.

Excess molar volume v^E (cm ³ mol ⁻¹)	This work		González et al., 2003 [1]			Dubey & Sharma, 2008 [2]			Keyshap et al., 2018 [3]			
	Temperature (K)	x_1	v^E	x_1	v^E	AARD %	x_1	v^E	AARD %	x_1	v^E	AARD %
298.15K	0	0	0	0	0	-	0	0	-	0	0	-
	0.2241	0.501	0.161	0.487	0.399	0.399	0.2709	0.56	1.682	0.2091	0.508	0.200
	0.3753	0.619	0.3954	0.655	0.831	0.831	0.3525	0.612	0.162	0.362	0.64	0.485
	0.5279	0.625	0.4988	0.655	0.686	0.686	0.5253	0.62	0.114	0.4851	0.667	0.960
	0.8001	0.396	0.8012	0.431	1.263	1.263	0.7895	0.4	0.144	0.818	0.403	0.253
	0.9094	0.207	0.9017	0.258	3.520	3.520	0.9099	0.195	0.828	0.9177	0.215	0.552
303.15K	1	0	1	0	-	-	1	0	-	1	0	-
	0	0	0	0	-	-	0	0	-	0	0	-
	0.2241	0.547	0.161	0.526	0.548	0.548	0.2709	0.710	4.257	0.2091	0.553	0.1567
	0.3753	0.671	0.3954	0.708	0.788	0.788	0.3525	0.761	1.916	0.362	0.697	0.5535
	0.5279	0.679	0.4988	0.709	0.631	0.631	0.5253	0.722	0.905	0.4851	0.728	1.0309
	0.8001	0.43	0.8012	0.464	1.130	1.130	0.7895	0.411	0.631	0.818	0.446	0.5316
308.15K	0.9094	0.223	0.9017	0.276	3.395	3.395	0.9099	0.161	3.972	0.9177	0.245	1.4094
	1	0	1	0	-	-	1	0	-	1	0	-
	0	0	-	-	-	-	0	0	-	-	-	-
	0.2241	0.592	-	-	-	-	0.2709	0.71	2.847	-	-	-
	0.3753	0.725	-	-	-	-	0.3525	0.761	0.709	-	-	-
	0.5279	0.736	-	-	-	-	0.5253	0.722	0.272	-	-	-
0.8001	0.465	-	-	-	-	0.7895	0.411	1.659	-	-	-	
0.9094	0.243	-	-	-	-	0.9099	0.161	4.821	-	-	-	
1	0	-	-	-	-	1	0	-	-	-	-	

3. Partial Molar Volume

The molar volume is calculated from the partial molar volume (Eq. (S3)).

$$nv = n_1v_1 + (n - n_1)v_2 \quad (\text{S3})$$

Consequently, partial volume is obtained from Eq. (S4).

$$v_i = \left(\frac{\partial nv}{\partial n_i} \right)_{T,p,n_{j \neq i}} \quad (\text{S4})$$

Combining Eq. (S3) and Eq. (S4) we can calculate the two partial molar volume using Eq. (S5) and (S6).

$$v_1 = v + n \left(\frac{\partial v}{\partial n_1} \right)_{T,p,n_{j \neq i}} \quad (\text{S5})$$

$$v_2 = v + n \left(\frac{\partial v}{\partial n_2} \right)_{T,p,n_{j \neq i}} \quad (\text{S6})$$

The calculated molar volume data were correlated using a second order polynomial expression (Eq. (S7)).

$$v = ax_1^2 + bx_1 + c \quad (\text{S7})$$

Figure S3 shows the molar volume of the binary mixture as a function 2-propanol molar composition at 303.15K as an example. Using Eq. (S7), the partial molar volume of each component for the system of 2-propanol and n-Decane can be expressed considering Eq. (S8) and (S9).

$$v_1 = v + (1 - x_1) \left(\frac{\partial v}{\partial x_1} \right)_{T,p,x_2} \quad (\text{S8})$$

$$v_2 = v + x_1 \left(\frac{\partial v}{\partial x_2} \right)_{T,p,x_1} = v - x_1 \left(\frac{\partial v}{\partial x_1} \right)_{T,p,x_2} \quad (\text{S9})$$

For each temperature, we have determined the parameters of the second order polynomial expression (Eq. (S7)). The results are presented in Table S4. Table S5 gives the values of the calculated partial molar volume for each temperature and composition.

Table S4: molar volume parameters for 2-propanol and n-Decane at 303.15K

T/K	$a / \text{cm}^3 \cdot \text{mol}^{-1}$	$u(a)$	$b / \text{cm}^3 \cdot \text{mol}^{-1}$	$u(b)$	$c / \text{cm}^3 \cdot \text{mol}^{-1}$	$u(c)$	R^2
283.15	-1.95	0.0472	-115.23	0.0490	192.93	0.0098	0.9999
288.15	-2.10	0.0494	-115.68	0.0514	193.93	0.0103	0.9999
293.15	-2.27	0.0537	-116.12	0.0558	194.94	0.0111	0.9999
298.15	-2.45	0.0600	-116.55	0.0624	195.96	0.0125	0.9999
303.15	-2.66	0.0672	-116.68	0.0699	196.60	0.0140	0.9999
308.15	-2.88	0.0743	-117.36	0.0772	198.05	0.0154	0.9999
313.15	-3.12	0.0833	-117.73	0.0866	199.11	0.0173	0.9999
318.15	-3.38	0.0919	-118.08	0.0955	200.20	0.0191	0.9999
323.15	-3.67	0.1041	-118.41	0.1082	201.29	0.0216	0.9999
328.15	-3.98	0.1152	-118.72	0.1198	202.41	0.0239	0.9999
333.15	-4.32	0.1295	-118.99	0.1347	203.53	0.0269	0.9999
338.15	-4.68	0.1415	-119.24	0.1471	204.68	0.0294	0.9999
343.15	-5.07	0.1553	-119.45	0.1615	205.84	0.0322	0.9999

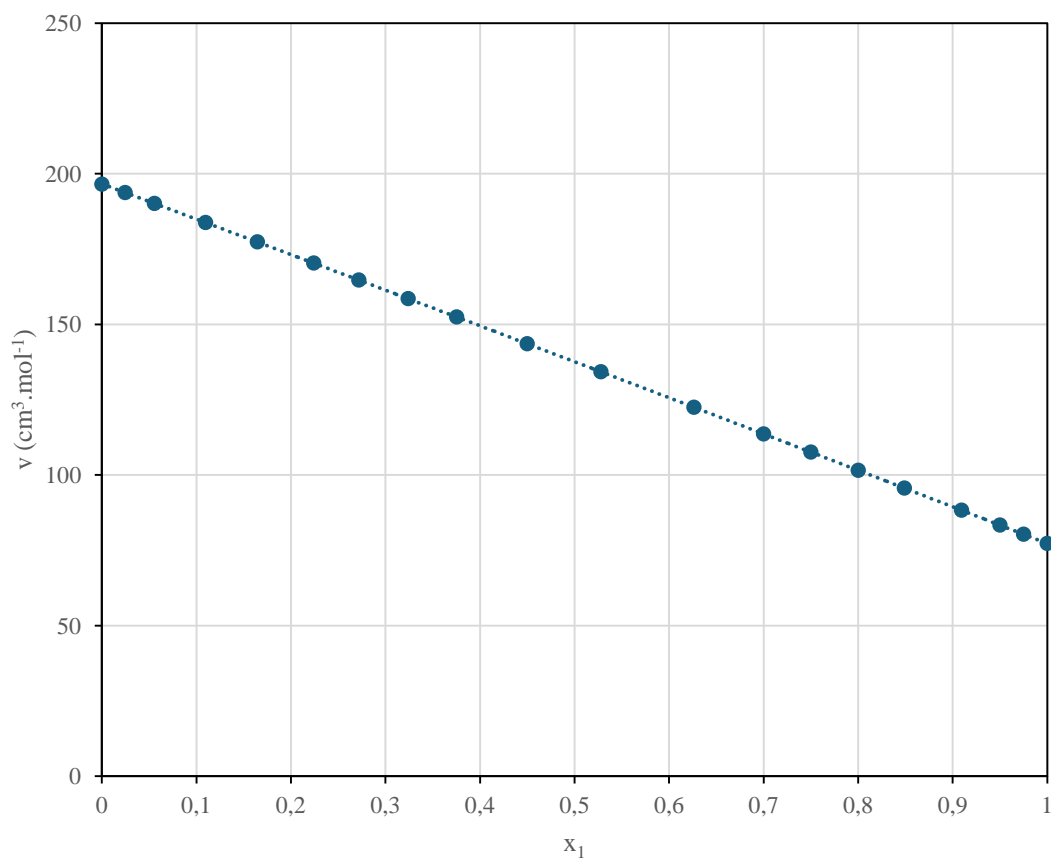
**Figure S3: Molar volume v as a function of 2-propanol mole fraction x_1 at 303.15K**

Table S5: Partial molar volume v_1 and v_2 ($\text{cm}^3\cdot\text{mol}^{-1}$) for 2-propanol (1) + n-decane (2) binary system as a function of 2-propanol mole fraction at atmospheric pressure ($p=101.33$ kPa)^a

x_1	$v_1/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_2/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_1/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_2/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_1/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_2/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_1/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_2/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_1/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_2/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_1/$ $\text{cm}^3\cdot\text{mol}^{-1}$	$v_2/$ $\text{cm}^3\cdot\text{mol}^{-1}$
	283.15 K		288.15 K		293.15 K		298.15 K		303.15 K		308.15 K	
0	77.66	192.88	78.19	193.87	78.76	194.87	79.34	195.89	79.96	196.92	80.61	197.96
0.0246	77.61	192.93	78.14	193.93	78.71	194.94	79.29	195.96	79.91	197.00	80.55	198.05
0.0556	77.50	192.95	78.03	193.95	78.59	194.96	79.17	195.99	79.78	197.03	80.41	198.09
0.1097	77.32	192.97	77.83	193.97	78.36	194.98	78.93	196.01	79.52	197.06	80.13	198.12
0.1645	77.14	193.01	77.64	194.01	78.16	195.03	78.70	196.05	79.27	197.10	79.86	198.16
0.2241	76.95	193.05	77.43	194.05	77.93	195.07	78.46	196.10	79.01	197.15	79.57	198.22
0.2718	76.81	193.09	77.28	194.10	77.77	195.12	78.28	196.16	78.81	197.21	79.36	198.28
0.3240	76.66	193.15	77.12	194.16	77.60	195.18	78.09	196.23	78.61	197.29	79.14	198.36
0.3753	76.52	193.21	76.97	194.23	77.44	195.26	77.92	196.31	78.42	197.37	78.94	198.45
0.4499	76.33	193.31	76.77	194.34	77.22	195.38	77.68	196.44	78.17	197.52	78.67	198.61
0.5279	76.17	193.46	76.60	194.50	77.04	195.55	77.49	196.63	77.95	197.72	78.44	198.83
0.6263	76.01	193.68	76.42	194.73	76.85	195.81	77.28	196.90	77.73	198.02	78.20	199.16
0.7000	75.93	193.88	76.33	194.95	76.74	196.04	77.17	197.15	77.61	198.29	78.07	199.45
0.7500	75.87	194.02	76.27	195.10	76.68	196.20	77.10	197.33	77.53	198.48	77.98	199.65
0.8001	75.83	194.17	76.23	195.27	76.63	196.38	77.05	197.52	77.48	198.69	77.92	199.88
0.8489	75.81	194.34	76.20	195.44	76.60	196.57	77.02	197.73	77.44	198.92	77.88	200.13
0.9094	75.78	194.55	76.17	195.67	76.57	196.82	76.98	197.99	77.41	199.20	77.84	200.43
0.9500	75.77	194.70	76.16	195.83	76.56	196.99	76.97	198.18	77.40	199.41	77.83	200.66
0.9750	75.77	194.79	76.16	195.93	76.56	197.10	76.97	198.30	77.39	199.53	77.83	200.79
1	75.76	194.88	76.15	196.03	76.55	197.21	76.96	198.42	77.39	199.66	77.82	200.93

^aExpanded uncertainties ($k=2$) $U(p)=0.3$ kPa, $U(T)=0.01$ K, $U(\bar{v}_1) = 2 \text{ cm}^3\cdot\text{mol}^{-1}$ $U(\bar{v}_2) = 2 \text{ cm}^3\cdot\text{mol}^{-1}$

Table S5: Continue

x_1	$v_1/$ $cm^3.mol^{-1}$	$v_2/$ $cm^3.mol^{-1}$	$v_1/$ $cm^3.mol^{-1}$	$v_2/$ $cm^3.mol^{-1}$	$v_1/$ $cm^3.mol^{-1}$	$v_2/$ $cm^3.mol^{-1}$	$v_1/$ $cm^3.mol^{-1}$	$v_2/$ $cm^3.mol^{-1}$	$v_1/$ $cm^3.mol^{-1}$	$v_2/$ $cm^3.mol^{-1}$	$v_1/$ $cm^3.mol^{-1}$	$v_2/$ $cm^3.mol^{-1}$
	313.15 K		318.15 K		323.15 K		328.15 K		333.15 K		338.15 K	
0	81.29	199.02	82.00	200.09	82.76	201.17	83.56	202.27	84.40	203.39	85.29	204.53
0.0246	81.24	199.11	81.94	200.19	82.70	201.29	83.48	202.39	84.31	203.51	85.18	204.65
0.0556	81.09	199.16	81.78	200.24	82.53	201.35	83.31	202.47	84.13	203.60	84.99	204.75
0.1097	80.78	199.19	81.46	200.29	82.18	201.39	82.93	202.52	83.73	203.66	84.56	204.82
0.1645	80.49	199.24	81.14	200.33	81.83	201.44	82.55	202.57	83.31	203.72	84.11	204.89
0.2241	80.17	199.30	80.79	200.39	81.45	201.51	82.14	202.64	82.87	203.79	83.63	204.96
0.2718	79.94	199.36	80.54	200.46	81.18	201.58	81.84	202.72	82.54	203.88	83.27	205.05
0.3240	79.70	199.45	80.28	200.56	80.89	201.68	81.53	202.83	82.20	203.99	82.91	205.18
0.3753	79.48	199.55	80.04	200.67	80.64	201.80	81.25	202.96	81.90	204.13	82.57	205.32
0.4499	79.19	199.73	79.73	200.86	80.30	202.01	80.88	203.18	81.50	204.37	82.14	205.59
0.5279	78.94	199.96	79.46	201.12	80.00	202.29	80.56	203.48	81.15	204.70	81.77	205.94
0.6263	78.68	200.32	79.18	201.50	79.70	202.71	80.24	203.94	80.80	205.20	81.38	206.48
0.7000	78.54	200.63	79.02	201.84	79.53	203.08	80.05	204.34	80.60	205.64	81.17	206.96
0.7500	78.45	200.86	78.93	202.09	79.43	203.35	79.94	204.63	80.48	205.95	81.04	207.29
0.8001	78.38	201.11	78.86	202.35	79.35	203.64	79.86	204.95	80.39	206.29	80.95	207.67
0.8489	78.34	201.37	78.81	202.64	79.30	203.94	79.80	205.28	80.33	206.65	80.88	208.06
0.9094	78.29	201.70	78.76	203.00	79.25	204.34	79.75	205.70	80.27	207.12	80.81	208.56
0.9500	78.28	201.94	78.75	203.26	79.23	204.62	79.73	206.01	80.25	207.45	80.79	208.92
0.9750	78.28	202.10	78.74	203.42	79.22	204.80	79.72	206.20	80.24	207.65	80.78	209.14
1	78.27	202.25	78.74	203.58	79.22	204.97	79.72	206.39	80.23	207.86	80.77	209.37

^aExpanded uncertainties (k=2) U(p)=0.3 kPa, U(T)=0.01 K, $U(\bar{v}_1) = 2 \text{ cm}^3.\text{mol}^{-1}$ $U(\bar{v}_2) = 2 \text{ cm}^3.\text{mol}^{-1}$

4. Thermal expansion

The density data measured at various compositions and temperatures are utilized to calculate thermal expansion coefficients. A second order polynomial expression is applied to determine the molar volume for each composition, with parameters provided in Table S4. By considering the definition of thermal expansion and taking the derivative of the molar volume equation with respect to temperature for each composition, the thermal expansion is then computed. Additionally, the excess molar thermal expansion α^E (Figure S4) was calculated using Eq. **Erreur ! Source du renvoi introuvable.**

$$\alpha^E = \alpha - \phi_1 \alpha_1^* - \phi_2 \alpha_2^* \quad (\text{S10})$$

where $\phi_i = \frac{x_i v_i^*}{\sum_i x_i v_i^*}$ is the volume fraction of component i and α_1^* and α_2^* are the molar thermal expansion coefficient of pure components 1 and 2, respectively. Analysing excess thermal expansion coefficients is important as it accounts for how temperature affects changes in molar volume. The accuracy of these coefficients depends on several factors, including the uncertainty in density measurements, the accuracy of temperature derivative calculations, and the uncertainty in molar fraction (Eq. S11).

$$u_{\alpha m} = \sqrt{u_{\alpha}^2 + u_x^2} \quad (\text{S11})$$

The uncertainty in composition is given by Eq. (8) of the main paper. For the thermal expansion, uncertainty is given by Eq. **Erreur ! Source du renvoi introuvable.**

$$u_{\alpha} = \sqrt{\left(\frac{\partial \alpha}{\partial \rho}\right)^2 u_{\rho}^2 + \left(\frac{\partial \alpha}{\partial T}\right)^2 u_T^2} \quad (\text{S12})$$

The value of u_{α} is $1 \times 10^{-5} \text{ K}^{-1}$. The uncertainty in the excess thermal expansion coefficient, as calculated by Eq. (S13), closely approximates $1.5 \times 10^{-5} \text{ K}^{-1}$.

$$u_{\alpha^E} = \sqrt{(1 + x_1^2 + x_2^2) u_{\alpha}^2 + (\alpha_1^2 + \alpha_2^2) u_x^2} \quad (\text{S13})$$

The dependence of $\frac{\alpha^E}{\varphi_1\varphi_2}$ on volumetric fraction and temperature, as depicted in Figure S5, demonstrates that the Redlich-Kister (RK) equation effectively represents the excess thermal expansion.

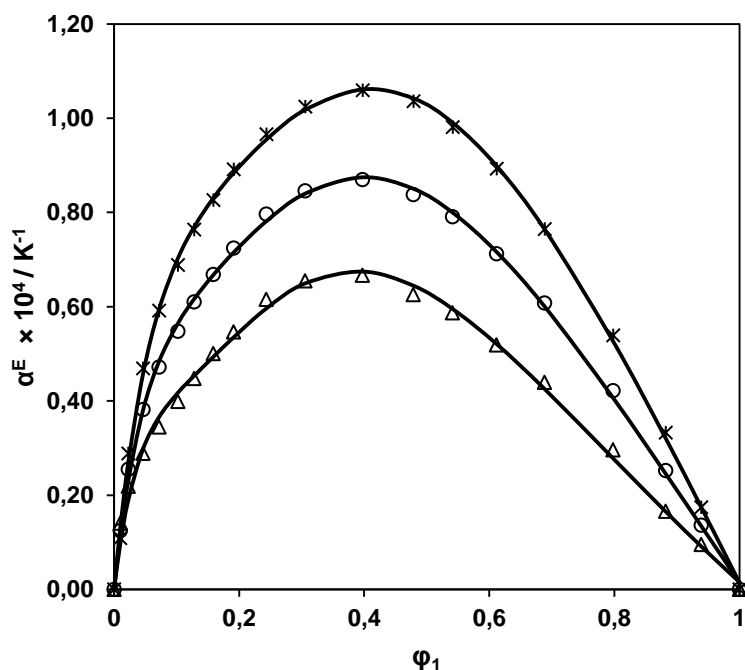


Figure S4: Excess molar thermal expansion coefficient (α^E) for 2-propanol (1) + n-Decane (2) binary system as a function of 2-propanol composition at atmospheric pressure and 3 different temperatures: (Δ) 293.15 K, (\circ) 308.15 K, (\times) 323.15 K, (—) Redlich–Kister Equation.

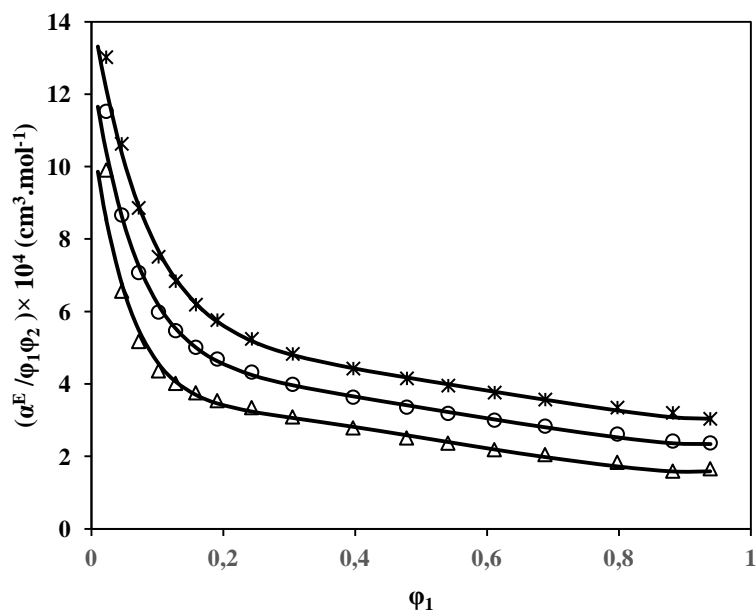


Figure S5: $\frac{\alpha^E}{\varphi_1\varphi_2}$ for 2-propanol (1) + n-Decane (2) binary system as a function of 2-propanol volumetric fraction at atmospheric pressure and 3 different temperatures: (Δ) 293.15 K, (\circ) 308.15 K, (\times) 323.15 K, and (—) Redlich–Kister Equation.

Table S6: Thermal expansion coefficients: Redlich-Kister parameters and deviation for 2-propanol + n-Decane binary system.

T / K	Redlich-Kister parameters ($\times 10^7$)										Variance $\sigma \times 10^7$ Eq 11
	A_o	$u(A_o)$	A_1	$u(A_1)$	A_2	$u(A_2)$	A_3	$u(A_3)$	A_4	$u(A_4)$	
283.15	7.438	0.0006	0.285	0.0019	-3.984	0.0056	-10.200	0.0043	6.669	0.0089	2.384
288.15	8.376	0.0004	-0.079	0.0014	-3.076	0.0040	-10.415	0.0031	5.398	0.0063	2.184
293.15	9.285	0.0003	-0.431	0.0009	-2.189	0.0027	-10.631	0.0021	4.166	0.0043	1.999
298.15	10.171	0.0002	-0.773	0.0006	-1.360	0.0018	-10.822	0.0014	2.985	0.0028	1.825
303.15	11.021	0.0001	-1.121	0.0004	-0.512	0.0012	-10.974	0.0009	1.781	0.0019	1.655
308.15	11.843	0.0001	-1.463	0.0003	0.310	0.0009	-11.127	0.0007	0.626	0.0014	1.500
313.15	12.635	0.0001	-1.794	0.0003	1.095	0.0008	-11.267	0.0006	-0.484	0.0012	1.361
318.15	13.399	0.0001	-2.123	0.0002	1.862	0.0007	-11.396	0.0005	-1.560	0.0011	1.251
323.15	14.128	0.0001	-2.439	0.0003	2.603	0.0008	-11.513	0.0006	-2.602	0.0012	1.164
328.15	14.724	0.0002	-2.922	0.0005	3.524	0.0015	-11.187	0.0012	-4.112	0.0024	1.597
333.15	15.523	0.0002	-2.814	0.0007	3.279	0.0021	-12.095	0.0017	-3.501	0.0034	0.961
338.15	16.165	0.0003	-3.093	0.0011	4.025	0.0032	-12.194	0.0024	-4.561	0.0050	1.032
343.15	16.760	0.0004	-3.726	0.0014	5.324	0.0041	-11.692	0.0032	-6.497	0.0066	1.164

5. Speed of sound

The excess speed of sound u^E (figure S6) was calculated using Eq. (S14). The results of the speed of sound measurement can be found in Table S5. Figure S6 shows how the relationship between u^E and the mole fraction of 2-propanol changes at three different temperatures: 293.15 K, 298.15 K, and 303.15 K.

$$\mathbf{u}^E = \mathbf{u} - x_1 \mathbf{u}_1 - x_2 \mathbf{u}_2 \quad (\text{S14})$$

where x_1 and x_2 represent mole fractions and u_1 and u_2 are the molar volumes of components 1 and 2, respectively. In the mixture of 2-propanol and n-decane, the u^E values are initially negative at lower x_1 values of 2-propanol, but they exhibit a positive trend at higher x_1 values. The negative u values indicate the importance of alkane molecules fitting between alcohol aggregates. Conversely, the positive u values for 2-propanol and n-decane suggest that as the size of the alkane molecule increases, the mixing component molecules have difficulty accommodating easily.

Using the experimental data for density and speed of sound, we calculated the relative association (R_A) using Eq. (S15) [4].

$$R_A = \left(\frac{\rho}{\rho_o} \right) \left(\frac{u_o}{u} \right)^{1/3} \quad (\text{S145})$$

where ρ and ρ_o are the densities, and u and u_o are the speeds of sound for the mixture and the

pure solvents, respectively.

Figure S7 displays the results of the relative association (R_A). The figure shows that R_A increases linearly with the concentration of 2-propanol, indicating a breakdown of solvent-solvent interactions. Additionally, the R_A values remain constant across different temperatures for the binary mixtures.

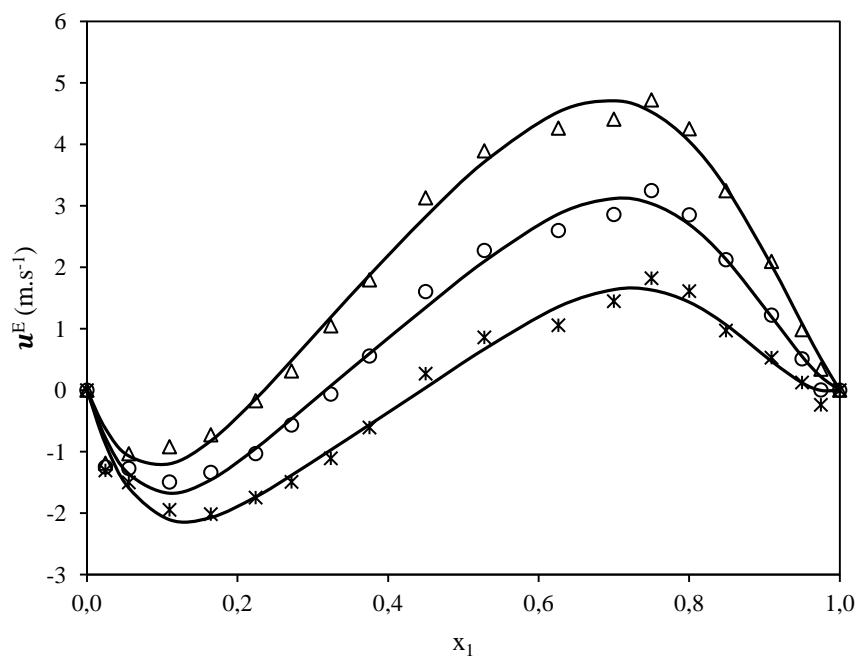


Figure S6. Excess speed of sound u^E for binary mixtures of 2-propanol (1) and n-decane as a function of 2-propanol mole fractions at atmospheric pressure and 3 different temperatures: (Δ) 293.15 K, (\circ) 298.15 K, (\times) 303.15 K, and (—) Redlich–Kister Equation.

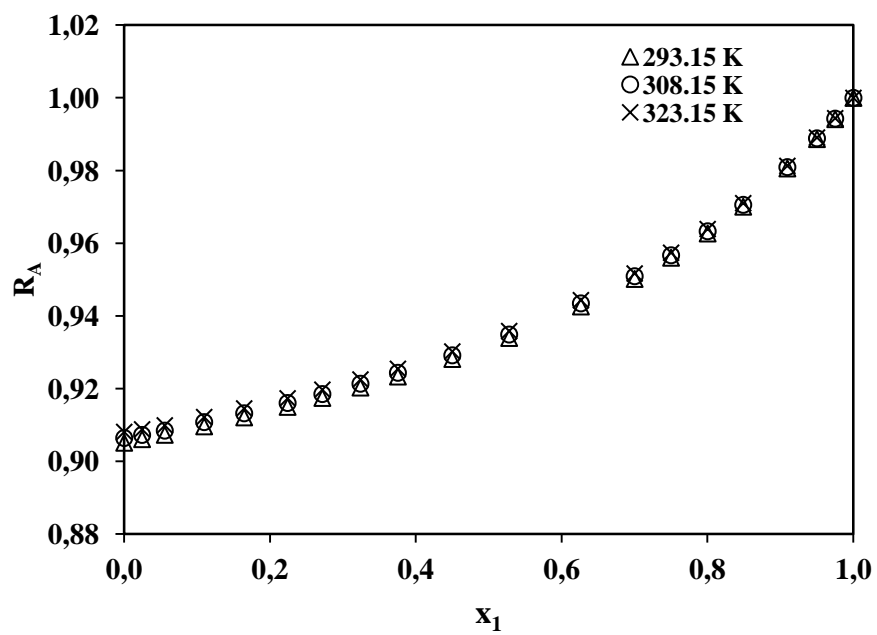


Figure S7. Plot of relative association (R_A) for the binary mixtures of 2-propanol (1) and n-decane as a function of 2-propanol mole fractions at atmospheric pressure and 3 different temperatures: (Δ) 293.15 K, (\circ) 308.15 K, (\times) 323.15 K

Table S7: Speed of sound $u(\text{m.s}^{-1})$ and relative association (R_A) for 2-propanol (1) + n-decane (2) binary system as a function of 2-propanol mole fraction at atmospheric pressure ($p=101.33 \text{ kPa}$)^a

x_1	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A
	T=283.15 K		T=288.15 K		T=293.15 K		T=298.15 K		T=303.15 K		T=308.15 K	
0	1294.3	0.905	1274.3	0.905	1254.3	0.905	1234.4	0.906	1214.6	0.906	1195.0	0.906
0.0246	1290.8	0.906	1270.8	0.906	1250.7	0.906	1230.8	0.906	1211.0	0.907	1191.4	0.907
0.0556	1288.0	0.907	1268.0	0.907	1247.8	0.907	1227.8	0.908	1207.9	0.908	1188.1	0.908
0.1097	1282.7	0.909	1262.7	0.909	1242.6	0.910	1222.4	0.910	1202.4	0.910	1182.5	0.911
0.1645	1277.7	0.912	1257.7	0.912	1237.4	0.912	1217.3	0.912	1197.2	0.913	1177.3	0.913
0.2241	1272.5	0.914	1252.4	0.915	1232.1	0.915	1211.9	0.915	1191.9	0.916	1172.0	0.916
0.2718	1268.3	0.917	1248.2	0.917	1227.9	0.917	1207.8	0.918	1187.7	0.918	1167.7	0.919
0.3240	1263.9	0.920	1243.8	0.920	1223.5	0.920	1203.3	0.921	1183.2	0.921	1163.2	0.921
0.3753	1259.6	0.923	1239.4	0.923	1219.2	0.923	1199.0	0.924	1178.9	0.924	1158.9	0.924
0.4499	1253.7	0.928	1233.5	0.928	1213.2	0.928	1192.9	0.929	1172.8	0.929	1152.8	0.929
0.5279	1246.7	0.933	1226.5	0.934	1206.3	0.934	1186.1	0.934	1166.1	0.935	1146.1	0.935
0.6263	1236.9	0.942	1217.0	0.942	1197.0	0.943	1177.0	0.943	1157.1	0.943	1137.3	0.943
0.7000	1229.2	0.950	1209.6	0.950	1189.9	0.950	1170.2	0.950	1150.6	0.951	1130.9	0.951
0.7500	1224.2	0.956	1204.8	0.956	1185.3	0.956	1165.8	0.956	1146.3	0.956	1126.9	0.957
0.8001	1218.2	0.962	1199.1	0.963	1179.9	0.963	1160.6	0.963	1141.4	0.963	1122.2	0.963
0.8489	1211.8	0.970	1193.0	0.970	1174.1	0.970	1155.2	0.970	1136.2	0.970	1117.3	0.971
0.9094	1203.8	0.980	1185.5	0.980	1167.0	0.981	1148.5	0.981	1130.1	0.981	1111.6	0.981
0.9500	1197.7	0.989	1179.9	0.989	1161.9	0.989	1143.9	0.989	1125.9	0.989	1107.8	0.989
0.9750	1194.4	0.994	1176.7	0.994	1158.8	0.994	1141.0	0.994	1123.2	0.994	1105.4	0.994
1	1190.9	1	1173.5	1	1156.0	1	1138.6	1	1121.1	1	1103.6	1

^aExpanded uncertainties ($k=2$) $U(p)=0.3 \text{ kPa}$, $U(T)=0.01 \text{ K}$, $U(\alpha)=2.2 \cdot 10^{-3} \text{ K}^{-1}$, $U(x)=0.002$, $U(u)=0.5 \text{ m.s}^{-1}$

Table S7: continued

x_j	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A	$u(\text{m.s}^{-1})$	R_A
	T=313.15 K		T=318.15 K		T=323.15 K		T=328.15 K		T=333.15 K		T=338.15 K		T=343.15 K	
0	1175.5	0.907	1156.1	0.908	1136.9	0.908	1117.8	0.909	1098.9	0.909	1080.1	0.910	1061.3	0.911
0.0246	1171.9	0.908	1152.5	0.908	1133.3	0.909	1114.2	0.909	1095.3	0.910	1076.5	0.911	1057.7	0.911
0.0556	1168.5	0.909	1149.0	0.909	1129.6	0.910	1110.4	0.910	1091.4	0.911	1072.4	0.912	1053.6	0.912
0.1097	1162.7	0.911	1143.1	0.912	1123.6	0.912	1104.3	0.913	1085.1	0.913	1065.9	0.914	1046.9	0.914
0.1645	1157.5	0.914	1137.8	0.914	1118.3	0.915	1098.9	0.915	1079.6	0.915	1060.4	0.916	1041.3	0.917
0.2241	1152.1	0.916	1132.5	0.917	1112.9	0.917	1093.5	0.918	1074.1	0.918	1054.8	0.919	1035.6	0.919
0.2718	1147.9	0.919	1128.2	0.919	1108.6	0.920	1089.1	0.920	1069.6	0.921	1050.3	0.921	1031.0	0.922
0.3240	1143.3	0.922	1123.6	0.922	1104.0	0.923	1084.5	0.923	1065.0	0.923	1045.6	0.924	1026.3	0.924
0.3753	1139.0	0.925	1119.3	0.925	1099.7	0.925	1080.1	0.926	1060.6	0.926	1041.2	0.927	1021.7	0.927
0.4499	1132.9	0.930	1113.1	0.930	1093.4	0.930	1073.8	0.931	1054.2	0.931	1034.7	0.931	1015.2	0.932
0.5279	1126.3	0.935	1106.5	0.936	1086.8	0.936	1067.1	0.936	1047.5	0.937	1027.9	0.937	1008.3	0.937
0.6263	1117.5	0.944	1097.8	0.944	1078.1	0.944	1058.5	0.945	1038.8	0.945	1019.2	0.945	999.4	0.946
0.7000	1111.3	0.951	1091.7	0.951	1072.2	0.952	1052.6	0.952	1033.0	0.952	1013.3	0.952	993.6	0.953
0.7500	1107.5	0.957	1088.0	0.957	1068.5	0.957	1049.0	0.958	1029.5	0.958	1009.8	0.958	990.0	0.958
0.8001	1103.0	0.963	1083.7	0.964	1064.4	0.964	1045.1	0.964	1025.7	0.964	1006.1	0.964	986.4	0.965
0.8489	1098.4	0.971	1079.4	0.971	1060.4	0.971	1041.3	0.971	1022.0	0.971	1002.6	0.971	983.0	0.972
0.9094	1093.1	0.981	1074.5	0.981	1055.8	0.981	1037.1	0.981	1018.1	0.981	999.0	0.982	979.6	0.982
0.9500	1089.6	0.989	1071.3	0.989	1053.0	0.989	1034.5	0.989	1015.8	0.989	996.9	0.989	977.8	0.989
0.9750	1087.5	0.994	1069.5	0.994	1051.4	0.994	1033.2	0.994	1014.7	0.994	996.0	0.994	977.1	0.995
1	1086.0	1	1068.3	1	1050.5	1	1032.4	1	1014.2	1	995.7	1	977.0	1

^aExpanded uncertainties (k=2) U(p)=0.3 kPa, U(T)=0.01 K, U(α)=2.2 10⁻³K⁻¹, U(x)=0.002, U(u)=0.5 m.s⁻¹

6. Isentropic compressibility

The speed of sound and density data measured at various compositions and temperatures are utilized to calculate the isentropic compressibility (κ_s) using Eq. (S16).

$$\kappa_s = (\rho u^2)^{-1} \quad (\text{S16})$$

Like excess molar thermal expansion, the excess molar isentropic compressibility (κ_s^E) was calculated using Eq (S17) and plotted on Figure S8.

$$\kappa_s^E = \kappa_s - (\varphi_1 \kappa_{s,1} + \varphi_2 \kappa_{s,2}) \quad (\text{S17})$$

Where $\varphi_i = \frac{x_i v_i^*}{\sum_i x_i v_i^*}$ is the volume fraction of component i and $\kappa_{s,1}$ and $\kappa_{s,2}$ are the isentropic compressibility pure components 1 and 2, respectively. Analysing excess isentropic compressibility is important as it accounts for how pressure affects changes in molar volume. The accuracy of these coefficients depends on several factors, including the uncertainty in density and speed of sound measurements, the accuracy of pressure calculations, and the uncertainty in molar fraction (Eq. (S18)).

$$u_{\kappa_s, m} = \sqrt{u_{\kappa_s}^2 + u_x^2} \quad (\text{S18})$$

The value of u_{κ_s} is 2 Pa^{-1} . The uncertainty in the excess isentropic compressibility, as calculated by Eq. (S19), closely approximates 2.5 Pa^{-1} .

$$u_{\kappa_s^E} = \sqrt{(1 + x_1^2 + x_2^2) u_{\kappa_s}^2 + (\kappa_{s,1}^2 + \kappa_{s,2}^2) u_x^2} \quad (\text{S19})$$

The volumetric fraction and temperature dependence of $\frac{\kappa_s^E}{\varphi_1 \varphi_2}$ for the binary mixture in Figure S9 shows the utilization of RK equation is well adapted for the representation of the excess isentropic compressibility (Table S8).

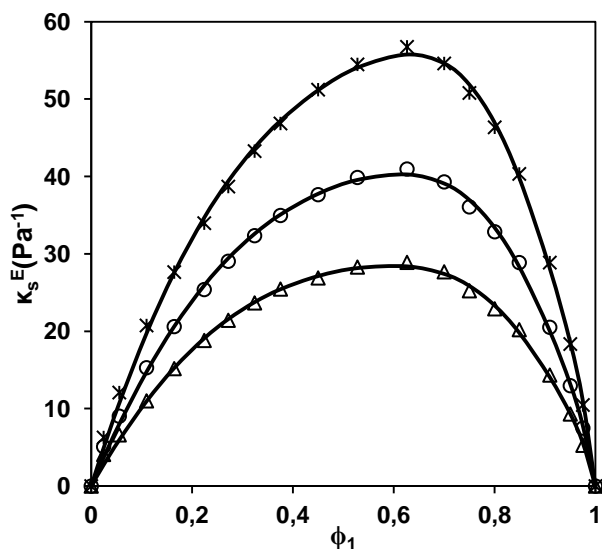


Figure S8: Excess isentropic compressibility (κ_s^E) for 2-propanol (1) + n-Decane (2) binary system as a function of 2-propanol mole fraction at atmospheric pressure and 3 different temperatures: (Δ) 293.15 K, (\circ) 308.15 K, (\times) 323.15 K, (—) Redlich–Kister Equation.

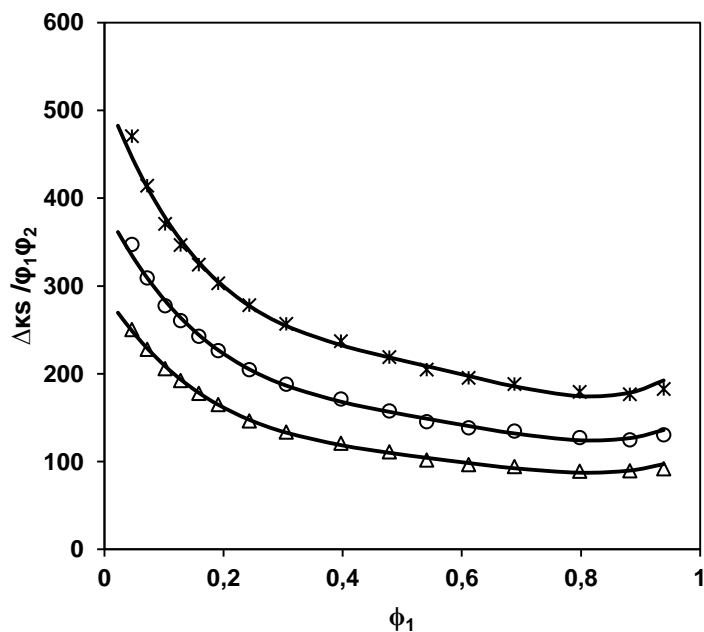


Figure S9: $\frac{\kappa_s^E}{\phi_1 \phi_2}$ for 2-propanol (1) + n-Decane (2) binary system as a function of 2-propanol volumetric fraction at atmospheric pressure and 3 different temperatures: (Δ) 293.15 K, (\circ) 308.15 K, (\times) 323.15 K, and (—) Redlich–Kister Equation.

Table S8: Excess isentropic compressibility: Redlich-Kister parameters and deviation for 2-propanol + n-Decane binary system.

T / K	Redlich-Kister parameters										Variance σ Eq 11
	A_0	$u(A_0)$	A_1	$u(A_1)$	A_2	$u(A_2)$	A_3	$u(A_3)$	A_4	$u(A_4)$	
283.15	84.99	0.0212	-34.56	0.0714	16.27	0.2091	-42.52	0.1620	68.92	0.3328	0.4280
288.15	95.71	0.0220	-40.42	0.0744	18.74	0.2178	-41.97	0.1687	66.87	0.3467	0.4491
293.15	107.86	0.0259	-45.99	0.0873	18.24	0.2556	-43.69	0.1980	75.86	0.4068	0.4981
298.15	121.98	0.0316	-51.70	0.1068	19.00	0.3128	-45.03	0.2423	82.72	0.4978	0.5366
303.15	137.00	0.0381	-56.49	0.1285	18.57	0.3764	-50.73	0.2916	90.16	0.5990	0.5798
308.15	153.94	0.0494	-62.41	0.1665	17.95	0.4878	-54.66	0.3778	100.99	0.7763	0.6501
313.15	172.35	0.0647	-68.50	0.2181	15.10	0.6390	-59.01	0.4949	116.48	1.0169	0.6993
318.15	192.80	0.0686	-73.69	0.2312	10.93	0.6775	-63.20	0.5248	131.73	1.0783	0.7475
323.15	215.42	0.0784	-78.99	0.2642	6.28	0.7743	-70.35	0.5996	150.30	1.2322	0.8194
328.15	239.26	0.0782	-85.52	0.2635	2.22	0.7726	-78.58	0.5982	163.16	1.2294	0.8647
333.15	266.27	0.1096	-91.29	0.3691	2.18	1.0823	-86.60	0.8379	179.67	1.7221	0.9210
338.15	296.10	0.1076	-95.64	0.3622	-6.00	1.0622	-99.60	0.8222	205.21	1.6900	0.9720
343.15	328.68	0.1280	-99.99	0.4307	-5.37	1.2635	-109.28	0.9778	215.59	2.0101	1.0020

7. Refractive index

Reis et al. [5] stated that the refractive index squared (n^2) is approximately equal to the relative permittivity (ϵ_r), also known as the dielectric constant. This property characterizes the ability of the solvent to form electrolytes and stabilize them [6–9]. The refractive index is connected to the molar volume through the Lorentz-Lorenz equation Eq. (S20) as presented by Iglesias-Otero et al. [10]:

$$\left(\frac{n^2 - 1}{n^2 + 2}\right)v = \frac{N_A \alpha_p}{3\epsilon_0} \quad (\text{S15})$$

In this equation, n represents the refractive index, v represents the molar volume, N_A represents Avogadro's number, ϵ_0 represents the permittivity of vacuum, and α represents the mean molecular polarizability.

To estimate the excess squared refractive index $(n^2)^E$, Eq. (S21) is applied, considering volume fractions instead of mole fractions. This equation is used for the calculation of the excess squared refractive index:

$$(n^2)^E = n^2 - \varphi_1 n_1^2 - \varphi_2 n_2^2 \quad (\text{S16})$$

Where $\varphi_i = \frac{x_i v_i^*}{\sum_i x_i v_i^*}$ is the volume fraction of component i and n_i^2 the squared refractive index of component i. The uncertainty in the refractive index is related to the uncertainty in the measured refractive index and the uncertainty in the molar fraction. Eq. (S22) provides the expression for this uncertainty:

$$\mathbf{u}_{(n^2)m} = \sqrt{\mathbf{u}_{n^2}^2 + \mathbf{u}_x^2} \quad (\text{S17})$$

The uncertainty in composition is given by Eq. (26) of the main paper. The value of \mathbf{u}_{n^2} is equal to 6×10^{-5} . The uncertainty of the excess squared refractive index is given by Eq (S23). The obtained value was close to 2×10^{-4} .

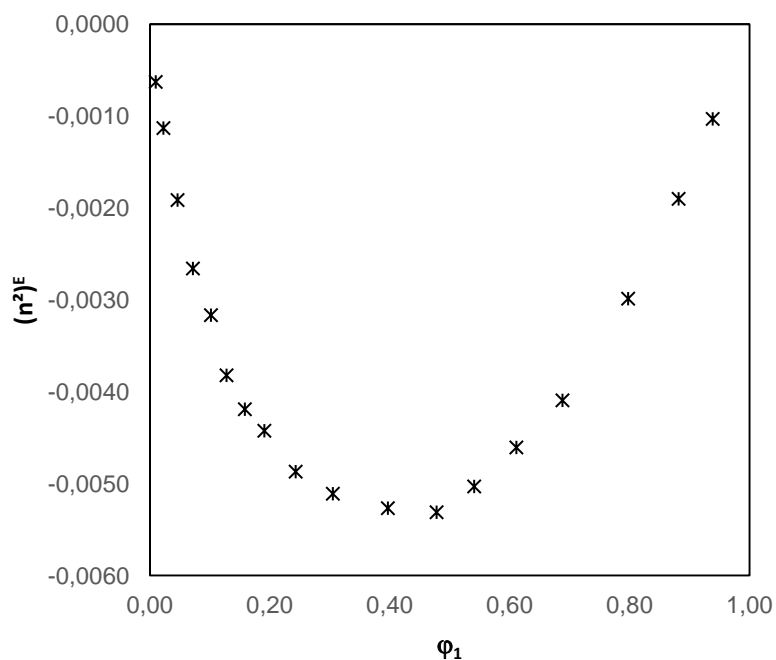
$$\mathbf{u}_{(n^2)^E} = \sqrt{(\mathbf{1} + \mathbf{x}_1^2 + \mathbf{x}_2^2)\mathbf{u}_{n^2}^2 + ((n^2)_1^2 + (n^2)_2^2)\mathbf{u}_x^2} \quad (\text{S18})$$

The refractive index at 293.15 K are presented in Table S9 and Figure S10. Redlich-Kister treatment was not administered. The excess squared refractive index presents a minimum, indicating that the intermolecular forces between 2-propanol and n-decane are weaker than those between pure 2-propanol or pure n-decane. This results in a less efficient packing of the molecules, leading to a decrease in the refractive index.

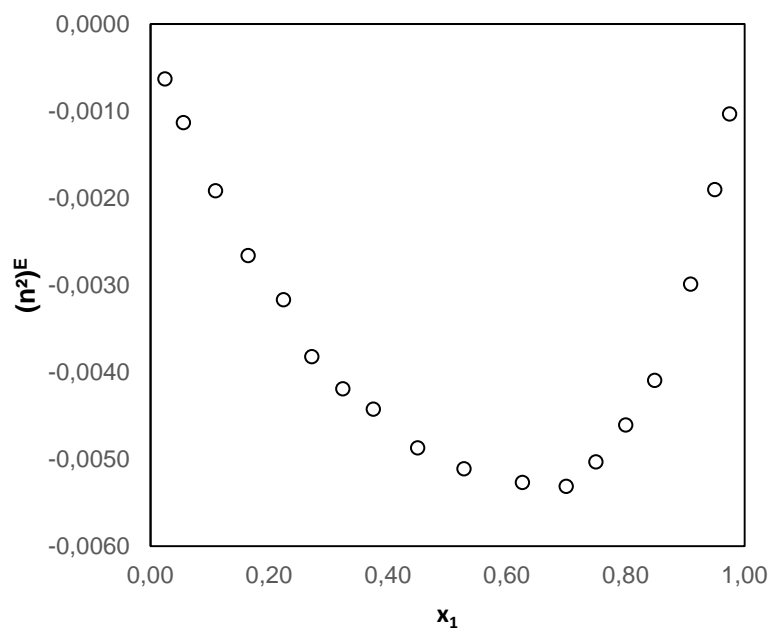
Table S9: Refractive index n_D and excess squared refractive index for 2-propanol (1) + n-decane (2) binary system as a function of 2-propanol mole fraction at 293.15K and atmospheric pressure ($p=101.33$ kPa)^a

x_1	n_D	$v/ \text{cm}^3 \cdot \text{mol}^{-1}$	volume fraction ϕ_1	$(n^2)^E$
0	1.41204	194.87	-	-
0.0246	1.41148	192.08	0.0098	-0.0006
0.0556	1.41086	188.49	0.0226	-0.0011
0.1097	1.40977	182.19	0.0462	-0.0019
0.1645	1.40862	175.80	0.0718	-0.0027
0.2241	1.40740	168.82	0.1019	-0.0032
0.2718	1.40627	163.23	0.1278	-0.0038
0.3240	1.40508	157.09	0.1584	-0.0042
0.3753	1.40387	151.04	0.1910	-0.0044
0.4499	1.40190	142.22	0.2432	-0.0049
0.5279	1.39966	132.99	0.3052	-0.0051
0.6263	1.39641	121.31	0.3970	-0.0053
0.7000	1.39356	112.53	0.4782	-0.0053
0.7500	1.39147	106.56	0.5409	-0.0050
0.8001	1.38916	100.57	0.6113	-0.0046
0.8489	1.38665	94.73	0.6881	-0.0041
0.9094	1.38320	87.46	0.7977	-0.0030
0.9500	1.38063	82.58	0.8819	-0.0019
0.9750	1.37894	79.57	0.9387	-0.0010
1	1.37715	76.55	-	-

^aExpanded uncertainties ($k=2$) $U(P)=0.3$ kPa, $U(T)=0.01$ K, $U(x)=0.002$, $U(v)=0.01$ $\text{cm}^3 \cdot \text{mol}^{-1}$, $u((n^2)^E)=0.0002$, $u(n)=6 \times 10^{-5}$



A



B

Figure S10: Excess squared refractive index 2-propanol (1) + n-decane (2) binary system as a function of 2-propanol: (A) volume fraction and (B) mole fraction at atmospheric pressure and 293.15 K.

Tables S10 to S13 present results obtained with PFP and Eyring models.

Table S10. Evaluation of the different contributions of the PFP model to the 2-propanol (1) + n-decane (2) binary system at 293.15 K and comparison with experimental data.

Experimental data		Constant value of χ_{12}					χ_{12} composition dependent					
x_1	$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Calculated contribution / $\text{cm}^3 \cdot \text{mol}^{-1}$			$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Deviation / $\text{cm}^3 \cdot \text{mol}^{-1}$	Calculated contribution / $\text{cm}^3 \cdot \text{mol}^{-1}$			$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Deviation / $\text{cm}^3 \cdot \text{mol}^{-1}$	
		Interactional	Free volume	P* effect			Interactional	Free volume	P* effect			
0	0	0	0	0	0	0	0	0	0	0	0	0
0.0246	0.115	0.0429	0.000022	-0.00011	0.043	0.0052	0.057	2.210-05	-1.1 10 ⁻⁰⁴	0.057	0.0034	
0.0556	0.191	0.0955	0.000049	-0.00026	0.095	0.0092	0.125	4.910-05	-2.6 10 ⁻⁰⁴	0.125	0.0044	
0.1097	0.294	0.1824	0.000094	-0.00049	0.182	0.0126	0.235	9.410-05	-4.9 10 ⁻⁰⁴	0.235	0.0035	
0.1645	0.391	0.2641	0.000137	-0.00072	0.263	0.0163	0.335	1.410-04	-7.2 10 ⁻⁰⁴	0.334	0.0033	
0.2241	0.462	0.3448	0.000181	-0.00095	0.344	0.0140	0.427	1.810-04	-9.5 10 ⁻⁰⁴	0.426	0.0013	
0.2718	0.508	0.4028	0.000213	-0.00112	0.402	0.0113	0.490	2.110-04	-1.1 10 ⁻⁰³	0.488	0.0004	
0.3240	0.547	0.4591	0.000245	-0.00129	0.458	0.0080	0.545	2.510-04	-1.3 10 ⁻⁰³	0.543	0.0000	
0.3753	0.571	0.5064	0.000274	-0.00144	0.505	0.0044	0.586	2.710-04	-1.4 10 ⁻⁰³	0.584	0.0002	
0.4499	0.579	0.5592	0.000308	-0.00162	0.557	0.0005	0.620	3.110-04	-1.6 10 ⁻⁰³	0.618	0.0015	
0.5279	0.575	0.5917	0.000333	-0.00175	0.590	0.0002	0.622	3.310-04	-1.7 10 ⁻⁰³	0.620	0.0021	
0.6263	0.533	0.5938	0.000344	-0.00180	0.592	0.0034	0.574	3.410-04	-1.8 10 ⁻⁰³	0.572	0.0015	
0.7000	0.483	0.5617	0.000334	-0.00175	0.560	0.0059	0.501	3.310-04	-1.7 10 ⁻⁰³	0.499	0.0003	
0.7500	0.426	0.5208	0.000316	-0.00165	0.519	0.0086	0.435	3.210-04	-1.6 10 ⁻⁰³	0.433	0.0000	
0.8001	0.366	0.4620	0.000287	-0.00149	0.460	0.0089	0.356	2.910-04	-1.5 10 ⁻⁰³	0.354	0.0001	
0.8489	0.299	0.3858	0.000245	-0.00127	0.384	0.0073	0.270	2.410-04	-1.3 10 ⁻⁰³	0.268	0.0010	
0.9094	0.192	0.2610	0.000171	-0.00089	0.260	0.0046	0.156	1.710-04	-8.9 10 ⁻⁰⁴	0.155	0.0014	
0.9500	0.116	0.1561	0.000105	-0.00054	0.155	0.0016	0.081	1.010-04	-5.4 10 ⁻⁰⁴	0.081	0.0013	
0.9750	0.061	0.0820	0.000056	-0.00029	0.082	0.0004	0.038	5.610-05	-2.9 10 ⁻⁰⁴	0.038	0.0005	
1	0	0	0	0	0	0	0	0	0	0	0	0

Table S11. Evaluation of the different contributions of the PFP model to the 2-propanol (1) + n-decane (2) binary system at 308.15 K and comparison with experimental data.

Experimental data		Constant value of χ_{12}					χ_{12} composition dependent					
x_1	$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Calculated contribution / $\text{cm}^3 \cdot \text{mol}^{-1}$			$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Deviation / $\text{cm}^3 \cdot \text{mol}^{-1}$	Calculated contribution / $\text{cm}^3 \cdot \text{mol}^{-1}$			$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Deviation / $\text{cm}^3 \cdot \text{mol}^{-1}$	
		Interactional	Free volume	P* effect			Interactional	Free volume	P* effect			
0	0	0	0	0	0	0	0	0	0	0	0	0
0.0246	0.156	0.054	0.0007	0.0014	0.054	0.0103	0.0719	0.0007	0.0014	0.073	0.0070	0.0070
0.0556	0.263	0.120	0.0016	0.0031	0.121	0.0202	0.1587	0.0016	0.0031	0.160	0.0106	0.0106
0.1097	0.392	0.228	0.0031	0.0059	0.231	0.0259	0.2981	0.0031	0.0059	0.301	0.0083	0.0083
0.1645	0.505	0.331	0.0045	0.0086	0.335	0.0289	0.4238	0.0045	0.0086	0.428	0.0059	0.0059
0.2241	0.592	0.432	0.0059	0.0113	0.438	0.0239	0.5409	0.0059	0.0113	0.546	0.0021	0.0021
0.2718	0.649	0.505	0.0069	0.0133	0.511	0.0189	0.6195	0.0069	0.0133	0.626	0.0005	0.0005
0.3240	0.697	0.576	0.0079	0.0153	0.583	0.0130	0.6893	0.0079	0.0153	0.697	0.0000	0.0000
0.3753	0.725	0.635	0.0088	0.0171	0.643	0.0066	0.7406	0.0088	0.0171	0.749	0.0006	0.0006
0.4499	0.740	0.702	0.0098	0.0191	0.711	0.0008	0.7828	0.0098	0.0191	0.792	0.0027	0.0027
0.5279	0.736	0.743	0.0105	0.0205	0.753	0.0003	0.7842	0.0105	0.0205	0.794	0.0034	0.0034
0.6263	0.683	0.746	0.0107	0.0210	0.756	0.0054	0.7211	0.0107	0.0210	0.731	0.0023	0.0023
0.7000	0.616	0.706	0.0102	0.0203	0.716	0.0100	0.6268	0.0102	0.0203	0.637	0.0004	0.0004
0.7500	0.543	0.655	0.0096	0.0191	0.664	0.0148	0.5413	0.0096	0.0191	0.551	0.0001	0.0001
0.8001	0.465	0.581	0.0086	0.0172	0.590	0.0156	0.4405	0.0086	0.0172	0.449	0.0003	0.0003
0.8489	0.379	0.485	0.0073	0.0146	0.493	0.0129	0.3314	0.0073	0.0146	0.339	0.0016	0.0016
0.9094	0.243	0.328	0.0050	0.0101	0.334	0.0082	0.1890	0.0050	0.0101	0.194	0.0024	0.0024
0.9500	0.144	0.196	0.0030	0.0061	0.200	0.0031	0.0968	0.0030	0.0061	0.100	0.0019	0.0019
0.9750	0.075	0.103	0.0016	0.0033	0.105	0.0009	0.0451	0.0016	0.0033	0.047	0.0008	0.0008
1	0	0	0	0	0	0	0	0	0	0	0	0

Table S12. Evaluation of the different contributions of the PFP model to the 2-propanol (1) + n-decane (2) binary system at 323.15 K and comparison with experimental data.

Experimental data		Constant value of χ_{12}					χ_{12} composition dependent				
x_1	$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Calculated contribution / $\text{cm}^3 \cdot \text{mol}^{-1}$			$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Deviation / $\text{cm}^3 \cdot \text{mol}^{-1}$	Calculated contribution / $\text{cm}^3 \cdot \text{mol}^{-1}$			$v^E / \text{cm}^3 \cdot \text{mol}^{-1}$	Deviation / $\text{cm}^3 \cdot \text{mol}^{-1}$
		Interactional	Free volume	P* effect			Interactional	Free volume	P* effect		
0	0	0	0	0	0	0	0	0	0	0	0
0.0246	0.197	0.0657	0.0026	0.0061	0.069	0.0163	0.089	0.003	0.006	0.093	0.0108
0.0556	0.353	0.1463	0.0058	0.0135	0.154	0.0396	0.197	0.006	0.014	0.205	0.0218
0.1097	0.524	0.2797	0.0110	0.0260	0.295	0.0526	0.371	0.011	0.026	0.386	0.0191
0.1645	0.658	0.4055	0.0160	0.0378	0.427	0.0532	0.527	0.016	0.038	0.549	0.0119
0.2241	0.762	0.5299	0.0209	0.0497	0.559	0.0413	0.672	0.021	0.050	0.701	0.0037
0.2718	0.831	0.6196	0.0245	0.0584	0.653	0.0315	0.770	0.024	0.058	0.804	0.0008
0.3240	0.890	0.7068	0.0280	0.0670	0.746	0.0208	0.856	0.028	0.067	0.895	0.0000
0.3753	0.926	0.7802	0.0309	0.0743	0.824	0.0105	0.919	0.031	0.074	0.962	0.0013
0.4499	0.948	0.8628	0.0342	0.0829	0.911	0.0013	0.970	0.034	0.083	1.018	0.0050
0.5279	0.943	0.9142	0.0364	0.0888	0.967	0.0006	0.969	0.036	0.089	1.022	0.0062
0.6263	0.878	0.9191	0.0367	0.0906	0.973	0.0090	0.887	0.037	0.091	0.941	0.0040
0.7000	0.791	0.8706	0.0348	0.0869	0.923	0.0173	0.767	0.035	0.087	0.819	0.0008
0.7500	0.700	0.8078	0.0324	0.0814	0.857	0.0246	0.659	0.032	0.081	0.708	0.0001
0.8001	0.600	0.7171	0.0288	0.0731	0.761	0.0260	0.533	0.029	0.073	0.577	0.0005
0.8489	0.488	0.5990	0.0241	0.0617	0.637	0.0221	0.397	0.024	0.062	0.434	0.0029
0.9094	0.312	0.4055	0.0163	0.0424	0.432	0.0143	0.222	0.016	0.042	0.248	0.0041
0.9500	0.185	0.2425	0.0098	0.0257	0.258	0.0054	0.111	0.010	0.026	0.127	0.0034
0.9750	0.097	0.1274	0.0051	0.0136	0.136	0.0015	0.051	0.005	0.014	0.059	0.0014
1	0	0	0	0	0	0	0	0	0	0	0

Table S13: Excess logarithm of kinematic viscosity $\ln(\eta\nu)^E$, and excess Gibbs energies of activation of viscous flow, ΔG^{E*} for 2-propanol (1) + n-decane (2) binary system as a function of 2-propanol mole fraction at atmospheric pressure (p=101.33 kPa)^a

x_1	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)
	283.15 K		288.15 K		293.15 K		298.15 K		303.15 K		308.15 K	
0	0	0	0	0	0	0	0	0	0	0	0	0
0.0246	-0.037	87	-0.036	86	-0.035	85	-0.034	83	-0.033	82	-0.031	80
0.0556	-0.063	148	-0.069	164	-0.066	160	-0.073	182	-0.058	146	-0.068	174
0.1097	-0.124	293	-0.126	302	-0.119	290	-0.122	302	-0.115	291	-0.107	275
0.1645	-0.187	441	-0.184	441	-0.162	395	-0.159	395	-0.148	372	-0.148	378
0.2241	-0.246	579	-0.237	569	-0.221	539	-0.213	528	-0.197	497	-0.178	455
0.2718	-0.282	664	-0.278	666	-0.258	628	-0.244	606	-0.237	597	-0.213	546
0.3240	-0.298	701	-0.295	706	-0.278	676	-0.269	666	-0.255	642	-0.238	611
0.3753	-0.375	882	-0.360	862	-0.340	828	-0.316	783	-0.298	751	-0.277	710
0.4499	-0.410	964	-0.393	941	-0.373	910	-0.350	868	-0.337	848	-0.307	785
0.5279	-0.427	1006	-0.414	993	-0.393	958	-0.368	913	-0.343	866	-0.327	838
0.6263	-0.425	1001	-0.415	994	-0.393	958	-0.380	941	-0.362	911	-0.330	845
0.7000	-0.414	974	-0.407	975	-0.386	941	-0.375	929	-0.353	891	-0.330	847
0.7500	-0.407	958	-0.381	913	-0.369	899	-0.345	854	-0.330	832	-0.306	783
0.8001	-0.373	877	-0.356	852	-0.343	837	-0.329	816	-0.321	808	-0.296	758
0.8489	-0.341	802	-0.330	791	-0.310	756	-0.295	731	-0.280	706	-0.260	665
0.9094	-0.267	628	-0.261	624	-0.246	600	-0.228	564	-0.222	559	-0.198	507
0.9500	-0.203	479	-0.199	476	-0.191	466	-0.179	443	-0.157	396	-0.147	376
0.9750	-0.146	344	-0.141	339	-0.138	335	-0.127	315	-0.112	283	-0.096	247
1	0	0	0	0	0	0	0	0	0	0	0	0

^aExpanded uncertainties (k=2) U(p)=0.3 kPa, U(T)=0.01 K, U(v)=0.01., U(ΔG^{E*})= 22 J.mol⁻¹

Table S13: Continue

x_1	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)	$\ln(\eta\nu)^E$ (m ² s ⁻¹)	ΔG^{E*} (Jmol ⁻¹)
	T=313.15 K		T=318.15 K		T=323.15 K		T=328.15 K		T=333.15 K		T=338.15 K		T=343.15 K	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0246	-0.030	79	-0.030	78	-0.029	78	-0.028	77	-0.027	76	-0.027	75	-0.027	77
0.0556	-0.066	171	-0.064	169	-0.062	167	-0.060	164	-0.058	161	-0.056	158	-0.057	161
0.1097	-0.102	264	-0.096	253	-0.090	242	-0.084	230	-0.098	272	-0.073	206	-0.071	203
0.1645	-0.138	359	-0.128	339	-0.119	320	-0.128	349	-0.119	331	-0.111	313	-0.109	310
0.2241	-0.163	424	-0.164	434	-0.151	405	-0.137	374	-0.143	396	-0.131	367	-0.104	295
0.2718	-0.195	507	-0.193	510	-0.176	474	-0.178	485	-0.162	449	-0.146	411	-0.139	397
0.3240	-0.215	561	-0.208	551	-0.187	504	-0.184	503	-0.183	507	-0.164	460	-0.155	441
0.3753	-0.265	691	-0.240	634	-0.233	625	-0.209	569	-0.204	565	-0.181	509	-0.170	485
0.4499	-0.287	748	-0.270	715	-0.257	689	-0.245	668	-0.235	650	-0.207	581	-0.193	550
0.5279	-0.299	779	-0.288	762	-0.267	717	-0.247	675	-0.229	635	-0.214	600	-0.195	557
0.6263	-0.315	820	-0.292	773	-0.275	740	-0.263	717	-0.254	702	-0.229	645	-0.206	588
0.7000	-0.305	793	-0.299	790	-0.273	733	-0.268	730	-0.251	694	-0.218	614	-0.210	600
0.7500	-0.293	764	-0.279	738	-0.259	697	-0.247	673	-0.239	662	-0.219	617	-0.208	593
0.8001	-0.274	713	-0.263	694	-0.248	667	-0.243	664	-0.229	635	-0.203	571	-0.206	589
0.8489	-0.247	643	-0.237	626	-0.226	607	-0.227	618	-0.205	567	-0.188	529	-0.186	532
0.9094	-0.186	485	-0.181	479	-0.179	480	-0.166	452	-0.160	443	-0.148	416	-0.156	444
0.9500	-0.139	361	-0.130	345	-0.126	340	-0.127	347	-0.125	347	-0.104	293	-0.120	344
0.9750	-0.093	242	-0.093	246	-0.090	243	-0.095	259	-0.085	236	-0.071	201	-0.082	233
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Expanded uncertainties (k=2) U(p)=0.3 kPa, U(T)=0.01 K, U(ν)=0.01., U(ΔG^{E})= 22 J.mol⁻¹

8. Optimal Numbers of RK parameters and χ^2 test

To validate the data treatment and the number of parameters used for each correlation, a χ^2 goodness-of-fit test was applied. The test statistic is given by Eq. (S24):

$$\chi^2 = \sum_k \left(\frac{U_k - f(T_R, \vec{X})}{\sigma_k} \right)^2 \quad (\text{S24})$$

The selected level of significance is $p=0.05$. We considered six correlations, each with five parameters. A total of 18 data points were used, giving a degree of freedom of 13. According to the χ^2 table, the critical χ^2 value for $p=0.05$ is 22.362. The null hypothesis (H_0) concerns the quality of the data treatment and the accuracy of the correlation in representing the data. The test is validated if the χ^2 value is lower than the critical value.

Table S13 presents the results, showing that the test was validated for all correlations except for ΔG^{E*} . A careful analysis revealed that this discrepancy is due to incorrect calculations for the data point with $x_1=0.9750$ in the correlation.

Table S13: Table of χ^2 test for estimation of optimal number of RK parameters

$\text{Chi}^2 / T \text{ (K)}$	v^E	α^E	κ_s^E	u^E	$\ln(\eta v)^E$	ΔG^{E*}
283.15	5.165	0.059	2.346	3.887	1.724	44.183
288.15	6.809	0.045	1.926	3.390	1.527	49.512
293.15	8.541	0.034	2.156	3.478	1.130	42.605
298.15	10.989	0.025	2.190	2.704	0.994	45.225
303.15	12.812	0.018	2.200	2.422	0.544	22.191
308.15	15.009	0.014	3.080	2.220	0.238	11.249
313.15	15.719	0.011	4.255	2.315	0.302	13.088
318.15	16.603	0.011	5.330	1.984	0.203	16.885
323.15	16.916	0.012	6.644	1.671	0.172	11.816
328.15	16.167	0.024	8.324	1.336	0.356	26.802
333.15	14.966	0.020	10.385	1.785	0.255	20.117
338.15	12.182	0.027	12.490	1.540	0.077	10.506
343.15	8.306	0.035	14.313	1.679	0.135	18.203

References

- [1] B. González, A. Dominguez, J. Tojo, Viscosities, densities and speeds of sound of the binary systems: 2-propanol with octane, or decane, or dodecane at T=(293.15, 298.15, and 303.15)K, *The Journal of Chemical Thermodynamics* 35 (2003) 939–953. [https://doi.org/10.1016/S0021-9614\(03\)00047-8](https://doi.org/10.1016/S0021-9614(03)00047-8).
- [2] G.P. Dubey, M. Sharma, Volumetric, viscometric and acoustic properties of binary mixtures of 2-propanol with *n*-alkanes (C₆, C₈, C₁₀) at 298.15 and 308.15 K, *Physics and Chemistry of Liquids* 46 (2008) 610–626. <https://doi.org/10.1080/00319100701344602>.
- [3] P. Kashyap, M. Rani, S. Gahlyan, D.P. Tiwari, S. Maken, Volumetric, acoustic and optical properties of binary mixtures of 2-propanol with n-alkanes (C₆-C₁₀) from 293.15 K to 303.15 K, *Journal of Molecular Liquids* 268 (2018) 303–314. <https://doi.org/10.1016/j.molliq.2018.07.043>.
- [4] D. Belhadj, A. Negadi, P. Venkatesu, I. Bahadur, L. Negadi, Density, speed of sound, refractive index and related derived/excess properties of binary mixtures (furfural + dimethyl sulfoxide), (furfural + acetonitrile) and (furfural + sulfolane) at different temperatures, *Journal of Molecular Liquids* 330 (2021) 115436. <https://doi.org/10.1016/j.molliq.2021.115436>.
- [5] J.C.R. Reis, I.M.S. Lampreia, Â.F.S. Santos, M.L.C.J. Moita, G. Douhéret, Refractive Index of Liquid Mixtures: Theory and Experiment, *ChemPhysChem* 11 (2010) 3722–3733. <https://doi.org/10.1002/cphc.201000566>.
- [6] C. Coquelet, E. Auger, A. Valtz, Density and Excess Volume for Four Systems Involving Eugenol and Furan, *J Solution Chem* 48 (2019) 455–488. <https://doi.org/10.1007/s10953-019-00870-6>.
- [7] A. Valtz, F. De Meyer, C. Coquelet, Density, viscosity and excess properties of aqueous solution of 2-(2-Diethylaminoethoxy)ethanol (DEAE-EO), *Fluid Phase Equilibria* 576 (2024) 113939. <https://doi.org/10.1016/j.fluid.2023.113939>.
- [8] A. Valtz, E. Neyrolles, F.B. Belaribi, C. Coquelet, Volumetric Properties of Binary Mixtures of 1,2-Dichloroethane with Ethers from 278.15–333.15 K and at Atmospheric Pressure, *J. Chem. Eng. Data* 67 (2022) 554–567. <https://doi.org/10.1021/acs.jced.1c00810>.
- [9] A. Valtz, C. Coquelet, G. Boukais-Belaribi, A. Dahmani, F.B. Belaribi, Volumetric Properties of Binary Mixtures of 1,2-Dichloroethane with Polyethers from (283.15 to 333.15) K and at Atmospheric Pressure, *J. Chem. Eng. Data* 56 (2011) 1629–1657. <https://doi.org/10.1021/je101361u>.
- [10] M.A. Iglesias-Otero, J. Troncoso, E. Carballo, L. Romání, Density and refractive index in mixtures of ionic liquids and organic solvents: Correlations and predictions, *The Journal of Chemical Thermodynamics* 40 (2008) 949–956. <https://doi.org/10.1016/j.jct.2008.01.023>.