Acoustic and thermodynamic parameter investigations in the mixture containing D-Panthenol using ultrasonic technique.

Dissertation report-1I

Submitted

BY

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DECEMBER 2017

ACKNOWLEDGEMENT

First of all, I am very grateful to my guide, Dr. Kailash Chandra Juglan, Associate Professor, Dept. of Physics, Lovely Professional University, Phagwara, to accept the application for a master's degree dissertation here. He is my continuous promoter, my inspiration. I thank him for accepting me for working on M. Sc. dissertation as well as for his warm encouragement, exceptional guidelines, critical comments, project repairs and providing an excellent atmosphere for action.

I also want to express my gratitude to Dr. Harsh Kumar, Associate Professor, Dept. of Chemistry, National Institute of Technology, Jalandhar, for supporting me and allowing me to do my experiment in their lab. I want thank Miss. Kirandeep Kaur and Miss. Ashima to help me through with the technicalities of the experiment and the calculations with the data obtained. I am also grateful for my entire M. Sc. friends who always encouraged me to finish my job.

I especially thank the parents who educated me and provided the opportunity to learn and especially to cooperate with me to finish my work.

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(Nabaparna Chakraborty)

INTRODUCTION:

The use of chemicals in the medical field requires attention of the public in every areas including ultrasonic behaviour. Usually, ultrasonic research can be widely used to learn molecular interactions when combined with other water resources. Much of the study has been done in molecular interactions on products and mixtures in various forms of the body. It plays an important role in developing molecular science. In recent years, ultrasonic technology has been an effective way to find out about more efficient method for gaining information about behaviour of liquids and solids having its ability of featuring the physiochemical behavior of the medium. Concern over a period of 20,000Hz (20 kHz). It is usually used for non-destructive techniques (NDT). The NDT is used to test as it cannot cause disorder to the structure. This approach has a wide range of scientific and business analyses to investigate properties without causing any damage. The NDT has a number of non-destructive tests such ultrasonic, magnetic particle, radiography and eddy current testing and low coherence of interferometry.

Ultrasound techniques can be a huge source of information about the structural and molecular changes that take place in liquid mixtures. Within the framework of the theory of physical acoustics, these kind of techniques could also provide useful information about the mixing solution and its temperature dependence. The ultrasonic speed technique is an interesting and effective technique to study the physicochemical properties of liquid - liquid mixtures, electrolytic solutions and polymeric solutions. These solutions find wide applications in the medical, pharmaceutical, leather, textile, chemical and solvent solutions industries. The study, understanding and analyzation of the thermodynamic properties of mixtures and liquid solutions were most significant for their applications in these industries.

The spread of ultrasound waves into a substance has become a major test to study its properties. Such studies, such as changes in temperature and concentration, are useful to obtain the insight into the structure and the various linkages of the bound molecular complexes and other related molecular processes. The velocity and the associated acoustic parameters help us to characterize the thermodynamic and physical and chemical aspects of liquid mixtures like molecular association and dissociation.

Ultrasonic velocity measurement allows us to accurately measure some important and applicable thermodynamic and acoustic parameters and their excessive values. These excessive ultrasound, intrinsically molecular free length, adiabatic compressibility and acoustic impedance in liquid mixtures plays an important role to understand the interactions between the solute and the solvent.

There may be existence of different types of interaction on the mixing of solvent. The magnitude of forces depends upon the type of solvent used and it decreases or increases accordingly. In the mixing components it is found that bond breaking or breaking of liquid order predominates over other types of molecular interactions. The ultrasonic velocity (U) and density (ρ) were used to calculate the parameters such as free adiabatic compressibility, acoustic impedance, intermolecular free length, Wada's constant, Rao's constant and Vander Waal's constant. The trends of these acoustical parameters have the ability to reveal the nature and behavior of a system more precisely.

REVIEW OF LITERATURE:

C.J. Burton (1948) [1] had measured the velocity of sound and density in binary mixtures of water with alcohols glycols. In the mixtures the ultrasonic absorption peaks at intermediate concentrations have been found in the solution which contain acetone, ethanol, propanol, isopropanol, d tertiary butanol and in the monoethyl and monobutyl glycol ethers. The magnitude of the peaks increases as one progresses from the ethyl to the butyl derivative, and there is a continous shift of the peak toward higher water concentration in both the series In mixtures containing methanol, glycol, monomethyl glycol ether, or dioxane no absorption peaks were found. In all of the mixtures listed the velocity peaks at intermediate concentrations have been found. Mixtures of tertiary butanol and methanol show neither absorption nor velocity peaks.

G.G. Hammes and P.R. Schimme1 (1967) [2] had measured the ultrasonic attenuation in both the presence and absence of a synthetic polymer,molecular weight range of polyethylene glycol solutions been made at 600- 20,000 in the ultrasonic attenuation

measurement. The relaxation time is independent of molecular weight and concentration over the entire range of molecular weights, as the relaxation time increases with molecular weight.

S. Bagchi et al (1986) [3] had measured density, absolute viscosities and ultrasonic velocity, for solutions of ISRO polyol, used in the Indian Space Research Organization. It has been studied for various solvents. In highly hydrogen-bonded solvents, the solvation number is found to be higher.

K.N. Mehrotra et al (1989) [4] had measured the degree of dissociation, dissociation constant, critical micelle concentration and thermodynamic parameters, for calcium myristate in a mixture of chloroform and propylene glycol of different composition. The results showed in dilute solutions these soaps behave like weak electrolytes in and with increasing temperature, CMC increases. The results showed that with increasing soap concentrations, the ultrasound velocity, specific acoustic impedance, apparent molar compressibility, and molar velocity were increased, whereas adiabatic compression and free intramolecular length and number of solvations decreased.

K.C. Rao et al (1990) [5] had measured viscosity, ultrasonic velocity, refractive for solutions and density for poly (vinyl pyrrolidone) in N,N-dimethyl formamide (DMF) at various concentrations and temperatures. The specific acoustic impedance (Z), molar compressibility (β), Van der Waals constant (b), Rao number (R), and the relaxation strength (r) have been computed. The variations of these parameters with concentration at several temperatures have been studied.

A.V. Rajulu and P.M. Sab (1995) [6] had measured the density (ρ) and ultrasonic velocity (U) for polyethylene glycol/ water mixtures at 30°C. The molar compressibility (β), van der Waals constant (b) adiabatic compressibility (β_{ad}), Rao number (R), and specific acoustic impedance (Z). The variations of U, ρ, $\beta_{ad,}$ β, R, R and b with mole ratio have been analyzed.

S. Magazu et al (1997) [7] had measured the density and ultrasonic velocity of aqueous solutions of α-α-trehalose, by means of ultrasonic techniques. The data showed that, in these aqueous solutions, the mixing process is not ideal. The behavior of the excess of

compressibility with the concentration was interpreted supposing that the α-α-trehalose molecules form intramolecular hydrogen bonds when folding at high concentrations.

A. Ali et al (1999)[8] had measured the viscosities, densities and ultrasonic velocities of pure ethanol, 1-hexanol, 1-octanol, acetonitrile, N,N-dimethylformamide, and of the binary mixtures of ethanol with 1-hexanol and 1-octanol, and those of acetonitrile with N,N-dimethylformamide at 303.15 K. The excess volume, excess intermolecular fee length, excess adiabatic compressibility, excess acoustic impedance, and excess viscosity the molecular association have been calculated from the experimental data.

V.K. Syal (2005) [9] had measured the viscosity, ultrasonic velocity and density of solutions of PEG's in water (H2O) and its a mixture with Acetonitrile (AN) at 250C. From the density, velocity and viscosity data values, various acoustical parameters namely, viscous relaxation time (ι),adiabatic compressibility (β), specific acoustic impedance (Z), apparent molar adiabatic compressibility (φ_{ks}), intermolecular free length (Lf), relative association (R.A.), molar sound velocity (R), Wada's constant (W), solvation number (Sn), internal pressure (π) and free volume (V_f) have been calculated.

R. Palani and A. Geetha (2008) [10] had measured the density (ρ), viscosity (η) and ultrasonic velocity (U) for the liquid mixtures of water+propylene, glycol+tetrahydrofuran, water+propylene, glycol+dimethylformamide, water+propylene, glycol+dimethylsulphoxide and water+propylene glycolþ1,4-dioxane, as a function of the composition at different temperature. Experimental data was used to calculate thermodynamic parameters namely, excess volumet (V_f^E), excess viscosity (η^E), excess Gibb free energy and interaction parameter (d).

P. Shanmuga et al (2010)[11] had measured the viscosity, density and ultrasonic velocity for binary liquid mixtures containing Methylmethacrylate+2-Methoxy ethanol, Methylmethacrylate +2-Ethoxy ethanol, Methyl methacrylate+2 Butoxy ethanol at 303K. Adiabatic compression, free energy values of Gibbs, internal pressure, free length, free volume, acoustic impedance, relaxation time and are calculated from experimental data.

J.N. Ramteke (2012)[12] had measured the density (ρ), ultrasonic velocity (u), and viscosity (η) of the binary liquid mixtures containing α-picolin in Ethanol at 301.15 K and

305.15 K. From these data some of acoustical parameters such as, free volume (V_f), free length (L_f), adiabatic compressibility ($\beta_{a)}$ and internal pressure (π_i) was computed. The variation of ultrasonic velocity (u) and excess adiabatic compressibility (β) implied the existence of molecular interaction between solvent and solute. The excess adiabatic compressibility was positive over whole concentration range and it became minimum at a concentration (0.5) of α-picoline in ethanol at observed temperatures.

D.R. Godlani et al (2012) [13] had measured the viscosity (η), density (ρ) and ultrasonic velocity (U) of pure solvents chloroform, N-N dimethyle formide and solutions of 2-((4-acetyl-5-(2-hydroxyphenyl)-5-methyl-4,5-dihydro-1,3,4-oxadiazol-2-yl)methylthio)-3-o-tolyquinazolin-4(3H)-1 ($PD_{1\text{-}C}$) (0.001, 0.002, 0.004, 0.006, 0.008 and 0.010 mol dm^3) in CF and DMF are investigated at different temperature at atmospheric pressure. Various thermodynamic parameters such as inter molecular internal pressure (л), free length (L_f), solvation number (S_n), specific acoustic impedance (Z), van der Waals constant (b), Rao number (R), adiabatic compressibility (β_{ad}), relaxation time (τ), free volume (V_f), and are calculated by using η, ρ and U data.

S. Parveen et al (2012) [14] had measured the density, ultrasonic velocity, refractive index and viscosity of binary mixtures of aniline with acetic acid(AA) and propionic acid(PA) at different temperature over the entire composition range. In addition, the thermal capacity, specific heat ratio, pseudo-Gruensisen parameter andDebye effective temperature and non-linearity were evaluated by ultrasonic absorption data. From the test data, detours of centripetal excess molar volume, compressibility, excess intramolecular length, relaxation time, deviation in molar refraction, enthalpy, viscosity deviation, entropy, and energy of Gibbs activation from the Redlich-Kister polymerization equation were calculated.

U.G. Pathak et al (2012) [15] had measured the density, viscosity and ultrasonic speed of several solvents: chloroform, THF, and 1,4-dioxane, along with epoxy resin solutions at 308.15 K. Various thermodynamic parameters such as the adiabatic compressibility (κα), internal pressure (π) , ultrasonic speed (U), Van der Waals constant (b), intermolecular free path length (Lf), and viscous relaxation time (τ) have been determined.

B. Kaur and K.C. Juglan (2013)[16] had measured the density, ultrasonic velocity and viscosity of binary liquid mixtures of polyvinyl acetate with acetic acid using ultrasonic

interferometer, gravity bottle and viscometer respectively at frequency 2MHz and at constant temperature of 295K. The experimental values obtained are used to determine various parameters such as intermolecular length, acoustic impedance, adiabatic compressibility, relaxation time, free, and ultrasonic attenuation. The variations of experimentally obtained parameters shows the possible presence of molecular interaction between the molecules of the mixture. As the concentration increases ultrasonic velocity increases. The viscosity increases with increase in the concentration. Linear variations in the Rao and Wada constant indicate the lack of complex formation.

B. Pal and S. Kundu (2013) [17] had measured the attenuation constant (α) and velocity (v) for ultrasonic waves at frequencies 1MHz and 2MHz travelling through the aqueous sodium chloride solution over the concentration region at room temperature (25^0 C). With the increase of concentration the velocity (v) and attenuation constant increases indicating relatively stronger bonding among the ions and water molecules solution.

M. Das et al (2013) [18] had measured the density and ultrasonic velocity for sodium nitroprusside in aqueous solutions of CH_3OH, ethylene glycol, DMSO, and n-propanol solvents at a fixed temperature. From the experiment parameters like acoustic impedance, adiabatic compressibility, apparent molar volume, limiting apparent molar compressibility, intermolecular free length, apparent molar compressibility, limiting apparent molar volume and their constants were obtained.

A. Pal et al (2013)[19] had measured the density (ρ) and ultrasonic velocity (U) of binary mixture of 1,4-dioxane with 1-propanol,2 propanol,1-butanol and 2-butanol as a function of concentration using DSA at different temperatures and at atmospheric pressure. Excess molar concentration, KES and Excess molar volume, Vf1, are computed from the experimental data. From the experimental density measurements, excess partial molar volume, V_i^E, the apparent molar volume, V_{fj}, partial molar volume V_i, and their infinite dilution limits Vj, V0i and V_{mj}^E were calculated.

F.M. Sannaningannavar et al (2013) [20] had measured the density and ultrasonic velocity at different temperatures for the pure liquid sample, poly (ethylene glycol) with average molecular mass 400 g mol-1 (PEG 400Of these, free intramolecular length (Lf), isotropic compressibility (b), molar volume (Vm), acoustic impedance (Z), Schaff Va (s)

volume, molar sound rate (Ra) and molar compressibility. The changes in these parameters of the sample at different temperatures were investigated. The data thus obtained is used to determine various other thermodynamic parameters.

A. Pal et al (2013) [21] had measured the ultrasonic speeds and densities have over the whole composition range for binary liquid mixtures of dipropylene glycol dimethyl ether, CH3(OC3H6)2OCH3, with methyl acetate, ethyl acetate, and n-butyl acetate using an DSA density and speed sound analyzer at different temperature and at atmospheric pressure.

A. Dixit et al (2014)[22] had measured the density, viscosity and ultrasonic velocity of liquid mixtures of n-butanol, water and acetic acid ($C_4H_9OH + H_2O + CH_3COOH$) at different concentrations using ultrasonic technique at a constant temperature 289K. The experimental values obtained are used to determine various acoustic parameters such as Vander Waal constant, adiabatic impedance, adiabatic compressibility, relaxation time, free intermolecular length ultrasound attenuation, volume present, effective molecular weight, Wada constant, molar volume, Rao constant, internal pressure, free energy and Gibbs enthalpy.

S. Kumari et al (2014) [23] had measured the viscosity, density and ultrasonic velocity of tyrosine derivative with non-aqueous dimethyl sulpho oxide (DMSO) at constant temperature of 290K using ultrasonic interferometer. Using these fundamental parameters were calculated. From these parameters the nonlinear variations were obtained which indicated that a weak interaction among solute and solvent molecules is present.

S.M. Naveem and D.K. Rao (2014)[24] had measured the density and the speed of sound of the systems (Benzyl Benzoate + *n*-butanol, *sec*butanol, *tert*-butanol) at different temperatures 308.15K and 313.15K respectively and at different mole fraction. From these experimental data the acoustic parameters such as deviation in isentropic compressibility, excess intermolecular free length, excess acoustic impedance and deviation in ultrasonic velocity was calculated for the systems at these temperatures.

H. Kumar et al (2014) [25] had measured the interactions of amino acids glycine, L-alanine and L-valine with sodium dihydrogen phosphate by the combination of acoustic and volumetric measurements as the function of temperature. Speeds of sound and Densities of amino acids in aqueous solutions of sodium dihydrogen phosphate have been measured at

different temperatur and at atmospheric pressure. The partial molar volume (V_ϕ^0), standard partial molar volumes of transfer ($\Delta V\phi^0$) and the apparent molar volume (V_ϕ), have been calculated from density data. Partial molar isentropic compression of transfer ($\Delta k_{\phi s}^0$) and partial molar isentropic compression ($k_{\phi s}$), have been calculated from ultrasonic speed data.

K. Kaur and K.C. Juglan (2015)[26] measured the viscosity, ultrasonic velocityand density and of the liquid mixture of chloroform and methanol by an ultrasonic interfering device, a 30 ml bottle of viscosimeter and a Oswald viscosimeter at 2MHz at constant temperature is 295K respectively. The experimental values obtained were then used to determine the various thermal parameters such as mole mass, adiabatic compression, acoustic impedance, free intermolecular length, relaxation time, ultrasonic attenuation, molecular weight volume, , constant Wada, intrinsic pressure constant, free energy, and Gibbs enthalpy.

K.H. Wananjea et al (2015)[27] had measured ultrasonic velocity and other acoustical parameters such as free length (L_f), acoustical impedance (z), adiabatic compressibility (β), and viscous relaxation time (τ) for aqueous polypropylene glycols, at room temperature. Ultrasonic velocity, free length, acoustic impedance, relaxation time and adiabatic compressibility, has been calculated and discussed in terms of concentration and structural dynamics for the given system. The variance in acoustic parameters has been found to be more complex with the higher concentration of the region for water PPG-425.

K. Kaur and K.C. Juglan (2016)[28] had measured the viscosity, density and ultrasonic velocity and of binary liquid mixtures of ethyl acetate and hexane at constant temperature of 292K and at frequency 2MHz using ultrasonic interferometer. The experimental values obtained are then used to determine different acoustic parameters such as viscosity, acoustic impedance adiabatic compressibility, ultrasonic attenuation, free intermolecular length, free volume, free energy of Gibb, internal pressure, and enthalpy.

A.R. Thakare and A.B. Naik (2016) [29] had measured the ultrasonic velocity and density of aqueous 2-amino-5-nitrothiazole – $NiCl_2$ solution at different temperatures and concentrations. The experimental values obtained are then used to determine different acoustic parameters such as specific acoustic impedance, free intermolecular length, isentropic compressibility and relative association.

H. Kumar et al (2016)[30] had measured the ultrasonic speed, u and densities, ρ for aqueous solutions of alkoxyalkanols like ethylene glycol mono methyl ether in aqueous solutions of surfactant sodium dodecyl sulphate at different temperatures. Various parameters such as transfer volume, partial molar stretch ability, apparent molar volume and limiting visible molar volume, are computed from density data. With an increase in the sodium dodecyl sulfate concentration for all the alkoxyalkanols, the molar volume value (V_f) decreases, whereas for which there is an increase in V_f values with an increase in the sodium dodecyl sulfate concentration.

H. Kumar et al (2016) [31] had measured the ultrasonic speed (c) and density (ρ) of the interactions of chloramphenicol with L-leucine and the dipeptide glycyl-L-leucine, in aqueous medium at different temperature and experimental pressure at p = 0.1 MPa. For L-leucine and the dipeptide. From the density data the apparent partial molar volume ($V_{\phi o}$), apparent molar volume (V_ϕ), the apparent partial molar volumes of transfer ($\Delta V_{\phi o}$), apparent molar isentropic compression ($K_{\phi,s}$), apparent partial molar isentropic compression ($K_{\phi,so}$), and apparent partial molar isentropic compression of transfer ($\Delta K_{\phi,so}$) have been obtained.

SCOPE OF STUDY:

Panthenol which is also known as pantothenol is the alkaline analog of pantothenic acid which is a vitamin B5 and thus is B5 provitamin. In organisms the panthenol is fastly oxidized to pantothenic acid therefore is used as a moisturizer as it is a biologically active substance. D-Panthenol is having a property of improving the wound healing in pharmaceutical and cosmetic products. It is also widely used in the biosynthesis of coenzyme A, which plays a role in cell growth. D-panthenol whichn represent dexapantol is biologically active and has moisturizing properties. It is widely used in the production of polymers and also find its application in the food industry.

D-Panthenol is used for the treatment, prevention, improvement and control of the following diseases, conditions and symptoms:

- Dandruff
- Skin disorders
- Muscular dystrophy
- Mild burns
- Minor skin injuries
- Sunburns

This topic is on an unexplored area and the work will be published in reviewed indexed journal.

OBJECTIVES OF THE STUDY:

The main objectives of this project are:

1. To understand the intermolecular interactions occurring in the aqueous solution of D-Panthenol in Ethylene glycol, diethylene glycol & triethylene glycol respectively at different temperatures.
2. To obtain the fundamental parameters Density and Ultrasonic Velocity of the mixtures at different concentrations and at four different temperatures of (293,298,303 and 308) K.
3. To calculate the derived thermo-acoustic parameters like intermolecular free length, acoustic impedance, adiabatic compressibility, Wada's constant, Rao's Constant and Vander Waal's constant.
4. To plot the graphs for each parameter against molality for better understanding of interaction in D-Panthenol and glycol mixtures at varying temperature.

RESEARCH METHODOLGY:

The ternary liquid mixture of an aqueous solution of D-panthenol and glycols of varying concentrations in the range of molar fractions was investigated by ultrasonic velocity and density measurement by ultrasound technique using Anton-Paar DSA 5000 M. The temperature varies from (293,298, 303 and 308) K. The sample is manually inserted in the equipment by the means of a syringe in the equipment. The two physically independent properties of a single specimen is being defined, as the multipurpose tool is equipped with a

density cell and a cell where the speed of sound is determined separately. In both the cells the temperature is controlled by built in Peltier-thermostat. The density and velocity of the sound and the values obtained are used as inputs for various concentration computation models that are integrated into the DSA. The data obtained is used for calculating different acoustic and thermodynamic parameters such as adiabatic compression, free intermolecular length, acoustic impedance, the constant of Rao, constant of Wada, and Vander Wall constant.

EXPERIMENTAL THEORY:

Measurement of Density:

The density of liquid mixtures, pure liquids and solution can be calculated using relative measurement method. The density of liquid has measured by a bottle of 10ml specific gravity at different concentration. With the liquid the bottle of specific gravity is immersed at a temperature controlled water bath. The measured density was measured with a formula,

$\rho_1 = (w_2/w_1)\ \rho_2$

Where,

W_1 = distilled water's weight

W_2= experimental liquid's weight

ρ_1= Water's density

ρ_2 = Experimental liquid's density

Ultrasonic velocity:

The ultrasonic interferometer is a device for determining the ultrasonic velocity in liquids with a large accuracy. The principle used for measuring the velocity (v), based on the exact calculation of wavelength in a medium. Then the wavelength is calculated as:

$\lambda=2d/n$

Now by the knowledge of the velocity (U), wavelength (λ), can obtained by following relation:

$$U=f \times \lambda$$

Where

U=velocity of ultrasonic wave

f= frequency of particle vibration

λ=wavelength of wave.

ACOUSTICAL PARAMETERS:

By using basic parameters which it is defined above we can calculate various parameters.

Acoustics impedance:

It is the resistance which is offered to the propagation of ultrasonic wave in a material, and is defined by the product of acoustic velocity (U) and density (ρ).

$Z = \rho \times U$

This impedance is used for determining the acoustic reflection and transmission at the boundary of two materials having different acoustics impedances.

Adiabatic compressibility:

It can be defined as fractional decrease in volume per unit increase of pressure, when there is no transfer of heat. These changes can be related to compressibility of medium but thermodynamic relations:

$$\beta = 1/v \, (dv/d\rho)$$

This can be determined by density of medium and speed of sound using equations of Newton's which were:

$$\beta = 1 / (U^2 \rho)$$

Where,

ρ= Density of medium

U = Ultrasonic velocity in the medium

Intermolecular free length:

The distances between surfaces of neighbouring molecules that is given by:

$L_F = K_T (\beta)^{½}$

Where,

β =Adiabatic compressibility of mixture.

K_T = Temperature of dependent Jacobson's constant

Wada's constant:

It is the relation between adiabatic compressibility, effective mass and density of the mixture. Relation is as follow as follows,

$$W= (\beta)^{-1/7} M/\rho$$

Where,

W = Wada's constant (independent of temperature)

β=Adiabatic compressibility

M =Effective molecular weight

ρ=Density of mixtre

Rao's constant:

It is the simple relation between velocity of ultrasound and density of mixture and can be given as,

$$R=U^{⅓} M/\rho$$

Where,

R=Rao's constant

U=Ultrasonic velocity

M=Effective molecular weight

ρ=Density of mixture

Rao's number gives an idea of how the nature of molecular interaction changes with concentration.

Vander Waal's constant:

It is determined by using the relation

$$b = (M/\rho)\,[1 - (R\,T/M\,U^2)\,[\{1 + (MU^2/3R\,T)\}^{1/2} - 1].$$

Where,

M = Molecular weight

R = constant i.e. 8.314J/mol

ρ = Density solution

PROPOSED WORK PLAN WITH TIMELINES:

The dissertation work on Acoustics under the Guidance of "Dr. Kailash Chandra Juglan" Dept. of Physics has been started in the month of January 2017. More than 40 research papers were studied based on acoustics during the period of January-November 2017. The acoustical parameters of 0.05 D-Panthenol with glycols has been investigated. As D-Panthenol is having many industrial and medicinal applications and is soluble in glycols. The experimental result for aqueous solution of 0.05 D-Panthenol with ethylene glycol, diethylene glycol and triethylene glycol has been done at varying temperatures. In the month of January the rest of the experimental work for 0.10 and 0.15 D-Panthenol with glycols will be carried out. Then in the month of February the calculations for basic parametrs and thermodynamic parameters for both of the concentrations will be done. Finally in the month of the march the entire paper will be completed.

EXPECTED OUTCOME OF THE STUDY:

D-panthenol is a nutritional element of the B family of vitamins that helps manage the negative effects that oxidative stress can have effect on our skin such as redness, fine lines, roughness of the skin, etc. It works for the support of the skin in many ways, first by maintaining the strength of the outer skin barrier, and then by infusing the cells of the skin with nutrients that go to work to fight environmental toxins that are also stressors of the skin.

It nourishes and gives vital moisture to the skin, first by thickening it in hydration by increasing the skin barrier, but also by helping to rejuvenate and revitalize the skin cells, which helps to counter the aging process. It has the ability to manage healthy levels of fibroblasts - the cells most fertile in the connective tissue of our skin - which in turn strengthens collagen and elastin, proteins that help keep the skin bright, elastic and even toned.

Ethylene glycolis a colorless, fluid liquid with a sweet taste and mild odor. It is widely used as antifreeze in automotive cooling systems and in the production of human filaments, low frost explosives and brake fluids. It is in the production of poly (ethylene terephthalate), or PET. Poly (ethylene terephthalate) is used for textile production, large soft drink containers, photographic films and head film. Poly (ethylene terephthalate) is used in the production of clothing, bedding, carpets and curtains.

Propylene glycol (1,2-propanediol), is similar to ethylene glycol in its physical properties. It is widely used in cosmetics, foods, and oral hygiene products as a solvent, moisture-retaining agent and preservative.

In different journals, these properties of glycols have been studied and further developed.

EXPERIMENTAL RESULT:

TABLE 1 Experimental values of Density and ultrasonic velocity of aqueous solution of 0.05 D-Panthenol + Glycols with varying temperature.

Molality	Density(ρ)				Ultrasonic velocity(U)			
	T= 293 K	T=298 K	T=303 K	T=308 K	T= 293 K	T=298 K	T=303 K	T=308 K
EG + 0.05 m D-Panthenol								
0.00000	0.999509	0.998338	0.996926	0.995295	1489.81	1503.12	1514.97	1525.19
0.09927	1.000260	0.999079	0.997653	0.996012	1492.40	1505.57	1517.19	1527.21
0.20000	1.001050	0.999849	0.998410	0.996755	1495.25	1508.23	1519.66	1529.49
0.29453	1.002540	1.001308	0.999843	0.998165	1500.76	1513.31	1524.35	1533.80
0.39970	1.003326	1.002079	1.000599	0.998809	1503.31	1515.65	1526.52	1535.82
0.49986	1.004967	1.003683	1.002170	1.000452	1509.72	1521.56	1531.99	1540.83
DEG + 0.05 m D-Panthenol								
0.09797	1.000883	0.999694	0.998259	0.996609	0.09797	1494.71	1507.66	1519.13
0.19870	1.002671	1.001447	0.999989	0.998317	0.19870	1500.04	1512.66	1523.76
0.29915	1.004124	1.002871	1.001384	0.999684	0.29915	1507.77	1519.90	1530.60
0.40094	1.005116	1.003845	1.002341	1.000628	0.40094	1511.01	1522.81	1533.18
0.49695	1.006327	1.005032	1.003507	1.001774	0.49695	1516.02	1527.49	1537.55
TEG + 0.05 m D-Panthenol								
0.10106	1.001710	1.000502	0.999053	0.997387	1498.16	1510.95	1522.21	1531.88
0.19881	1.003768	1.002519	1.001034	0.999337	1505.66	1517.82	1528.51	1537.63
0.30095	1.005808	1.004516	1.002994	1.001263	1513.34	1524.88	1534.98	1543.58
0.41255	1.008158	1.006818	1.005252	1.003482	1521.92	1532.79	1542.26	1550.25
0.49633	1.009694	1.008322	1.006725	1.004928	1527.75	1538.13	1547.18	1554.76

Fig.1 Density versus Molality

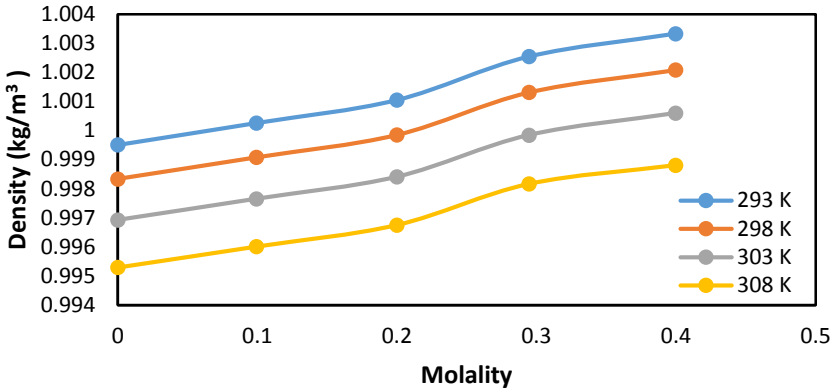

Figure 1: Density versus molality at various temperature for 0.05 D-Panthenol+ EG

Fig.2 Ultrasonic velocity versus Molality

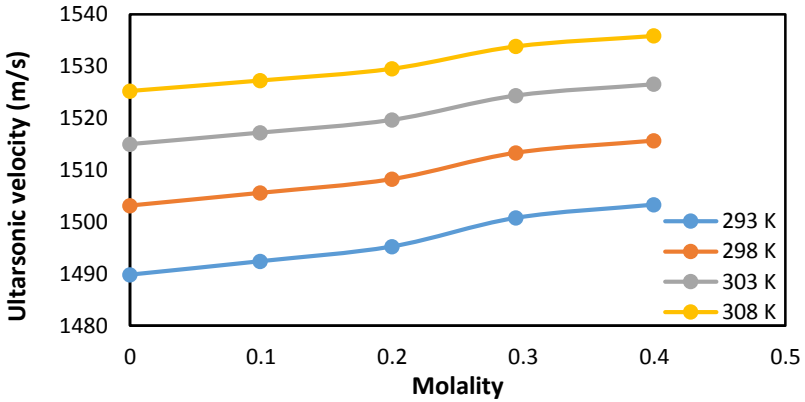

Figure 2:Ultrasonic velocity versus molality at various temperature for 0.05 D-Panthenol+ EG

Fig.3 Density versus Molality

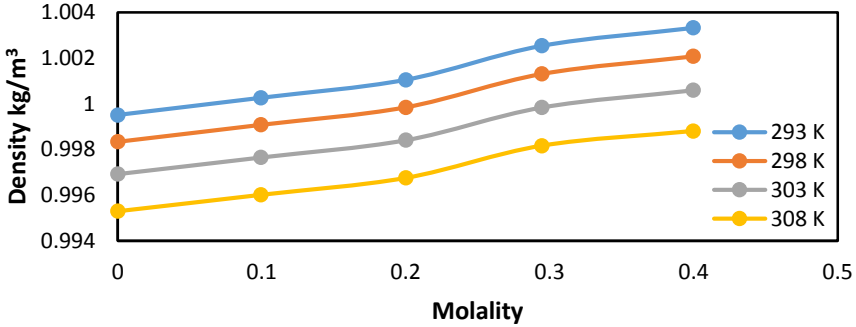

Figure 3: Density versus molality at various temperature for 0.05 D-Panthenol+ DEG

Fig.4 Ultrasonic velocity versus Molality

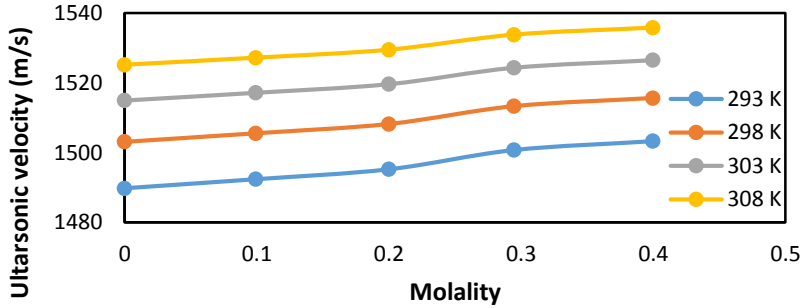

Figure 4:Ultrasonic velocity versus molality at various temperature for 0.05 D-Panthenol+ DEG

Fig.5 Density versus Molality

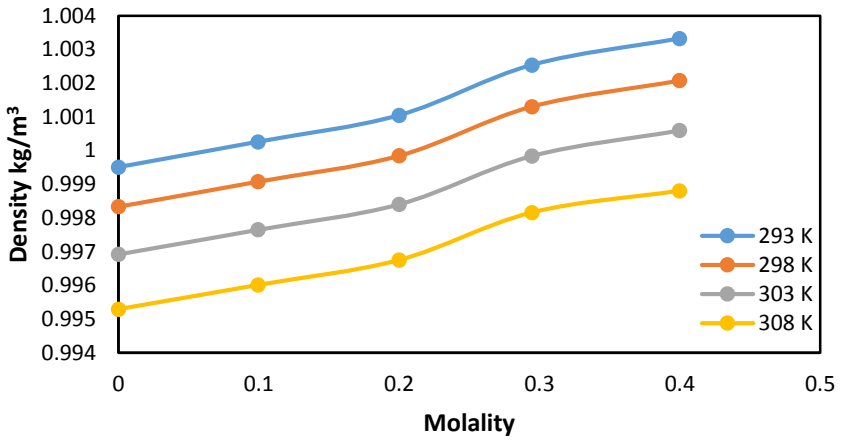

Figure 5: Density versus molality at various temperature for 0.05 D-Panthenol+ TEG

Fig.6 Ultrasonic velocity versus Molality

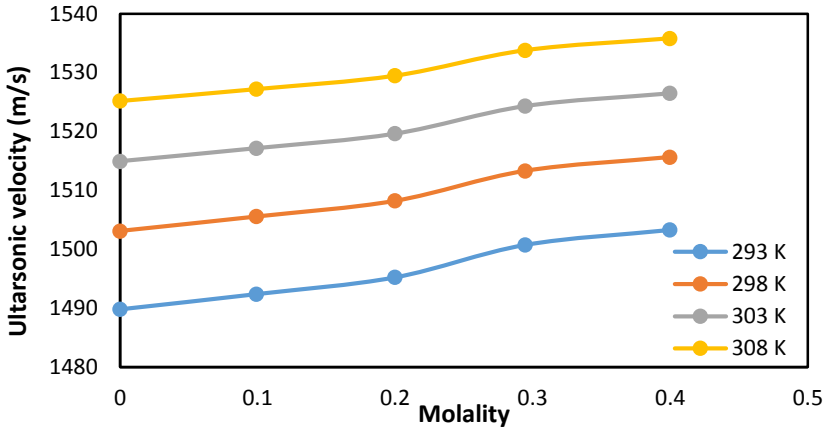

Figure 6:Ultrasonic velocity versus molality at various temperature for 0.05 D-Panthenol+ TEG

TABLE 2: Experimental values of Acoustic impedance and Adiabatic compressibility of aqueous solution of 0.05 D-Panthenol+Glycols with varying temperature.

Molality	Acoustic Impedance(Z)				Adiabatic Compressibility(β)			
	T= 293 K	T=298 K	T=303 K	T=308 K	T= 293 K	T=298 K	T=303 K	T=308 K
EG + 0.05 m D-Panthenol								
0.00000	1489.079	1500.622	1510.313	1518.014	0.00000	4.507664	4.433381	4.370478737
0.09927	1492.788	1504.183	1513.629	1521.119	0.09927	4.488659	4.415687	4.354522552
0.20000	1496.820	1508.002	1517.244	1524.527	0.20000	4.468035	4.396736	4.337087792
0.29453	1504.572	1515.289	1524.111	1530.985	0.29453	4.428695	4.360904	4.304262996
0.39970	1508.310	1518.801	1527.434	1533.991	0.39970	4.410226	4.344104	4.288791546
0.49986	1517.219	1527.164	1535.314	1541.526	0.49986	4.365715	4.303534	4.251544617
DEG + 0.05 m D-Panthenol								
0.09797	1496.030	1507.199	1516.485	1523.795	0.09797	4.47201	4.400744	4.340771
0.19870	1504.047	1514.849	1523.743	1530.690	0.1987	4.432369	4.364047	4.306968
0.29915	1513.988	1524.264	1532.718	1539.263	0.29915	4.380689	4.316432	4.262613
0.40094	1518.740	1528.665	1536.769	1542.988	0.40094	4.357618	4.295779	4.244223
0.49695	1525.612	1535.176	1542.942	1548.883	0.49695	4.323655	4.264453	4.215228
TEG + 0.05 m D-Panthenol								
0.10106	1500.722	1511.708	1520.768	1527.877	4.447763	4.378061	4.319787	4.272547
0.19881	1511.333	1521.643	1530.090	1536.611	4.394534	4.32979	4.275773	4.232377
0.30095	1522.129	1531.766	1539.576	1545.530	4.341221	4.281262	4.231518	4.191732
0.41255	1534.336	1543.241	1550.360	1555.648	4.282405	4.227501	4.182249	4.14655
0.49633	1542.560	1550.930	1557.585	1562.422	4.243319	4.191936	4.149612	4.116597

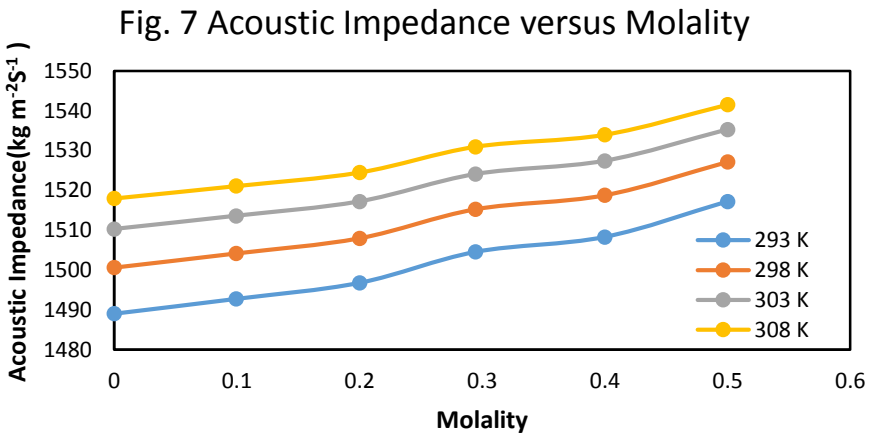

Figure 7: Acoustic Impedance versus molality at various temperature for 0.05 D-Panthenol+ EG

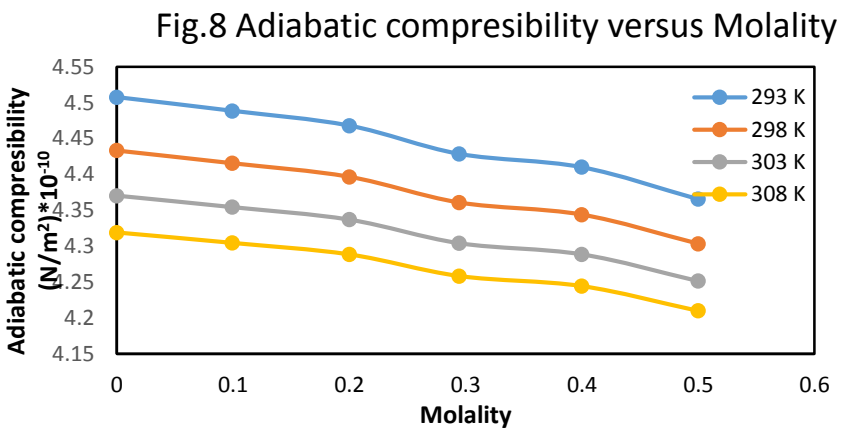

Figure 8:Adaibatic Compressibility versus molality at various temperature for 0.05 D-Panthenol+ EG

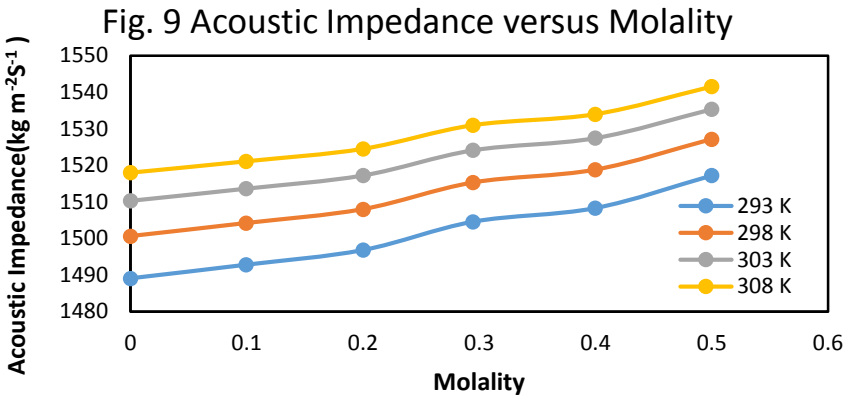

Figure 9: Acoustic Impedance versus molality at various temperature for 0.05 D-Panthenol+ DEG-

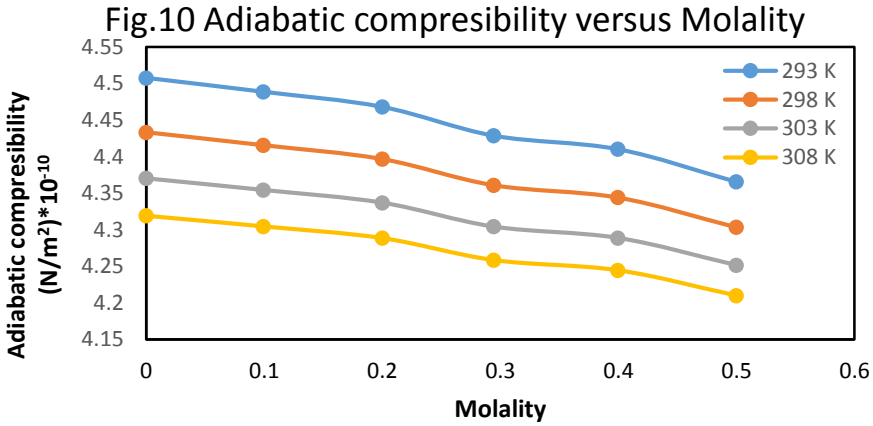

Figure 10:Adaibatic Compressibility versus molality at various temperature for 0.05 D-Panthenol+ DEG

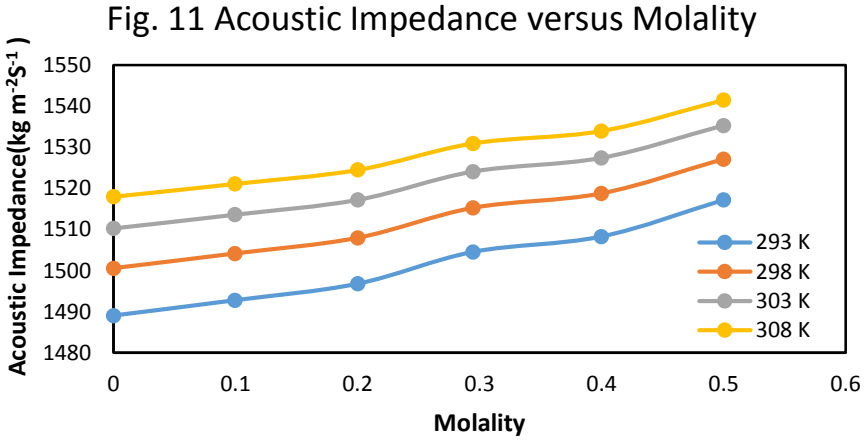

Figure 11: Acoustic Impedance versus molality at various temperature for 0.05 D-Panthenol+ TEG

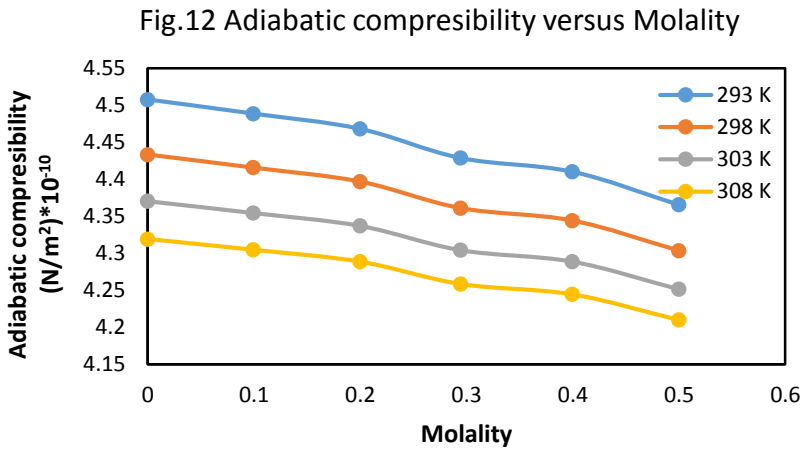

Figure 12:Adaibatic Compressibility versus molality at various temperature for 0.05 D-Panthenol+ TEG

TABLE 3: Experimental values of Wada's constant and Rao's constant of aqueous solution of 0.05 D-Panthenol+Glycols with varying temperature.

Molality	Wada's Constant (W)				Rao's Constant (R)			
	T= 293 K	T=298 K	T=303 K	T= 308 K	T=293 K	T=298 K	T= 303 K	T= 308 K
EG + 0.05 m D-Panthenol								
0.00000	50.08105	50.25895	50.43299	50.60092	709.2598	712.2001	715.0781	717.8569
0.09927	50.07366	50.25037	50.42257	50.58883	709.1377	712.0583	714.9059	717.6567
0.20000	50.06707	50.24254	50.41323	50.57806	709.0289	711.9287	714.7513	717.4785
0.29453	50.05586	50.22801	50.39564	50.55744	708.8436	711.6886	714.4604	717.1373
0.39970	50.04652	50.21705	50.38348	50.54850	708.6893	711.5074	714.2592	716.9894
0.49986	50.03725	50.20405	50.36722	50.52433	708.5363	711.2925	713.9903	716.5894
DEG + 0.05 m D-Panthenol								
0.09797	85.60221	85.90093	86.19320	86.47504	1212.271	1217.208	1222.041	1226.704
0.19870	85.55832	85.85320	86.14024	86.41737	1211.546	1216.419	1221.165	1225.749
0.29915	85.57777	85.86576	86.14754	86.42014	1211.867	1216.626	1221.285	1225.795
0.40094	85.55783	85.84125	86.11847	86.38660	1211.537	1216.221	1220.805	1225.240
0.49695	85.55044	85.82956	86.10268	86.36771	1211.415	1216.028	1220.543	1224.928
TEG + 0.05 m D-Panthenol								
0.10106	121.1375	121.5577	121.9673	122.3630	1715.495	1722.440	1729.213	1735.761
0.19881	121.0972	121.5054	121.9041	122.2892	1714.830	1721.576	1728.168	1734.539
0.30095	121.0625	121.4593	121.8468	122.2223	1714.257	1720.813	1727.221	1733.433
0.41255	121.0159	121.4005	121.7767	122.1410	1713.487	1719.843	1726.062	1732.087
0.49633	120.9902	121.3658	121.7347	122.0916	1713.062	1719.269	1725.367	1731.271

Fig. 13 Wada's Constant versus Molality

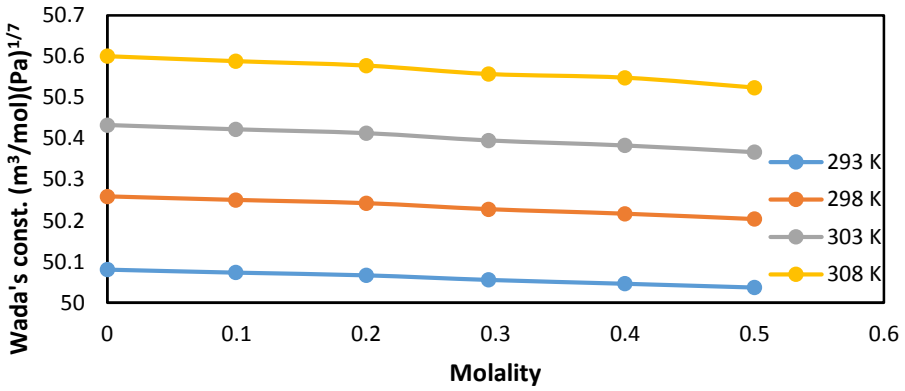

Figure 13: Wada's Constant versus molality at various temperature for 0.05 D-Panthenol+ EG

Fig. 14 Rao's Constant versus Molality

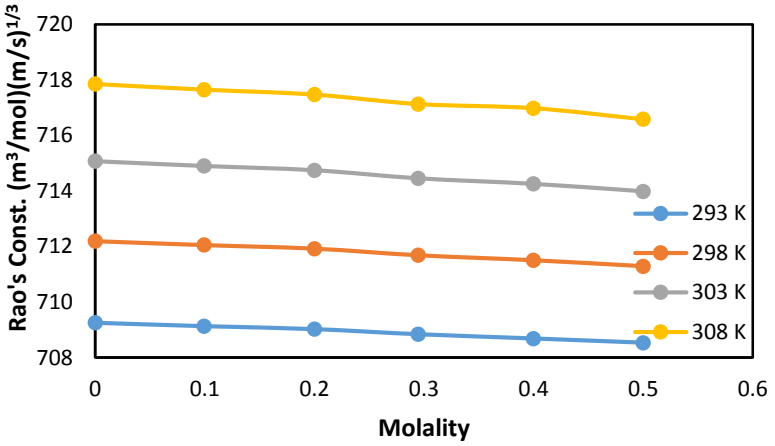

Figure 14: Rao's Constant versus molality at various temperature for 0.05 D-Panthenol+ EG

Fig. 15 Wada's Constant versus Molality

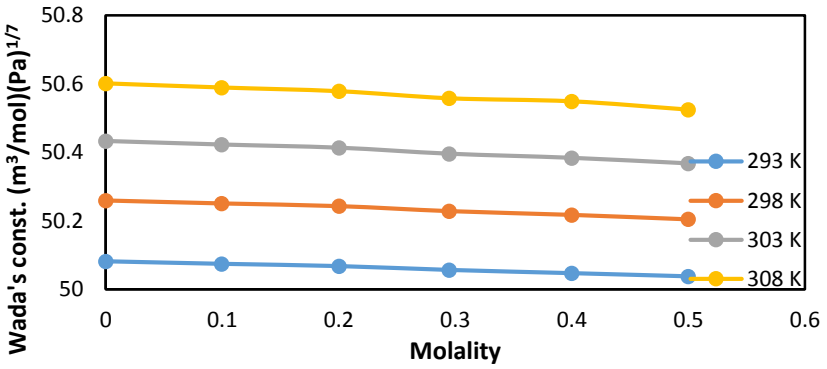

Figure 15: Wada's Constant versus molality at various temperature for 0.05 D-Panthenol+ DEG

Fig. 16 Rao's Constant versus Molality

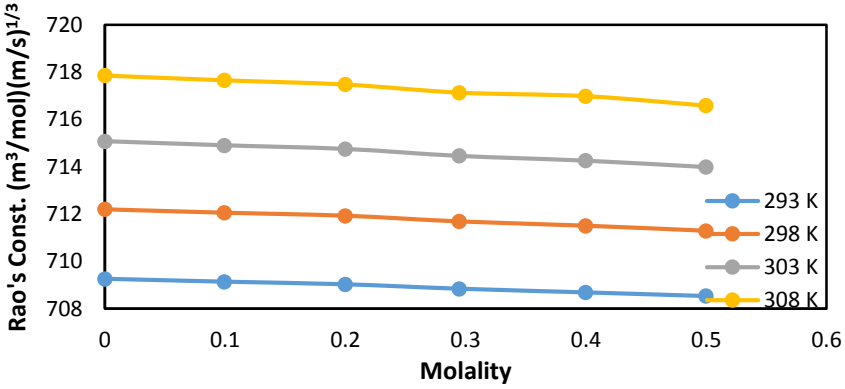

Figure 16: Rao's Constant versus molality at various temperature for 0.05 D-Panthenol+ DEG

Fig. 17 Wada's Constant versus Molality

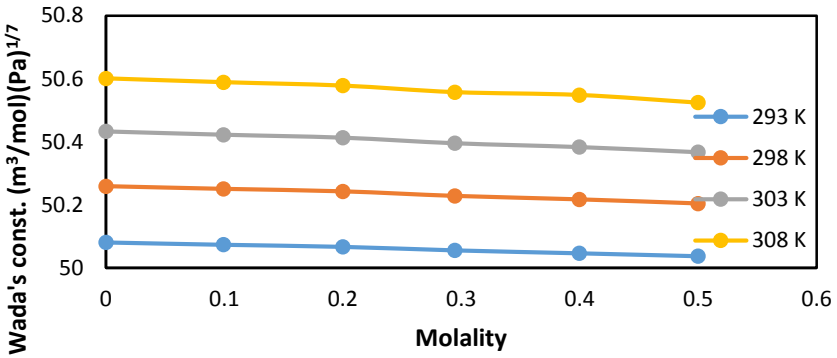

Figure 17: Wada's Constant versus molality at various temperature for 0.05 D-Panthenol+ TEG

Fig. 18 Rao's Constant versus Molality

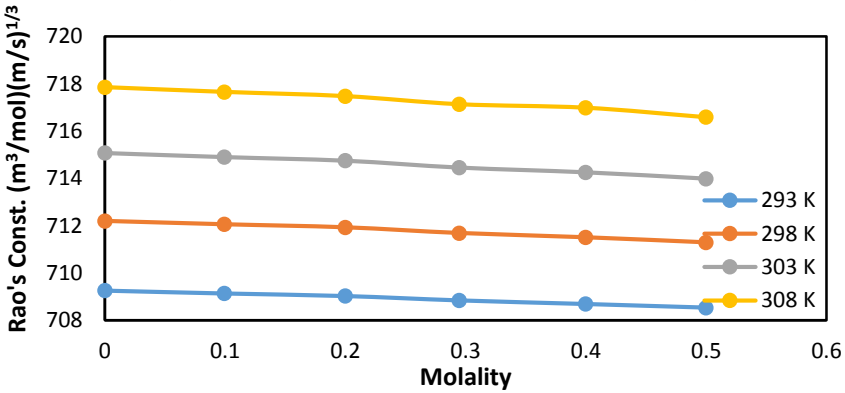

Figure 18: Rao's Constant versus molality at various temperature for 0.05 D-Panthenol+ TEG

TABLE 4: Experimental values of Intermolecular free length and Van der Waal's constant of aqueous solution of 0.05 D-Panthenol+Glycols with varying temperature.

Molality	Intermolecular free length(L_f)				Vander Waal's constant (b)			
	T= 293 K	T=298 K	T=303 K	T= 308 K	T=293 K	T=298 K	T= 303 K	T= 308 K
EG + 0.05 m D-Panthenol								
0.00000	4.325869	4.329556992	4.337930672	4.351359	124.0502	124.1958	124.3716	124.5752
0.09927	4.316740	4.320908280	4.330004753	4.344040	123.9573	124.1039	124.2812	124.4857
0.20000	4.306812	4.311626495	4.321327762	4.335947	123.8598	124.0086	124.1872	124.3932
0.29453	4.287810	4.294021063	4.304943944	4.320708	123.6763	123.8284	124.0097	124.2179
0.39970	4.278860	4.285741880	4.297200030	4.313634	123.5796	123.7334	123.9162	124.138
0.49986	4.257212	4.265682709	4.278499362	4.296076	123.3785	123.5362	123.7225	123.9346
DEG + 0.05 m D-Panthenol								
0.09797	4.308727	4.313591	4.323162	4.337711	211.8565	212.1085	212.4133	212.7646
0.19870	4.289588	4.295568	4.306296	4.321873	211.4794	211.7379	212.0464	212.4012
0.29915	4.264507	4.272070	4.284065	4.300741	211.1744	211.4382	211.7519	212.1116
0.40094	4.253262	4.261837	4.274814	4.292383	210.9664	211.2334	211.5501	211.9117
0.49695	4.236655	4.24627	4.260187	4.278496	210.7132	210.9845	211.3048	211.6698
DEG + 0.05 m D-Panthenol								
0.10106	4.297030	4.302460	4.312700	4.327810	299.6146	299.9763	300.4112	300.9126
0.19881	4.271241	4.278675	4.290673	4.307418	299.0014	299.3738	299.8177	300.3263
0.30095	4.245253	4.254630	4.268411	4.286685	298.3962	298.7798	299.2327	299.7495
0.41255	4.216397	4.227832	4.243489	4.263520	297.7019	298.0978	298.5617	299.0876
0.49633	4.197111	4.210011	4.226899	4.248093	297.2499	297.654	298.1256	298.6579

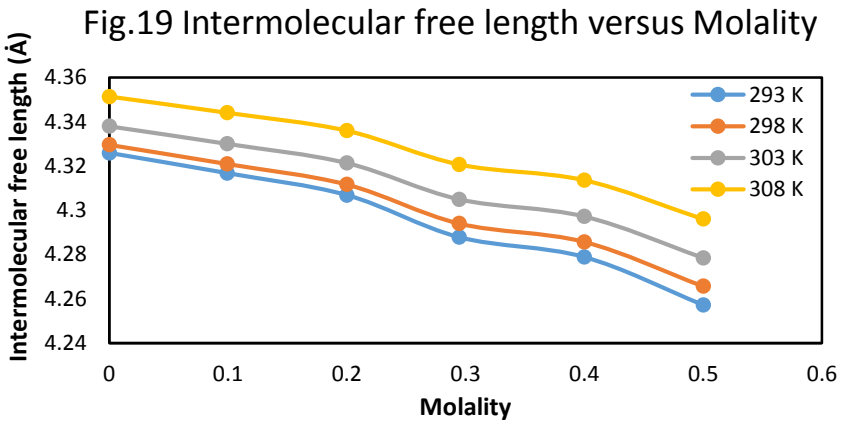

Figure 19: Intermolecular free length versus molality at various temperature for 0.05 D-Panthenol+ EG

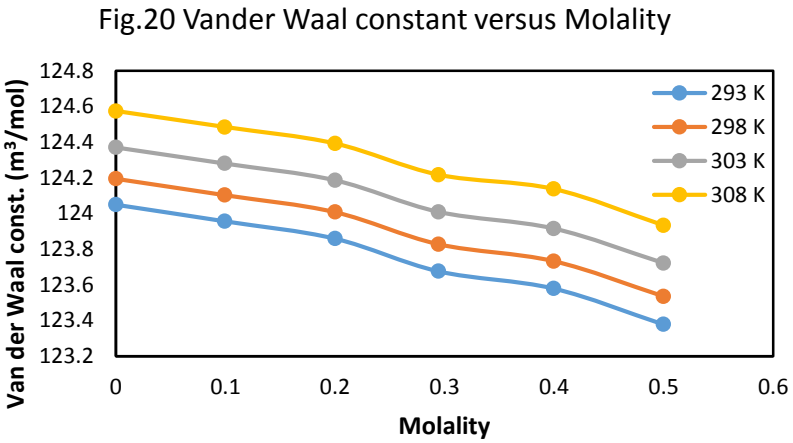

Figure 20: Vander Waal constant versus molality at various temperature for 0.05 D-Panthenol+ EG

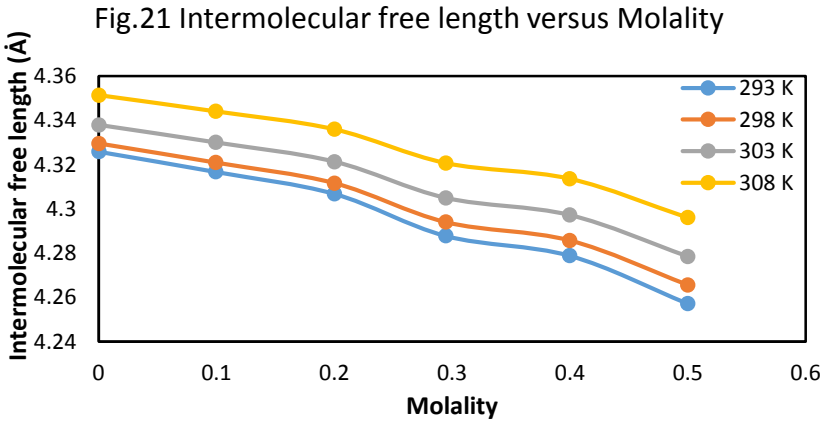

Figure 21: Intermolecular free length versus molality at various temperature for 0.05 D-Panthenol+ DEG

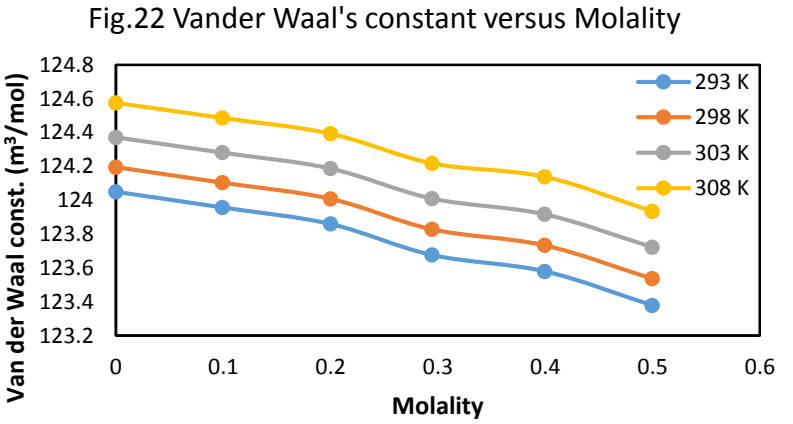

Figure 22: Vander Waal's constant versus molality at various temperature for 0.05 D-Panthenol+ DEG

Fig.23 Intermolecular free length versus Molality

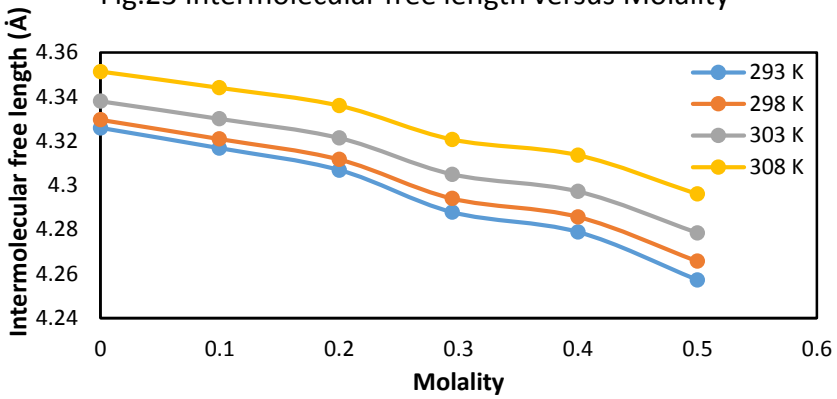

Figure 23: Intermolecular free length versus molality at various temperature for 0.05 D-Panthenol+ TEG

Fig.24 Vander Waal's constant versus Molality

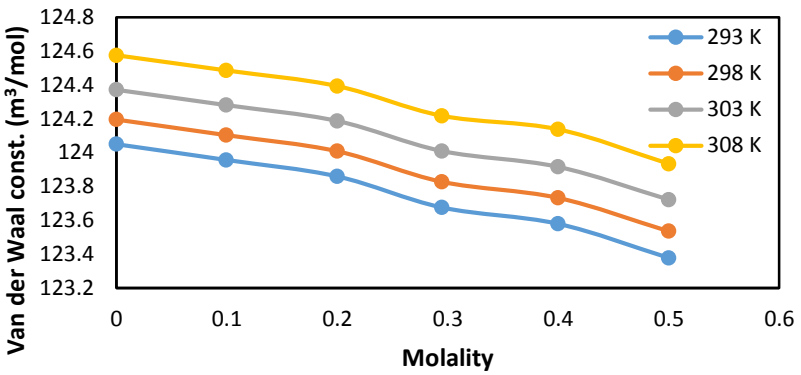

Figure 24: Vander Waal's constant versus molality at various temperature for 0.05 D-Panthenol+ TEG

REFERENCES:

[1] C.J. Burton, "A Study of Ultrasonic Velocity and Absorption in Liquid Mixtures, "The journal of the acoustics society of America, 20: 186-199, (1948)

[2] G.G. Hammes and P.R. Schimme, "An Investigation of Water-Urea and Water-Urea-Polyethylene Glycol Interactions", Journal of the American Chemical Society, 89, (1967)

[3] S. Bagchi, S.K. Nema and R.P. Singh, "Ultrasonic and viscometric investigation of isro polyol in various solvents and its compatibility with polypropylene glycol", Eur. Polym. J. Vol. 22: 851-857, (1986)

[4] K.N. Mehrotra and S.K. Upadhyaya, "Thermodynamics and acoustical studies on calcium soap solutions", Phys. Chem. Liq., 19, (1989)

[5] K.C. Rao, S.V. Aidu and A.V. Rajulu, "Acoustical parameters of poly (vinyl pyrrolidone) in n,n-dimethyl formamide solutions", Eur. Polym. J., 26: 257-259, (1990)

[6] A.V. Rajulu and P.M. Sab, "Acoustical parameters of polyethylene glycol/water mixtures", Bull. Mater. SCI., 18: 247-253, (1995)

[7] S. Magazu, P. Migliardo, A.M. Musolino, and M.T. Sciortino, "α-αTrehalose-Water Solutions, Hydration Phenomena and Anomalies in the Acoustic Properties", J. Phys. Chem. B, 101: 2348-2351, (1997)

[8] A. Ali, S. Hyder and A.K. Nain, "Studies on molecular interactions in binary liquid mixtures by viscosity and ultrasonic velocity measurements at 303.15 k", Journal of Molecular Liquids, 79: 89-99, (1999).

[9] V.K. Syal, A. Chauhan and S. Chauhan, "Ultrasonic velocity, viscosity and density studies of poly (ethylene glycols)(PEG - 8,000, PEG - 20,000) in acetonitrile (AN) and water (H2O) mixtures at 250C", J. Pure Appl. Ultrason., 27: 61-69, (2005)

[10] R. Palani and A. Geetha, "Acoustical and excess thermodynamic studies of molecular interaction in aqueous mixed solvent systems at 303, 308 and 313K", Physics and Chemistry of Liquids, 47: 542–552, (2009)

[11] P. Shanmuga, S. Nithya, G. Velraj and A.N. Kanappan, "Molecular interactions studies in liquid mixture using Ultrasonic technique", International Journal of Advanced Science and Technology, 18, (2010)

[12] J.N. Ramteke ,"Ultrasonic study of molecular interaction in binary liquid mixture containing α - picolin in ethanol at 301.15 K and 305.15K ", Advances in Applied Science Research, 3:1832-1835, (2012)

[13] D.R. Godhani, P.B. Dobriya, A.M. Sanghani and J.P. Mehta, "Thermodynamic properties of binary mixtures of 1,3,4-oxadiazole derivative with chloroform, N,N-dimethyl formamide at 303,308, and 313 K and atmospheric pressure", Arabian Journal of Chemistry, (2012)

[14] S. Parveen, S. Singh, D. Shukla, M. Yasmin,· M. Gupta and J.P. Shukla, "Study of Molecular Interactions in Binary Mixtures of Aniline with Carboxylic Acids at 293.15 K, 303.15 K and 313.15 K", J Solution Chem, 41:156–172, (2012)

[16] U.G. Pathak, J.V. Patel and P.H. Parsania, "Ultrasonic Speed and Thermodynamic Parameters of Novel Epoxy Resin Solutions Based on Cardo Symmetric Double Schiff Bases at 308.15 K", J Solution Chem, 41:755–765, (2012)

[16] B. Kaur and K.C. Juglan, "Acoustic parameter investigation of polyvinyl acetate with acetic acid using ultrasonic technique", J Polym Eng, 33: 851-856, (2013)

[17] B. Pal and S. Kundu, "Anomalous Ultrasonic Attenuation in Aqueous NaCl Solutions" Journal of Chemistry, (2013)

[18] M. Das, S. Das, and A.K. Pattanaik, "Acoustical Behaviour of Sodium Nitroprusside in Aquo-Organic Solvent Media at 308.15 K**",** Journal of Chemistry, (2013)

[19] A. Pal, H. Kumar, B. Kumar and R. Gaba, "Density and speed of sound of binary mixtures of 1,4-dioxane with propanol and butanol isomers at different temperatures", Journal of Molecular liquids, (2013)

[20] F.M. Sannaningannavar, B.S. Navati and N.H. Ayachit, "Studies on thermo-acoustic parameters of poly (ethyleneglycol)-400 at different temperatures", J Therm Anal Calorim, 112: 1573–1578, (2013)

[21] A. Pal, H. Kumar, R. Maan and H. K. Sharma, "Volumetric and Acoustic Studies of Binary Liquid Mixtures of Dipropylene Glycol Dimethyl Ether with Methyl Acetate, Ethyl Acetate and n-Butyl Acetate in the Temperature Range T 5 (288.15, 293.15, 298.15, 303.15, and 308.15) K", J Solution Chem , 42:1988–2011, (2013)

[22] A. Dixit, K.C. Juglan and A Sharma, "Acoustic parameter investigation of ternary mixture of n-butanol, water and acetic acid by using ultrasonic technique", Journal of Chemical and Pharmaceutical Research, 6:93-104, (2014)

[23] S. Kumari, K.C. Juglan and A Sharma, "Acoustic parameter investigation of tyrosine derivative in dimethyl sulpho oxide by using ultrasonic technique", Journal of Chemical and Pharmaceutical Research, 6:782-794, (2014)

[24] S.M. Nayeem and D.K. Rao, "Ultrasonic Investigations of Molecular Interaction in Binary Mixtures of Benzyl Benzoate with Isomers of Butanol", International Journal of Pharma Research & Review, 3, (2014)

[25] H. Kumar, M. Singla and R. Jindal, "Investigations on solute–solvent interactions of amino acids in aqueous solutions of sodium dihydrogen phosphate at different temperatures", Monatsh Chem, 145:1063–1082, (2014)

[26] K. Kaur and K.C. Juglan, "Studies of molecular interaction in the binary mixture of chloroform and methanol by using ultrasonic technique", Der Pharma Chemica, 7:160-167, (2015)

[27] K.H. Wananjea, K.B. Kabarab, A.C. Kumbharkhane and A.V. Sarodeb, "Relaxation Dynamics in Aqueous Polypropylene Glycol using Acoustic Spectroscopy", Bionano Frontier, 8: 381-383, (2015)

[28] K. Kaur and K.C. Juglan, "Ultrasonic velocity, density and viscosity studies of the binary mixtures of ethyl acetate and hexane", Journal of Chemical and Pharmaceutical Research, 8:49-53, (2016)

[29] A.R. Thakare and A.B. Naik, "Study of Molecular Interactions in Aqueous 2-Amino-5-Nitrothiazole-$NiCl_2$ Solution at Different Temperatures and Concentrations", Trade Science Inc. 9, (2016)

[30] H. Kumar, K. Kaur, S. Arti and M. Singla, "Study of thermodynamic properties of sodium dodecyl sulphate in aqueous solutions of alkoxyalkanols at different temperatures", Journal of Molecular Liquids, 221: 526-534, (2016)

[31] H. Kumar and I. Behal, "Densities and Speeds of Sound of Antibiotic Drug Chloramphenicol with L-Leucine and Glycyl-L-leucine in Aqueous Medium at T= (288.15−318.15) K: A Volumetric, Ultrasonic, and UV Absorption Study", J. Chem. Eng. Data, 61: 3740−3751, (2016)

[32] A.P. Sarvazyan, “Development of methods of precise ultrasonic measurements in small volumes of liquids”, 20: 451-154, (1982)

[33] F. Eggers and U. Kaatze, “Broad-band ultrasonic measurement techniques for liquids”, Meas. Sci. Technol., 7: 1–19, (1996)

[34] G. Andreatta, N. Bostrom, and O.C. Mullins, “High-Q Ultrasonic Determination of the Critical Nanoaggregate Concentration of Asphaltenes and the Critical Micelle Concentration of Standard Surfactants”, Langmuir, 21: 2728-2736, (2005)

[35] A. Pal, H. Kumar, R. Maan and H.K. Sharma, “Volumetric and Acoustic Studies of Binary Liquid Mixtures of Dipropylene Glycol Dimethyl Ether with Methyl Acetate, Ethyl Acetate and n-Butyl Acetate in the Temperature Range T5 (288.15, 293.15, 298.15, 303.15, and 308.15) K”, J Solution Chem, 42: 1988–2011, (2013)

[36] R. Abraham, M. Abdulkhadar and C.V. Asokan, “Ultrasonic investigation of molecular interaction in binary mixtures of nitriles with methanol/toluene”, J. Chem. Thermodynamics, 32: 1–16, (2000)

[37] JS Taurozzi, VA Hackley, and MR. WIesner, “Ultrasonic dispersion of nanoparticles for environmental, health and safety assessment – issues and recommendations”, Nanotoxicology, 5: 711–729, (2011)

[38] S.M. Nayeem, M Kondaiah,ˑK Sreekanth, and DK Rao, “Ultrasonic Investigations of Molecular Interaction in Binary Mixtures of Cyclohexanone with Isomers of Butanol”, Journal of Applied Chemistry, (2014)