Thermodynamic studies of different concentrations of Etodolac in water and methanol as solvent systems at 298K , 303K , 308K , 313K,318K

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Abstract: Density and ultra sound velocity of different concentration of Etodolac in pure water and in pure methanol as solvent systems have been studied experimentally at five different temperatures (298 K to 318 K).This measured data used further to calculate the apparent molar volume φ_v, partial molar volume φ_v^0, at infinite dilution. The obtainable results have been interpreted in terms of solute – solute and solute – solvent interactions.

Keywords: Etodolac, density, ultrasound velocity, apparent molar volume, partial molar volume and volume of transfer.

1. Introduction:

The thermodynamic properties like density and ultrasound velocity studies of various types of drugs in different types of solvent systems plays a significant role to understand the mix behavior of a particular drug [1].Presently, most of the efforts have been made to study the physicochemical properties of different types of drugs in various solvent systems. Each drug have special kind of functioning as well as interactions towards human body, as they imply in the formation of a specific complex [2-4]. The activity of a drug can be interpreted by examining the temperature dependence of a drug and it bonding with solvent [5].Currently, pharmaceutical industries are facing various complications in such as poor solubility, high instability, poor drug delivery and polymorphic conversion [6]. In spite from the significant studies on solution and thermodynamic properties of a solution [7,8], it has been found that drugs with anti-inflammatory, analgesic and antipyretic properties have been studied very less.So keep this point in view, we have describe the thermodynamic studies of Etodolac as a non-steroidal anti-inflammatory drug (NSAID) [8].

2. Experimental

2.1 Chemicals and instruments

Etova – 400 mg tablets were purified and then seven different concentrations of this drug have been studied in Methanol of AR grade and in double distilled water. The densities of these seven concentrations have been determined with the help of pynometer and ultrasound velocity with help of ultrasonic interferometer at five different temperatures (298K to 318 K). Using these data, further various thermodynamic parameters have been calculated. The temperature of solutions was maintained on an electronically controlled thermostatic water bath with ± 0.02K.The density and ultrasound velocity data were found to be in accuracy with in ± 0.01 each.

Result and Discussion:

The densities and ultrasound velocities of Etodolac of seven different concentrations (0.0048, 0.0089, 0.0119, 0.0182, 0.0235, 0.0339, 0.0583) mol Kg^{-1} in double distilled water and in pure methanol solutions have been determined experimentally at 298K, 303K, 308K, 313K and 318K recorded in Table 1 and Table 2 respectively.

Table 1: Density (ρ) data of different concentrations of Etodolac in pure methanol at 298K , 303K , 308K , 313K,318K

S.No.	Concentration (mol/kg)	Density(Kg/m^3)				
		298K	303K	308K	313K	318K
1	0.0000	0.7700	0.7750	0.7853	0. 7890	0. 7970
2	0.0048	0.7802	0.7818	0.7886	0.7812	0. 7987
3	0.0089	0.7805	0.7886	0.7957	0. 8038	0. 8058
4	0.0119	0.7834	0.7855	0.7895	0. 7936	0. 7972
5	0.0182	0.7781	0.7850	0.7930	0. 7942	0. 7950
6	0.0235	0.7853	0.7906	0.7939	0. 8010	0. 8042
7	0.0339	0.7930	0. 7994	0.8267	0. 8330	0. 8337
8	0.0583	0.7936	0. 8201	0.8286	0. 8332	0. 8379

Table 2: The ultrasonic velocity data (μ) of different concentrations of etodolac in pure methanol at 298K, 303K, 308K, 313K, 318K.

S.No.	Concentration (mol/kg)	Ultrasonic Velocity (m/s)				
		298K	303K	308K	313K	318K
1	0.0000	14.67	27.33	40.67	65.33	80.33
2	0.0048	15.33	34.33	45.33	68.00	84.00

3	0.0089	17.40	37.36	52.00	87.00	94.67
4	0.0118	26.21	41.67	59.33	90.67	98.33
5	0.0181	28.45	45.04	62.33	94.00	102.00
6	0.0235	31.02	48.67	68.33	98.67	107.30
7	0.0339	36.00	53.00	72.33	100.33	110.02
8	0.0583	39.36	57.38	83.20	102.67	112.33

It have been noticed that densities and ultrasound velocities values of Etodolac drug in both water as well as in methanol as solvent systems are increasing with rise of temparture. This types of trend reflect due to hydrogen bonding formation. This increment in the both parameters reflects the strong solute – solvent interactions between Etodolac and in water as well as in methanol solvent systems.

Further, using these densities data of drug have been used to calculate the apparent molar volume (φ_v), with the help of equation 1.

$$\varphi_v = \frac{1000(\rho^\circ - \rho)}{m\rho\rho^\circ} + \frac{M}{\rho} \qquad 1$$

Here, φ_v is the apparent molal volume, ρ° and ρ is the density of solution and solvent respectively and m is the molality of the solution and M is the molecular mass of solute. The calculated, φ_v have been recorded in Table 3.

Table 3: The apparent molal volume data of selected concentrations of Etodolac in pure water and methanol at 298K, 303K, 308K, 313K, 318K.

S.No.	Concentration (mol/kg)	Apparent molal volume(m^3mol^{-1})				
		298K	303K	308K	313K	318K
1	0.0048	31.34	36.00	44.12	56.09	65.12
2	0.0089	38.12	43.20	48.23	59.10	72.23
3	0.0118	42.45	48.91	53.67	63.76	78.45
4	0.0181	45.67	54.76	61.20	67.45	80.12
5	0.0235	47.78	56.78	64.45	72.23	82.45
6	0.0339	51.23	60.34	67.78	78.34	84.75
7	0.0583	53.56	64.89	72.34	81.23	89.45

φ_v values recorded in the Table 3 are in the increasing trend, shows the presence of electrostriction effect. This reflects the reduction in electrostriction effect. In addition to this, the apparent molal volume at infinite dilution, φ_v^0 (ion – ion interactions) and experimental slope values, S_v (ion – solvent interactions) for the selected drug in both selected solvent systems have been calculated by using Massion's equation (2)

$\varphi_v = \varphi_v^0 + S_V\, m^{1/2}$ 2

and calculated values using equation 2 have been recorded in Table 4.

Table 4: Apparent molar volume (φ_v^0) at infinite dilution and experimental slope (S_V) values for Etodolac in pure water and in pure methanol as solvent systems at 298K, 303K, 308K, 313K and 318K.

Temperature (K)	φ_v^0	S_V
Water		
298	38.56	-24.23
303	34.43	-16.78
308	29.41	02.45
313	18.50	12.67
318	12.34	23.54
Methanol		
298	41.23	-10.76
303	39.47	05.87
308	34.68	13.56
313	28.87	24.65
318	21.45	32.97

Apparent molar volume (φ_v^0) at infinite dilution data in table 4 reflect that with rise in temperature, φ_v^0 values decrease continuously, while experimental slope S_V values are negative at 298K and 303K reflects that ion - solvent inactions are weak in these two temperatures ranges while at 308K onwards S_V are positive which showing the strong ion – solvent interactions. This reflects the presence of ion – ion interactions which get weaker with rise of temperatures, while experimental slopes values shows the presence of ion – solvent effect, which is getting stronger with rise of temperature. In addition to this, data also reflecting that the ion – solvent interactions are more than the ion – ion interactions. These trends have been observed in the water as well as in methanol as solvent systems. In case of methanol as solvent system, magnitude of φ_v^0 as well as S_V are greater than that in water as solvent system for Etodolac. These data indicates that Etodolac has good affinity for both in water as well as in methanol solvents systems. But Etodolac has more affinity for methanol than in water.

Conclusion:

In the present study, Etodolac drug shows the presence of both ion – ion as well as ion – solvent interactions in water and in methanol solvent systems. With the rise in temperature, the ion – solvent interactions are dominates over ion – ion interactions. Etodolac acts as structure makers in both selected

solvent systems. This drug has more structure enhancing effect in methanol as system as compared to pure water solvent system.

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