VISCOMETRIC STYDY OF BINARY MIXTURES CONTAINING PROPIOPHENONE WITH 1-ALKANOLS AT TEMPERATURES 303.15K- 318.15K

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Abstract: The current study works out on Densities 'ρ', and Viscosities of binary mixtures of Propiophenone (PPH) with 1-alcohols [1-Propanol, 1-Butanol, & 1-Pentanol] measured over the entire composition range at temperatures from 303.15K to 318.15K and at atmospheric pressure 0.1MPa. The worked out experimental η data has been used to calculate deviations in viscosity (Δη) by correlating with theories like Grunberg Nissan (d), Hind(H_{12}), Katti –Chowdary (Wvis/RT), Tamura-Kurata(T_{12}) and Gibb's free energy(G^{*E}) activation relations. The deviations in viscosity with the composition and temperature of the mixtures have been discussed in terms of molecular interaction in these mixtures. The parameters of these studied systems were found to be responsive towards molecular interactions. The computed results were fitted with the Redlich Kister equation to estimate the binary coefficients and standard deviation between experimental and calculated data.

Keywords: Density, Deviation In Viscosity, Molecular Interactions.

1. Introduction: Physical properties of liquid mixtures such as Density (ρ) and Viscosity (η) are important in designing, engineering processes and to understand liquid theory. Viscosity of the binary mixtures is vital for hydraulic calculations of fluid transport and for energy transference calculations in the chemical, foodstuff, cosmetic and pharmaceutical industries etc. [1-6]. Excess thermodynamic properties of binary mixtures are essential to understand the intermolecular interactions of the liquid mixtures.

Literature survey reported on viscosity studies of binaries of some n-alkanols with Ethylbenzene at temperatures 298.15K & 308.15K[7], n-Butyl Acetate at temperatures from 298.15K-313.15K [8], Propiophenone at temperatures from 298.15K to 308.15K [9], Ethyl Valerate at temperatures from 293.15K-313.15K [10], and Benzylalcohol at temperatures 303.15k & 313.15K[11], further studies were made on Propiophenone with Methyl Acetate at 303.15K-313.15K [12] and Methanol at temperatures from 298.15K-308.15K[13]. No previous study was reported on the current binary mixtures at temperatures beyond 308.15K along with extensive viscosity relations as studied in this paper. Therefore, this study was undertaken to obtain reliable density and viscosity data for binary mixtures of Propiophenone with 1-Alkanols at Temperatures from 303.15 K to 318.15 K.

Propiophenone is widely used component in perfumes industries. It is used in the synthesis of ketoamphetamines such as cathinone and methcathinone. It can also be converted to synthetic aryl alkenes such as cinnamic acids. It is also used as a volatile low toxicity solvent in glues, paints and nail polish removers [14].

Alcohols play an important role in many chemical reactions due to the ability to undergo self-association with manifold internal structures and are in wide use in industry and science as reagents, solvents, and fuels and attract great attention as useful solvents in the green technology [15].

This research paper presents the data on densities, and viscosities of binary liquid mixtures of Propiophenone (PPH) with 1-Propanol, 1-Butanol, and 1-Pentanol at temperatures 303.15K, 308.15K, 313.K, and 318.15K. The experimental values of density and viscosity are used to calculate the deviations in viscosity and correlated with various viscosity relations like Grunberg and Nissan, Katti-Chaudari, Hind, Tamura-Kurata and Gibbs free energy activation. The values of $\Delta\eta$ and G^{*E} of binary mixtures were fitted to the Redlich Kister equation to estimate the standard deviations between the experimental and calculated values. Variations in excess properties of these binary mixtures at all four temperatures reflect the strong interactions between the unlike molecules. The effect of temperature and chain length in 1-alcohols when mixed with Propiophenone may induce changes in sign and magnitude of excess thermodynamic and transport properties [16]. Hence, the current study of these binary mixtures has been carried out at various temperatures (303.15-318.15k) to understand the behaviour of intermolecular interactions.

2. Material and Methods: Propiophenone, 1-Propanol, 1-Butanol & 1-Pentanol, these chemicals purchased from S.D. Fine chemicals Ltd, India and used in the present investigation, purities of the solvents are as shown in Table-01a.

Table 1: Provenance and purity of the materials used

CHEMICALS	CAS number	Source	Water content (%)	Mass fraction purity(final)
Propiophenone	93-55-0	S.D fine Chemicals, India	0.00049	> 99.5%
1-Propanol	71-23-8	S.D fine Chemicals, India	0.0001	>99.5%
1-Butanol	71-36-3	S.D fine Chemicals, India	0.00035	>99%
1-Pentanol	71-41-0	S.D fine Chemicals, India	0.0004	>99%

Estimated purities of the liquid samples are greater than 99% and water content found less than 0.003 mas%. Mixtures were prepared by mixing weighed amounts of the pure liquids adopting the method of closed system by using Mettler Toledo (ME204) balance with the precision of ± 0.1 mg. Mixtures were allowed to stand for some time before every measurement so as to avoid air bubbles. The purities of the liquids were checked by comparing the values of densities and ultrasonic velocities with literature data.
Proper care was taken to avoid any evaporation loss while doing the experiment. The densities of liquids and their mixtures were measured using bi-capillary Pycnometer having a capillary diameter of 0.85 mm, which was calibrated using double distilled water. The necessary buoyancy corrections were applied. The density (ρ) values were reproducible within ± 0.2 Kg m^{-3}. The viscosity of the binary liquid mixtures was measured using a suspended level Ubbelohde Viscometer (capacity 30 cm3) with proper calibration and the method as described earlier [33]. The estimated uncertainty in viscosity is ±0.005 mPa.s. The mole fraction of each mixture measured with the masses of the components.

2. Results and Discussions: The experimental values of Density and Viscosity of binary mixtures at temperatures 303.15, 308.15, 313.15 and 318.15 K with respective mole fractions (x_1) are reported in Table-01.

Table-01: Experimental values at temperatures T=303.15, 308.15, 313.15 and 318.15 K								
X1	**303.15K**		**308.15K**		**313.15K**		**318.15K**	
	ρ	**η**	**ρ**	**η**	**ρ**	**η**	**ρ**	**η**
	g cm-3	**mPa.s**	**g cm-3**	**mPa.s**	**g cm-3**	**mPa.s**	**g cm-3**	**mPa.s**
PPH+1-PROPANOL								
0	0.7953	1.7155	0.7914	1.5491	0.7873	1.3869	0.7834	1.2270
0.0588	0.8179	1.6899	0.8146	1.5325	0.8111	1.3802	0.8083	1.2277
0.1233	0.8404	1.6658	0.8372	1.5162	0.8338	1.3714	0.8311	1.2282
0.1943	0.8627	1.6433	0.8596	1.5022	0.8562	1.3656	0.8536	1.2304
0.2728	0.8846	1.6199	0.8815	1.4883	0.8783	1.3608	0.8756	1.2346
0.3601	0.9060	1.5978	0.9030	1.4767	0.8998	1.3594	0.8972	1.2425
0.4577	0.9267	1.5762	0.9237	1.4669	0.9207	1.3608	0.9181	1.2546
0.5676	0.9466	1.5547	0.9437	1.4587	0.9407	1.3654	0.9383	1.2722
0.6924	0.9657	1.5343	0.9629	1.4532	0.9601	1.3745	0.9577	1.2962
0.8351	0.9845	1.5189	0.9819	1.4550	0.9792	1.3929	0.9769	1.3301
1	1.0045	1.5150	1.0015	1.4690	0.9985	1.4230	0.9955	1.3770
PPH+1-BUTANOL								
0	0.8022	2.2602	0.7982	2.0247	0.7943	1.7922	0.7904	1.5636
0.0710	0.8236	2.1914	0.8199	1.9723	0.8164	1.7551	0.8128	1.5412
0.1468	0.8449	2.1238	0.8415	1.9191	0.8382	1.7160	0.8348	1.5179
0.2278	0.8662	2.0551	0.8629	1.8658	0.8596	1.6778	0.8563	1.4944
0.3145	0.8872	1.9829	0.8839	1.8100	0.8807	1.6381	0.8774	1.4706
0.4077	0.9077	1.9089	0.9045	1.7536	0.9013	1.5991	0.8981	1.4480
0.5080	0.9276	1.8321	0.9245	1.6958	0.9213	1.5600	0.9182	1.4268
0.6163	0.9468	1.7520	0.9438	1.6363	0.9408	1.5207	0.9378	1.4076
0.7336	0.9656	1.6692	0.9628	1.5757	0.9600	1.4820	0.9571	1.3910
0.8610	0.9845	1.5874	0.9817	1.5181	0.9791	1.4481	0.9763	1.3797
1	1.0045	1.5150	1.0015	1.4690	0.9985	1.4230	0.9955	1.3770
PPH+1-PENTANOL								
0	0.8076	3.0120	0.8040	2.6823	0.8002	2.3583	0.7960	2.0422
0.0836	0.8279	2.8690	0.8246	2.5660	0.8212	2.2683	0.8174	1.9764
0.1703	0.8484	2.7281	0.8453	2.4497	0.8420	2.1761	0.8384	1.9096
0.2602	0.8689	2.5851	0.8658	2.3323	0.8626	2.0836	0.8591	1.8414
0.3537	0.8891	2.4377	0.8860	2.2113	0.8829	1.9886	0.8794	1.7716
0.4508	0.9090	2.2877	0.9060	2.0888	0.9028	1.8932	0.8994	1.7018
0.5518	0.9285	2.1344	0.9255	1.9642	0.9224	1.7966	0.9191	1.6321
0.6570	0.9474	1.9776	0.9446	1.8372	0.9416	1.6989	0.9385	1.5632
0.7665	0.9662	1.8181	0.9634	1.7089	0.9606	1.6010	0.9577	1.4956
0.8808	0.9850	1.6603	0.9823	1.5835	0.9795	1.5073	0.9767	1.4321
1	1.0045	1.5150	1.0015	1.4690	0.9985	1.4230	0.9955	1.3770

The following relations are used to calculate the viscosity deviations and excess thermodynamic functions, dependent of viscosity on temperatures of binary liquid mixtures over the entire composition range to understand further on the molecular interactions of the binary mixtures.

a) Viscosity deviation is calculated by using the relation

$\Delta\eta = \eta - (x_1\eta_1 + x_2\eta_2)$ ..... (1a)

$\Delta ln\eta = ln\,\eta_{mix} - (x_1 ln\,\eta_1 + x_2 ln\,\eta_2)$ ..... (1b)

Where η_{mix}, η_1 & η_2 are the viscosities of components 1 & 2 of the binary mixtures and x_1 & x_2 are the mole fractions.

b) The excess Gibbs free energy of activation of viscous flow (G^{*E}) is obtained by the equation

$G^{*E} = RT[\ln \eta_m V_m - (x_1 ln V_1 \eta_1 + x_2 ln V_2 \eta_2)]$ ..... (2)

Where V_m is the molar volume of the mixture, $V_1$and V_2 are the molar volumes of component1 and component 2 respectively, R and T have their usual meanings

c) Grunberg and Nissan[34] proposed the following logarithmic equation for the measurement of viscosity of liquid mixtures;

$ln\eta = x_1 ln\, \eta_1 + x_2 ln\eta_2 + x_1 x_2 d$ ..... (3)

where d is a constant proportional to interchange energy, it may be considered as an approximate measure to know the strength of molecular interactions between the mixing components.

d) Katti and Chaudhri [35] proposed the following equation:

$ln\eta V = x_1 ln V_1 \eta_1 + x_2 ln V_2 \eta_2 + x_1 x_2 W_{vis}/RT$ ..... (4)

where Wvis/RT is an interaction energy parameter, and x_1 & x_2 are the mole fractions.

e) Hind et al. [36] suggested an equation for the viscosity of binary liquid mixtures as

$\eta = x_1^2 \eta_1 + x_2^2 \eta_2 + 2\, x_1 x_2 H_{12}$ ..... (5)

Where H_{12} is Hind interaction constant which is a function of composition and temperature, η is the predicted value of dynamic viscosity.

f) Tamura-Kurata's equation [37] for the viscosity of binary liquid mixtures:

$\eta = x_1 \emptyset_1 \eta_1 + x_2 \emptyset_2 \eta_2 + 2(x_1 \emptyset_1 x_2 \emptyset_2)^{0.5} T_{12}$ ..... (6)

Where ϕ_i is the ideal state volume fraction and is defined by the relation:

$\phi_i = \frac{x_i V_i}{\sum_{i=1}^{2} x_i V_i}$ ..... (7)

Where $\emptyset_i$ is the volume fraction of the pure components, x_i is the mole fraction and V_i is the molar volume

Computed values of the parameters (Δη, Δlnη, G^{*E}, d, Wvis/RT, H_{12}, T_{12}) are given in Table-03 at temperatures 308.15K and 318.15K for the binary mixtures of Propiophenone with 1-Propanol, 1-Butanol & 1-Pentanol. Remaining temperatures are not mentioned to avoid recurrence.

Table-02: Values of Deviation in viscosity(Δη, lnΔη),Gibbs free energy (G^{*E}) ,Grunberg-Nissan (d'), Katti-chaudhari($W_{vis/RT}$), Hind et al (H_{12}) and Tamura-Kurata (T_{12}) interaction parameters of Propiophenone with 1-Alkanols at temperatures T= 308.15 and 318.15 K. with mole fractions.

X_1	Δn	ln Δn	G^{*E}	d'	W_{vis}	H_{12}	T_{12}	X_1	Δn	ln Δn	G^{*E}	d'	W_{vis}	H_{12}	T_{12}
308.15K		**PPH+1-PROPANOL**						**318.15K**		**PPH+1-PROPANOL**					
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.059	-0.013	-0.009	-0.022	-0.155	-0.016	1.389	1.476	0.059	-0.009	-0.007	-0.041	-0.130	-0.030	1.218	1.260
0.123	-0.023	-0.015	0.009	-0.138	0.003	1.403	1.473	0.123	-0.019	-0.015	-0.042	-0.135	-0.016	1.214	1.247
0.194	-0.032	-0.021	0.021	-0.134	0.005	1.407	1.463	0.194	-0.028	-0.022	-0.053	-0.138	-0.014	1.212	1.237
0.273	-0.040	-0.027	0.015	-0.134	0.003	1.407	1.450	0.273	-0.036	-0.028	-0.074	-0.140	-0.015	1.210	1.226
0.360	-0.046	-0.031	0.011	-0.133	0.002	1.409	1.440	0.360	-0.042	-0.032	-0.081	-0.139	-0.014	1.210	1.219
0.458	-0.049	-0.033	0.002	-0.132	0.000	1.410	1.430	0.458	-0.045	-0.034	-0.081	-0.137	-0.013	1.211	1.213
0.568	-0.048	-0.032	0.002	-0.131	0.000	1.411	1.422	0.568	-0.044	-0.032	-0.059	-0.132	-0.010	1.212	1.210
0.692	-0.042	-0.028	-0.011	-0.132	-0.002	1.410	1.414	0.692	-0.038	-0.028	-0.041	-0.129	-0.008	1.213	1.208
0.835	-0.030	-0.020	-0.054	-0.146	-0.016	1.401	1.401	0.835	-0.026	-0.018	-0.051	-0.133	-0.015	1.208	1.204
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
308.15K		**PPH+1-BUTANOL**						**318.15K**		**PPH+1-BUTANOL**					
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.071	-0.018	-0.006	-0.077	-0.093	-0.047	1.608	1.698	0.071	-0.014	-0.009	-0.160	-0.133	-0.097	1.362	1.412
0.147	-0.032	-0.010	-0.116	-0.083	-0.037	1.621	1.697	0.147	-0.028	-0.017	-0.312	-0.137	-0.100	1.360	1.402
0.228	-0.040	-0.013	-0.125	-0.073	-0.028	1.632	1.695	0.228	-0.036	-0.023	-0.400	-0.129	-0.091	1.367	1.401
0.315	-0.047	-0.015	-0.134	-0.070	-0.025	1.638	1.688	0.315	-0.043	-0.027	-0.468	-0.126	-0.087	1.371	1.396
0.408	-0.051	-0.017	-0.147	-0.070	-0.025	1.640	1.680	0.408	-0.047	-0.030	-0.514	-0.126	-0.086	1.372	1.391
0.508	-0.053	-0.018	-0.167	-0.073	-0.027	1.640	1.669	0.508	-0.049	-0.032	-0.539	-0.129	-0.087	1.371	1.384
0.616	-0.051	-0.019	-0.177	-0.079	-0.030	1.638	1.658	0.616	-0.047	-0.031	-0.522	-0.133	-0.089	1.370	1.377
0.734	-0.046	-0.018	-0.205	-0.094	-0.042	1.629	1.641	0.734	-0.042	-0.028	-0.480	-0.145	-0.099	1.363	1.366
0.861	-0.034	-0.015	-0.219	-0.129	-0.074	1.606	1.610	0.861	-0.030	-0.020	-0.367	-0.171	-0.123	1.346	1.346
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
308.15K		**PPH+1-PENTANOL**						**318.15K**		**PPH+1-PENTANOL**					
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.084	-0.026	0.002	0.059	0.023	0.031	1.908	1.984	0.084	-0.022	-0.006	-0.145	-0.074	-0.076	1.568	1.615
0.170	-0.039	0.006	0.184	0.046	0.052	1.937	2.002	0.170	-0.035	-0.008	-0.212	-0.059	-0.060	1.585	1.624
0.260	-0.049	0.011	0.296	0.056	0.062	1.950	2.004	0.260	-0.045	-0.010	-0.252	-0.053	-0.053	1.594	1.626
0.354	-0.054	0.014	0.393	0.063	0.069	1.958	2.003	0.354	-0.050	-0.011	-0.266	-0.048	-0.047	1.600	1.627
0.451	-0.057	0.017	0.451	0.067	0.073	1.961	1.998	0.451	-0.053	-0.012	-0.277	-0.048	-0.045	1.603	1.624
0.552	-0.058	0.016	0.447	0.065	0.073	1.959	1.987	0.552	-0.054	-0.013	-0.303	-0.053	-0.049	1.601	1.617
0.657	-0.056	0.013	0.364	0.056	0.065	1.951	1.971	0.657	-0.052	-0.015	-0.347	-0.067	-0.062	1.593	1.604
0.767	-0.052	0.006	0.196	0.032	0.044	1.931	1.944	0.767	-0.048	-0.017	-0.390	-0.094	-0.088	1.576	1.583
0.881	-0.038	-0.002	0.000	-0.015	0.000	1.896	1.901	0.881	-0.034	-0.014	-0.342	-0.138	-0.131	1.549	1.551
1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

2.1 Deviation in Viscosity (Δη): The studied parameters showed a nonlinear variation in viscosity. The deviations in viscosity (Δη) for Propiophnone with 1-Alkanols are negative and these values are decreasing with increase in temperature, it is due to the reduction in dispersion forces. It suggests that mutual loss of specific interactions in like molecules outweigh the specific interactions between unlike molecules [38]. Excess viscosity may depend on the combined effect of molecular size, shape and intermolecular forces [39]. The values of Δη for the binary mixtures fall in the order of 1-Propanol > 1-Butanol > 1-Pentanol

Δη values for all the three binary systems at temperatures from 303.15K to 318.15K are shown in the Figure-01 to 04

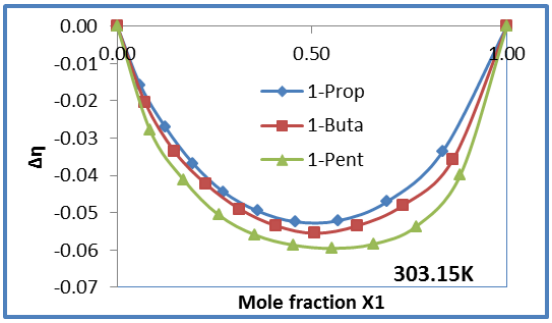

Figure 1: Δη values of Propiophenone with 1-Propanol, 1-Butanol and 1-Pentanol at temperature 303.15K with respective mole fractions.

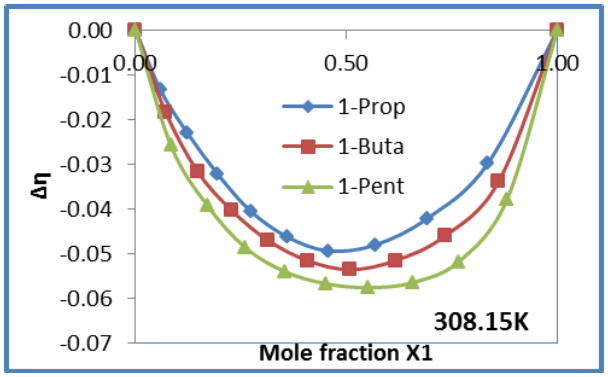

Figure 02: Δη values of Propiophenone with 1-Propanol, 1-Butanol and 1-Pentanol at temperature 308.15K with respective mole fractions.

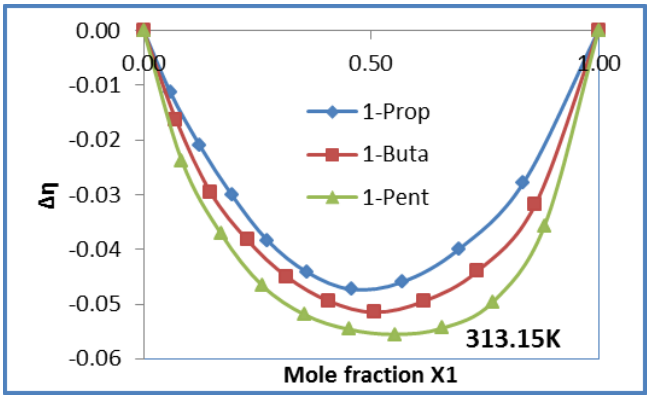

Figure 03: Δη values of Propiophenone with 1-Propanol, 1-Butanol and 1-Pentanol at temperature 313.15K with respective mole fractions

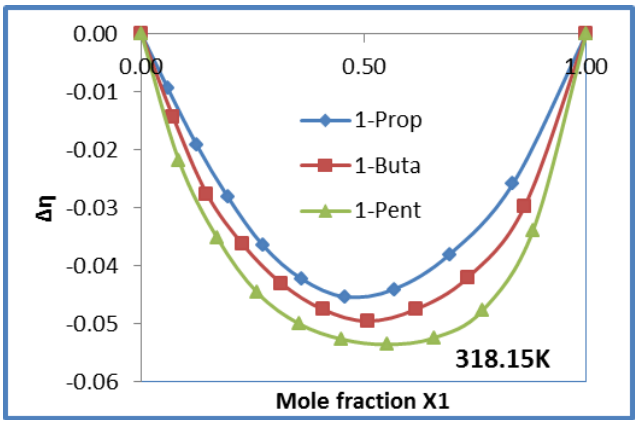

Figure 4: Δη values of Propiophenone with 1-Propanol, 1-Butanol and 1-Pentanol at temperature 318.15K with respective mole fractions.

2.2 Gibbs Free Energy of Activation of Viscous Flow and Grunberg-Nissan Parameters: According to Reed and Taylor et al. [40] positive G^{E} values indicate specific interactions while negative values indicate the dominance of dispersion forces; similarly, if 'd' values are positive the interactions between like molecules are strong and if d values are negative the interactions are weak. The values of G^{*E} are positive for 1-Pentanol at the temperatures 303.15K & 308.15K and inclined towards negative at the remaining temperatures, same trend is observed in 1-Propanol but this trend is different in 1-Butanol,

where the negative trend was started from 308.15K to 318.15K. It shows the dominance of dispersion forces between the unlike molecules. All the G^{*E} values are decreasing with increase in temperatures. The values of G^{*E} are graphically (3D) represented in Figure-05 and in the order of

1Pentanol > 1-Butanol > 1-Propanol

Grunberg-Nissan values ('d') are completely negative in the 1-Propanol and 1-Butanol binary mixtures and mixed values are observed in 1-Pentanol. The trend is mostly decreasing with increase in temperatures. This shows that strong interactions between like molecules in 1- Pentanol and weak interactions in 1-Propanol and 1-Butanol. Specific interactions between the molecules are controlled mainly by hydrogen bond that binds the molecules together. Thus hydrogen bonding causes considerable influence of these interaction parameters. The Grunberg-Nissan values of the binary systems are of the order of

1-Propanol < 1-Butanol< 1-Pentanol

2.3 Katti-Chaudari parameter; Hind and Tamura-Kurata parameters: Interaction parameter W_{vis}/RT shows almost the same trend as that of 'd'. In fact, one could say that the parameters 'd' and Wvis/RT exhibit almost similar behavior. Negative values of W_{vis} indicate weak interactions and positive values for strong interactions [41]. The values of Hind (H_{12}) and Tamura-Kurata (T_{12}) are positive for the whole range of composition. The main difference in these two parameters is the molar volume. These values are decreasing with increases in temperatures from 303.15K to 318.15K. The order of values of these interaction parameters is
1-Propanol < 1-Butanol < 1-Pentanol

2.4 Redlich-Kister Equation: The deviations in viscosity (Δη) and Gibbs Energy (G^{*E}) with respect to the mole fraction at temperatures from 303.15K to 318.15K were fitted to the Redlich–Kister Equation of the type:

$$Y^E = x_i x_2\{a0 + a1(x_1 - x_2) + a2(x_1 - x_2)^2\} \quad \text{..... (8)}$$

Where Y^E is for Δη and G^{*E} in the polynomial degree. The values of a0, a1 and a2 are the coefficients of the polynomial equation and were obtained by the method of least-squares and are given in Table 04 along with standard deviation values. The standard deviations are calculated by using the equation:

$$\sigma(Y^E) = \frac{\{\sum_{i=1}^{n}(Y^E_{obs} - Y^E_{cal})\text{^}2\}^{1/2}}{n-m} \quad \text{..... (9)}$$

Where n is the total number of experimental points and m is the number of coefficients.

TABLE- 03– Coefficients of Redlich-Kister Polynomial Equation for the Deviation in Viscosity and Gibbs free energy activation – of binary mixture Propiophenone with 1-Alkanols (1-Propanol, 1-Butanol & 1-Pentanol) at temperatures from 303.15K to 318.15K

Property	Temp (K)	A0	A1	A2	σ
		PPH+1-Propanol			
Δn	303.15	-0.2082	-0.0034	-0.0821	0.0005
	308.15	-0.1953	-0.0014	-0.0368	0.0024
	313.15	-0.1881	-0.0020	-0.0181	0.0439
	318.15	-0.1809	-0.0026	0.0007	0.0416
G*E	303.15	-0.0115	0.0012	0.0000	0.0257
	308.15	-0.0046	0.0006	0.0000	0.0534
	313.15	0.0034	-0.0002	0.0000	0.0489
	318.15	0.0099	-0.0009	0.0000	0.0720
		PPH+1-Butanol			
Δn	303.15	-0.2160	-0.0154	-0.1262	0.0010
	308.15	-0.2088	-0.0158	-0.1078	0.0024
	313.15	-0.2015	-0.0162	-0.0894	0.0500

	318.15	-0.1943	-0.0166	-0.0709	0.0476
G*E	303.15	0.2775	-0.4787	-1.3694	0.0156
	308.15	-0.6153	-0.4846	-1.3351	0.1895
	313.15	-1.4333	-0.4351	-1.2606	0.3760
	318.15	-2.1243	-0.3154	-1.1033	0.5313
		PPH+1-Pentanol			
Δn	303.15	-0.2354	-0.0281	-0.1932	0.0011
	308.15	-0.2282	-0.0283	-0.1749	0.0027
	313.15	-0.2209	-0.0285	-0.1566	0.0573
	318.15	-0.2136	-0.0287	-0.1383	0.0550
G*E	303.15	3.3718	-0.0527	-2.0190	0.0227
	308.15	1.8559	-0.3998	-2.1479	0.3597
	313.15	0.3347	-0.6601	-2.2283	0.0999
	318.15	-1.1442	-0.8004	-2.2325	0.3552

3. Conclusions: In this paper, the obtained results are discussed and interpreted in terms of molecular interactions between the binary mixture constituents. From the experimental values of density (ρ) and viscosity (η), the deviation in viscosity (Δη & ln Δη) was calculated and viscosity values were correlated with the relations such as Gibbs energy activation (G^{*E}), Grunberg and Nissan (d), Katti-chaudari (W_{vis}/RT), Hind (H_{12}) and Tamura-Kurata (T_{12}) interaction parameters. Deviation viscosity (Δη) and Gibbs energy (G^{*E}) values have been correlated by Redlich–Kister type polynomial equation to derive the coefficients and standard deviation. The sign and magnitude of these thermodynamic excess functions have been interpreted in terms of dispersion forces, Hydrogen-bond, and dipole-dipole interactions between the component molecules of binary mixture Propiophenone with 1-Alkanols.

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