Scholarly Research Journal for Interdisciplinary Studies,
Online ISSN 2278-8808, SJIF 2016 = 6.17, www.srjis.com
UGC Approved Sr. No.45269, JULY-AUG 2017, VOL- 4/35

APPARENT MOLAR VOLUME AND JONES-DOLE VISCOSITY COEFFICIENT STUDY OF N-PHENYL MALEANILIC ACID AND N-PHENYL MALEIMIDE IN 80 % AQUEOUS DMSO AT 308.15 AND 313.15 K

Jayraj S. Aher

Department of Chemistry, K. T. H. M. College, Nashik 422 002, (MS), India.

Abstract

Apparent molar volume and viscosity of N-phenyl maleanilic acid and N-phenyl maleimide have been determined in 80% aqueous dimethyl sulphoxide at 308.15 and 313.15 K. Parameters such as limiting apparent molar volume, semi-empirical parameter and Jones-Dole viscosity coefficients were evaluated.. From theses parameters, various types and extent of molecular interactions present in the solution were predicted.

Keywords: *N-phenyl maleimide, viscosity, apparent molar volume, DMSO.*

Introduction:

Maleimide is an important heterocyclic moiety in biology [1-3] and pharmacology [4-7] due to its multi-functional nature. Density, viscosity, apparent molar volume, limiting apparent molar volume and Jones-Dole viscosity coefficients 'A' and 'B' are very useful in predicting the type and extent of molecular interactions present and it is also important to understand different biochemical aspects at the body temperature. The results can be interpreted in terms of solute-solute, solute-solvent and solvent-solvent interactions in these systems. Dimethyl sulphoxide is an aprotic solvent and is strongly associated due to highly polar S=O group. The study of DMSO is important because of its application in medicine [8-9]. Density and viscosity of some 4-substituted N-phenyl maleimides in aqueous dimethyl sulphoxide have been studied at 308.15 K [10]. The study of molecular interactions present in N- phenyl maleanilic acid and N-phenyl maleimide at 298.15 and 303.15 K in aqueous dimethyl sulphoxide has been reported earlier [11]. In the present article the study has been extended at higher temperature and results were interpreted for the same compounds.

Experimental:

N-phenyl maleanilic acid (a) and N-phenyl maleimide (b) were synthesized [12] and purified by recrystallization. Triple distilled water and analytical reagent grade dimethyl

sulphoxide of minimum assay of 99.9% (SD Fine Chemicals) were used for preparation of solution in the range 0.002 M to 0.01 M at room temperature.

The bicapillary pycnometer and Ubbelohde viscometer was calibrated [13] using triple distilled water. The desired temperature was maintained with the help of thermostatic water bath. The solutions of different concentrations were prepared in 80 % aqueous dimethyl sulphoxide. The flow time was recorded by using digital stop watch. The solution densities and viscosities were determined at 308.15 and 313.15 K. Apparent molar volumes, ϕ_v were obtained by following equation [14-15].

$$\phi_v = \frac{1000\ (\ \rho_0 - \rho\ )}{C\ \rho_0} + \frac{M2}{\rho_0}$$

Where, M_2, C, ρ_0 and ρ are the molar mass of solute, concentration (mol. L^{-1}) and densities of the solvent and the solution respectively.

The apparent molar volumes ϕ_v were plotted against the concentration as per the Masson's equation [16].

$$\phi_v = \phi o_v + S_v C^{1/2}$$

Where ϕo_v is the limiting apparent molar volume and S_v is semi empirical parameter which depends on the nature of solvent, nature of solute and temperature. The viscosity data was analysed using Jones-Dole equation [17].

$$\frac{\eta_r - 1}{C^{1/2}} = A + B\ C^{1/2}$$

Where, $\eta_r = \eta/\eta_o$ (relative viscosity), η and η_o are viscosities of the solution and solvent respectively. C is the molar concentration. The intercept (A) of linear plot of $(\eta_r\text{-}1)/C^{1/2}$ vs $C^{1/2}$ predicts the extent of solute-solute interaction while slope (B) reflect the extent of solute-solvent interaction.

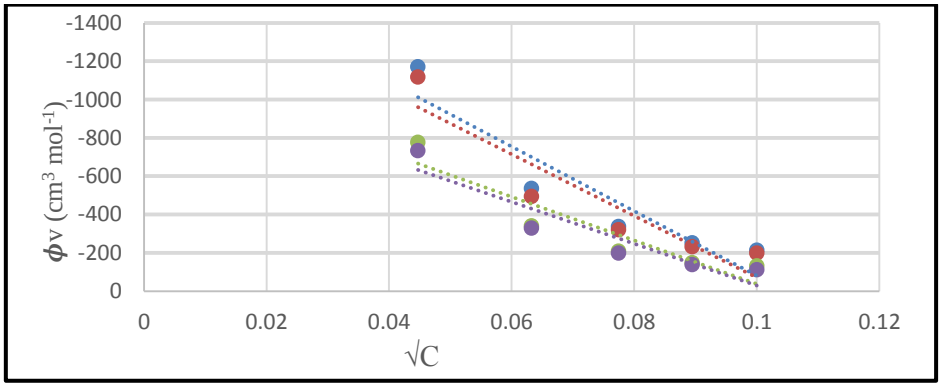
Results and Discussion:

Different parameters such as density, viscosity, apparent molar volume and relative viscosity of N-phenyl maleanilic acid and maleimide in 80 % aqueous DMSO at 308.15 and 313.15 K are given in table 1. The density and apparent molar volume ϕ_v for both acid and imide were found to be increased with concentration. The more negative ϕ_v values in acid (a) are may be due to strong molecular association i.e. presence of electrostriction and hydrophilic interaction (solute solvent interactions). Figure 1 shows linear plots of ϕ_v vs $C^{1/2}$ of maleanilic acid and maleimide solution at 308.15 and 313.15 K respectively. Limiting apparent molar volume (ϕo_v) and semi empirical parameter (S_v) were obtained from linear plots are listed in table 2. The high positive value of S_v

indicates the presence of strong solute-solute interactions. Maleanilic acid (a) has more solute-solute interactions than maleimide (b). The viscosities of solutions were found to be increased with concentration. Figure 2 shows variation of $(\eta_r\text{-}1)/C^{1/2}$ vs $C^{1/}2$ at 308.15 and 313.15 K. The values of viscosity coefficients 'A' and 'B' obtained from the linear plots are listed in table 2. Falkenhagen coefficient (A) represent the extent of solute-solute interactions and 'B' is Jones-Dole coefficient which measures the order and disorder introduced by solute in solvent (solute-solvent interactions). Positive values of 'A' show the presence of strong solute-solute interactions while negative values of 'B' shows weak solute-solvent interactions at low temperature. The high value of 'A' for an acid (a) indicates the presence of stronger solute-solute interactions than that for maleimide.

Table 1: Densities (ρ) (g.cm^{-3}), apparent molar volumes ϕ_v (cm^3.mol^{-1}), viscosities (η) and relative viscosities (η_r) of N-phenyl maleanilic acid (a) and maleimide (b) in aqueous dimethyl sulphoxide at 308.15 and 313.15 K.

	Comp.	Conc. (C) mol dm^{-3}	Conc. √C	Density (ρ) (g/cc)	ϕ_v (cm^3. mol^{-1})	Viscosity (η)	Relative viscosity (η_r)
FI	**308.15 K**						
		0.002	0.0447	1.09216	-1063.6646	2.72655	1.01938
		0.004	0.0632	1.09234	-485.3964	2.73312	1.02184
	a	0.006	0.0775	1.09258	-301.8192	2.73985	1.02435
		0.008	0.0894	1.09294	-223.7989	2.74687	1.02698
		0.01	0.1	1.09346	-191.6729	2.75430	1.02976
		0.002	0.0447	1.09121	-644.1998	2.69973	1.00935
		0.004	0.0632	1.09138	-281.6349	2.70626	1.01179
	b	0.006	0.0775	1.09157	-163.8395	2.71285	1.01426
		0.008	0.0894	1.09186	-116.4154	2.71969	1.01682
		0.01	0.1	1.09234	-105.4008	2.72700	1.01955
	313.15 K						
		0.002	0.0447	1.08769	-1003.4005	2.38631	1.01628
		0.004	0.0632	1.08781	-441.2558	2.39267	1.01898
	a	0.006	0.0775	1.08809	-278.4489	2.39938	1.02184
		0.008	0.0894	1.08834	-193.5897	2.40603	1.02468
		0.01	0.1	1.08872	-154.6542	2.41297	1.02763
		0.002	0.0447	1.08677	-596.0852	2.36602	1.00764
		0.004	0.0632	1.08691	-250.5045	2.37242	1.01036
	b	0.006	0.0775	1.08709	-141.4546	2.38499	1.01577
		0.008	0.0894	1.08729	-89.2335	2.39152	1.01850
		0.01	0.1	1.08763	-70.8025	2.39837	1.02141



GURE 1: Plot of ϕ_v vs c½ of N-phenyl maleanilic acid and N-phenyl maleimide in aqueous dimethyl sulphoxide at 308.15 and 313.15 K.

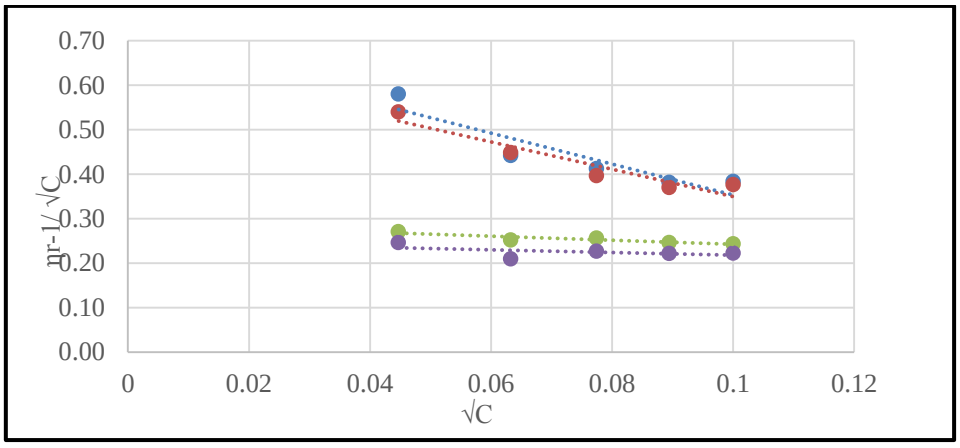


FIGURE 2: Plot of $(\eta_r-1)/c^{½}$ vs $c^{½}$ of N-phenyl maleanilic acid and N-phenyl maleimide in aqueous dimethyl sulphoxide at 308.15 and 313.15 K.

Table 2: Masson and Jones-Dole Parameters of N-phenyl maleanilic acid (a) and N-phenyl maleimide (b) in aqueous dimethyl sulphoxide at 308.15 and 313.15 K.

Comp.	ϕo_v	S_v	A ($dm^{3/2}mole^{-1/2}$)	B (dm^3mole^{-1})
308.15 K				
a	-1604.3	15352	0.5193	-2.412
b	-977.07	9533.6	0.210	-0.235
313.15 K				
a	-1528.9	14867	0.4154	-1.543
b	-924.36	9266.5	0.161	-0.251

Conclusion:

In the present work we have systematically reported apparent molar volume and Jones-Dole viscosity coefficient study of N-phenyl maleanilic acid (a) and maleimide (b) in 80 % aqueous dimethyl sulphoxide solution at 308.15 and 313.15 K. It was observed that the negative values of apparent molar volume indicate strong molecular association in

compound a and b. Positive values of Sv and viscosity constant 'A' indicate the presence of strong solute-solute interaction that becomes weak as temperature increases. The extent of interactions were found to be more in N-phenyl maleanilic acid than the N-phenyl maleimide. The value of Jones-Dole coefficient 'B' indicates strong interactions between solute and solvent at higher temperature. The Jones -Dole and Masson's equations were found to be obeyed for maleanilic acid and maleimide in aqueous dimethyl sulphoxide solution at 308.15 and 313.15 K.

Acknowledgement:

The author is very thankful to UGC WRO, Pune, Savitribai Phule Pune University, Pune for financial assistance, Maratha Vidya Prasarak Samaj Nashik for providing infrastructure facilities, Principal, K. R. T. Arts B. H. Commerce and A. M. Science College, Gangapur Road, Nashik (MS) India for providing the research facilities.

References:

S. Watanabe, Y. Igarashi, K. Yagami, R. Imai, Pestic. Sci. ***1991,*** *31, 45.*

N. Matuszak, G. Muccioli, G. Laber, D. Lambert, J. Med. Chem. ***2009****, 52, 7410.*

M. Sortino, V. Fihlo, R. Correa, S. Zacchino, Bioorg. Med. Chem. ***2008****, 16, 560.*

P. Brookes, P. Lawely, J. Biochem. ***1961****, 80, 496.*

P. Davis, C. Hill, G. Lawton, J. Nixon, S. Wilkinson, S, E. Hurst, S. Keech, Turner, J. Med. Chem. ***1992****, 35, 177.*

P. Goekjian, R. Jirousek, Curr. Med. Chem. ***1999****, 6, 877.*

M. Coghlan, A. D. Culbert, S. Cross, Yates Cororan, J. N, Pearce, O, Rausch, Murphy, G. P. Carter, L. Cox, D. Mills, M. Brown, D. Haigh, R Ward. D. Smith, K. Murphy, A. Reith, Holder, J. Chemistry and Biology, ***2000****, 7, 793.*

H. H. Szmant, S. W. Jacob, E. E. Rosenbaum, D. C. Wood (Eds.), Dimethyl sulphoxide, Marce Dekker, New York, NY, ***1971****, 1-98.*

J. T. Lal, F. W. Lau, D. Robb, P. Westh, G. Nielsen, C. Tranudum, A. Hvidt, Y. Koga, J. Solution Chem. ***1995****, 24, 271.*

Dnyaneshwar D. Lokhande, Jayraj S. Aher, Manoj R. Gaware and Anant V. Kardel; Scholarly Research Journal for Interdisciplinary studies, ***2017****, 6 (21), 173.*

Jayraj S. Aher, Scholarly Research Journal for Interdisciplinary studies, ***2017****, 4 (31), 5160.*

S. V. Patil, K. A. Mahale, K. S. Gosavi, G. B. Deshmukh and N. S. Patil; OPPI, ***2013****, 45, 314.*

P. S. Nikam, L. N. Shirsat, M. Hasan, J. Chem. Eng. Data ***1998****, 43, 732.*

M. L. Parmar and M.K. Guleria, Indian J. Chem, ***2009,*** *48A, 806.*

Muhammad Javed Iqbal and Mansoora Ahmed Chaudhry, J. Chem. Thermodynamics ***2009****, 41, 221.*

D. O. Masson, Phil. Mag., ***1929****, 8, 218.*

Jones G. and Dole M, J. Am. Chem. Soc., ***1929****, 51 (10), 2950.*