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A Case Study :

Acoustic study of acetone and water in DMSO at 303.15K

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ABSTRACT

Ultrasonic velocity (v) and density of binary mixtures of acetone and water in DMSO of different composition was measured at 303.15K. Parameters such as isentropic compressibility K_s, intermolecular free length L_f, relative association R_A, acoustic impedances Z, Coefficients A_i, standard deviations $\pm(Y^E)$ and molar sound velocity R_m were derived using ultrasonic velocity and density for these binary mixtures. Theoretical values of ultrasonic velocity calculated from FLT (Free Length Theory), CFT (Collision Factor Theory), Nomoto's and Van Dael and Vangeel's relation were compared with experimental values of ultrasonic velocity for above said binary mixtures. Nomoto's relation provides best results for experimental ultrasonic velocity of the systems under study. The mixing of DMSO with water tends to break the hydrogen bond present between the water molecules with subsequent increase in ΔK_s and V^E.

Key words : Acoustical studies, Ultrasonic velocity, Acetone, Water and DMSO.

Binary liquid mixtures find practical applications in most chemical processes. Derived parameters from ultrasonic velocity measurement and the corresponding excess functions provide qualitative information regarding the nature and strength of interactions in liquid mixtures. The use of acetone and DMSO in preparing a large number of aromatic compounds is well known. Acetone is also used as solvent in various organic synthesis. Thus, acetone and water with DMSO mixed solvents would enable us to have a large number of solvents, with appropriate physico-chemical properties, which can be used for a particular chemical process. Moreover, literature survey indicates that no ultrasonic study on these binary systems has been reported. Therefore present study was undertaken in order to have deeper understanding of the intermolecular interaction between the components of the above binary liquid mixtures. Thus, a study of physical properties data on the binary mixtures containing DSMO has attracted considerable interest in our present study.

An ultrasonic interferometer is a simple and direct device to determine the ultrasonic velocity with a high degree of accuracy. It helps us to determine various thermodynamic parameters like ultrasonic velocity, Adiabatic Compressibility Compressibility (β_{ad}), Isentropic Compressibility (β), Isothermal Compressibility (β_T), Effective Debye Temperature (Q_D), Grunesian Parameters (T), Intermolecular Free Path length (L_f), Internal Pressure (π_i), free volume (V_f), Rao's constant (R), Surface Tension (S_t), Mean Square Thermodynamic Fluctuation, Vander Waal's Constant (b), Wada Constant (W), Space Filling Factor (r) and Relative Association (R_a). With the help of these thermodynamic properties, we can study phenomenon like azeotropism, intermolecular interactions, miscibility and compatability of binary liquid mixture, phase transition between various phases, various thermodynamic properties of binary and ternary liquid mixture, transport related phenomenon and various properties related with transport phenomenon etc.

Thermodynamic properties of liquid mixtures has relevance in understanding the nature and extent of the molecular interaction between the component of the mixtures, in developing the new theoretical models and also in carrying out engineering applications in the process industry. The ultimate goal of the thermodynamics of mixtures it so predict excess properties from the pure components properties without any experimental knowledge of the actual system itself. Our knowledge about molecular size, molecular structure and polarity allows us to make some qualitative predictions about the behavior of such molecules in mixtures. However, the progress in the field of molecular theory has not reached that stage where we can directly predict the properties of a mixture from the nature of its constituents. The main problem is the non-availability of data to understand the nature of interactions amongst the constituents. Such types of interactions are involved in the formation complicated chemical complexes in the binary liquid mixtures and are also responsible for the non-ideal thermodynamic behavior of systems.

Research workers in the past (Alessandra *et al.*, 1997; Ali *et al.*, 1996, 1998; Becu *et al.*, 2006 and Brasllev and Grfesex, 2002) have shown that NMR (Alessandra *et al.*, 1997 and Ali *et al.*, 1996) IR (Ali *et al.*, 1998 and