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Study of Solute-Solvent Interaction of Some Pesticide-Monochrotophos with Aqueous Organic Sovlents

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Ultrasonic velocity, density and viscosity measurements have been used to calculate isentropic compressibility (β_s), intermolecular free length (L_f), ultrasound velocity (V), density (ρ), excess viscosity (η), specific acoustic impedance (Z), Rao's constant (R), Shear's relaxation time (τ_s), apparent molal adiabatic compressibility (ξ_k) and excess values (A^E) of solutions of pesticides-monochrotophos in aqueous organic solvents such as benzene and toluene. In each case, ultrasound velocity decreases and isentropic compressibility (β_s) intermolecular free length (L_f), density (ρ) and viscosity increases with the increases in molar concentration of monochrotophos. As usual apparent molal adiabatic compressibility (ξ_k) has been found to be negative in both cases. The results have been interpreted in terms of ion-solvent interaction on the basis of acoustic properties.

Key Words: Solute solvent interaction, Monochrotophos, Benzene, Toluene, Pesticides.

INTRODUCTION

Pesticides are chemicals and biological material which are used by mean to reduce pest organisms[1]. The greatest use of pesticides in any country is for agriculture and forest pest control[2]. Pesticides are vital for increasing the agriculture yield by reducing crop losses and insuring optimum utilization of fertilizers and seeds[3]. Present work covers and extensive survey of physico-chemical and solvolytic studies of some pesticides-monochrotophos in aqueous organic solvents such as benzene and toluene systems studied at various temperature (25, 30 and 35 ºC)[4]. Lagemann and Dunbar[5] was the first point out the sound velocity approach for qualitative determination of the degree of association in liquids, to study the behaviour of binary liquid mixtures by measuring the sound velocity and related properties[6].

The compressibility of the dilute aqueous solution of pesticides increases with increasing concentration of the dissolved ions with water molecules[7,8]. Present work is reporting the finding of a study of a ultrasound velocity, density and viscosity measurement to calculate isentropic compressibility (β_s), intermolecular free length (L_f), molar volume (M_V), Rao,s constant (R), apparent molar adiabatic compressibility (ξ_k), shear,s relaxation time (τ_s) of pesticides in solvent[9,10].

A continuous wave interferometric technique was employed for the measurement of ultrasonic velocity. The density and viscosity were determined using a vibrating densitometer. The experiment was repeated at least twice and results were reproducible with experimental error of 0.0002 kg m^{-3} and 0.0002 mPas, respectively.

Details of various physical parameters

$$\beta_s = \left[\frac{1}{(V^2 \cdot \rho)}\right]$$

$$Z = [V \cdot \rho \cdot 10^3]$$

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

$$R = \left[\frac{M}{\rho} \cdot V^{1/3}\right]$$

$$R_A = \left(\frac{\rho}{\rho_0}\right) \cdot \left(\frac{v_0}{v}\right)^{1/3}$$

$$\xi_k = \frac{1000}{(c \cdot \rho_o)}(\rho_o \beta_s - \beta_s o \cdot \rho) + \left(\beta_s o \cdot \frac{M}{\rho_o}\right)$$

$$\tau_s = \frac{4}{3} \cdot \eta \cdot \beta_s$$

$$S_n = \frac{n_1}{n_2}\left[1 - \frac{\beta_s}{\beta_s o}\right]$$

where, V = ultrasound velocity, Z = specific acoustic impedance, β_s = isentropic compressibility, L_f = intermolecular free length, R = molar sound velocity, R_A = relative association, τ_s = shear's relaxation time, ξ_k = apparent molal compressibility and S_n = solvation number.

While ρ_o and β_so are density and compressibility of pure solvent and ρ and ρ_s are the density and compressibility of the solution, respectively. C is the concentration in mol/L of solute, M is the molecular weight of solute and n_1 and n_2 are the moles of solute and solvent, respectively[11-14].

RESULTS AND DISCUSSION

Present work covers an extensive survey of physico-chemical and solvolytic study of some pesticides (monochrotophose) in aqueous organic solvent such as benzene and toluene. All the system studied at various temperatures (25, 30 and 35 ºC). We have reported ultrasound velocity (v), density (ρ) and viscosity (η), of binary liquid mixture. With the help of experimental data, the following thermodynamic and acoustic properties like isentropic compressibility (β_s), intermolecular free length (L_f), molar volume (M_V), available volume (Va), shear's relaxation time (τ_s) have been calculated.

The positive excess compressibility and negative viscosity concluded the non specific interaction between the molecules of monochrotophos in binary solvents. The excess intermolecular free length also being positive observed which also support the non specific interaction between the unlike molecules. The excess molar volume and available volume reported in the Tables 1-6 as well as on Figs. 1-4. The continuos observation of above binary parameters also given the comparative conclusion of results. The positive excess compressibility increases from benzene to toluene.

The reported structure of monochrotophos pesticides, although has two ketonic group with oxy-methyl and fullfilled nitrogen atom so pesticides must be in position to interact with unlike molecule benzene and methyl group of toluene. It will

TABLE-1
MONOCROTOPHOS + BENZENE AT 25 ± 0.05 ºC

Conc. (c)	V	ρ	Z	β_s	β_so	β_s- $\beta_{sO/C}$	L_f	η	η_{sp}	η- η_{sp}/C	M_V	R	τ_s
0.0000	1290	0.8734	1.1267	68.80	68.80	0.00	0.5233	0.5976	0.5976	0.0000	89.44	9.73	0.55
0.0423	1268	0.8789	1.1144	70.77	69.93	0.83	0.5308	0.5976	0.5992	-0.0058	87.07	9.37	0.56
0.0905	1246	0.8849	1.1020	72.83	71.22	1.61	0.5385	0.5934	0.6010	-0.0072	84.38	8.99	0.58
0.1457	1224	0.8899	1.0892	75.01	72.70	2.31	0.5464	0.5938	0.6030	-0.0086	81.29	8.56	0.59
0.2097	1202	0.8954	1.0763	77.30	74.40	2.89	0.5547	0.5944	0.6054	-0.0090	77.71	8.10	0.61
0.2846	1180	0.9009	1.0631	79.72	76.41	3.31	0.5633	0.5964	0.6082	-0.0085	73.52	7.59	0.63
0.3738	1158	0.9064	1.0496	82.27	78.79	3.48	0.5723	0.5997	0.6115	-0.0072	68.53	7.01	0.66
0.4814	1136	0.9119	1.0359	84.98	81.67	3.31	0.5816	0.6043	0.6155	-0.0056	62.50	6.35	0.68
0.6141	1114	0.9174	1.0220	87.84	85.21	2.62	0.5913	0.6099	0.6204	0.0040	55.08	5.56	0.71
0.7817	1092	0.9229	1.0078	90.87	89.69	1.18	0.6014	0.6164	0.6267	-0.0025	45.70	4.61	0.75
1.0000	1062	0.9282	0.9857	95.52	95.52	0.00	0.6167	0.6348	0.6348	0.0000	33.48	0.54	1.62

TABLE-2
MONOCROTOPHOS + BENZENE AT 30 ± 0.05 ºC

Conc. (c)	V	ρ	Z	β_s	β_so	β_s- $\beta_{s/C}$	L_f	η	η_{sp}	η- η_{sp}/C	M_V	R	τ_s
0.0000	1275	0.8682	1.1070	70.85	70.85	0.00	0.5357	0.5684	0.5684	0.0000	89.98	9.75	0.54
0.0423	1253	0.8725	1.0932	73.00	72.07	0.93	0.5438	0.5684	0.5707	-0.0035	87.25	9.40	0.55
0.0905	1231	0.8768	1.0793	75.26	73.45	1.81	0.5521	0.5673	0.5734	-0.0055	84.24	9.03	0.57
0.1457	1209	0.8811	1.0652	77.65	75.04	2.61	0.5608	0.5679	0.5764	-0.0074	80.88	8.61	0.59
0.2097	1187	0.8854	1.0510	80.16	76.88	3.28	0.5698	0.5690	0.5800	-0.0078	77.09	8.16	0.61
0.2846	1165	0.8897	1.0365	82.81	79.03	3.78	0.5792	0.5722	0.5841	-0.0073	72.76	7.65	0.63
0.3738	1143	0.8940	1.0218	85.62	81.59	4.03	0.5889	0.5769	0.5890	-0.0059	67.72	7.08	0.66
0.4814	1121	0.8983	1.0070	88.59	84.69	3.90	0.5990	0.5831	0.5950	-0.0047	61.75	6.41	0.69
0.6141	1099	0.9026	0.9920	91.73	88.50	3.23	0.6096	0.5903	0.6023	-0.0031	54.54	5.63	0.72
0.7817	1077	0.9069	0.9767	95.06	93.31	1.75	0.6205	0.5992	0.6116	-0.0014	45.59	4.67	0.76
1.0000	1050	0.9108	0.9563	99.59	99.59	0.00	0.6351	0.6236	0.6236	0.0000	34.12	3.47	0.83

TABLE-3
MONOCROTOPHOS + BENZENE AT 35 ± 0.05 ºC

Conc. (c)	V	ρ	Z	β_s	β_so	β_s- $\beta_{s/C}$	L_f	η	η_{sp}	η- η_{sp}/C	M_V	R	τ_s
0.0000	1260	0.8620	1.0861	73.07	73.07	0.00	0.5483	0.5154	0.5154	0.0000	90.63	9.78	0.50
0.0423	1238	0.8655	1.0715	75.39	74.34	1.04	0.5569	0.5170	0.5194	-0.0024	87.96	9.44	0.52
0.0905	1216	0.8691	1.0567	77.82	75.79	2.04	0.5659	0.5194	0.5240	-0.0046	85.00	9.07	0.54
0.1457	1194	0.8725	1.0418	80.39	77.44	2.95	0.5751	0.5228	0.5293	-0.0065	81.68	8.66	0.56
0.2097	1172	0.8760	1.0267	83.11	79.36	3.75	0.5848	0.5285	0.5354	-0.0069	77.92	8.21	0.59
0.2846	1150	0.8795	1.0114	85.97	81.61	4.37	0.5948	0.5366	0.5426	-0.0060	73.60	7.70	0.62
0.3738	1128	0.8830	0.9960	89.01	84.28	4.73	0.6052	0.5462	0.5511	-0.0049	68.56	7.13	0.65
0.4814	1106	0.8865	0.9805	92.22	87.51	4.71	0.6160	0.5575	0.5613	-0.0038	62.58	6.46	0.69
0.6141	1084	0.8900	0.9648	95.62	91.49	4.13	0.6272	0.5716	0.5740	-0.0024	55.32	5.68	0.73
0.7817	1062	0.8935	0.9489	99.23	96.51	2.72	0.6390	0.5892	0.5900	-0.0008	46.28	4.72	0.78
1.0000	1040	0.8971	0.9330	103.06	103.06	0.00	0.6512	0.6108	0.6108	0.0000	34.64	3.50	0.84

TABLE-4
MONOCROTOPHOS + TOLUENE AT 25 ± 0.05 ºC

Conc. (c)	V	ρ	Z	β_s	$\beta_s o$	$\beta_s - \beta_{s/C}$	L_f	η	η_{sp}	$\eta - \eta_{sp}/C$	M_V	R	τ_s
0.0000	1304	0.8626	1.1248	68.18	68.18	0.00	0.5210	0.5528	0.5528	0.0000	106.65	11.67	0.50
0.0423	1280	0.8684	1.1116	70.28	69.14	1.14	0.5290	0.5512	0.5557	-0.0046	111.43	12.10	0.52
0.0905	1256	0.8742	1.0980	72.51	70.26	2.25	0.5373	0.5521	0.5591	-0.0070	116.75	12.59	0.53
0.1457	1232	0.8800	1.0842	74.87	71.57	3.30	0.5459	0.5544	0.5630	-0.0085	123.02	13.19	0.55
0.2097	1208	0.8858	1.0700	77.36	73.11	4.25	0.5550	0.5579	0.5676	-0.0097	130.49	13.89	0.58
0.2846	1184	0.8916	1.0557	80.01	74.96	5.04	0.5644	0.5625	0.5731	-0.0106	139.51	14.76	0.60
0.3738	1160	0.8974	1.0410	82.81	77.23	5.58	0.5742	0.5684	0.5800	-0.0116	150.62	15.82	0.63
0.4814	1136	0.9032	1.0260	85.79	80.07	5.72	0.5844	0.5760	0.5885	-0.0125	164.59	17.17	0.66
0.6141	1112	0.9090	1.0108	88.97	83.74	5.23	0.5951	0.5867	0.5995	-0.0128	182.67	18.92	0.70
0.7817	1088	0.9148	0.9953	92.35	88.64	3.71	0.6063	0.6031	0.6141	-0.0110	206.93	21.28	0.74
1.0000	1062	0.9282	0.9857	95.52	95.52	0.00	0.6167	0.6348	0.6348	0.0000	239.17	24.40	0.81

TABLE-5
MONOCROTOPHOS + TOLUENE AT 30 ± 0.05 ºC

Conc. (c)	V	ρ	Z	β_s	$\beta_s o$	$\beta_s - \beta_{s/C}$	L_f	η	η_{sp}	$\eta - \eta_{sp}/C$	M_V	R	τ_s
0.0000	1282	0.8576	1.0994	70.95	70.95	0.00	0.5361	0.5342	0.5342	0.0000	98.15	10.66	0.00
0.0423	1260	0.8632	1.0876	72.97	71.96	1.01	0.5437	0.5339	0.5374	-0.0035	103.16	11.14	0.00
0.0905	1238	0.8688	1.0756	75.10	73.13	1.97	0.5515	0.5352	0.5410	-0.0058	108.97	11.70	-0.01
0.1457	1216	0.8744	1.0633	77.34	74.50	2.85	0.5597	0.5381	0.5453	-0.0072	115.80	12.36	-0.01
0.2097	1194	0.8800	1.0507	79.71	76.11	3.60	0.5682	0.5421	0.5503	-0.0083	123.90	13.14	-0.01
0.2846	1172	0.8856	1.0379	82.21	78.05	4.15	0.5771	0.5472	0.5564	-0.0092	133.67	14.09	-0.01
0.3738	1150	0.8912	1.0249	84.85	80.43	4.41	0.5862	0.5536	0.5638	-0.0102	145.66	15.26	-0.01
0.4814	1128	0.8968	1.0116	87.64	83.41	4.23	0.5958	0.5622	0.5731	-0.0109	160.72	16.73	-0.01
0.6141	1106	0.9024	0.9981	90.59	87.24	3.35	0.6058	0.5739	0.5851	-0.0111	180.18	18.63	-0.01
0.7817	1084	0.9080	0.9843	93.73	92.37	1.35	0.6162	0.5920	0.6011	-0.0091	206.26	21.18	-0.01
1.0000	1050	0.9108	0.9563	99.59	99.59	0.00	0.6351	0.6236	0.6236	0.0000	243.74	24.77	0.00

TABLE-6
MONOCROTOPHOS + TOLUENE AT 35 ± 0.05 ºC

Conc. (c)	V	ρ	Z	β_s	$\beta_s o$	$\beta_s - \beta_{s/C}$	L_f	η	η_{sp}	$\eta - \eta_{sp}/C$	M_V	R	τ_s
0.0000	1263	0.8416	1.0629	74.49	74.49	0.00	0.5536	0.5084	0.5084	0.0000	100.01	10.81	0.00
0.0423	1242	0.8471	1.0521	76.53	75.50	1.03	0.5611	0.5096	0.5120	-0.0024	105.12	11.30	0.00
0.0905	1220	0.8526	1.0402	78.80	76.67	2.14	0.5694	0.5121	0.5162	-0.0041	111.04	11.86	0.00
0.1457	1198	0.8581	1.0280	81.20	78.03	3.17	0.5780	0.5158	0.5211	-0.0053	117.99	12.53	-0.01
0.2097	1176	0.8636	1.0156	83.73	79.64	4.09	0.5869	0.5205	0.5269	-0.0063	126.25	13.32	-0.01
0.2846	1154	0.8691	1.0029	86.40	81.58	4.82	0.5962	0.5266	0.5338	-0.0073	136.20	14.28	-0.01
0.3738	1132	0.8746	0.9900	89.23	83.95	5.28	0.6059	0.5342	0.5423	-0.0081	148.43	15.47	-0.01
0.4814	1110	0.8801	0.9769	92.22	86.92	5.30	0.6160	0.5441	0.5530	-0.0089	163.77	16.95	-0.01
0.6141	1088	0.8856	0.9635	95.39	90.75	4.64	0.6265	0.5573	0.5667	-0.0094	183.60	18.88	-0.01
0.7817	1066	0.8911	0.9499	98.76	95.86	2.89	0.6374	0.5786	0.5850	-0.0064	210.18	21.47	-0.01
1.0000	1040	0.8971	0.9330	103.06	103.06	0.00	0.6512	0.6108	0.6108	0.0000	247.46	25.07	0.00

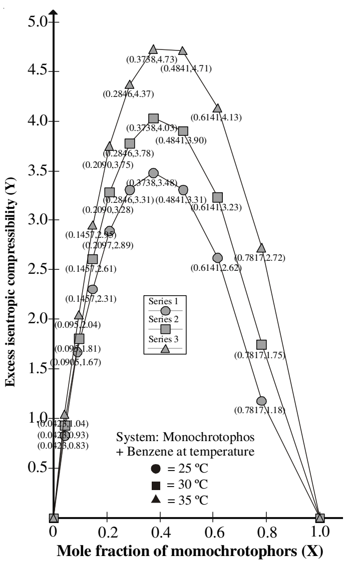

Fig. 1. Excess isentropic compressibility *versus* mole fraction of monocrotophore + benzene

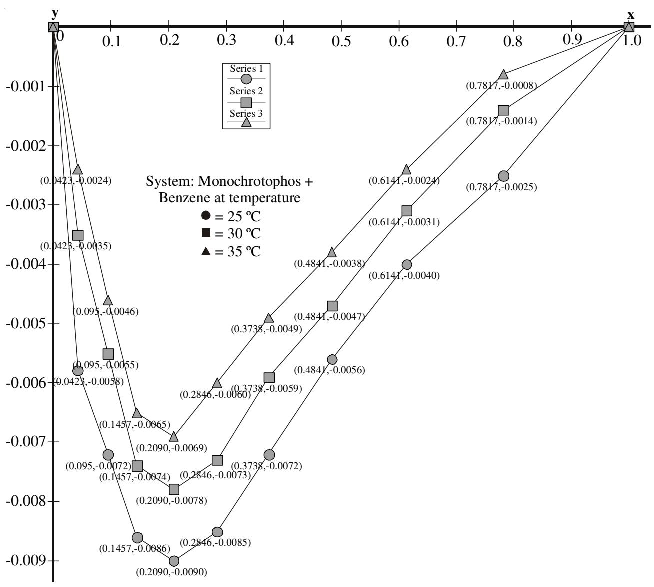

Fig. 2. Lowering viscosity *vs.* mole fraction ion of monocrotophore + benzene

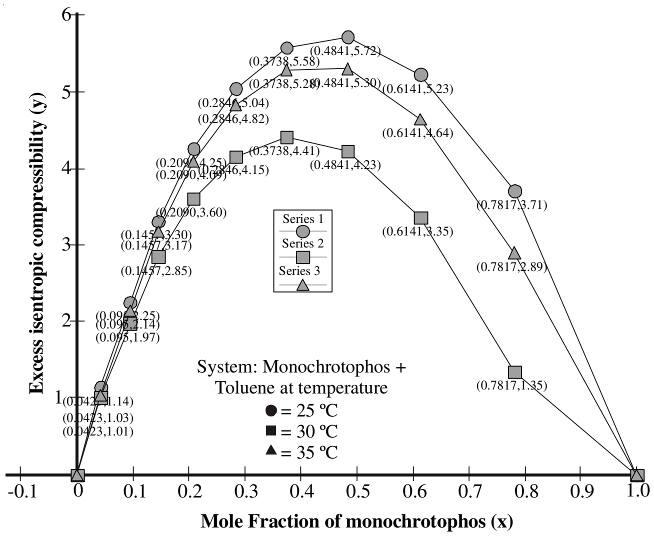

Fig. 3. Excess isentropic compressibility *versus* mole fraction of monocrotophore + toluene

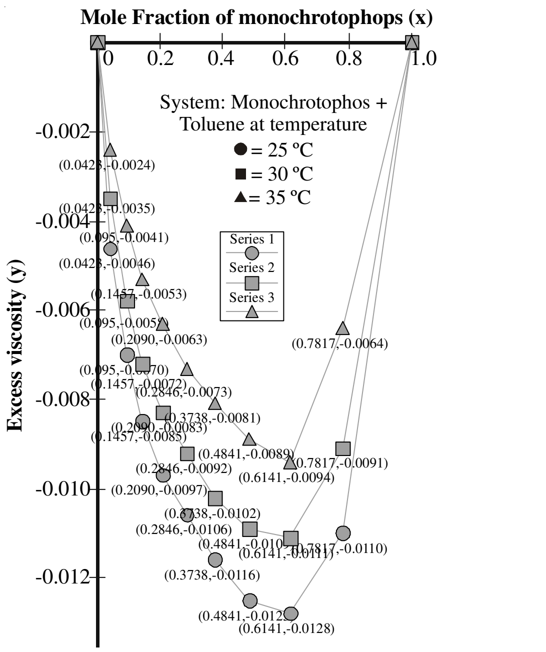

Fig. 4. Lowering viscosity *vs.* mole fraction of monocrotophore + toluene

be possible that slight interaction may be possible due to ketonic group of pesticides and dipolar nature of non-polar solvents like benzene and toluene. It is possible that associating nature of ketonic group of pesticide activate the non polar group and molecules of unlike molecules so that least interaction with induced group or molecules. The above facts also observed in toluene because the positive excess compressibility is highest in toluene and least in benzene.

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