Apparent molar volumes and viscosity B coefficients of Atrazine pesticide in binary liquid mixtures of DMF and DMSO at different temperatures.

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Abstract:

To study apparent molar volumes (ϕ_v) and viscosity B-coefficients for Atrazine in binary mixture of Dimethyl formamide (DMF) and Dimethyl sulphoxide (DMSO). The density (ρ) and viscosity (η) at 298.15 to 313.15 K were determined by using a bicapillary pycnometer and Ubbelohde viscometer respectively. The density data were analyzed in terms of limiting apparent molar volume (ϕ_v^o) and experimental slopes (S_v) obtained from Masson equation. The viscosity data were analyzed in term of A and B coefficient obtained from Jone-Dole equation. The evaluated parameters were interpreted in terms of different interactions exists therein. The positive values of Jones-Dole coefficient 'B' indicate strong interactions between solute and solvent at high temperature. The Masson's equations and Jones-Dole equations were found to be obeyed for selected concentration of pesticide Atrazine in DMF + DMSO binary liquid mixture. The physicochemical properties of Atrazine play important role in the design of new pesticides as well as therapeutic agents.

Keywords: Apparent molar volume, B-coefficient, density, viscosity, pesticide Atrazine.

INTRODUCTION:

It is known that ever growing use of pesticides in the agricultural sector has cause several environmental problems. Pesticides residues or their toxic metabolites may be detected in the lipid portion of such fluids as milk and blood serum. In the case of certain lipophilic organochlorine pesticides, residues of the parent compound or metabolites are assimilated and stored in the lipid portion of adipose tissues[1]. India is ranked only 2nd in Asia and 12th in the world in pesticides production. Unfortunately, 2- 3% of pesticide is actually utilized and the rest persists in soil and water causing environmental pollution leading to toxicity. Thus, pesticide residues remain in top soil, leading to toxicity in the soil-water compartment. Pesticide residues existing in the soil-water environment are causing harmful effects on biota and entering into the food chain[2]. Insecticides like DDT, dialdrin and melathinin at high concentration showed toxicity to nitrifying bacteria and retard the nitrification activity[3].

Atrazine is one of most effective and inexpensive herbicides so it used more commonly. The atrazine herbicides (2-chlorce-4-ethylamino-6-isopropylamino-s-triazine) were introduced in 1950. Atrazine used to control broad leaved weeds and annual grasses in selected vegetables, sugarcane, fruit orchards, grassland and forestry. Atrazine is most widely used herbicides in the India[4]. Atrazine inhibits the growth of target weed by disturbing the function of photosynthesis[5-7].

The atrazine accumulated in soil depends on many factors such as type of soil, organic matter, pH and soil structure[8]. It effects on mechanism of soil reactions due to its more extensive properties, high water solubility, low bioconcentration factor[9] and persistence in soil with a half-life of more than 1 years[10-12]. The atrazine decreases the quantity of dissolve oxygen from water. Atrazine also effect on physiological process in aquatic animals. It effects on haematology and metabolism of fish[13-14].

The aim of the present study is to understand solute-solute and solute-solvent at different temperature.

MATERIAL AND METHODS:

Materials:

The chemicals DMSO and DMF employed were of analytical grade (E. Merck, Germany 99.5%), used without further purification. Pesticide atrazine was purified by standard methods and then used to prepare various solutions[15].

Density measurements:

The densities of the sample solutions were measured by using a bicapillary pycknometer (made of borosil glass) having a bulb capacity of ~ 15 mL at different temperatures. The pycknometer was calibrated by using triply distilled water.

Viscosity measurements:

The dynamic viscosities were evaluated by measuring flow time of solution using an Ubbelohde suspended-level viscometer, calibrated with water. Electronic digital stop watch with accuracy of 0.01 s was used for the flow time measurements. Viscosity values were determined using the relation [16, 17].

$$\eta_1/\eta_2 = \rho_1 t_1/\rho_2 t_2 \qquad (1)$$

Each term involved in the equation have their usual meaning.

RESULTS AND DISCUSSION:

The apparent molar volumes were calculated from density data using the following equation[18-20].

$$\Phi_V = [1000(\rho_0 - \rho)/C\rho_0] + [M/\rho_0] \qquad (2)$$

Where M, C, ρ and ρ0 are the molar mass of the Atrazine, concentration (mol. L^{-1}) and the densities of the solution and solvent, respectively. The apparent molar volume may be considered to be the sum of the geometric volume of the solute molecules and changes that occur in to the solution due to its interaction with solvent. The limiting partial molar volumes were evaluated by Masson equation[21] and experimental slope by least square method[22].

$$\Phi_v = \Phi_v^0 + S_v\sqrt{C} \qquad (3)$$

Where ϕ_v^0 is the limiting apparent molar volume and S_v a semi-empirical parameter which depends on the nature of solvent, solute and temperature.

The relative viscosities have been analysed by Jones-Dole equation[23].

$$(\eta_r - 1)/\sqrt{C} = A + B\sqrt{C} \qquad (4)$$

Where $\eta_r = (\eta/\eta_o)$ is relative viscosity and η, η_o are viscosities of the solution and solvent respectively, C is molar concentration, A is the Falkenhagen coefficient which is the measure of solute-solute interactions[24] and B is the Jones-Dole coefficient which is the measure of solute - solvent interaction.

Moulik and Root parameters were evaluated by the following equations[25, 26].

$$\eta_r^2 = M + KC^2 \qquad (5)$$

$$(\rho - \rho_0)/C = R - SC^{1/2} \qquad (6)$$

The values of the densities (ρ), viscosities (η) and apparent molar volumes (ϕ_v) of Atrazine solution in binary liquid mixture of DMF and DMSO at 298.15, 303.15, 308.15 and 310.15 K temperature are shown in Table 1 to Table 4. The densities of Atrazine solution was increases with percentage of DMSO in the binary liquid mixture. The ϕ_v values of Atrazine pesticide for all the system are large and positive which indicate strong solute-solvent interaction[27, 28]. These ϕ_v values decrease with increase in concentrations of Atrazine in binary mixtures.

The plot of apparent molar volumes (ϕ_v) versus √C were found to be linear with negative slopes in different compositions of binary liquid mixture of DMF and DMSO and is shown in figure 1 at 298.15 K. Similar such plots were observed for Atrazine in different compositions of binary liquid mixture of DMF + DMSO solutions at 303.15, 308.15, and 313.15 K and are not shown to avoid repetition.

The limiting apparent molar volumes (ϕ_v^0) were calculated from the intercept of linear plots using equation (3). They are listed in table 5. The values provide information regarding the solute-solvent interactions. A close perusal of table 5, shows the positive values of limiting apparent molar volume (ϕ_v^0). The (ϕ_v^0) values decreases with an increase in percentage of DMSO in binary mixture DMF + DMSO and temperatures[29, 30]. S_v values for Atrazine were found to be negative and increases further with rise in temperatures. The S_v values are found to increase with increases in percentage of DMSO in binary mixture. This indicates increased solute-solute interactions. Negative values of S_v for the system illustrate weak solute-solute interactions in the solutions at all experimental temperatures.

The viscosities (η) increases with concentration and decreases with rise in temperature. This suggests the existence of molecular interactions occurring in the system. The viscosity data have been analyzed by using Jones -Dole equation (4). Figures 2 shows the variation of $(\eta_r\text{-}1)/C^{½}$ against $\sqrt{C}$ of Atrazine in binary liquid mixture of DMF + DMSO solution at 298.15 K. Similar such plots were observed for Atrazine in binary liquid mixture of DMF + DMSO solutions at 303.15, 308.15, and 313.15 K. The values of ‘A’ and ‘B’ coefficients are recorded in Table 5.

‘A’ values for Atrazine were found to be negative and decreases further with rise in temperatures. The ‘A’ values decreases with increase in percentage of DMSO in binary mixture of DMF and DMSO; thus indicate weak solute-solute interactions in the binary mixtures.

The viscosity ‘B’ coefficients are positive for all the composition of Atrazine in binary liquid mixture of DMF + DMSO solutions. Atrazine shows solute-solvent interactions was increases when both the percentage of DMSO in binary liquid mixture (DMF + DMSO) [31, 32] and with the rise in temperature, there by showing the solute-solvent interactions further improve with the increase in temperature[33]. All B-coefficients are positive; hence existing solute-solvent interaction are strong.

The values of ‘R’ and ‘S’ coefficients of Root’s equation are recorded in Table 6. The ‘R’ coefficients of Root’s equation for all compositions are negative. The ‘S’ coefficients of Root’s equation for all compositions are negative. The values of ‘M’ and ‘K’ coefficients of Maulik equation are tabulated in Table 6. ‘M’ and ‘K’ coefficients are positive in all solvent systems and temperatures. ‘M’ values are of low magnitudes and ‘K’ values are of higher magnitudes. These models support the existence solute-solute interactions.

Table (1): Concentration (C), Density (ρ), Viscosity (η), Apparent molar volume (ϕ_v) of Atrazine in DMF and 10% DMSO.

C/ mol/dm^3	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3. mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3. mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3. mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3. mol^{-1}**
DMF												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	0.94410	0.8076	222.82	0.94168	0.7658	217.04	0.93556	0.7182	209.94	0.93156	0.6845	207.98
0.0231	0.94419	0.8110	220.67	0.94182	0.7687	214.81	0.93577	0.7213	207.44	0.93178	0.6875	206.02
0.0329	0.94432	0.8151	218.80	0.94201	0.7734	212.93	0.93605	0.7258	205.24	0.93207	0.6915	204.17
0.0445	0.94454	0.8199	216.09	0.94229	0.7792	210.45	0.93643	0.7305	202.72	0.93247	0.6960	201.67
0.0577	0.94484	0.8268	213.41	0.94263	0.7851	208.46	0.93689	0.7368	200.58	0.93296	0.7011	199.41
0.0727	0.94518	0.8335	211.57	0.94309	0.7923	205.99	0.93747	0.7432	198.25	0.93355	0.7079	197.33
0.0894	0.94564	0.8419	209.28	0.94362	0.8003	204.01	0.93816	0.7503	196.05	0.93424	0.7146	195.46
0.1079	0.94622	0.8512	206.87	0.94433	0.8082	201.31	0.93892	0.7594	194.43	0.93512	0.7239	192.88
0.1281	0.94691	0.8623	204.57	0.94517	0.8184	198.73	0.93989	0.7693	192.04	0.93609	0.7339	190.86
0.1500	0.9477	0.874	202.1	0.9461	0.830	196.5	0.9410	0.780	189.6	0.9371	0.744	189.0

	5	4	3	1	2	1	2	3	2	8	1	1
10% DMSO												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	0.96063	0.8787	212.07	0.95812	0.8372	207.77	0.95178	0.7813	201.47	0.94778	0.7643	199.51
0.0231	0.96078	0.8825	209.67	0.95831	0.8410	205.26	0.95203	0.7846	198.91	0.94804	0.7674	197.47
0.0329	0.96099	0.8865	207.46	0.95856	0.8453	203.26	0.95235	0.7894	196.96	0.94839	0.7716	195.24
0.0445	0.96129	0.8920	204.90	0.95891	0.8512	200.76	0.95276	0.7949	195.03	0.94882	0.7767	193.49
0.0577	0.96169	0.8988	202.18	0.95935	0.8584	198.38	0.95327	0.8017	192.99	0.94935	0.7834	191.62
0.0727	0.96216	0.9064	200.07	0.95989	0.8660	196.15	0.95392	0.8097	190.54	0.95001	0.7908	189.47
0.0894	0.96272	0.9153	198.13	0.96054	0.8745	193.99	0.95468	0.8174	188.37	0.95078	0.8013	187.52
0.1079	0.96341	0.9256	195.99	0.96131	0.8839	191.87	0.95559	0.8284	186.06	0.95171	0.8103	185.29
0.1281	0.96422	0.9372	193.91	0.96219	0.8953	189.95	0.95662	0.8393	184.02	0.95278	0.8217	183.15
0.1500	0.96524	0.9492	191.31	0.96321	0.9074	188.00	0.95782	0.8517	181.85	0.95399	0.8332	181.15

Table (2): Concentration (C), Density (ρ), Viscosity (η), Apparent molar volume (ϕ_v) of Atrazine in 30% DMSO and 50% DMSO.

C/ mol/dm^3	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**
30% DMSO												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	0.99443	1.0326	194.83	0.99082	0.9922	192.86	0.98442	0.9091	188.70	0.98011	0.8031	186.14
0.0231	0.99466	1.0365	192.55	0.99107	0.9963	190.64	0.98472	0.9135	186.17	0.98042	0.8068	184.34
0.0329	0.99496	1.0414	190.65	0.99139	1.0017	188.90	0.98511	0.9195	183.96	0.98082	0.8122	182.60
0.0445	0.99537	1.0494	188.24	0.99181	1.0094	186.89	0.98559	0.9260	182.18	0.98133	0.8186	180.70
0.0577	0.99587	1.0577	186.10	0.99229	1.0172	185.56	0.98618	0.9335	180.26	0.98195	0.8258	178.76
0.0727	0.99651	1.0664	183.61	0.99293	1.0265	183.31	0.98687	0.9423	178.65	0.98269	0.8335	176.91
0.0894	0.9972	1.076	181.63	0.9937	1.037	180.61	0.9877	0.952	176.23	0.9835	0.843	174.96

	4	2		4	0		5	4		7	3	
0.1079	0.99812	1.0895	179.47	0.99456	1.0474	179.29	0.98879	0.9642	173.78	0.98461	0.8528	172.85
0.1281	0.99922	1.1025	176.74	0.99561	1.0627	177.08	0.98998	0.9778	171.50	0.98581	0.8645	170.75
0.1500	1.00046	1.1163	174.31	0.99682	1.0769	174.88	0.99131	0.9914	169.46	0.98717	0.8782	168.72
50% DMSO												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	1.02705	1.2208	179.57	1.02247	1.1232	178.43	1.01628	1.0416	174.28	1.01247	1.0001	172.96
0.0231	1.02736	1.2262	177.18	1.02279	1.1283	176.28	1.01664	1.0462	172.25	1.01284	1.0042	171.19
0.0329	1.02776	1.2327	175.08	1.02321	1.1350	174.14	1.01709	1.0537	170.72	1.01332	1.0109	169.27
0.0445	1.02827	1.2422	173.08	1.02373	1.1433	172.33	1.01765	1.0625	169.18	1.01391	1.0193	167.60
0.0577	1.02889	1.2518	171.09	1.02435	1.1534	170.68	1.01839	1.0707	166.44	1.01462	1.0286	165.87
0.0727	1.02967	1.2634	168.69	1.02513	1.1641	168.51	1.01918	1.0815	165.21	1.01546	1.0385	164.21
0.0894	1.03055	1.2756	166.84	1.02605	1.1764	166.39	1.02015	1.0937	163.34	1.01649	1.0504	161.98
0.1079	1.03166	1.2907	164.22	1.02709	1.1893	164.61	1.02129	1.1068	161.33	1.01764	1.0635	160.20
0.1281	1.03291	1.3063	161.95	1.02829	1.2048	162.77	1.02268	1.1210	158.69	1.01895	1.0786	158.44
0.1500	1.03432	1.3242	159.83	1.02971	1.2217	160.55	1.02421	1.1358	156.49	1.02045	1.0951	156.56

Table (3): Concentration (C), Density (ρ), Viscosity (η), Apparent molar volume (ϕ_v) of Atrazine in 70% DMSO and 90 % DMSO.

C/ mol/dm^3	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s.**	**ϕ_v/ cm^3.mol^{-1}**
70%DMSO												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	1.05431	1.5563	167.36	1.05027	1.4131	166.73	1.04424	1.2692	161.32	1.04123	1.2113	156.68
0.0231	1.05468	1.5626	165.21	1.05064	1.4194	165.02	1.04467	1.2754	159.35	1.04169	1.2162	155.24
0.0329	1.05515	1.5723	163.41	1.05112	1.4268	163.17	1.04522	1.2837	157.43	1.04227	1.2239	153.80
0.0445	1.05574	1.5825	161.59	1.05173	1.4378	161.14	1.04589	1.2933	155.84	1.04301	1.2347	151.76

0.0577	1.05648	1.5975	159.28	1.05245	1.4502	159.40	1.04670	1.3055	154.03	1.04387	1.2467	150.15
0.0727	1.05736	1.6106	157.16	1.05331	1.4648	157.64	1.04768	1.3186	151.97	1.04489	1.2594	148.46
0.0894	1.05841	1.6283	154.90	1.05432	1.4795	155.82	1.04882	1.3324	149.99	1.04607	1.2748	146.78
0.1079	1.05965	1.6450	152.51	1.05545	1.4968	154.34	1.05009	1.3475	148.41	1.04740	1.2896	145.28
0.1281	1.06107	1.6671	150.22	1.05684	1.5175	152.07	1.05158	1.3673	146.45	1.04898	1.3079	143.21
0.1500	1.06265	1.6887	148.19	1.05838	1.5386	150.09	1.05321	1.3872	144.84	1.05075	1.3276	141.24
90% DMSO												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	1.08175	1.8472	156.34	1.07823	1.6661	150.68	1.07239	1.4999	150.26	1.06941	1.4168	145.70
0.0231	1.08218	1.8545	154.22	1.07891	1.6731	148.68	1.07287	1.5066	148.71	1.06993	1.4237	144.27
0.0329	1.08274	1.8642	151.96	1.07931	1.6821	147.11	1.07348	1.5152	147.06	1.07059	1.4334	142.65
0.0445	1.08344	1.8766	149.81	1.08007	1.6943	145.09	1.07424	1.5287	145.26	1.07141	1.4437	140.83
0.0577	1.08427	1.8919	147.88	1.08098	1.7084	143.07	1.07513	1.5412	143.69	1.07235	1.4578	139.56
0.0727	1.08527	1.9095	145.81	1.08204	1.7255	141.32	1.07621	1.5564	141.70	1.07346	1.4722	138.12
0.0894	1.08643	1.9329	143.85	1.08325	1.7446	139.76	1.07741	1.5742	140.32	1.07477	1.4907	136.33
0.1079	1.08779	1.9535	141.71	1.08467	1.7667	137.89	1.07881	1.5961	138.64	1.07626	1.5106	134.61
0.1281	1.08936	1.9776	139.49	1.08628	1.7924	136.04	1.08043	1.6163	136.71	1.07794	1.5326	132.94
0.1500	1.09114	2.0068	137.29	1.08812	1.8170	134.04	1.08221	1.6414	135.08	1.07981	1.5549	131.35

Table (4): Concentration (C), Density (ρ), Viscosity (η), Apparent molar volume (ϕ_v) of Atrazine in DMSO

C/ mol/dm^3	**ρ/ g.cm^3**	**η/ Nm^{-3}.s**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s**	**ϕ_v/ cm^3.mol^{-1}**	**ρ/ g.cm^3**	**η/ Nm^{-3}.s**	**ϕ_v/ cm^3.mol^{-1}**
DMSO												
	298.15 K			**303.15 K**			**308.15 K**			**313.15 K**		
0.0150	1.09597	1.9982	145.81	1.09213	1.8032	143.27	1.08643	1.6205	140.35	1.08368	1.5164	137.02

0.0231	1.09648	2.0075	143.53	1.09265	1.8114	141.66	1.08698	1.6283	138.82	1.08426	1.5243	135.58
0.0329	1.09713	2.0183	141.40	1.09331	1.8221	139.95	1.08767	1.6394	137.33	1.08499	1.5343	134.04
0.0445	1.09794	2.0326	139.26	1.09412	1.8353	138.31	1.08853	1.6524	135.53	1.08588	1.5451	132.55
0.0577	1.09889	2.0492	137.43	1.09509	1.8520	136.49	1.08954	1.6678	133.86	1.08692	1.5592	131.17
0.0727	1.10003	2.0698	135.39	1.09626	1.8703	134.36	1.09072	1.6843	132.28	1.08814	1.5751	129.71
0.0894	1.10134	2.0910	133.52	1.09759	1.8892	132.56	1.09208	1.7042	130.69	1.08956	1.5965	128.03
0.1079	1.10289	2.1163	131.26	1.09910	1.9146	130.87	1.09364	1.7255	129.01	1.09115	1.6194	126.60
0.1281	1.10461	2.1474	129.35	1.10079	1.9403	129.31	1.09539	1.7495	127.41	1.09296	1.6432	125.00
0.1500	1.10662	2.1785	127.00	1.10272	1.9672	127.51	1.09737	1.7786	125.67	1.09495	1.6694	123.60

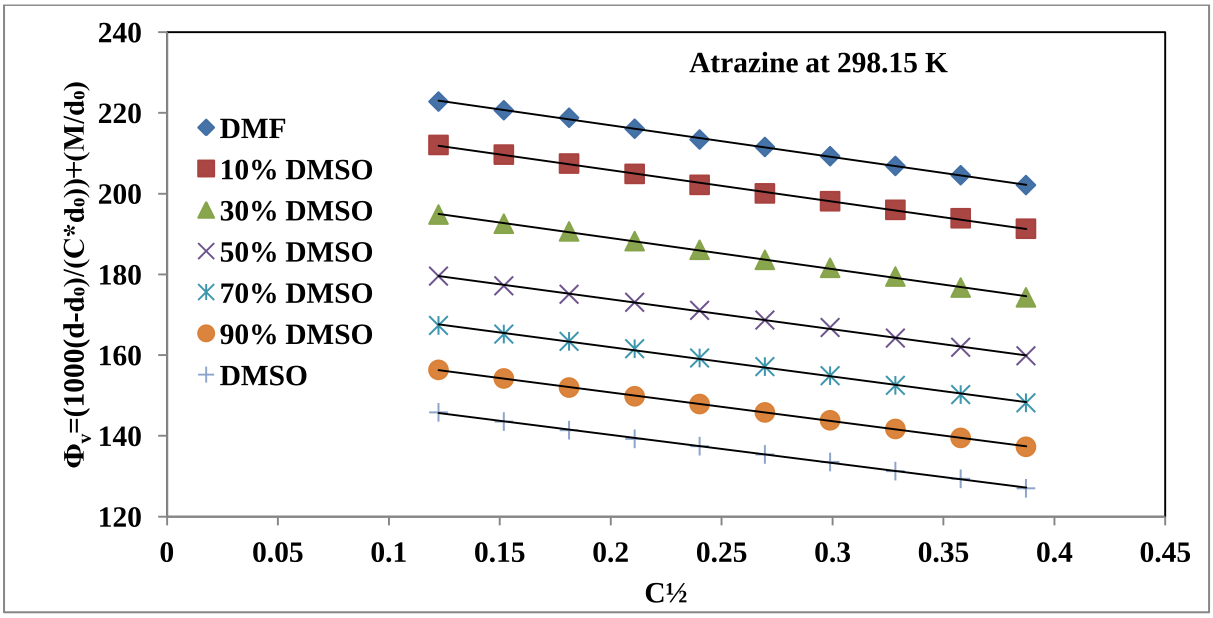

Figure (1): Plots of apparent molar volume ϕ_v against square root of concentration, C for Atrazine in DMF + DMSO solution at 298.15 K.

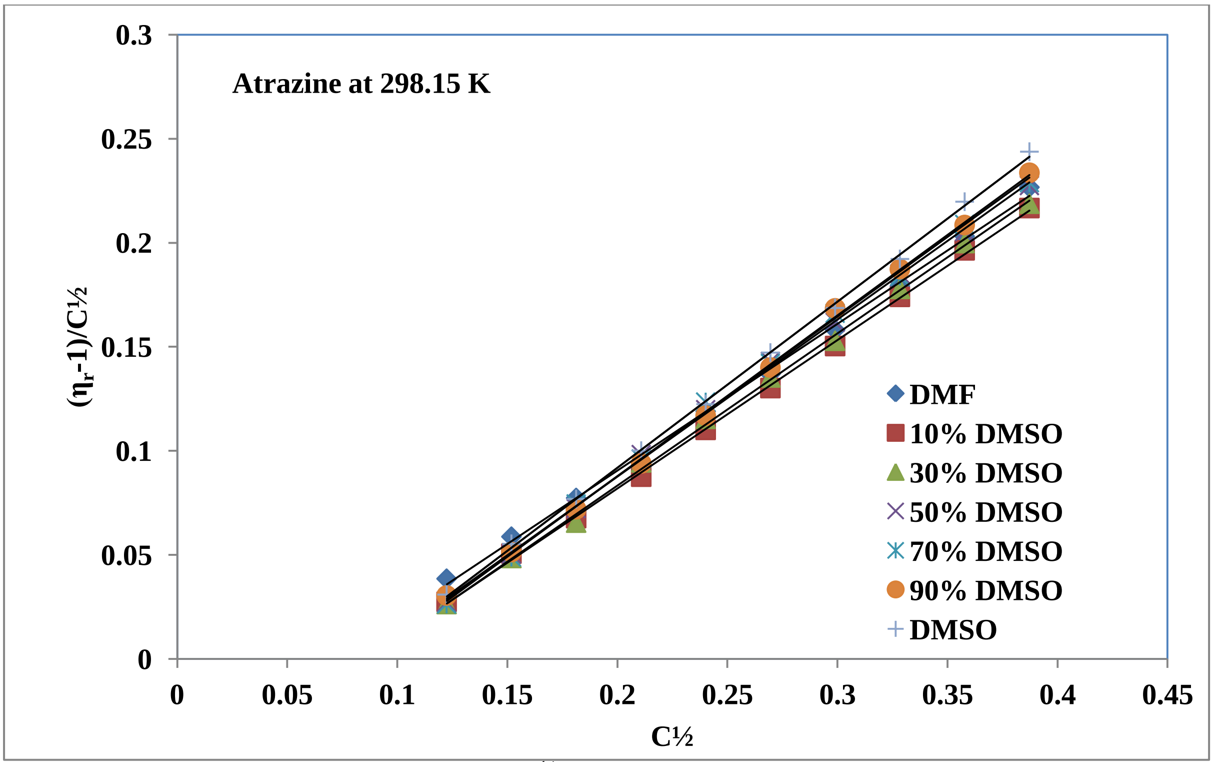

Figure (2): Plots of variation of $(\eta_r - 1)/C^{½}$ against square root of concentration C for Atrazine in DMF + DMSO solution at 298.15 K.

Table V. ϕ_v^0 ($cm^3.mol^{-1}$), S_V ($cm^3.mol^{-2/3}. L^{1/2}$), A ($dm^{3/2}.mol^{-1/2}$) and B ($dm^3. mol^{-1}$) of Atrazine in different compositions of DMF and DMSO at different temperatures.

Temp. (K)	DMF	10% DMSO	30% DMSO	50% DMSO	70% DMSO	90% DMSO	DMSO
	ϕ_v^0 ($cm^3.mol^{-1}$)						
298.15	232.62	221.36	204.43	188.64	176.58	165.00	154.17
303.15	226.84	216.68	201.11	186.43	174.42	158.23	150.82
308.15	218.91	210.41	197.27	182.64	168.89	157.42	147.26
313.15	217.07	208.00	194.47	180.62	164.09	152.48	143.30
	S_V ($cm^3.mol^{-2/3}.L^{1/2}$)						
298.15	-78.467	-77.643	-76.949	-74.092	-72.948	-71.243	-69.740
303.15	-77.721	-75.094	-67.106	-66.544	-62.286	-62.236	-60.376
308.15	-75.629	-73.705	-71.315	-66.075	-62.496	-57.581	-55.563
313.15	-72.932	-69.079	-65.871	-61.964	-58.195	-54.302	-50.902
	A ($dm^{3/2}.mol^{-1/2}$)						
298.15	-0.0503	-0.0606	-0.0639	-0.0646	-0.0651	-0.0667	-0.0677
303.15	-0.0559	-0.0638	-0.0643	-0.0653	-0.0686	-0.0676	-0.0724
308.15	-0.0670	-0.0661	-0.0676	-0.0691	-0.0702	-0.0736	-0.0763
313.15	-0.0728	-0.0750	-0.0731	-0.0751	-0.0771	-0.0792	-0.0813

	B ($dm^3. Mol^{-1}$)						
298.15	0.7046	0.7121	0.7327	0.7578	0.7655	0.7725	0.7981
303.15	0.7329	0.7476	0.7598	0.7823	0.7972	0.8077	0.8223
308.15	0.7691	0.7976	0.8037	0.8195	0.8299	0.8474	0.8708
313.15	0.7834	0.8209	0.8359	0.8556	0.8745	0.8854	0.9069

Table VI. Moulik constants (M and K) and Roots parameters (R and S) of Atrazine in different compositions of DMF and DMSO at different temperatures.

Temp. (K)	**DMF**	**10% DMSO**	**30% DMSO**	**50% DMSO**	**70% DMSO**	**90% DMSO**	**DMSO**
	M						
298.15	1.0238	1.0209	1.0216	1.0231	1.0235	1.0225	1.0235
303.15	1.0246	1.0226	1.0230	1.0245	1.0238	1.0241	1.0239
308.15	1.0225	1.0244	1.0244	1.0260	1.0256	1.0250	1.0256
313.15	1.0208	1.0223	1.0248	1.0251	1.0260	1.0254	1.0251
	K						
298.15	7.6602	7.4512	7.5519	7.8226	7.8894	8.0565	8.3998
303.15	7.7255	7.7324	7.9036	8.0985	8.2695	8.5310	8.4941
308.15	7.9610	8.3908	8.3937	8.3998	8.5952	8.8057	9.0232
313.15	8.0812	8.4998	8.6197	8.8466	8.9834	9.1456	9.4885
	R						
298.15	0.0039	-0.0031	-0.0124	-0.0220	-0.0296	-0.0373	-0.0468
303.15	-0.0021	-0.0081	-0.0165	-0.0252	-0.0325	-0.0452	-0.0511
308.15	-0.0109	-0.0155	-0.0216	-0.0302	-0.0394	-0.0470	-0.0558
313.15	-0.0135	-0.0186	-0.0252	-0.0329	-0.0450	-0.0528	-0.0605
	S						
298.15	-0.0741	-0.0746	-0.0765	-0.0761	-0.0769	-0.0770	-0.0764
303.15	-0.0732	-0.0719	-0.0664	-0.0680	-0.0654	-0.0671	-0.0659
308.15	-0.0707	-0.0701	-0.0702	-0.0671	-0.0652	-0.0617	-0.0603
313.15	-0.0679	-0.0654	-0.0645	-0.0627	-0.0605	-0.0580	-0.0551

CONCLUSIONS:

1. All the values of ϕ_v^0 at all temperatures are positive and higher; suggest the strong solute-solvent interactions in binary mixture of DMF + DMSO. All the Sv values are negative and suggesting weak solute-solute interactions.
2. The positive values of Jones-Dole coefficient 'B' indicate strong interactions between solute and solvent at high temperature.
3. The Masson's equations and Jones-Dole equations were found to be obeyed for selected concentration of pesticide atrazine in DMF + DMSO binary mixture.
4. The B coefficients for the atrazine increases with an increase in concentration of DMSO in DMF and DMSO binary mixtures.
5. The B coefficients for the atrazine increases with a rise of temperatures.

6. A positive value of the B coefficient for atrazine pesticide indicates a structure-forming effect.
7. Root's and Moulik equations are found to be obeyed for atrazine in binary liquid mixture DMSO and DMF.

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