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Evaluation of Refractive Index(n) and Molar Refraction from Velocity

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Abstract. An empirical relationship between refractive index and sound velocity has been suggested. The relation can be used to compute directly refractive index from the knowledge of ultrasonic velocity. The proposed relation for the evaluation of refractive index and molar refraction have been tested for thirty two pure liquids, eighteen binaries and three ternary liquid mixtures. The results are discussed in terms of average percentage deviation (APD). A satisfactory result has been found.

Introduction

The knowledge of refractive index plays an important role in understanding the nature of molecular interaction in liquids and liquid mixtures. The refractive index of pure liquids and liquid mixtures has been measured by different workers[1-4]. Various mixing rules for the theoretical prediction of refractive index of liquid mixtures have been proposed due to Arago and Biot[5], Dale and Gladstone[6], Lorentz and Lorentz[7,8], Eykman[9], Weiner[10], Heller[11] etc. These relations were applied to binary liquid mixtures recently by Pandey *et al*[12]. In the present investigation an attempt has been made to establish a relationship between refractive index and sound velocity. On the basic of proposed relation refractive index(n) and molar refraction(R_m) of pure liquids and liquid mixtures have been evaluated. The values of *n* and R_m are compared with the experimental findings and quite satisfactory results has been obtained for all the systems taken.

Proposed Relation

According to Snell's law the refractive index of medium 2 relative to medium 1 is defined as

$$n = u_1/u_2$$

where u_1 and u_2 are the velocities of light waves in medium 1 and 2 respectively. By trial and error method it is found that the refraction index of liquid system can be expressed as,

$$n = (u^{1/4}/u_0^{1/4}) \qquad (1)$$

where u and u_0 are the velocity of sound in liquid at given temperature and in air at $0^{o}C$ respectively. Molar refraction Rm is defined as

(2) $$R_m = [(n^2 - 1)/(n^2 + 2)]\ V$$

where V is the molar volume.

Result and Discussion

Equations (1) and (2) have been employed to compute the values of refractive index and molar refraction for thirty two pure liquids, eighteen binaries and three ternary liquid mixtures. The system which are studied here are classified under the following groups:

A. Pure Liquids

1) Primary and secondary amines
2) Ternary amines
3) Aliphatic hydrocarbon liquids
4) Polar and non-polar liquids
5) Aromatic hydrocarbon liquids

B. Binary Liquid Mixtures

1) Diglyme + hexane
2) Diglyme + heptane
3) Diglyme + octane
4) Diglyme + 2, 2, 4 trimethyl pentane
5) Diglyme + ethyl acetate
6) Diglyme + methyl benzoate
7) Diglyme + ethyl benzoate
8) Diglyme + diethyl succinate
9) Diglyme + nonane
10) Diglyme + decane
11) Diglyme + dodecane
12) Diglyme + hexadecane
13) n-heptane + tolueme
14) n-heptane + n-hexane
15) Toluene + n-hexane
16) Cyclohexane + heptane
17) Cyclohecxane + n-hexane
18) n-decane + n-hexane

Ternay Liquid Mixtures

1) Toluene + n-heptane + n-hexane
2) Cyclohexane + n-hepatne + n-hexane
3) n-hexane + n-heptane + n-decane

Table 1

System	Average Percentage Deviations (APD)	
	n	R_m
(I)	1.66	5.00
(II)	2.74	7.98
(III)	2.19	7.01
(IV)	2.21	6.16
(V)	3.97	11.77
(VI)	2.07	6.75
(VII)	2.02	6.51
(VIII)	1.77	5.62
(IX)	2.48	7.95
(X)	0.91	2.94
(XI)	3.01	8.30
(XII)	0.80	2.43
(XIII)	1.61	5.05
(XIV)	1.59	4.97
(XV)	1.33	4.71
(XVI)	1.44	4.37
(XVII)	1.38	4.16
(XVIII)	3.31	9.65
(XIX)	2.15	7.03
(XX)	4.38	12.76
(XXI)	1.77	5.48
(XXII)	2.02	6.34
(XXIII)	1.93	6.18
(XXIV)	2.63	8.24
(XXV)	3.06	9.55
(XXVI)	2.80	9.00

The experimental values of sound velocity and density needed for the purpose were collected from different sources. The calculated values of n and R_m for all the systems are compared with observed values taken from different sources. The values and their sources may be obtained from authors if so needed. The APD values for different systems are listed in table 1.

For pure liquids: In the case of primary and secondary amines the APD are minimum and for aromatic hydrocarbon liquids it is maximum.

For binary mixtures: In the case of binary liquid mixtures the APD are found to be minimum for diglyme (diethylene gycol dimethyl ether) + ethyl benzoate and maximum for toluene + n-hexane.

For ternary mixture: The APD are maximum for the mixture toluene + n-heptane + hexane and maximum for cyclohexane + n-heptane + n-heptane.

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