THERMO-ACOUSTIC PROPERTIES OF TRAMADOL IN ALCOHOLIC MEDIA AT DIFFERENT TEMPERATURE

Dr. Sanjay P. Ramteke
Associate Professor,
Dept. of Physics,
S.P.College, Chandrapur,
Email: sanjuram1608@gmail.com

Absract:

The aim of this research is to work out the various interactions of Tramadol molecules in the alcoholic media at the different temperature. The evaluation of molecular interaction of alcohol and Tramadol drug at different temperature have been examined under the ultrasonic technique at frequency 2MHz. Ultrasonic data of drug solutions has been evaluated at various desired thermo-acoustical parameters.

The peculiar deviation of these physical parameters confirms the structural change in the experimental solution so it is an appreciable existence of solute-solvent and solute-solute interactions present in the system. Hence it is evident that the ultrasonic velocity measurement in the given medium serves as a careful probe in characterizing the physico-chemical properties of the medium.

This research paper assigns the different types of molecular interaction in the drug solution. This search have been comprehensively analyzed and eventually interpreted different molecular interactions such as structural re-arrangement effect and also solute-solvent, ionic interaction, H-bonding effect in the drug solution. The results obtained from these studies can thus be helpful for pharmacological application of drugs.

Keywards: Ultrasonic velocity, Density and Acoustical parameters, Tramadol, Alcohol.

Introduction:

Ultrasonic information on thermo acoustic properties of solutions is more essential for their application in chemical, textile, leather and nuclear industries. Various spectroscopic methods like infra-red, Raman effect, di-electric, magnetic resonance are used to know molecular interaction and solution properties. Like other methods, assessment of ultrasonic velocity and allied parameters in liquid mixture is very useful and convenient tool to identify the physico-chemical behavior and molecular interactions. The various characterization of ultrasonic sense has been adequately employed in understanding the nature of molecular interactions in pure liquids and liquid mixtures. The ultrasonic measurements are highly sensitive to molecular interactions and used to provide qualitative information of the nature and strength of molecular interaction in the solution [1-6]. The varied thermo-acoustic data throw much pin out the structural changes associated with the liquid mixtures having weakly and strongly interacting components [7-8].

Alcohols are strongly self-associating and polar behavior of attraction with any other

such a group of compound. Accurate knowledge of thermo-dynamic mixing properties and their excess values for mixtures of protic, non-protic and associated liquids has a great importance in a way of theoretical and applied areas of research. The deviations from ideality and specific or non-specific interactions have been revealed. Alcohols [9] and aromatic compounds exist as associated structures in liquid state. Thus interaction of drug with alcohols give interesting properties arising from charge-transfer, dipole-dipole, donor– acceptor and hydrogen bonding may be observed.

When the absorption is measured as a function of frequency, relaxation process is observed although the relaxation parameters are considerably dependent on the alcohol structures [10-15]. The biological activities of drug molecules, the activation energy of the metabolic process basically arise due to nature and strength of the intermolecular interactions.

Tramadol is extensively metabolized after oral administration. The inhibition of one or both types of the enzymes engaged in the biotransformation of tramadol may affect the plasma concentration of tramadol or its active metabolite [16]. Tramadol and its metabolites are excreted mainly by the kidneys, with a cumulative renal excretion (tramadol and metabolites) of approximately 95%. Should to avoid or limit the use of alcohol while being treated with tramadol.

In the present paper ultrasonic velocity and other related parameters of the mixture of tramadol and ethanol are reported at different temperature range i.e. 278.15K-293.15K. Analyze the various interactions and their subsequent effect on transport properties of tramadol. The analysis of physicochemical activities of drug can be the great interest from academic as well as physiological sense [17-22].

II) Materials and methods:

The solvents alcohols like ethanol and analgesic drug tramadol were used AR grade (E-Merck chemicals, Germany) without further purification. The purity of chemicals has been verified out by comparing the ultrasonic data with standard literature value [23]. The measurement of ultrasonic parameter 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 measured 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 measured at particular temperature by using Oswald's viscometer; the calibration of viscometer by using doubled distilled water with literature value. The time rate of doubled distilled water and experimental mixture are measured 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 ethanol and tramadol at T=278.15K-293.15K at various molar range.

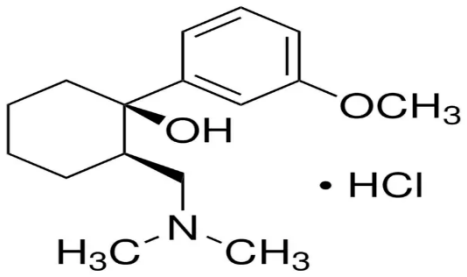
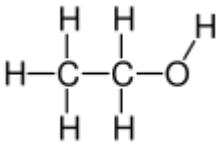
III) Ultrasonic and thermo-acoustic parameters are formulizing as follows:

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 $(\alpha/f^2) = (8\pi^2\eta)/(3\ U\ \rho)$ ..... (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)

Various acoustic and thermodynamic parameters such as adiabatic compressibility (β), intermolecular free length (L_f), specific acoustic impedance (Z), internal pressure (P), Rao constt. (R) and relative association (Ra) etc. were calculated by using ultrasonic velocities (U), density (ρ), viscosity (η) measured parameters.

From such calculated and measured parameters molecular interaction, effectiveness of drug, drug properties for pharmaceutical science and drug release pattern will be obtained.

Materials used in the present study :

Sr. No.	Drug Name	Structure	Molecular Weight	Molecular Formula
1	**Tramadol**		299.84	$C_{16}H_{25}NO_2$
2	**Ethanol**		46.069	C_2H_6O

IV) Data interpretation by graphical tactic as follows:

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

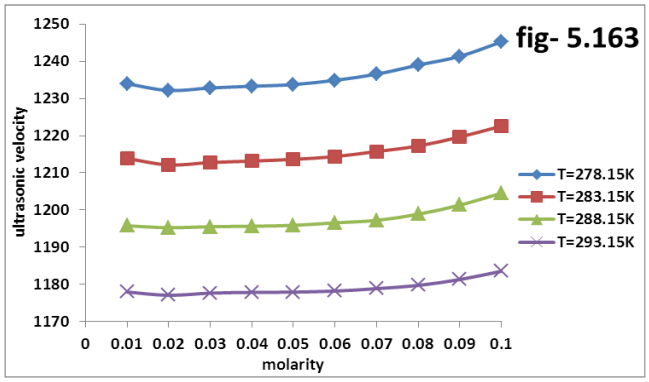


fig- 5.163
ultrasonic velocity
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K

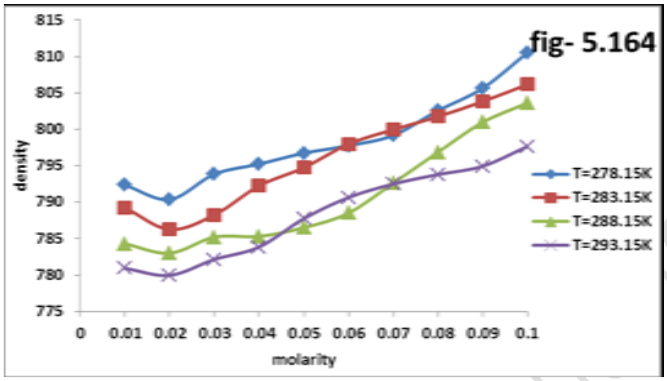


fig- 5.164
density
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K

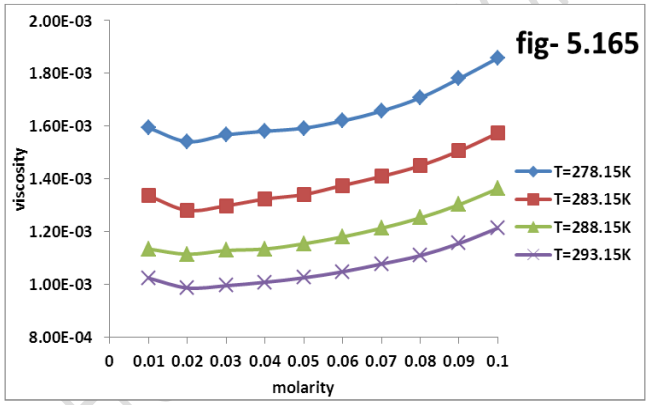


fig- 5.165
viscosity
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K

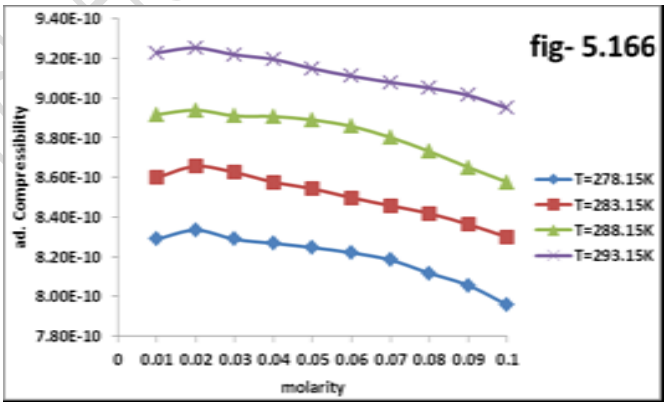
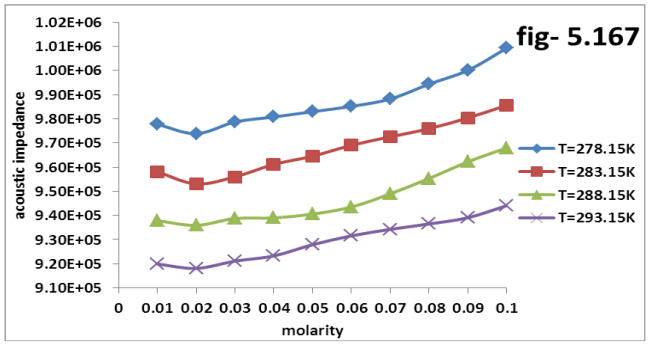
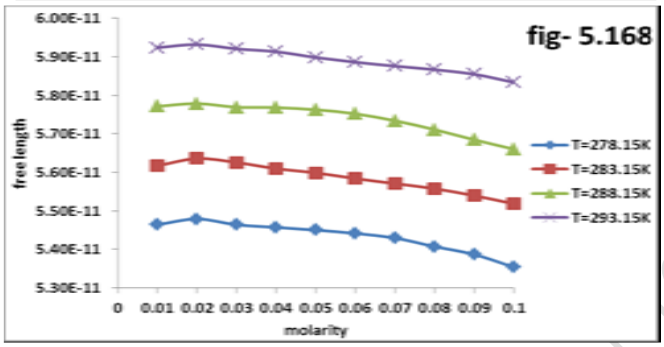
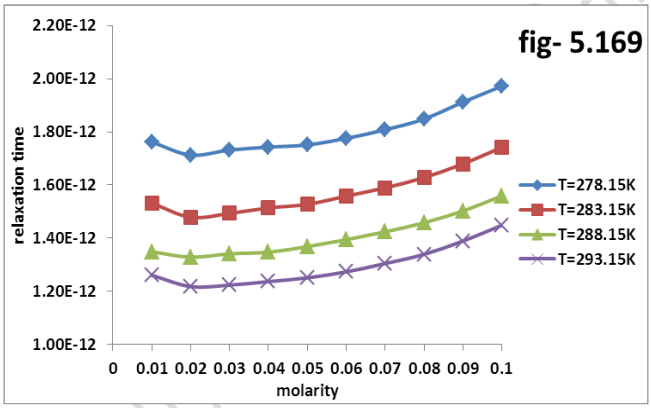
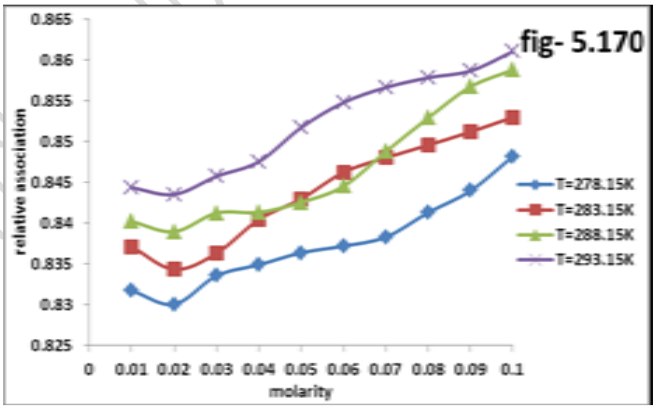


fig- 5.166
ad. Compressibility
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K









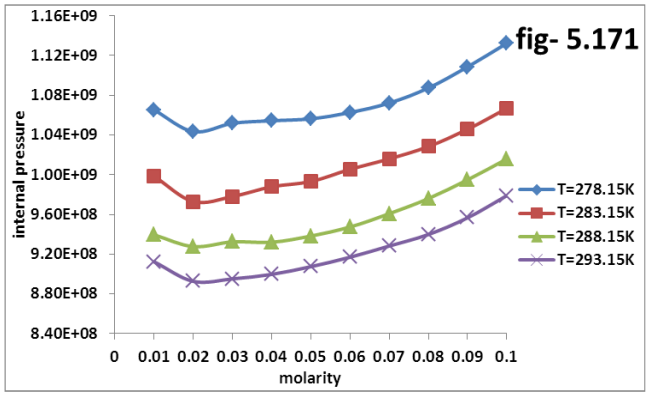


fig- 5.171
internal pressure
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K

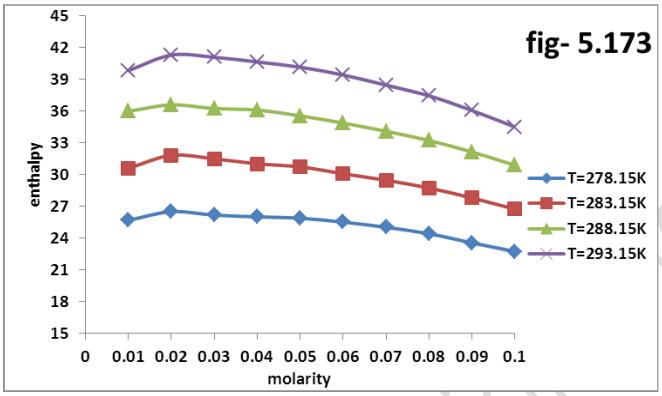


fig- 5.173
enthalpy
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K

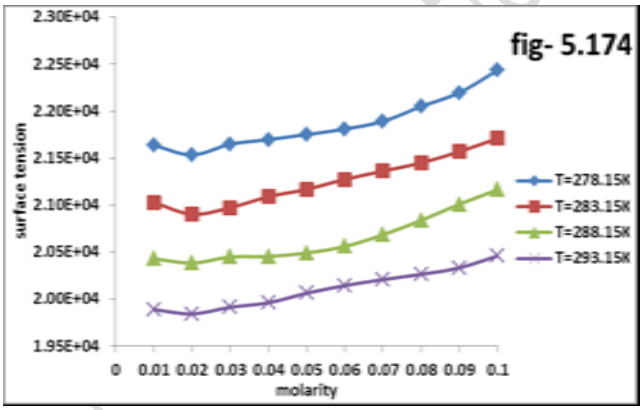


fig- 5.174
surface tension
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K

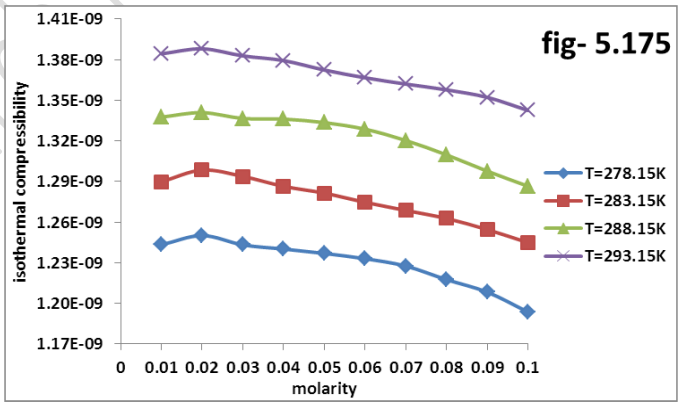
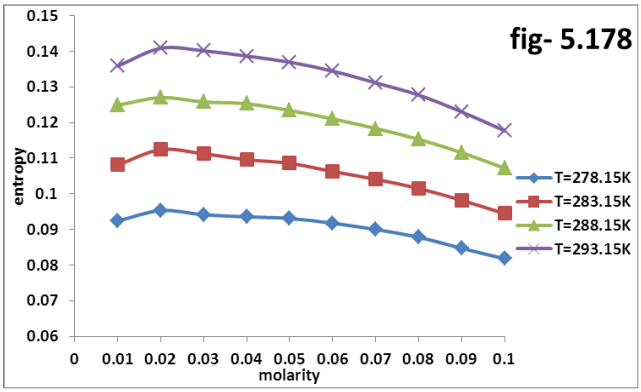


fig- 5.175
isothermal compressibility
molarity
T=278.15K
T=283.15K
T=288.15K
T=293.15K



V) Results and discussion:

Experimental assessment in terms of Ultrasonic and allied parameters with increase in concentration of Tramadol with ethanol at temperature T=278.15K-293.15K it has been revealed graphically. Nonlinear variation of ultrasonic velocity with increase in mole fraction of Tramadol 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. A sudden decrease in molecular free length shows a tightly packing molecules or strong interaction. Increase of acoustic impedance with mole concentration may provide 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 reveals the particular interaction exists in the solution and quite it is strong in nature. Internal pressure gives an outstanding examination of the solution phenomenon and evaluating various properties of the liquid state. The changes in the internal energy of liquid mixtures, it seems to undergo a very small 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 [24]. 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 [25].

Conclusion:

The estimation of alcoholic tramadol solution, mentioned in research paper, accomplish towards the strong intermolecular interaction that revealed the structure making property in the liquid mixture. Solute-solvent interaction interpreted in terms of structural re-arrangement due to hydrogen bond interaction between constituent of liquid system. The present study of molecular interaction of alcoholic tramadol solution using ultrasonic investigation provides important information about the physiological system and used to understand the mechanism of their metabolism in the living system. The results obtained from these studies can thus be helpful for pharmacological applications of drugs as well as to understand form kinetic processes such as transport of drug across biological membranes, drug action and physicochemical properties. Complex formation produces displacement of drug molecules.

References:

- Kincaid J.F. and Eyring H.,J. Chem. Phy.,5, 587.,1937.
- Mehta S.K. and Chauhan R.K.,J. Solution. Chem., 26, 295. 1996
- Dewan R.K., Mehta S.K., Parashar R. and Bala K., J. Chem. Soc. Faraday Trans.,87, 1561.1991.
- Kannappan A.N. and Rajendran V., Ind.J. Pure & Appl. Phys. 29, 451.1991.
- Kannappan A.N. and Rajendran V., Ind.J. Pure & Appl. Phys., 30, 240.1992.
- Isht Vibhu, Amit Misra, Manisha Guptha and Shukla J.P., Ind. Acad. of Sci., 62(5),2004.
- Arul and Palaniappan L.,J. Acoust.Soci. Ind., 28, 393,2000.
- Ponday J.D. and Shukla A.K., J. Pure Appl. Ultrason. 15, 37.1997.
- Iloukhani H. and Rostam Z. ,J. Chem1147,2007.
- Y. Marcus in “Introduction to liquid state chemistry” John Willey and Sons, London 142,1997.
- Mcglashan M. L. in “Chemical thermodynamics”, Academic press, London,.241,1779.
- Huggins,M.L. J. Phy. Chem. 74, 371,1970.
- Maitland,G.C.,Rigby,M.,SmithE.B.and Wakeham W.A. in “Inter molecular forces” Clerendon press, Oxford 8,1981.
- Roulinson J.S. in “Liquid and Liquid mixtures”,ButterworthPublishing Co; London 1957.
- Prigogine in “Molecular theory of solutions”, North Holl and Publishing Co; Amsterdam 1957.
- Winnic,J. Industrial and Engg. Chem.15, 180 1976.
- Umaley K.D. and Aswar, A.S. Ind. J. Of Chem. Tech. 19, 295-302. 2012.
- Syal, V.K., S. chauhan and P. Sharma, J. of Electrochem Soc. India 1(53),2004.
- Saneel K. Thakur and Shivani Chauhan J. Chem. Pharm. Res. 3(2):657-664,2011.
- Weast, R.C CRC Hanbook of Chemistry and Physics, 51st.Edn.(CRC Press, Cleaveland),C-405,1970.
- Wankhede, D.S., Lande M.K and Arbad B.R. Jof Chem Engg Data,50:260,2005.
- Riyazuddeen and UmaimaGazal, J. Chem. Eng. data, 57: 7-13,2012.
- Hirschfelder J O, Kurtiss C F and Bird R B, Molecular theory of gases and Liquids (John Willy, New York-01, 256, 1954.