IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 06, Issue 09 (Sep. 2016), ||V1|| PP 20-24

Physico-chemical Properties of Ethambutaol HCl in Aqueous Solvent System at Different Temperatures.

S.B.Ingole[1], V.D.Bhale[2], S. G. Shankarwar[3] and A. G. Shankarwar[4]
1, *2, 4. Department of Chemistry, S.B.E.S. College of Science, Aurangabad.*
3. Department of Chemistry, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Abstract: - The study of the volumetric behavior of antituberculosis Ethambutaol HCl as electrolytes in solution provides information useful to elucidate ion–ion, ion–solvent, and solvent–solvent interactions. Apparent molar volumes (Φv) and viscosity B-coefficients for Ethambutaol HCl in aqueous system have been determined from density (ρ) and viscosity (η) measurements at 298.15 to 313.15 K using the ANTON PAAR densitometer and Mansing Survismeter respectively. Various concentrations of Ethambutaol HCl solutions ranging from 0.02 to 0.1 M were prepared. The apparent molar volumes were calculated from the density data. In addition, the concentration dependence of the apparent molar volumes was examined using Masson's equation. The concentration dependence of the apparent and partial molar volumes can be used to study ion–ion interactions, whereas the partial molar volumes at infinite dilution provide information on ion–solvent interactions.

Keywords*: - B-coefficient, density, Ethambutanol HCl , partial molar volumes ,viscosity.*

I. INTRODUCTION

It is well known that physicochemical characterization of drugs plays a crucial role in all the stages associated to design and development of pharmaceutical dosage forms, especially those intended to parenteral administration [1]. In this context, as a contribution to generation and systematization of physicochemical information about drugs behavior in aqueous system, the main goal of this study was to evaluate the effect of concentration and temperature on the apparent molar volume of drugs in aqueous solvent system at different temperature.The apparent molar volumes of antituberculosis Ethambutaol HCl in aqueous solvents systems and at different temperatures (T =298.15, 303.15, 308.15, 310.15 and 313.15 K) are reported in the present paper. Non-narcotic analgesics have three important properties namely analgesics, antipyretics and anti-inflammatory (e.g. Aspirin and Paracetamol). The non-narcotics (salicylates) are called aspirin like or Nonsteroidal Anti-inflammatory Drugs (NSAIDS). These drugs have common mechanism of inhibiting the cyclooxygenase (COX), the key enzyme responsible for biosynthesis of Prostaglandins (PG).

Bio-pharmaceutics is the study of factors influencing the extent and rate of absorption. The rate and amount of drug absorption depends on biological and physicochemical factors. During their way to site of action, drug molecules have to cross one or more membranous barrier, which are lipoid in nature and have different size of pores. Physicochemical factors include lipid solubility, salt complexation, dissolution rate, Viscosity and drug stability in Gastro-Intestinal Track (GIT). Lipid soluble drugs and more unionized and easily absorbed Na and K salts of weak acid have higher absorption rate than acids. All the drugs in any solid dosage form or suspension when administered will first change into drug solution in body fluids. So, dissolution rate is important factor affecting the rate of absorption.

Viscosity limits the dissolution rate and there by affect the rapid absorption. E.g. Aqueous Solution of Na-Salicylate showed its rapid appearance in plasma while the same drug in suspension form failed to reach the target as quickly as with aqueous solution [2]. The study of the volumetric behavior of electrolytes in solution provides information useful to elucidate ion–ion, ion–solvent, and solvent–solvent interactions. The concentration dependence of the apparent and partial molar volumes can be used to study ion–ion interactions, whereas the partial molar volumes at infinite dilution provide information on ion– solvent interactions. The data reported here were obtained by performing density measurements on solutions of Ethambutaol HCl in aqueous solvent systems.

II. EXPERIMENTAL

2.1. Materials

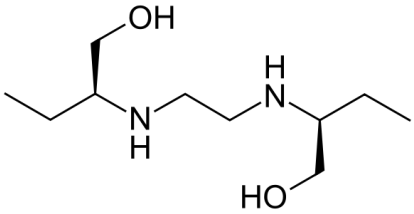
Ethambutaol HCl of high purity was obtained from Research Lab, recrystallized and then used. Double distilled water was used for the preparation of solutions of different concentration (0.02, 0.04, 0.06, 0.08, 0.1M). The precision of balance used was ± 0.0001g.

2.2. Drug profile

Molecular Formula- $C_{10}H_{24}N_2O_2$

Molecular weight- 204.31 g·mol^{-1}

Structure-



IUPAC name- (2S,2'S)-2,2'-(Ethane-1,2-diyldiimino)dibutan-1-ol

Category- Antituberculosis.

Solubility- It is sparingly soluble in water, greately soluble in ethanol (95%), very slightly soluble in ether and chloroform.

Description- Ethambutol HCl contains not less than 98.5% not more than 101.0% of $C_{10}H_{24}N_2O_2$ calculated with reference to the dried substance. It is a white crystalline powder.

Uses- Ethambutol HCl is used along with other medications to treat a number of infections including: tuberculosis, *Mycobacterium avium complex*, and *Mycobacterium kansasii*.

Side Effects- Following are the side effects of Ethambutaol- 1.Optic neuritis 2.Red-green color blindness 3.Peripheral neuropathy 4.Hepatotoxicity 5. Hyperuricaemia 6.Vertical nystagmus.

2.3. Density measurements

In the present work density of drug Ethambutaol HCl in aqueous solutions having concentrations of 0.02M, 0.04M, 0.06M, 0.08M, and 0.1M at different temperatures was measured with ANTON PAAR Densitometer at School Of Chemical Sciences, North Maharashtra University, Jalgaon. The ANTON-PAAR densitometer contains two units-

1. Sample holder unit.
2. Reading display unit.

The sample tube starts to oscillate as soon as the instrument is switched on. It is therefore ready to use. The filling of the oscillator with solution is facilitated by the glass syringe. While loading vibrating tube with sample liquid, one has to make sure that the introduction of the liquid must take place slowly, enough to enable the sample liquid to properly wet the walls of the sample tube.

To have the more accuracy in the measurement, at each time the density of air was measured before the reading of sample solution. The density of air was found to be in the range of 0.001140 to 0.001148 gm/cm^3. The densities of standard solvent (distilled water) were also measured at different temperatures and are found to be very close to the literature values. Density was measured with an uncertainty of ± 0.000148 g.cm$^{-3.}$

2.4. Viscosity measurements

The solutions of Ethambutaol HCl having concentration of 0.02M, 0.04M, 0.06M, 0.08M, and 0.1M were prepared in aqueous system. The viscosities were measured at 298.15, 303.15, 308.15, 310.15 and 313.15K temperatures for different concentrations. To have more accuracy in the viscosity measurement, the specially designed Mansing Survismeter from Central University Gujrat, Gandhinagar was used to measure the flow time of different solutions. The flow time was measured at the accuracy of ± 0.01 s. The solution viscosities were measured with an uncertainty of ± 2.4×10^{-4} mPa.s by using Mansing Survismeter. The temperature was maintained by circulating water through Mansing Survismeter from an electronically controlled JULABO thermostatic water bath (NOVA NV-8550 E). The uncertainty of temperature was ± 0.01^{o}K.

III. DATA EVALUTION

The apparent molar volumes, (Φv,) were obtained from the density results using the following equation-

$$\Phi v = \frac{1000}{C} \times \frac{d0 - d}{d0} + \frac{M}{d0}$$

where M= molar mass of Ethambutaol HCl, C= concentration in mol.L^{-1} , d= densities of the solution and d_0= density of the solvent. The viscosity of aqueous solutions having different concentrations of drug Ethambutaol HCl was calculated by using following equation-

$$\eta_1 = \frac{d_1}{d_2} \times \frac{t_1}{t_2} \times \eta_2$$

where, d_2= density of the solvent (water), d_1 = densities of the solution, t_1= viscous flow time of solution, and t_2 = viscous flow time of solvent, η_2 = viscosities of water .

The viscosities of water at different temperatures are available in the literature; therefore, water was taken as reference standard for determination of viscosity of unknown solution.

IV. RESULTS AND DISSCUSSION

The values of the densities (ρ) and apparent molar volumes (Φv) of Ethambutaol HCl in aqueous solution at different temperatures are shown in table no. 1.

Table 1. Densities (gm.cm^{-3}) and Apparent molar volumes (Φv) of Ethambutaol HCl in aqueous solutions of different concentrations and at different temperatures.

Concentration (M)	Densities (gm.cm^{-3})				Apparent molar volumes (Φv)			
	298.1K	303.15 K	308.15 K	313.15 K	298.15 K	303.15 K	308.15 K	313.15 K
0.02	0.99830	0.99689	0.99548	0.99344	214.8856	218.6398	222.6538	226.3465
0.04	0.99944	0.99803	0.99662	0.99521	217.8695	221.057	225.3687	229.0568
0.06	1.00058	0.99917	0.99776	0.99636	220.8641	224.9861	228.8976	232.2068
0.08	1.00172	1.00028	0.99895	0.99740	223.3614	227.9964	231.1079	235.1765
0.1	1.00286	1.00142	0.99977	0.99793	226.6598	230.2368	234.4539	239.0548

The table no.1 reveals that densities of Ethambutaol HCl solutions under investigation decrease with increase in temperature and increases with increase in concentration. Such observations were previously made by Sharma et al.[3] for other solutions. The values of Φv increases with increase in concentration. The apparent molar volumes (Φv) were plotted (Fig.1) against the square root of concentration ($C^{½}$) in accordance with the Masson's equation**.**

$\Phi v = \Phi v^0 + Sv.C^{½}$

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

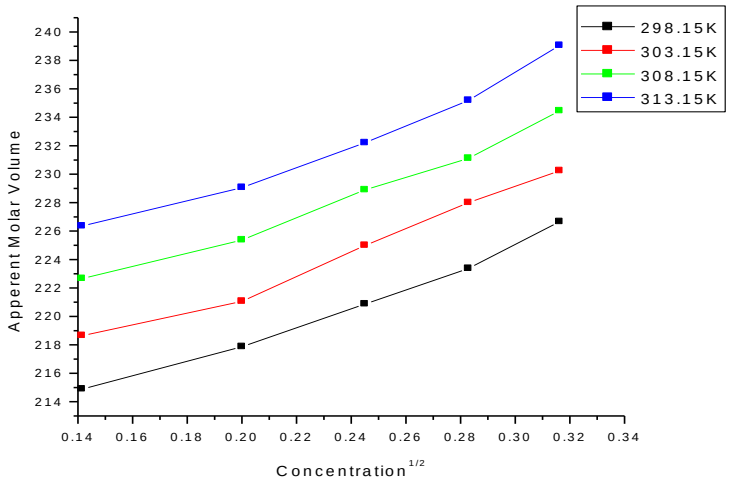


Figure 1. Plot of Φv (cm^3.mol^{-1}) versus $C^{½}$ for Ethambutaol HCl solutions in aqueous system at different temperature.

Figure 1 is representative plot which represents variation of Φv with $C^{½}$ in aqueous system. It is observed plot is linear indicates strong solute- solvent interactions. Φv^0 values also increases linearly with increase in temperature.

The values of the viscosity and relative viscosities of Ethambutaol HCl in aqueous system at 298.15, 303.15, 308.15, and 313.15K temperature are given in table no.2.

Table 2. Viscosities and Relative viscosities of Ethambutaol HCl in aqueous solutions of different oncentrations and at different temperatures.

Concentration (M)	Viscosities				Relative viscosities			
	298.1K	303.15 K	308.15 K	313.15 K	298.15 K	303.15 K	308.15 K	313.15 K
0.02	0.989913	0.893052	0.791342	0.744246	1.111014	1.120517	1.100615	1.088079
0.04	1.000235	0.901928	0.826056	0.779788	1.122598	1.131653	1.148896	1.140042
0.06	1.014156	0.913627	0.858654	0.809747	1.138222	1.146333	1.194234	1.183841
0.08	1.025756	0.931228	0.880992	0.838545	1.151242	1.168417	1.225301	1.225943
0.1	1.035937	0.946888	0.913885	0.859845	1.162667	1.188066	1.27105	1.257083

In all sets the viscosities of solutions increases with increase in concentration of solution, while viscosity decreases with increase in temperature. This is in accordance with the observation made earlier by Arbad et al.[4-6] and Nikumbh et.al[7]. For each temperature relative viscosity increases with increase in concentration. The viscosity results for the aqueous solutions of drugs were plotted in accordance with Jones-Dole equation [8].

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

Where $\eta_r = (\eta/\eta o)$ and η, ηo are viscosities of the solution and solvent respectively, C is the molar concentration. The linear plots (Figure 2) for $(\eta_r - 1)/C^{½}$ versus $C^{½}$ were obtained for the Ethambutaol HCl.

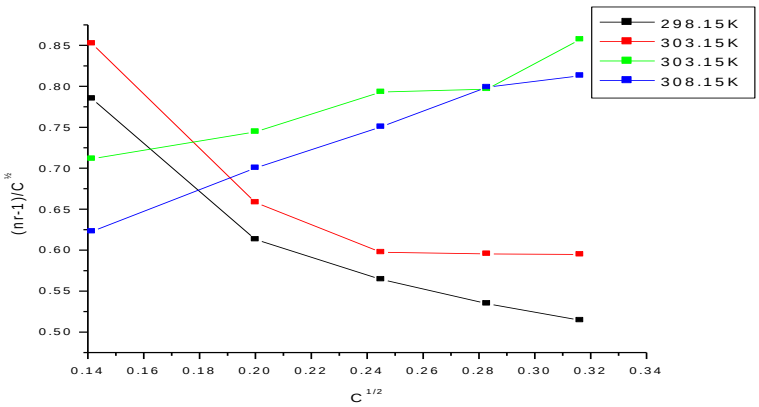


Figure 2. Plot of $(\eta r-1)/C^{½}$ versus $C^{½}$ for Ethambutaol HCl solutions in aqueous system at different temperatures.

The B-coefficients were obtained from the linear plots using the least-square fitting method. The A- coefficient reflects solute -solute interaction [9] and the B-coefficient reflect the solute-solvent interactions. Since in general, A/B <<1, the Jones –Dole equation reduces to, $\eta r = l + \beta C$,

Table 3. Different parameters of Ethambutaol HCl in aqueous solution at different temperatures.

Parameters	Temperature (K)			
	298.15	303.15	308.15	313.15
Partial molar volumes Φv^0	205.0114	208.2385	212.6155	215.4084

Sv	66.2903	68.9394	69.9831	71.53425
B ($dm3.mol^{-1}$)	0.955427	0.996652	0.594827	0.471328

The Φv^0 values of Ethambutaol HCl under investigation in aqueous solvent systems are large and positive suggests presence of strong solute-solvent interactions promotes structure making effect[10].

Sv is positive in aqueous system. Sv is measure of solute-solute interactions. The positive Sv values show that Ethambutaol HCl considerably associated in presence of ions. These results indicate that there is presence of strong solute-solute interactions. Sv values do not change systematically with change in temperature, and hence it suggests that the solute-solute interactions are insensitive to change in temperature.

The present system obeys Jones- Dole, Moulik, Roots and Jones-Dole reduced equation. The linear Plots obtained show the applicability of these equations. 'A' is constant independent of concentration and 'B' is Jones- Dole coefficient represents measure of order and disorder introduced by solute into the solution; positive 'B' coefficient shows strong alignment of solvent towards solute and is related to the effect of the ions on the structure of water. The positive values of 'B' at all temperatures indicate water structure making effect**.**

V. CONCLUSION

In the present paper, physicochemical properties of solutions of Ethambutaol HCl in aqueous system at different temperatures are systematically presented. It has been observed that there exist strong solute–solvent interactions in these systems, which increases with increase in drug concentration. The values of Φv^0 are positive suggest strong ion-solvent interactions. The positive values of Jones-Dole coefficient 'B' indicates structure promoting tendency and strong interactions between solute and solvent. Positive values of 'B' suggesting strongly hydrated solute indicating structure promoting tendency i.e. kosmotropes (structure makers).

REFERENCES

[1] A. Martin, P. Bustamante, A. H. C. Chun, Physical chemical principles in the
[2] pharmaceutical sciences (4th edition, Lea & Febiger, Philadelphia, 1993).
[3] S. Singh, Essentials of Pharmacology, 1st edition, General Pharmacology,
[4] (Academa publishers,2004)8-10.
[5] S. Chauhan, V.K. Syal, M.S. Chauhan, and P. Sharma, "Viscosity studies of
[6] some narcotic– analgesic drugs in aqueous– alcoholic mixtures at 25 °C'',
[7] J. Mol. Liqs.136, 2007, pp.161- 164.
[8] B.R.Arbad, C.S.Patil and A.G.Shankarwar, "Studies in acoustic properties, partial
[9] molar volumes, viscosity B- coefficients of LiCl in aqueous medium at five temperatures"
Indian J. Pure and Appl. Phys. 3, 2000, pp.645-650.
[10] B.R.Arbad, C.S.Patil and A.G.Shankarwar, "Ultrasonic velocity, viscosity and density
[11] of LiCl in aqueous solutions of alcohols at 303.15K", Asian J. Chem., 13, 2001,
[12] pp.787-789.
[13] M.K.Lande, A.A.Walvekar, A.G.Shankarwar, B.R.Arbad, and D.V. Jahagirdar,
[14] Partial molar volumes, viscosity B- coefficient and hydration number of
[15] some pharmacologically important drugs in aqueous solutions", J.Indian Chem.
[16] Soc.,79, 2002, pp.356-358.
[17] A. B. Nikumbh, G. K. Kulkarni and R .C. Bhujbal, "Densitometric
[18] and viscometric study of diclofenac sodium in aqueous solution in presence and absence
[19] of additives at different temperatures." J. of Chemistry and Materials research, 3,12,
[20] 2013, pp.260-209.
[21] G. Jones, and M. Dole, "The viscosity of aqueous solutions of strong electrolytes with
[22] special reference to barium chloride", J. Am. Chem. Soc. 51,1929, pp. 2950-2964.
[23] H. Falkenhagen, and M. Dole, "Viscosity of electrolyte solutions and its significance to
[24] the Debye theory", Zeitschrift Für Physik 30, 1929, pp. 611- 616.
[25] M.Iqbal and R.Verrall, "Apparent molar volume and adiabatic compressibility studies
[26] of aqueous solutions of some drug compounds at 25°C", Can Journal Chem,67,
[27] 1989, pp.727-735.