The study of the propagation behaviour of ultrasonic waves in solids, liquids, liquid mixtures, electrolyte solutions, suspensions, polymers etc. is now rather well established as an effective means for examining certain physical properties of these materials or media. Intimate relations between the values of sound velocity and chemical or structural characteristics of the molecules of the liquid or liquid mixtures have been found. This gives to the sound velocity, the properties of a primary quantity in the molecular theory of liquids. The nature and type of intermolecular interactions in liquid mixtures can be studied from the measurement of ultrasonic velocity in conjunction with thermo-acoustical parameters and excess thermodynamic functions.

The thesis titled “Ultrasonic study of certain binary and ternary liquid mixtures” is a detailed theoretical and experimental ultrasonic study of a few binary and ternary liquid mixtures at different temperatures, to elucidate the nature and type of intermolecular interactions present in the mixtures.

The thesis is divided into nine chapters. Chapter 1 provides a general introduction to ultrasonics followed by a brief review of ultrasonic studies that have been done in the binary and ternary mixtures during the recent past. The liquid mixtures chosen for the present study are also included.

Chapter 2 gives an account of Jacobson’s free length theory (FLT), Schaaffs’ collision factor theory (CFT), Flory-Patterson theory (FPT), Nomoto’s relation (NR) and Van Dael and Van Geel’s ideal mixture relation (IMR) which are used in predicting the ultrasonic velocity in the liquid mixtures. The nonlinearity parameter (B/A) plays a significant role in nonlinear acoustics and hence its determination is of increasing interest in a number of areas ranging from underwater acoustics to medicine. The calculation of B/A by the thermodynamic method requires the experimental determination of velocity at different temperatures and pressures which involves practical difficulty. The method of theoretical evaluation of acoustic nonlinearity parameter (B/A) of binary and ternary liquid mixtures, by
making use of the experimental velocity value, at a constant temperature and at atmospheric pressure is explained in this chapter. The pulse echo overlap method of measuring ultrasonic velocity in liquid mixtures is also discussed.

A short description of the theoretical aspects of the different acoustical parameters and the computational procedure used in the evaluation of thermo-acoustical parameters and excess thermodynamic functions is given in Chapter 3. Since many quantities had to be evaluated in the present study, a computer program was written for this purpose and the program is included in this chapter.

Chapter 4 is concerned with the theoretical estimation of ultrasonic velocity, and the evaluation of various acoustical parameters and excess isentropic compressibility in the binary mixtures of toluene with n-alkanols. The theoretically calculated velocity values were compared with the experimental velocity values taken from the literature.

Chapter 5 deals with the theoretical prediction of ultrasonic velocity and the evaluation of excess isentropic compressibility in ternary mixtures of methyl ethyl ketone and n-nonane with n-alkanols. The theoretically calculated velocity values were compared with the experimental velocity values taken from the literature.

A detailed experimental study of the binary mixtures of acetonitrile/benzonitrile in methanol/toluene at different temperatures is given in Chapter 6. The ultrasonic velocity in the mixtures was measured at different temperatures using Matec ultrasonic velocity measuring system (Matec Instruments Inc., USA), which employs pulse echo overlap method. The density and viscosity of the mixtures were also measured at different temperatures. The ultrasonic velocities in these mixtures were computed using various theories and were compared with the experimentally obtained velocity values. The values of thermo-acoustical parameters and excess thermodynamic functions were evaluated and were used to determine the nature, type and strength of intermolecular interactions present in the binary mixtures. Acoustic nonlinearity parameter (B/A) and a few thermodynamic parameters of the binary mixtures were evaluated theoretically and the values are included in this chapter.

A detailed experimental study of the binary mixtures of methyl ethyl ketone/methyl phenyl ketone in methanol/toluene at different temperatures is given
in Chapter 7. A comparative study of the theoretically calculated velocity values with the experimentally measured values was made in these binary mixtures. Molecular interaction studies were carried out in these mixtures based on thermo-acoustical parameters and excess thermodynamic functions.

Chapter 8 gives an account of a detailed experimental study carried out in the ternary mixtures of methyl ethyl ketone and toluene with $n$-alkanols at different temperatures. The experimental ultrasonic velocity was compared with the theoretically predicted ultrasonic velocity and the validity of each theory in predicting ultrasonic velocity in ternary mixtures was studied. The intermolecular interactions in the ternary mixtures were examined with help of the results obtained from the study of the binary constituents. A theoretical evaluation of acoustic nonlinearity parameter ($B/A$) and a few thermodynamic parameters has been done for the ternary mixtures and the values are included in this chapter.

Chapter 9 deals with a detailed experimental study in another set of ternary mixtures, methyl phenyl ketone and toluene with $n$-alkanols, at different temperatures. A comparative study of the theoretically calculated velocity values with the experimentally measured values was made in the ternary mixtures. Molecular interaction studies in the ternary mixtures were carried out on the basis of excess thermodynamic functions.

A major part of the work included in this thesis has been published/communicated and presented in the following journals and conferences.

**Research papers published in journals**

1. Theoretical estimation of ultrasonic velocity in the binary mixtures of toluene with $n$-alkanols.
   Roshan Abraham, J. Jogan and M. Abdulkhadar

2. Ultrasonic parameters of the binary mixtures of toluene with $n$-alkanols.
   Roshan Abraham, J. Jogan and M. Abdulkhadar

3. Theoretical estimation of ultrasonic velocity in ternary mixtures of methyl ethyl ketone and $n$-nonane with $n$-alkanols.
   Roshan Abraham, J. Jogan and M. Abdulkhadar
   *J. Pure Appl. Ultrasonics*, 18 (1996) 114
Research papers communicated to journals

1. Theoretical estimation of ultrasonic velocity and acoustic nonlinearity parameter (B/A) in binary mixtures of nitriles with methanol/toluene.
2. Ultrasonic investigation of molecular interaction in binary mixtures of nitriles with methanol/toluene.
3. Theoretical estimation of ultrasonic velocity and acoustic nonlinearity parameter (B/A) in binary mixtures of ketones with methanol/toluene.
4. Ultrasonic investigation of molecular interaction in binary mixtures of ketones with methanol/toluene.
5. Theoretical estimation of ultrasonic velocity and acoustic nonlinearity parameter (B/A) in ternary mixtures of methyl ethyl ketone and toluene with n-alkanols.
6. Theoretical estimation of ultrasonic velocity and acoustic nonlinearity parameter (B/A) in ternary mixtures of methyl phenyl ketone and toluene with n-alkanols.

Research papers presented/accepted for presentation in conferences/symposia

1. Ultrasonic studies in CTAB-NaSal system.
   Roshan Abraham, J. Jugan and M. Abdulkhadar
   National Symposium on Acoustics, Indira Gandhi Centre for Atomic Research, Kalpakkam (1994)

2. Ultrasonic studies in silica hydrogel.
   Jugan J., Roshan Abraham and M. Abdulkhadar
   National Symposium on Acoustics, Indira Gandhi Centre for Atomic Research, Kalpakkam (1994)

3. Theoretical estimation of ultrasonic velocity in the binary mixtures of toluene with n-alkanols.
   Roshan Abraham, J. Jugan and M. Abdulkhadar
   National Symposium on Acoustics, National Physical Laboratory, New Delhi (1995)

4. Ultrasonic parameters of the binary mixtures of toluene with n-alkanols.
   Roshan Abraham, J. Jugan and M. Abdulkhadar
   National Symposium on Acoustics, National Physical Laboratory, New Delhi (1995)
5. Theoretical calculation of acoustic nonlinearity parameter (B/A) and internal pressure of some organic liquids at 293.15 K. Jugan J., Roshan Abraham and M. Abdulkhadar National Symposium on Acoustics, National Physical Laboratory, New Delhi (1995)


Other papers published

