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Ultrasonic Study on Enhancement of Intermolecular Interaction in Aspirin with Ethanol by the Effect of Polyethylene glycol

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Abstract: ***There are many techniques available to study physical properties to interpret the molecular interaction in liquids, liquid mixtures and solutions. The study of ultrasonic waves through solution is found to be quite interesting. The study of ultrasonic waves through solution is used for knowing the nature and strength of intermolecular forces and their interaction in liquids, liquid mixtures and solutions. Thermo-acoustical and its allied properties are very helpful in predicting the physico-chemical behavior and molecular interactions occurring in liquids, liquid mixtures and solutions. Hence this motivates the researchers to take up the research project in the field. Here we are interacting Aspirin drug particles with liquid solution of ethanol and polymer Polyethylene glycol to study the interactions and to study the absorption rate of drug particles. Physicochemical properties of drugs are of great interest to understand 'drug action' at molecular level. By varying acoustical parameters and sonication time respective acoustical parameters are obtained.***

1. Introduction

Ultrasonic measurements stand as one of the primary techniques for study of properties of matter such as mechanical, electromagnetic and particle interaction. The propagation behavior of high frequency stress wave is determined by the measurements of velocity and attenuation of ultrasonic waves as a function of any environmental variable such as temperature, pressure etc.

Ultrasonic technique has been adequately employed to investigate the properties of any substance to understand the nature of molecular interactions in pure liquid,[1] liquid mixtures[2-3] and solutions[4]. 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.[5-6] All the pharmokinetic 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.

Sonication is the specially designed ultrasound bath which uses low frequency ultrasound waves to agitate particles. By this process the particle size can be reduced. Sonication can be used to speed dissolution, by breaking intermolecular interactions. In solution the particle vibrate as they will collapse into solution, these vibrations can disrupt molecular interactions, break clumps of particles apart, and lead to mixing.

2. Experimental Section

In this work, we studied the thermo acoustic parameters and thereby establishing the physicochemical properties of drug with polymer and without polymer. The drug used here is Aspirin and the polymer is Poly Ethylene Glycol. The first solution is taken as the mixture of Aspirin, PEG and ethanol. Here ethanol is taken as the solvent. For the next solution Aspirin and Ethanol is taken. For both solutions by varying molar concentration of drug and sonication time at frequency 2MHz and temperature 307K the thermoacoustic parameters are studied and reached at particular results.

3. Results and Discussion

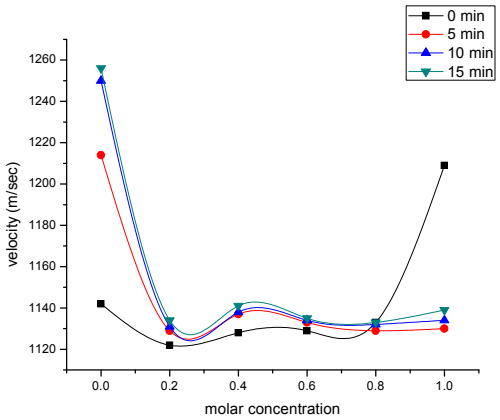

Figure 1: Variation of Velocity with Molar Concentration

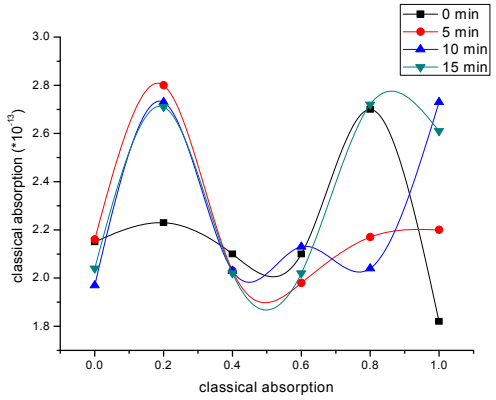

Figure 2: variation of classical absorption with molar concentration

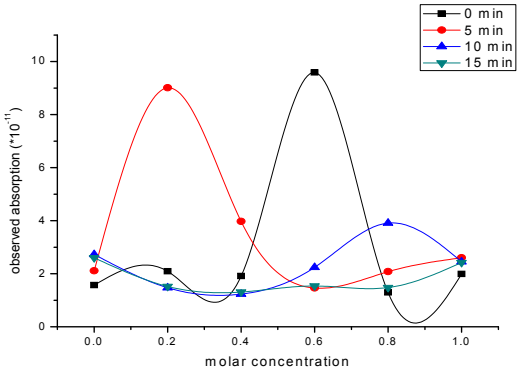

Figure 3: variation of observed absorption with molar concentration

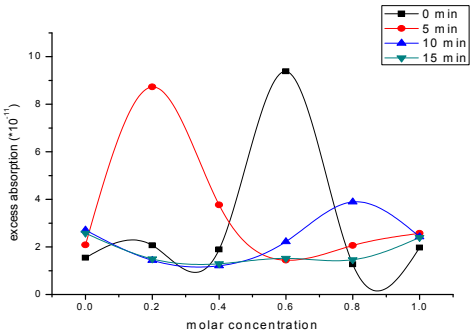

Figure 4: variation of excess absorption with molar concentration

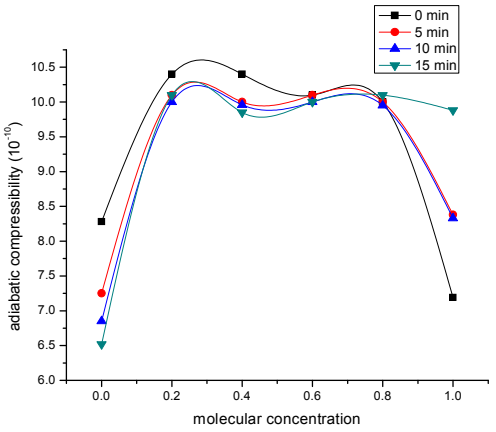

Figure 5: Variation of adiabatic compressibility with molar concentration

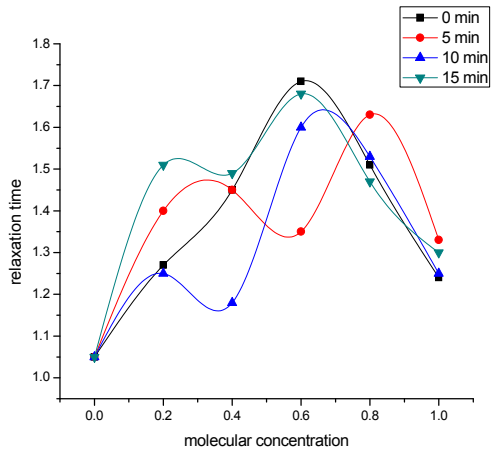

Figure 6: variation of relaxation time with molar concentration

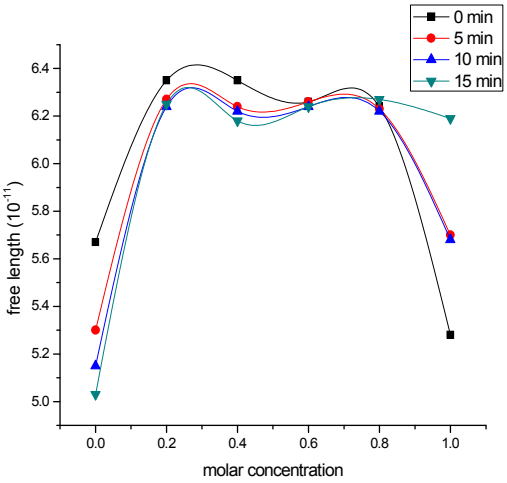

Figure 7: variation of free length with molar concentration

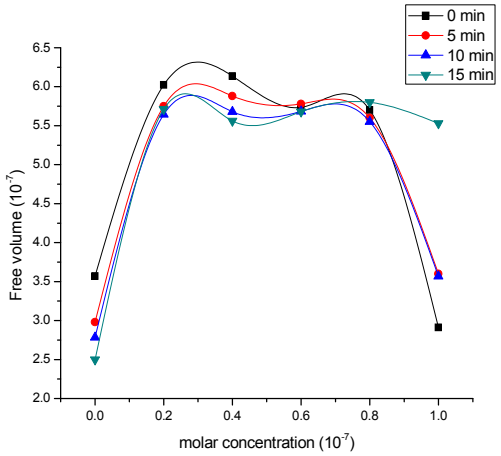

Figure 8: variation of free volume with molar concentration

Fig. 1 shows the non linear variation of ultrasonic velocity with molar concentration at different sonication time 0 min, 5 min, 10min, 15 min refelects the presence of intermolecular interactions in drug Aspirin and polymer PEG. These variations depend on structural changes due to intermolecular interactions in short regions around the molecules of solute and solvent. The dip in ultrasonic velocity shows the breakage of bonds between the molecules

of Aspirin and ethanol and thereafter forming a strong bonding among Aspirin and PEG and then a steady phase is formed.[7]

Fig.2,3,4 and 6 the observed decrease in ultrasonic absorption and relaxation time at higher concentration may be attributed to the formation of strong hydrogen bonding . For such a solution the absorption of ultrasound energy is too less. When a polymer is added to Aspirin it affects the structured equillibrium existing between bonds of Aspirin and ethanol.. A sudden dissociation is occured. Then restructuring of bonds of Aspirin, ethanol and PEG leads to highly structured solution.[8]

Fig.5 shows the variation of adiabatic compressibility with molar concentration at different sonication time. Adiabatic compressibility decreases at higher molar concentration indicates the enhancement of degree of association among the solute and solvent molecules. Intermolecular distance decreses with increase in molar concentration; hence it means a large cohesive force due to the increase in molecular strength of particular solution. The non linear variation of adiabatic compressibility indicates complex formation in the mixture. The greater molecular association may be brought through the hydrogen bonding possible between the solute and solvent molecules.[9]

Fig. 7 shows variation of free length with molar concentration at different sonication time. The decrease of free length with concentration suggests the presence of strong solute-solvent interactions. Free length shows similar effect as adiabatic compressibility. Free length and adiabatic compressibility shows an opposite effect to ultrasonic velocity. The decrease in free length at higher concentration is due to the formation of hydrogen bonds between aspirin and ethanol.[10]

Fig. 8 shows variation of free volume with molar concentration. The increasing value of Free volume can be caused by dissociation of closed packed molecules of drug, polymer and ethanol. The decreasing value of free volume at higher concentration is due to structuring of hydrogen bonds.

4. Conclusion

The present investigation concludes that for Aspirin, Polyethylene glycol and Ethanol; there is a dissociation at lower concentration, due to breaking of bonds. Then at higher concentration there is association between the molecules of PEG, Aspirin and ethanol. This good attachment of bonds, changes the phase of the system to a crystallized structure. The observed absorption is found to decrease shows that there is good attachment of bonds of polymer with aspirin.

5. Acknowledgement

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