Exploration of Thermo-acoustical Conduct of Dichlofenac sodium Drug in Butanol at Different Temperature

Sanjay P. Ramteke,
Email:- sanjuram1608@gmail.com
Department of Physics, S. P. College, Chandrapur, (M. S.), Maharashtra, India

Abstract:
The approach of this study to estimate the various physico-chemical mechanism of liquid drug system with respect to temperature and the outcome indicates the structural sense and interactions in the drug mixture. Physico-chemical examinations play a vital role to understand the nature and strength of molecular aggregation that exist in binary liquid drug system and their sensitivities to variations in composition and the molecular structure of pure components. The drug-solvent molecular interactions play an important role in the understanding of drug action. In the present investigation we tried to study of various molecular interactions in alcohol solution of dichlofenac sodium by measuring ultrasonic velocity, density, viscosity and thermodynamic parameters at 2 MHz at different temperature with different concentrations.
These parameters have been thoroughly analysed and eventually interpreted at the possible molecular interactions such as structure making and structure breaking effect and also solute-solvent, ionic interaction, H-bonding effect in the alcoholic diclofenac sodium drug solution.

Keywords: Ultrasonic velocity, density and Acoustical parameters, Dichlofenac sodium, Butanol

I) Introduction :
Viscometric, Refractrometric and Interferometric measurement methods are very useful to sort out suitable interactions in the drug solution. Drug activity and drug effect can be explained by knowing suitable types of interactions [1-3]. Drug action, although complex result from various kinds of physico-chemical interactions, e.g. Ion-dipole, ionic or covalent, hydrogen bonding, charge transfer interactions, hydrophilic interactions etc.[4,5]. Formokinetic processes involve transport of drug across biological membranes, which can be understood by transport property measurements such as ultrasonic velocity, viscosity, thermal conductivity and diffusion. Diclofenac sodium is a nonsteroidal anti-inflammatory drug (NSAID) with analgesic and antipyretic properties. It has been found to relieve pain, reduce fever, swelling and tenderness, and increase mobility in patients with rheumatic disorders. Diclofenac sodium is rapidly and almost completely absorbed and distributed to blood, liver, and kidney. When drug is absorbed and transmitted in blood; the drug metabolism starts and at last there occurs excretion of bye product, if formed. All systems in the body directly or indirectly take part in this process. Each step in the pharmacokinetics and pharmacodynamics depends on solute-solvent, solute-solute-solvent and solute-solvent solvent interactions [6-7]. The wide ultrasonic sense has been adequately employed in understanding the nature of molecular interactions in pure liquids and liquid mixtures. The ultrasonic characterizations are highly sensitive to molecular interactions and used to demonstrate qualitative nature and strength of molecular interaction in the drug solution [8]. The characterization of mixtures through their thermodynamic and transport properties is important from the fundamental viewpoint of understand their mixing behavior [9-13]. A thorough knowledge of transport properties of non-aqueous solutions is essential in many chemical and industrial applications [14]. Alcohols serve as simple examples of biological and industrially important amphiphilic materials that exist in the liquid state which may be due to hydrogen bonding of their O–H group. The dipolar association of alcohols decreases when they are mixed with aromatic hydrocarbons due to some specific intermolecular interactions between the alcohol and an aromatic hydrocarbon [15-17].
The present paper deals with the measurement of density, viscosity, speed of sound, internal pressure, surface tension etc.in the liquid mixture of diclofenac sodium and butanol at different temperatures. The investigation of physicochemical activities of drug can be the great attention from academic as well as physiological intellect

Ultrasonic technique investigation is to study molecular interaction, drug absorption, transmission activity of alcoholic drug solution [18-20].

II) Materials and Methods:

The Butanol alcohol and analgesic Diclofenac sodium drug were used AR grade (E-Merck chemicals, Germany) with pure form. The purity of chemicals has been confirmed out by comparing the ultrasonic data with standard literature value [21]. The observation of ultrasonic velocity of the solution by using ultrasonic interferometer supplied by Vi-Micro system, Chennai (Model VCT: 71) having frequency at 2 MHz with an accuracy of 0.0001 m/s. The densities are found out using 10 ml specific gravity bottle. Specific gravity bottle having accuracy of ± 2 $X10^{-2}$ kg/m^3.Automatic temperature controller water bath supplied by Lab-Hosp Company Mumbai having an accuracy ±1K temperature. Viscosities were calculated at particular temperature by using Oswald's viscometer; the calibration of viscometer by using doubled distilled water with literature data. The time rate of doubled distilled water and experimental mixture are considered with digital stop clock having accuracy of 0.01 sec (Model: RACER- 10W).Weights were measured with an electronic digital balance (Contech CA-34) having accuracy 0.0001gm. Such a set up make use of to determine the ultrasonic and thermo-acoustic evaluation in butanol and tramadol at temperature T=278.15K-293.15K at various molar concentration.

III) Ultrasonic and thermo-acoustic parameters are formulizing as follows:

Adiabatic Compressibility $(\beta) = 1 / U^2\rho$ ..... (1)
Specific Acoustic Impedance $(Z) = U\rho$ ..... (2)
Intermolecular Free Length $(L_f) = K_T \beta^{1/2}$ ..... (3)
Relaxation Time $(\tau) = (4/3)^*\beta^*\eta$ ..... (4)
Relative association $(Ra) = (\rho/\rho_0)(U_0/U)^{1/3}$ ..... (5)
Classical Absorption $(\alpha/f^2) = (8\pi^2\eta)/(3U\rho)$ ..... (6)
Internal Pressure $(P) = bRT(K\eta/U)^{1/2}x(\rho^{2/3}/M^{7/6}eff)$. (7)
Free Volume $(V_f) = (M_{eff} U/\eta K)^{3/2}$ ..... (8)
Molar volume $(Vm) = Meff/\rho$ ..... (9)
Molar Sound Velocity or Rao Constant $(R) = Meff/\rho (U)^{1/3}$. (10)
Molar compressibility or Wada constant $(W) = V\beta^{-1/7}$ ..... (11)
Isothermal Compressibility $(\beta i) = \gamma\beta$ ..... (12)
Surface Tension $(\sigma) = (6.3 \times 10^{-4})\rho U^{3/2}$ ..... (13)

IV) Data interpretation by graphical tactic as follows:

Following figures are of thermo-acoustic parameters V/S molar concentration

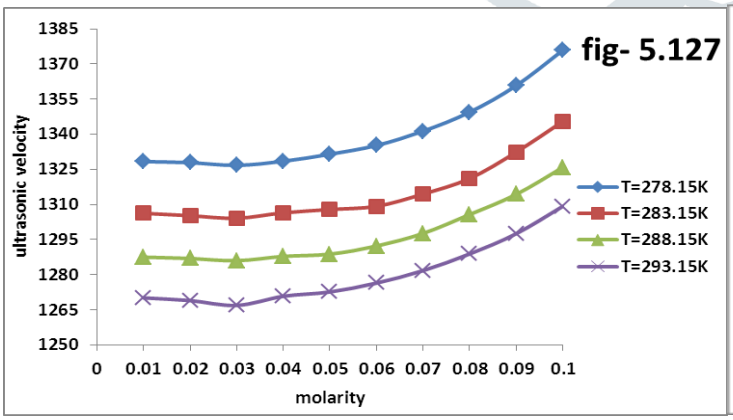

Fig.1 Ultrasonic velocity

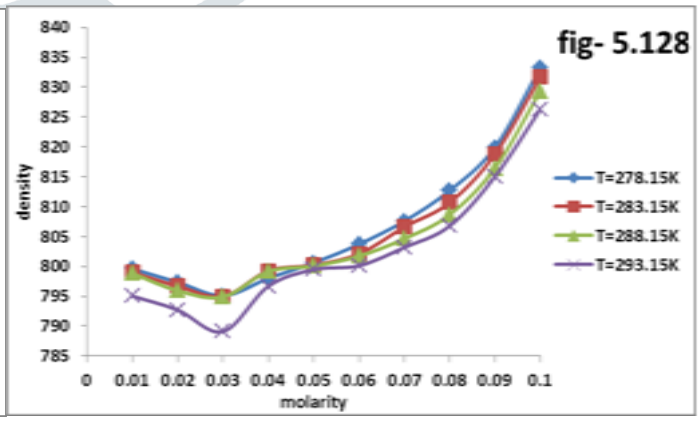

Fig.2 Density

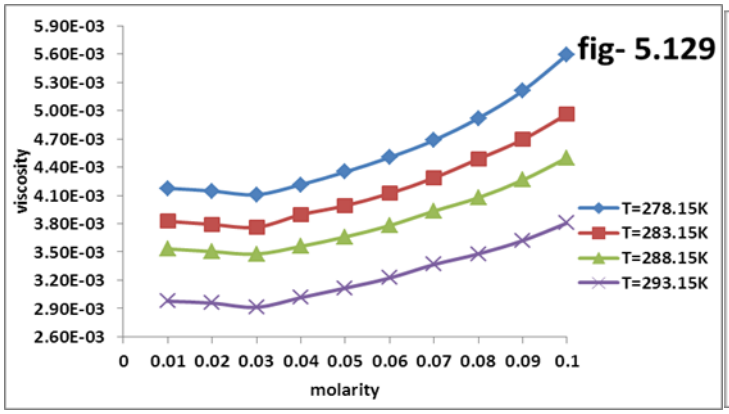

Fig.3 Viscosity

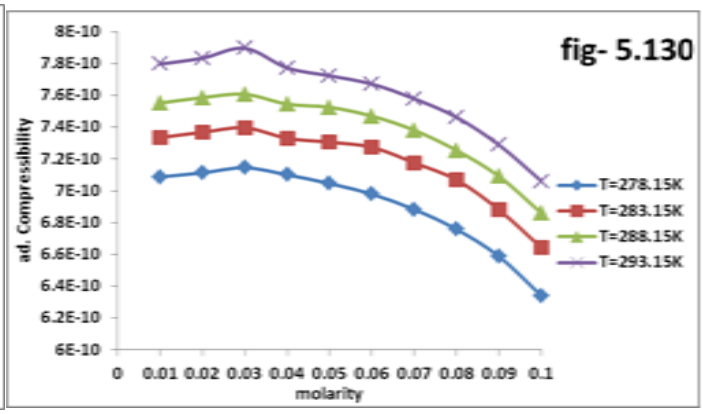

Fig.4 Ad. Compressibility

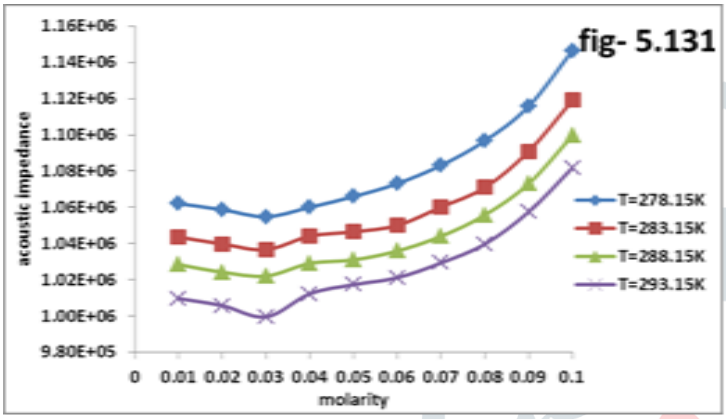

Fig.5 Acoustic Impedence

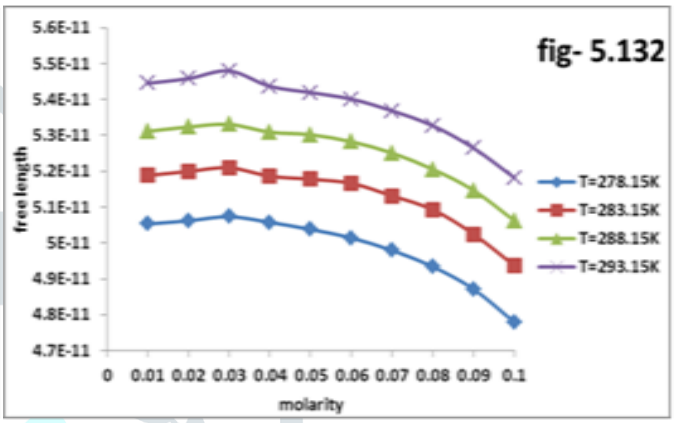

Fig.6 Free length

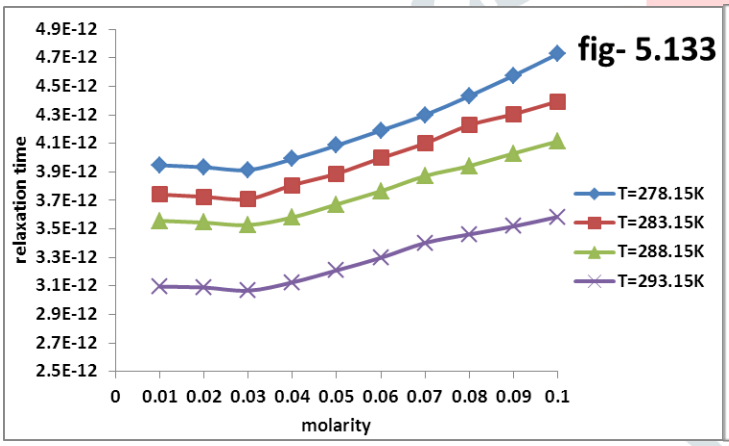

Fig.7 Relaxation Time

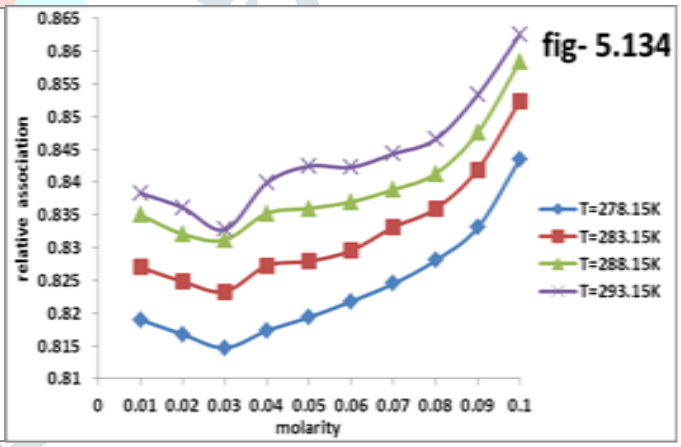

Fig.8 Relative Association

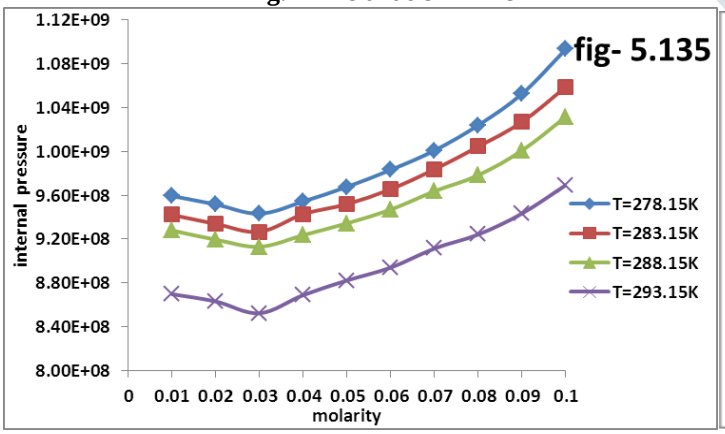

Fig.9 Internal Pressure

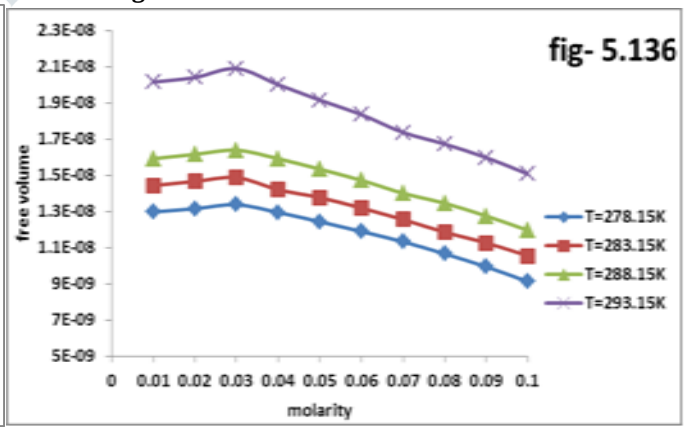

Fig.10 Free Volume

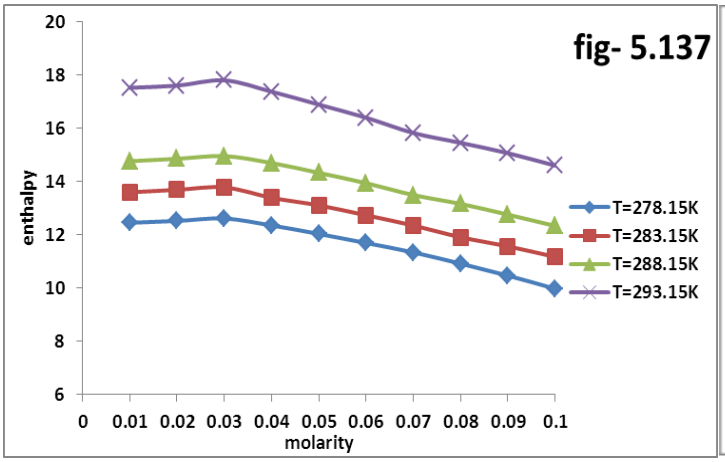

Fig.11 Enthalpy

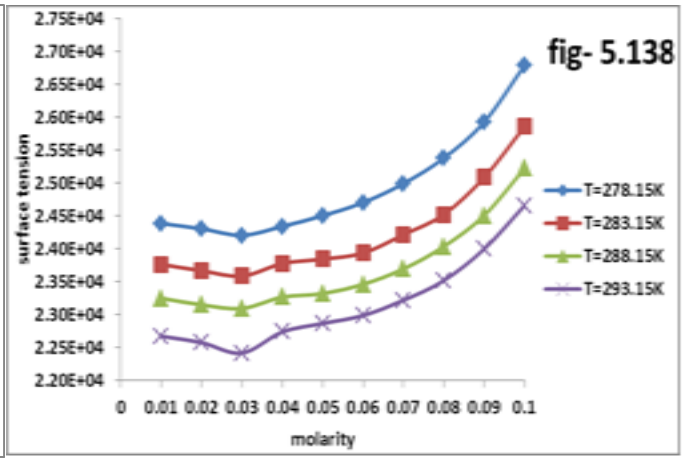

Fig.12 Surface Tension

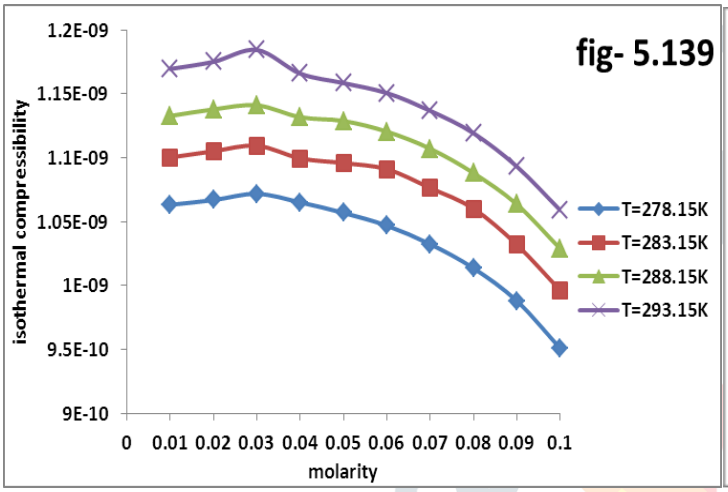

Fig.13 Isothermal Compressibility

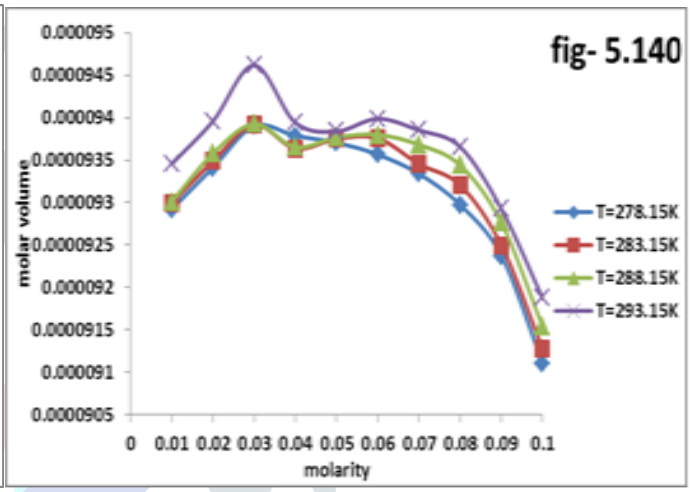

Fig.14 Molar Volume

V) Results and Discussion:

Resulting the experimental data and it has going to assess in terms of Ultrasonic and allied parameters with increase in concentration of Diclofenac sodium with Butanol at temperature T=278.15K-293.15K it has been revealed graphically. Nonlinear variation of ultrasonic velocity with increase in mole fraction of diclofenac sodium gives the dipole-dipole interaction or hydrogen bonded complex structure between unlike molecules which leads to increase in sound velocity and decrease in compressibility. At lower concentration, the number of hydrogen bonds formed may less and at higher concentration it may more because of solute-solute interactions and it forms a tightly bounded system. Adiabatic compressibility is a wide measure of intermolecular association or dissociation or repulsion. Free length decreases as the mole concentration increases; these considerable interactions between solute and solvent molecules. Ultrasonic velocity increases on decrease in free length and vice-versa. An abrupt decrease in molecular free length exhibits a tightly packing molecules or strong interaction in the liquid system. Increase of acoustic impedance with mole concentration may give the strength of inter molecular interaction so it reveal on the basis of the interaction between solute and solvent molecules. Relative association varies linearly which deals with the particular interaction exists in the mixture and relatively it is strong. Internal pressure suggests an outstanding assessment of the solution phenomenon and evaluating various properties of the liquid state. The variation in the internal energy of liquid mixtures, it seems to undergo a much quit isothermal change. So it is a measure of cohesive or binding forces between solute and solvent molecules. The internal pressure may provide information regarding the nature and strength of forces exist between the molecules. The variation of surface tension also supports the significant associative nature in the solution.

Loss of di-polar associating nature and difference in size and shape of the molecules, which provide to decrease in velocity and increase in compressibility. Increase in the compressibility value indicates the weakening of molecular interactions. The positive value of entropy change indicates the reaction must be spontaneous process of flipping of molecule over each other. Increase in temperature of drug solution increases the disorder of the molecules in the mixture; hence there is a reduction in molecular interaction and cohesive forces between the

molecules. Effect of temperature produced destruction in hydrogen bonding between the molecules and hence weakens the molecular interaction. As the result of this drug solution behaves dissociative nature.

VI) Conclusion:

The inference drawn of the alcoholic diclofenac sodium mixture, it has pointing out in this research, the strong intermolecular interaction that exposed the structure making property in the drug mixture. Solute-solvent interaction interpreted in terms of structural re-arrangement due to hydrogen bond interaction between constituent of liquid system. These kinds of sense of interactions directly suggest the wide utility of drugs in various applications.The results obtained from these studies can thus be helpful for pharmacological application of drugs.

REFERENCES

[1] Nagar, S.; Singh, H.. *J. Med. Chem.*, 2007, *16*, 178-180.
[2] Hall, L.. *J. Phys. Rev.*, 1998, 73-76.
[3] Pandy, J.; Shukla, A.; Rai, R.; Mishra, K. *J. Chem. Eng. Data*, 1989, *34*, [4] A Karol Kovas. Essentials of Medicinal Chemistry, 2nd Ed. Wiley, New York, 1988, chap. 3.
[4] JB Stenleke. Founations of molecular Pharmacology, Athlone Press, London, 1975.
[5] F. D. King ; Medicinal Chemistry, 'Principles and Practice', The Royal Soc. Chem. (1984).
[6] Essentials of Pharmacology, Surender Singh, General Pharmacology (Academa publishers), 1st edition, 2004.
[7] K.D.Tripathi, Essentials of Medical Pharmacology, 4th Edn.,Jaypee Brothers Medical Pub.New Delhi,(1999).
[8] A Kar, Medicinal Chemistry *(Wiley Eastern Ltd.)*, 1993.
[9] G. Conti, P. Gianni, L. Lepori, E. Matteoli. *J. Pure & Appl. Chem.* 67(1) (1995) 1849.
[10]B. R. Kumar, B. Satyanarayana, S. A. Banu, K. A. Jyoti,. *Ind. J. Pure Appl. Phys. 47 (2009) 511.*
[11]S. Parveen, M. Yasmin, M. Gupta, J. P. Shukla. *Int. J. Thermodyn.* 13(2) (2010) 59.
[12]S. Singh, B. P. S. Sethi, R. C. Katyal, V. K. Rattan. *J. Chem. Eng. Data* 49 (2004) 1373.
[13]R. A. Clara, A. C. G. Marigliano, V. V. Campos, H. N. Solimo. *Fluid Phase Equilib*. 293 (2010) 151.
[14]B. Gonzalez, N. Calvar, E. Gomez, A. Dominguez. *J. Chem. Thermodyn.* 39 (2007) 1578.
[15]S. C. Bhatia, J. Sangwan, R. Bhatia. *J. Mol. Liq.* 161 (2011) 95.
[16]B. Sathyanarayana, B. Ranjithkumar, T. S. Jyostna,. *J. Chem. Thermodyn.* 39 (2007) 16 .
[17] R. Baskaran, T. R. Kubendran. *Int. J. Appl. Sci. Eng.* 8(2) (2010) 149.
[18] [Umaley K.D. and Aswar, A.S. Ind. J. Of Chem. Tech. 19, (2012)295-302.
[19] Syal, V.K., S. chauhan and P. Sharma, J. of Electrochem Soc. India 1(53), 2004.
[20] Saneel K. Thakur and Shivani Chauhan J. Chem. Pharm. Res. 3(2)(2011)657-664.
[21] Hirschfelder J O, Kurtiss C F, Mole theory of gases and Liquids (John Willy,New York01,(1954),256.