An Equation of State and Non-Linearity Parameter (B/A) of Multicomponent Liquid Systems

V. Vyas[C,S]
Bio-Acoustics Research Laboratory, Department of Chemistry, University of Allahabad, Allahabad, India
vimlavyas@rediffmail.com

The measurements of ultrasonic propagation constants become unreliable when sound waves of finite amplitude are made to propagate in fluids, because non-linear effects like acoustic streaming and distortion of waveform occur due to greater attenuation of high frequency components compared to low frequency ones. These non-linear effects, represented by the non-linear terms in the equation of wave motion, are well studied by the factor (B/A), (C/A) and (D/A) called the non-linearity parameters. The importance of these parameters lies in obtaining information about the errors in absorption measurements produced by the presence of finite amplitude sound waves and physical attributes of liquid such as internal pressure and acoustic scattering.

It has become of much interest to predict the extent of various kinds of non-linear effects, which are due to deviation from linearity in ordinary acoustics. It is possible to obtain certain information about the physical pressure, intermolecular spacing etc. from the values of non-linearity parameters. The non-linearity parameters play a significant role in nonlinear acoustics and its determination is of increasing interest in a number of areas ranging from underwater acoustics to medicine. In my opinion knowledge of B/A of multi-component liquid systems is very important for their structural and intermolecular interaction studies.

The present paper deals with the study of non-linearity parameter for three ternary and three quaternary liquid systems containing n-alkanes at 298.15 K. The study has been carried out with the help of Tong and Dong equation by making use of experimental sound velocity and density data generated in our laboratory. In the process of evaluation of non-linearity parameter (B/A) values for pure liquid components of various ternaries and quaternaries, Tong and Dong equation has been used along with the aid of Flory's statistical theory. The thermodynamic parameters occurring in the Tong and Dong equation have been calculated by using Flory's statistical theory. B/A values of all the systems have been further utilized to deduce the values of (C/A) & (D/A). Intermolecular interactions have also been discussed in the light of excess non-linearity parameter $(B/A)^E$, in the case of all the multi-component systems undertaken for the present study. The $(B/A)^E$ values for all the ternary and quaternary systems were fitted to the smoothing equations through regression analysis and plotted against the composition.
From the overall study, it may be concluded that the molecular interactions play a very vital role in understanding the complete picture of the various liquid systems taken for the present study. Since nature and extent of intermolecular interactions are usually expressed in terms of excess functions, the values of $(B/A)^E$ prove to be very important tools for studying the molecular interactions of the concerned systems under investigation.