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Thermo Acoustic Study of Salicylaldehyde in Carbon Tetra Chloride at 303.15K, 308.15K, 313.15K

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Abstract: ***Thermo-acoustic study in binary mixture of salicylaldehyde and carbon tetra chloride were reported at 303.15K, 308.15K, 313.15K. The molecular interaction have been carried out by computing various thermo acoustical parameters i.e. Intermolecular free length (L_f), Specific acoustic Impedance (Z), Molar Volume (Vm), Available Volume (V_a), Isentropic compressibility (β_S) and other constant and the excess value of foresaid parameters have been evaluated by using ultrasonic velocity, density, viscosity data, the results of these parameters conclude the strength of molecular interaction.***
Keywords: Excess values of Salicylaldehyde, Acoustic Parameters, Molecular Interaction.

I. INTRODUCTION

Ultrasonic is the best technique to yield valuable information regarding the behavior of liquid binary systems. The Intermolecular association effect the compressibility of the system produce variation in corresponding ultrasound velocity has drawn the attention of some workers[1-5], The present works[6-10] deals with the study of the excess isentropic compressibility (βs^E), excess intermolecular free length (L_f^E), Excess viscosity (η^E), Specific acoustic impedance (Z), Excess available volume (Va^E), Excess molar volume for (Vm^E), the binary mixture of salicylaldehyde in carbon tetra chloride at 303.15K, 308.15K, 313.15K.

II. EXPERIMENTAL

All the chemicals used in this study have been distilled to remove impurities by following standard procedure. The purity of the each sample was checked by a continuous wave interferometric technique for the measurement of ultrasonic velocity at 2MHz. The density and viscosity were determined using a vibrating densitometer DMA 48 fitted with a Hoak G thermostat and Ubbelhode viscometer. The result were reproducible with accuracy of 0.00002 Kgm^3 and 0.0002 mPas respectively.

III. COMPUTATION OF DIFFERENT PHYSICAL PARAMETERS

A. Ultrasound Velocity (V)

$V = 2d \times 10^3$ m/sec

'V' Ultrasound velocity , 'd' Distance

B. Density

$$\rho = \frac{M}{V+\pi r^2(h_1+h_2)}$$

Where –

'M' : is the wt. of the liquid
'r' : is the radius of capillaries
'h_1' : & 'h_2' are the height of the liquid in capillaries
'V' : volume

C. Viscosity (η)

$$\eta_p = \rho\left(at - \frac{b}{t}\right)$$

Where –

'η' : is the viscosity of liquid
'ρ' : is density of liquid
't' : is the time flow of liquid
'a' & 'b' are viscometric constants

D. Specific Acoustic Impedance

$$Z = V.\square$$

Where, 'V' and '□' are the ultrasonic velocity and density respectively.

E. Isentropic Compressibility (□s)

The relation between ultrasonic velocity and compressibility in the liquid media.

$$\square_s = \frac{1}{V^2\rho}$$

Where, 'V' is the ultrasound velocity and '□' is the density of liquid mixtures or electrolytic solution.

F. Intermolecular Free Length (L_f)

$$L_f = K\sqrt{\beta_s}$$

Where 'K' is temp. dependant constant[11]

G. Molar Volume

$$Vm = \frac{\bar{M}}{e} \quad \text{Where } \bar{M} = (m_1x_1 + m_2x_2)$$

H. Available Volume

$$Va = Vm\left[1 - \frac{V_t}{V_\infty}\right]$$

Where Vm = Molar Volume, V_t = Ultrasound velocity, V_∞ = 1600 m/s

I. Shear's Relaxation time (□s)

$$\square_s = \frac{4}{3}\ \square\square.\square\square s$$

IV. RESULT AND DISCUSSION

The values of ultrasound velocity, density, viscosity available volume molar volume, istentropic compressibility, specific acoustic impedance, intermolecular free length and shear's relaxation time of Salicylaldehyde in Carbon tetra chloride at 303.15K, 308.15K, 313.15K are tabulated (1,2,3). The excess value of Isentropic compressibility ($\square s^E$), molar volume (Vm^E), Available Volume (Va^E), Intermolecular free length (L_f^E), Viscosity ($\square^E$) and specific acoustic impedance (Z) are plotted with respect to mole fraction at temperature 303.15K, 308.15K, 313.15K in fig. (1,2,3,4,5,6).

According to observation of tables that ultrasound velocity of salicylaldehyde decreases with increase in mole fraction and temperature. The density increases on increasing mole fraction of salicylaldehyde but decreases with increase in temperature.

The occurrence of peaks of curves of the excess value at mole fraction (0.6284, 0.5782, 0.5300) predicts at temperature 303.15K, 308.15K, 313.15K, the more interaction between salicylaldehyde and carbon tetrachloride through complex formation[12-17] either by hydrogen bonding or by vander waal interaction forces. The existence of structurally different species in solution also reflected in the thermal and physical parameters as well. The isentropic compressibility of salicylaldehyde increases with increase mole fraction and temperature. The variation in excess isentropic compressibility of salicylaldehyde in carbon tetra chloride at various temperature is shown in fig. (1) where the system tends to attain a close packing at around (0.6284, 0.5782, 0.5300) mole fraction of salicylaldehyde at various temperature. The structural change is maximum hence peaks show maxima at this mole fraction.

Similarly, the positive deviation in intermolecular free length with increase in mole fraction and temperature also support interaction in carbon tetrachloride. Its excess intermolecular free length (L_f^E), is shown in fig. (2).

The value of specific acoustic impedance (Z) decreases with increase in mole fraction of salicylaldehyde with increase in temperature. It can be explained on the basis of lyophobic interaction. The main cause of impedance in the propagation of ultrasound waves is shown in fig. (3).

Fig. (4,5,6) shows the variation of excess molar volume (Vm^E), Available Volume (Va^E) and Viscosity ($\square^E$) drawn as a mole fraction of Salicylaldehyde at 303.15K, 308.15K, 313.15K. The new structural species in solution formed by the intermolecular forces because the solution possess less flow capability and hence increase in viscosity. The positive deviation shows the strong interaction strength between Salicylaldehyde in carbon tetra chloride with respect to temperature variation.

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Table 1
Thermo Acoustic parameter of
Salicylaldehyde + Carbon Tetra Chloride at Temp. 303.15 K

Mole Fraction of $C_7H_6O_2$	Ultrasound Velocity (m/sec.)	Density (gm/mol)	Density (add.) gm/ml.	Density (excess) gm/ml.	Isentropic Compressibility (Exp.) $cm^2/dyne.10^{12}$	Isentropic Compressibility (add.) $cm^2/dyne.10^{12}$	Sear's Relaxation Time
0.000	1418	1.1530	1.1530	0.0000	43.1338	43.1338	2.9338
0.1576	1342	1.1887	1.2144	-0.0257	46.7173	48.4520	2.7958
0.2969	1270	1.2253	1.2685	-0.0422	50.5586	53.3168	2.6790
0.4203	1206	1.2639	1.3170	-0.0531	54.3992	57.3168	2.5717
0.5300	1150	1.3014	1.3599	-0.0585	58.1023	61.0186	2.4891
0.6284	1110	1.3330	1.3983	-0.0593	60.6140	64.3392	2.4057
0.7172	1062	1.3765	1.4329	-0.0564	64.3924	67.3358	2.2868
0.7980	1022	1.4141	1.4646	-0.0505	67.7045	70.0624	2.2031
0.8712	985	1.4574	1.4931	-0.0417	70.3854	72.5325	2.1244
0.9385	954	1.4892	1.5194	-0.0302	73.7819	74.8034	2.0481
1.000	918	1.5435	1.5435	0.0000	76.8790	76.8790	1.9950

Mole Fraction of $C_7H_6O_2$	Molar Volume (Exp.) ml./mole	Molar Volume (Add.) ml./mole	Inter-molecular Free Length (Exp.) A^0	Inter-molecular Free Length (Add.) A^0	Viscosity (Exp.) C.P.	Viscosity (Add.) C.P.	Available Volume (Exp.) ml./mole	Available Volume (Add.) ml./mole
0.000	105.81	105.81	0.4144	0.4144	1.9084	1.9084	12.0539	12.0539
0.1576	106.87	104.85	0.4312	0.4361	1.7640	1.7603	17.2337	16.8566
0.2969	107.23	104.00	0.4486	0.4555	1.6385	1.6292	22.1169	21.0160
0.4203	107.16	103.27	0.4653	0.4727	1.5261	1.5136	26.3899	24.8622
0.5300	106.77	102.61	0.4804	0.4878	1.4545	1.4106	30.0311	28.2052
0.6284	106.13	102.01	0.4912	0.5015	1.3475	1.3182	32.5024	31.2039
0.7172	105.30	101.48	0.5063	0.5138	1.2460	1.2348	35.4089	33.9100
0.7980	104.29	101.29	0.5192	0.5251	1.1685	1.1589	37.6439	36.3723
0.8712	103.26	100.55	0.5312	0.5352	1.0978	1.0903	39.6932	38.6031
0.9385	102.20	100.14	0.5420	0.5445	1.0315	1.0270	41.2668	39.9128
1.000	99.77	99.77	0.5532	0.5532	0.9694	0.9694	42.5283	42.5283

Table 2
Thermo Acoustic parameter of
Salicylaldehyde + Carbon Tetra Chloride at Temp. 308.15 K

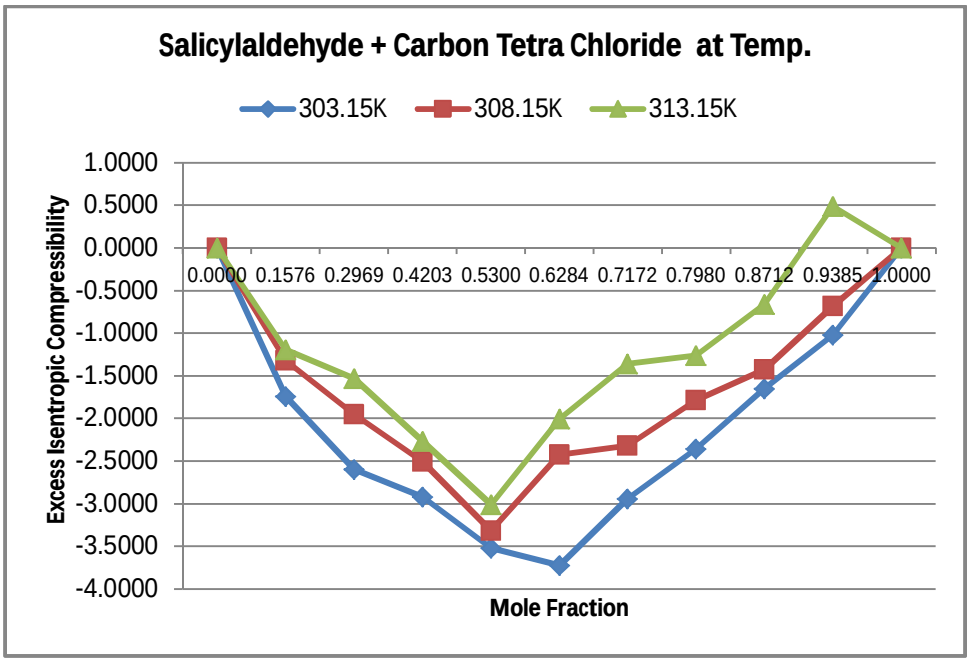
Mole Fraction of $C_7H_6O_2$	Ultrasound Velocity (m/sec.)	Density (gm/mol)	Density (add.) gm/ml.	Density (excess) gm/ml.	Isentropic Compressibility (Exp.) $cm^2/dyne.10^{12}$	Isentropic Compressibility (add.) $cm^2/dyne.10^{12}$	Sear's Relaxation Time
0.000	1398	1.1391	1.1391	0.0000	44.9183	44.9183	2.4744
0.1576	1317	1.1698	1.1990	-0.0292	49.2852	50.6038	2.3466
0.2969	1245	1.2019	1.2521	-0.0502	53.6775	55.6292	2.2384
0.4203	1184	1.2390	1.2990	-0.0600	57.5738	60.0811	2.1461
0.5300	1136	1.2761	1.3407	-0.0646	60.7237	64.0387	2.0732
0.6284	1086	1.3132	1.3782	-0.0680	65.1655	67.5886	2.0049
0.7172	1040	1.3503	1.4121	-0.0618	68.4704	70.7921	1.9089
0.7980	1005	1.3781	1.4428	-0.0647	71.8434	73.7070	1.8246
0.8712	970	1.4245	1.4707	-0.0462	74.9181	76.3478	1.7699
0.9385	932	1.4616	1.4963	-0.0347	78.0943	78.7758	1.7044
1.000	904	1.5198	1.5198	-0.0000	80.9946	80.9946	1.6548

Mole Fraction of $C_7H_6O_2$	Molar Volume (Exp.) ml./mole	Molar Volume (Add.) ml./mole	Inter-molecular Free Length (Exp.) A^0	Inter-molecular Free Length (Add.) A^0	Viscosity (Exp.) C.P.	Viscosity (Add.) C.P.	Available Volume (Exp.) ml./mole	Available Volume (Add.) ml./mole
0.000	107.10	107.10	0.4265	0.4265	1.6292	1.6292	13.5216	13.5216
0.1576	108.60	106.19	0.4468	0.4494	1.5045	1.5018	19.2090	18.3372
0.2969	109.41	105.39	0.4653	0.4698	1.3968	1.3893	24.2754	22.5541
0.4203	109.32	104.65	0.4829	0.4879	1.2991	1.2896	28.4236	26.3644
0.5300	108.89	104.04	0.4959	0.5039	1.2185	1.0201	31.3825	29.7164
0.6284	108.21	103.47	0.5138	0.5183	1.1451	1.1216	34.6284	32.7232
0.7172	107.34	102.96	0.5266	0.5314	1.0603	1.0498	37.4701	35.4367
0.7980	107.05	102.49	0.5393	0.5431	0.9938	0.9845	39.8120	37.9056
0.8712	105.21	102.07	0.5509	0.5539	0.9319	0.9254	41.4292	40.1423
0.9385	104.01	101.58	0.5624	0.5637	0.8746	0.8710	43.4274	42.1987
1.000	101.32	101.32	0.5728	0.5728	0.8215	0.8215	44.0781	44.0781

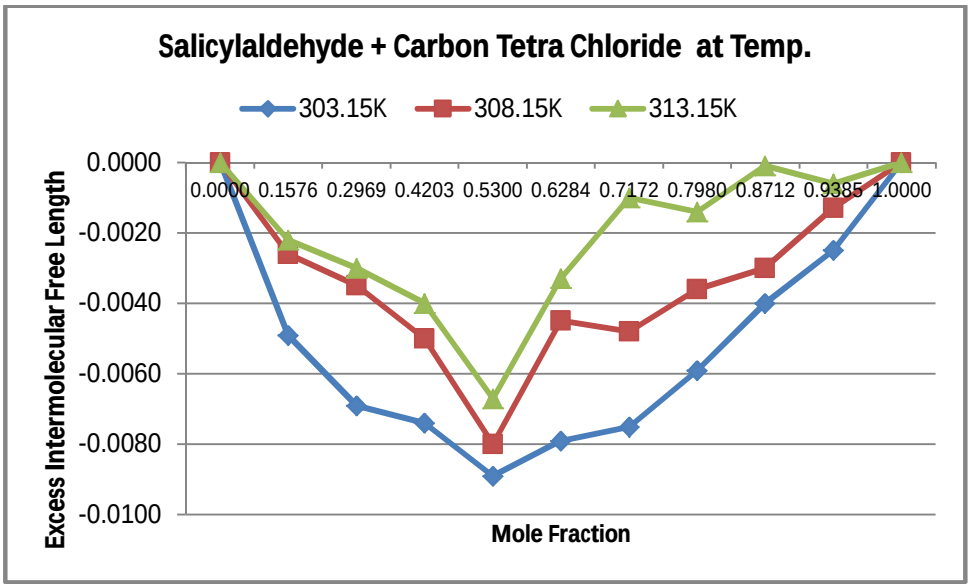
Table 3
Thermo Acoustic parameter of
Salicylaldehyde + Carbon Tetra Chloride at Temp. 313.15 K

Mole Fraction of $C_7H_6O_2$	Ultrasound Velocity (m/sec.)	Density (gm/mol)	Density (add.) gm/ml.	Density (excess) gm/ml.	Isentropic Compressibility (Exp.) $cm^2/dyne.10^{12}$	Isentropic Compressibility (add.) $cm^2/dyne.10^{12}$	Sear's Relaxation Time
0.000	1390	1.1226	1.1226	0.0000	46.1047	46.1047	2.1347
0.1576	1307	1.1550	1.1834	-0.0284	50.6835	51.8759	2.0240
0.2969	1230	1.1921	1.2373	-0.0452	54.1188	56.9771	1.9353
0.4203	1172	1.2292	1.2849	-0.0557	59.2273	61.4976	1.8626
0.5300	1124	1.2663	1.3274	-0.0511	62.5073	65.5145	1.7790
0.6284	1070	1.3033	1.3654	-0.0621	67.0174	69.1177	1.7160
0.7172	1025	1.3404	1.3997	-0.0593	71.0097	72.3693	1.6420
0.7980	987	1.3775	1.4309	-0.0534	74.0692	75.3279	1.5743
0.8712	956	1.4196	1.4592	-0.0446	77.8360	78.0084	1.5138
0.9385	928	1.4517	1.4777	-0.0266	79.9884	80.4728	1.4557
1.000	895	1.5091	1.5091	0.0000	82.7248	82.7248	1.4189

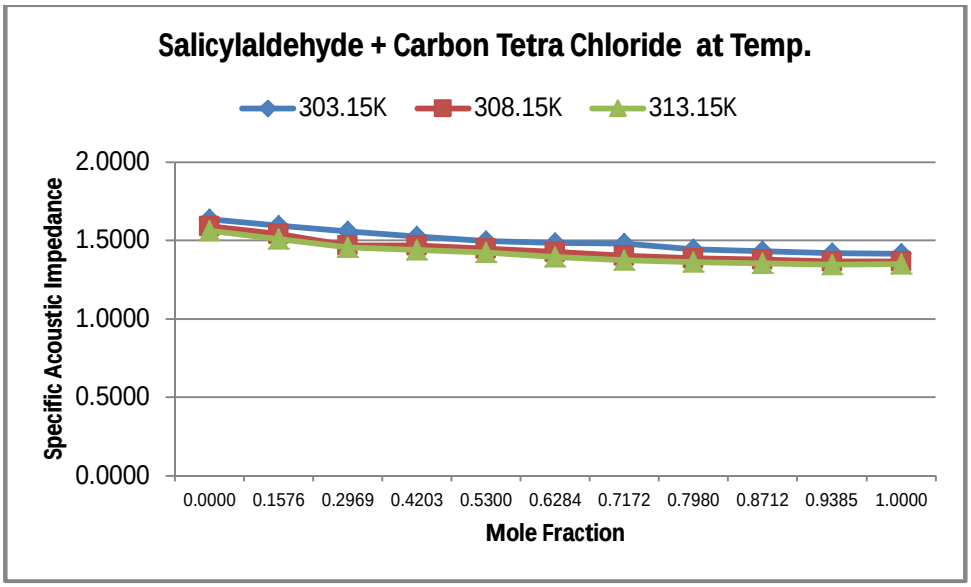
Mole Fraction of $C_7H_6O_2$	Molar Volume (Exp.) ml./mole	Molar Volume (Add.) ml./mole	Inter-molecular Free Length (Exp.) A^0	Inter-molecular Free Length (Add.) A^0	Viscosity (Exp.) C.P.	Viscosity (Add.) C.P.	Available Volume (Exp.) ml./mole	Available Volume (Add.) ml./mole
0.000	108.67	108.67	0.4359	0.0000	1.4262	1.4262	14.2637	14.2637
0.1576	109.99	107.63	0.4570	0.4592	1.3143	1.3125	20.1426	19.1020
0.2969	110.31	106.70	0.4722	0.4797	1.2176	1.2120	26.1986	23.3786
0.4203	110.19	105.89	0.4940	0.4980	1.1365	1.1230	29.4766	27.1669
0.5300	109.73	105.16	0.5075	0.5142	1.0537	1.0440	32.6467	30.5348
0.6284	109.03	104.51	0.5255	0.5288	0.9875	0.9730	36.1166	33.5556
0.7172	108.14	103.92	0.5409	0.5419	0.9188	0.9090	38.8655	36.2818
0.7980	107.10	103.38	0.5525	0.5539	0.8572	0.8507	40.8334	38.7624
0.8712	105.95	102.90	0.5646	0.5647	0.8026	0.7979	42.5801	41.0097
0.9385	104.72	102.45	0.5741	0.5747	0.7521	0.7495	43.9852	43.0759
1.000	102.04	102.04	0.5839	0.5839	0.7052	0.7052	44.9646	44.9646



Excess Isentropic Compressibility Vs. Mole Fraction
Fig. 1



Excess Intermolecualr Free Length Vs. Mole Fraction
Fig. 2



Specific Acoustic Impedance Vs. Mole Fraction
Fig. 3

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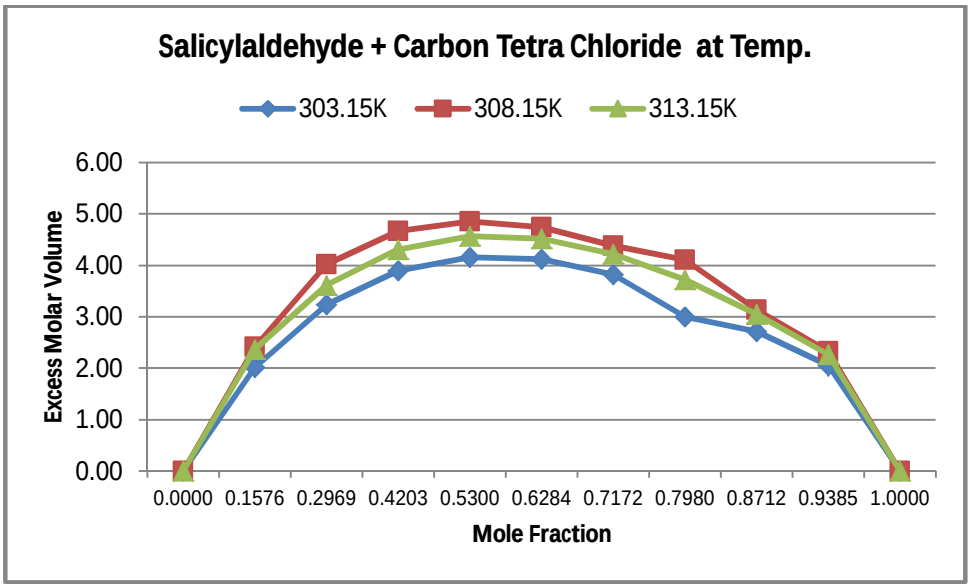
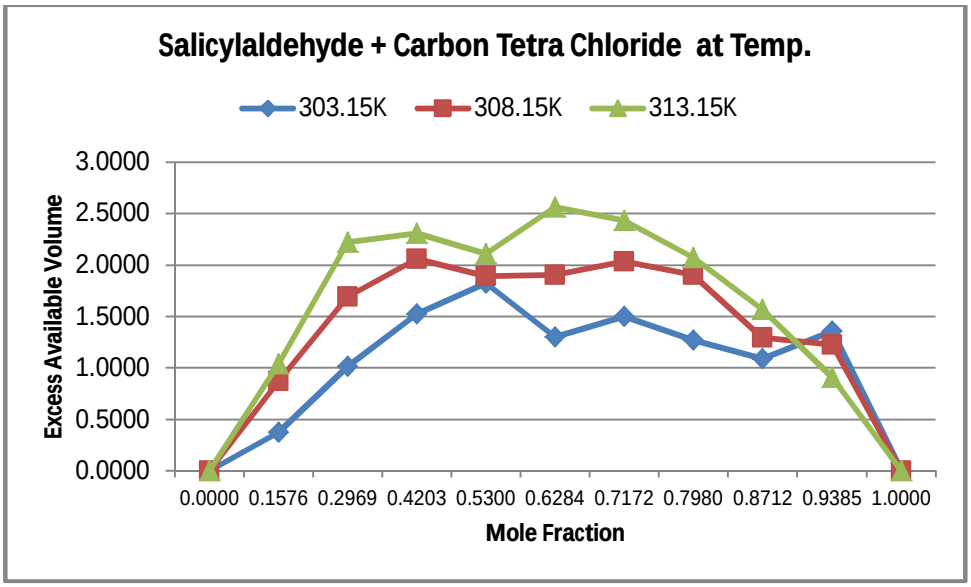


Excess Molar Volume Vs. Mole Fraction
Fig. 4



Excess Available Volume Vs. Mole Fraction
Fig. 5

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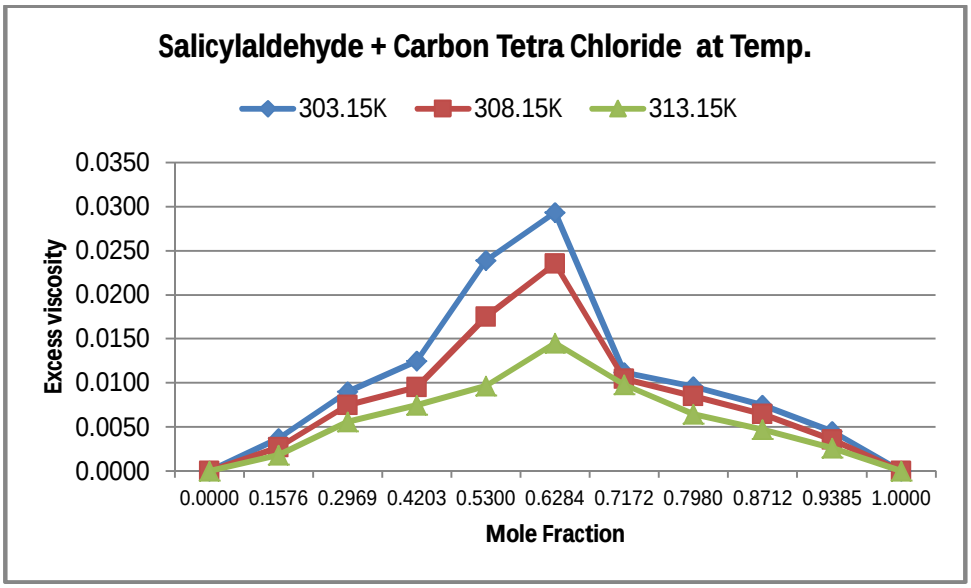
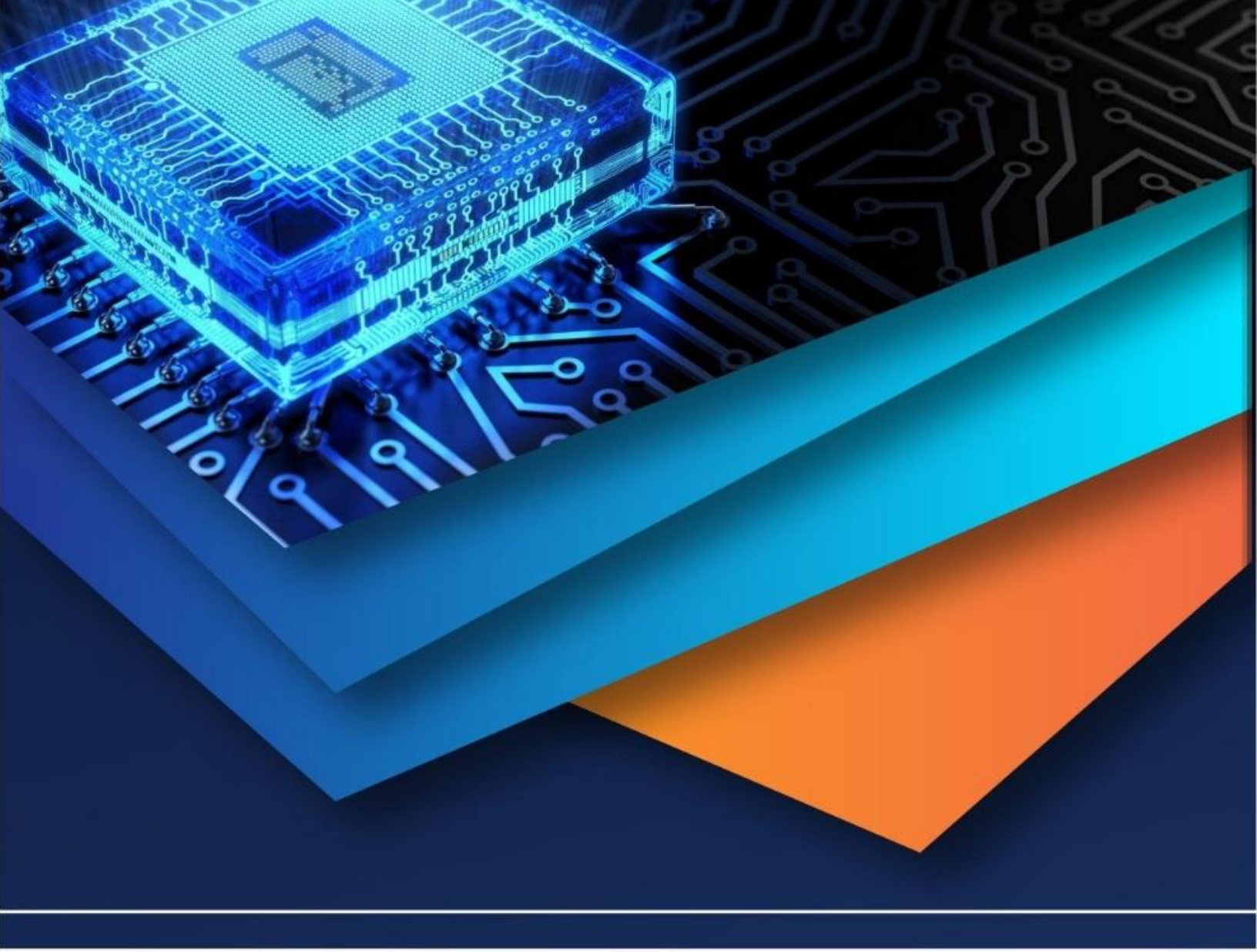


Excess Viscosity Vs. Mole Fraction
Fig. 6



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