Various Mixing Rules For Study of Refractive Index Under Small Temperature Difference

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Abstract- *We have made an attempt to observe the result of various mixing rules viz. Weiner (W), Lorentz–Lorentz (L–L), Heller (H), Gladstone–Dale (G–D), Arago-Biot (A-B) and Newton's relation (N) with organic binary liquid mixtures of Dioxan (D)+ Acetic ester (E), + Hydrogen acetate (A), + butyl alcohol (B), at different temperatures (295,300,305) K over the entire mole fraction range. Analysis of various mixing rules has been expressed in terms of average percentage deviation.*

Keywords- Refractive index, Heller relation, Gladstone–Dale relation, Arago-Biot

I. INTRODUCTION

With the help of refractive index we can study about various properties of the organic liquid and liquid mixtures [1,2]. Refractive index gives the behavior of the medium to the electromagnetic radiations and depends on the temperature, pressure and nature of liquid for a given wavelength. It also finds applications over many multiphase systems. Refractive index of an organic liquid mixture of liquids of different refractive indices gives useful information about the proportion in which they are mixed. Prediction of refractive indices of binary organic liquid mixtures is very important for the determination of composition of binary liquid mixtures. For the study of physical property of medium we can divide them into two broad categories; macroscopic and microscopic. Macroscopic scale gives information about the external structure of matter and internal structure is immaterial for this as in it matter possesses a continuum with certain properties defined by well set up measuring operations. On the other hand, under the microscopic point of view, we study the composition of matter in deep. In this work the study of variation of these macroscopic physical properties of liquid mixtures have been carried out. With the help of this study we can determine the purity of liquid sample. In fact in the field of Analytical Chemistry, the measurement of refractive index is used as very important tool of investigation. For the prediction of refractive index there are many numbers of theoretical mixing rules [5-7]. Various workers have tested these mixing rule and they also study the relative merits and demerits of these mixing rules. In this paper, as a continuation of our research work, we have attempted to discuss about relative validity and importance of these mixing rule with following organic binary liquid mixtures.

Dioxan (D) + Acetic ester (A)
Dioxan (D) + Hydrogen acetate (H)
Dioxan (D) + Butyl alcohol (B)

II. THEORY

Lorentz-Lorentz relation (L-L) is given by

$$\frac{(n_m^2-1)}{(n_m^2-2)} = \phi_1 \frac{(n_1^2-1)}{(n_1^2+2)} + \phi_2 \frac{(n_2^2-1)}{(n_2^2+2)}$$
…………………….. (1)

This is most frequently used mixing rule in analysis of refractive index.

Gladstone-Dale relation (G-D) is given as

$$(n_m-1) = \phi_1 (n_1-1) + \phi_2 (n_2-1)$$
………………… (2)

Weiner relation (W) is given by

$$\frac{(n_m^2-n_1^2)}{(n_m^2-2n_1^2)} = \phi_2 \frac{(n_2^2-n_1^2)}{(n_2^2+2n_1^2)}$$
………………… (3)

It applies to isotropic bodies of spherically symmetrical shape and proposes volume additivity.
Heller (H) equation is given by –

$$\frac{n_m-n_1}{n_1} = \frac{3}{2}\phi_2 \frac{(n_2^2-n_1^2)}{(n_2^2+2n_1^2)}$$
………………… (4)

This relation is limiting case of Weiner's relation.
Arago - Biot relation (A-B) is given by

$$n_m = \phi_1 n_1 + \phi_2 n_2 \qquad \ldots\ldots\ldots\ldots (5)$$

Newton relation (N) is given by

$$\left(n_m^2 - 1\right) = \left(n_1^2 - 1\right)\phi_1 + \left(n_2^2 - 1\right)\phi_2 \qquad \ldots\ldots\ldots\ldots (6)$$

In above equations n_m, n_1, n_2 respectively represents the refractive index of mixture, solvent and solute respectively ϕ_1 and ϕ_2 are the volume fractions of solvent and solute respectively.

III. RESULTS AND DISCUSSION

Values of average percentage deviation (APD) at different temperatures for all the binary organic liquid mixtures are listed in Table1. With the study of table1 we can make following discussion. The first thing which we have noticed here that all the theoretical relations for the prediction of refractive indices are in very good agreement with the corresponding value of refractive index which are find out experimentally, for all the mixtures under consideration here. For system (D+A) at temperature 295K APD values have both types of values i.e. negative and positive. For G-D, A-B and N, APD values are negative while for other these are positive. It is important to mention that of the all relations we have minimum value for Newton's formula and maximum for Heller from this it is concluded that Newton's relation shows best agreement among all the theoretical relations for (D+A) mixture at temperature 295K. At temp 300K for (D+A) system G-D, A-B, L-L, W and H relation are in good agreement to each other. Newton (N) relation gives the minimum APD values for (D+A) combination for all three temperatures. Over all values of APD for system (D+H) due to G-D, A-B, L-L, W and H are very close to each other. Similar trend is followed by (D+B) system for which Weiner and Heller's relation are very prominent as they have lowest value at 300K. As a conclusion we can say that all the theoretical relations are in well agreement. However in present study Newton's relation gives minimum values of APD mostly.

There are number of reasons for the deviation of theoretical values with the experimental values. When two organic liquids form a liquid mixture then the various physical properties change and they are quite different from the properties of the original components. In liquid phase of matter there is lack of shear rigidity and exist very low compressibility, thus it exhibits both type of nature as exhibited by gases and solids because the lack of shear rigidity and very low compressibility are the properties of gases and solids respectively. Due to mixing of organic liquids the interaction between molecules of liquids takes place because of the presence of various types of forces such as dispersion forces, change transfer, hydrogen bonding, dipole-dipole and dipole-induced dipole interactions [8-10]. Hence it can be stated that the observed deviation of theoretical values of refractive index from experiment values confirms that the molecular interaction is taking place between the molecules in liquid mixture.

IV. CONCLUSION

In present study, it is attempted to study the relative validity and importance of various mixing rules for the prediction of refractive index of binary organic liquid mixture. Temperature variation of these relations has also been discussed. It is find out that these rules are interrelated. Different nature and size of the molecules has been taken into consideration hence particular relation shows good agreement in some systems but deviates for others systems.

REFERENCES

[1] Aralaguppi M I, Jadar C V and Aminabhavi T M; J.Chem. Eng. Data 41, 1307 (1996)
[2] Nayak J N, Aralaguppi M I and Aminabhavi T M; J. chem. Eng. Data 48, 1489 (2003)
[3] Akbar S and kumar M, Indian j of applied research 1,4 (2012) 208
[4] Nayak J N, Aralaguppi M I , Naidu B V K and Aminabhavi T. M;J. Chem. Eng. Data 49, 468 (2003)
[5] Krishnaiah A, Surendranath K N, and Vishwanath D S; J. chem.. Eng. Data 39, 756 (1994)
[6] Nath J G and Pandey J. D; J. Chem. Eng. Data 41, 844 (1996)
[7] Isht Vibhu PhD Thesis (Lucknow University, India) (2003).
[8] Oswal S L , Oswal ,P and Phalak R P;J. Solution chem. 27, 507 (1998)
[9] Ohji H, Tamura K and Ogawa H;J. Chem. Thermodyn. 32, 319 (2000)
[10] Aralaguppi M I, Jadar C V and Aminabhavi T M ; J. Chem. Eng. Data, 44, 441 (1999)

Table-1: Values of APD for various mixtures

Mixture	T (K)	GD	AB	LL	W	H	N
D+A	295	-0.0530	-0.0620	0.1360	0.0263	0.1541	-0.1966
	300	-0.0820	-0.0860	0.0570	-0.0535	0.0950	-0.2654
	305	-0.6150	-0.6211	-0.5160	-0.6667	-0.4890	-0.7807
D+H	295	-0.1150	-0.1154	0.0493	-0.0626	0.0430	-0.2770
	300	-0.0220	-0.0280	0.0940	0.0127	0.0864	-0.1690
	305	-0.0670	-0.0612	-0.0230	-0.0577	-0.0167	-0.0830
D+B	295	0.1025	0.1044	0.1038	0.1034	0.1027	0.1029
	300	0.0042	0.0024	0.0234	0.0055	0.0040	0.0337
	305	-0.0650	-0.0650	0.0758	-0.0468	0.0777	-0.2636