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Studies of Derived Specific Refractive Index Formula for Binary Organic Mixture and Compare with Lorentz & Lorenz Formula

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Abstract: *Refractive index is an intensive property of physical chemistry whose value is independent of the quantity of matter containing in the system. The measurement of refractive index and optical activity of organic liquids is of great important in physical chemistry. Specific refractive index of selected sets of organic binary mixture are calculated by Lorentz & Lorenz formula, and suggested DDJ formula of specific refractive index, the data with very little difference confirming that the applicability of the suggested DDJ formula is comparable to those of Lorentz & Lorenz.*

***Key-Words*:** *Specific refractive index, Intensive property, Optical property, DDJ formula, Binary mixture.*

I. Introduction

The measurement of refractive index and optical activity of organic liquids is of great importance in chemistry. These measurements provide invaluable information regarding the molecular structure, purity of organic compounds and the composition of binary mixtures [1-4].Gladstone and Dale [5]. An extensive discussion will be found in N. Bauer and K. Fajans and Lewin in physical methods of organic chemistry.[7-8]. For a homogeneous and transparent mixture or solution of substance A and B, whose molecules not have strong interactions with each other, the molecular refractivity of the mixture, $R_{M(mix)}$ is given by the expression.

$$R_{M(mix)} = \frac{n^2_{(mix)} - 1}{n^2_{(mix)} + 2} \cdot \frac{X_A M_A + X_B M_B}{d_{(mix)}} \quad \ldots\ldots(1)$$

$R_{M(mix)}$ is related to individual molecular refractions R_{M_A} and R_{M_B} by the expressions.

$$R_{M(mix)} = X_A R_{M\,A} + X_B R_{M\,B} \quad \ldots..(2)$$

This equations are used for finding out if two mutually miscible substances will form an ideal solution.In physical chemistry nearly thirty formulae are used for determination

of specific refraction of organic compounds . Out of these formulae main being Lorenz and Lorentz which is shown below

$$R = \frac{n^2 - 1}{n^2 + 2} \times \frac{1}{\mathrm{d}} \quad \ldots.. (3)$$

Where n=Refractive index ,d=density

In each formula R is in terms of n and d and also some constant. It is found that refractive index 'n' is always found in numerator and 'd' is in denominator. So ,the simplest formula should be very likely to be n/d .The following formula possesses all the merits of above mentioned formulae

This formula can be written in the most general form

$$R = \frac{x}{d} \times \left(n^3 - y\ \right) \quad \ldots.. (4)$$

In above equation x and y are statistically revaluated, where as n and d bears the usual meaning to find out the value of specific refraction of organic compounds. According to Lorenz and Lorentz equation the mean value of "n" and "d" for all organic compounds are ,n=1.4699 and d=1.0251 these values are substituted in equation (3)

$$R = \frac{x}{1.0251} \times \left((1.4699)^3 - y\ \right) \quad \ldots.. (5)$$

Considering the above values of x and y the specific refraction were calculated to be R= 0.272108. Now the new formula is emerged as under.

$$R = \frac{0.0843}{1.0251} \times \left(n^3 - 0.0045 \right) \quad \text{..... (6)}$$

This equation (6) known as "DDJ" formula of specific refraction is nearly equal to the Lorenz and Lorentz formula . What is more important is that, this formula holds good to the extent of 99.72 % with Lorenz and Lorentz determination of specific refraction of organic compounds.

II. Experimental Section

The present work describes determination of densities and refractive indices of organic compounds. The specific refraction of organic compounds calculated by Lorenz and Lorentz and suggested formula and also the difference between Lorenz and Lorentz and suggested formula for binary mixture of organic liquids is negligible under study.

2.1. Preparation of Binary System

The Liquids were selected analytically pure and also freshly distilled for the purpose of research. The binary systems are prepared weight by weight and are shown as follows.

Table-1

Sample No	% of A	% of B	Mixture
1	0	100	$\frac{0}{Density\ of\ A} + \frac{100}{Density\ of\ B}$
2	10	90	$\frac{10}{Density\ of\ A} + \frac{90}{Density\ of\ B}$
3	20	80	$\frac{20}{Density\ of\ A} + \frac{80}{Density\ of\ B}$
4	30	70	$\frac{30}{Density\ of\ A} + \frac{70}{Density\ of\ B}$
5	40	60	$\frac{40}{Density\ of\ A} + \frac{60}{Density\ of\ B}$
6	50	50	$\frac{50}{Density\ of\ A} + \frac{50}{Density\ of\ B}$
7	60	40	$\frac{60}{Density\ of\ A} + \frac{40}{Density\ of\ B}$
8	70	30	$\frac{70}{Density\ of\ A} + \frac{30}{Density\ of\ B}$
9	80	20	$\frac{80}{Density\ of\ A} + \frac{20}{Density\ of\ B}$
10	90	10	$\frac{90}{Density\ of\ A} + \frac{10}{Density\ of\ B}$

11	100	0	$\frac{100}{Density\ of\ A} + \frac{0}{Density\ of\ B}$

The calculations of densities of all samples were carried by following formula.

$$Density\ of\ sample = \frac{Net\ weight\ of\ sample}{Net\ weight\ of\ water} \times Density\ of\ water$$

The densities of water were taken according to room temperature. The refractive indices ware measured with respect to the sodium-D line. An Abbe.refractometer was used. Calibration of the instrument was performed with double distilled water.

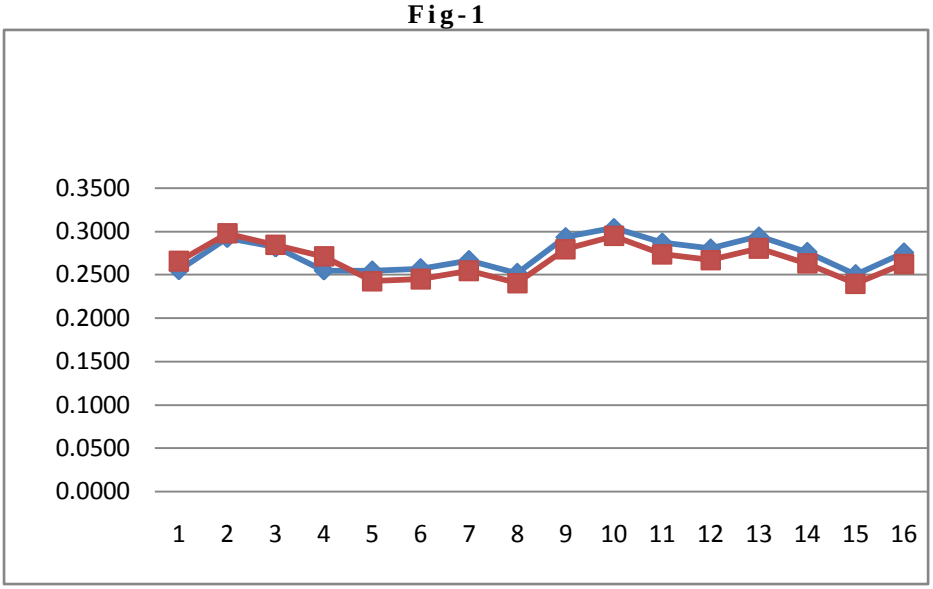
III. Result And Discussion

Measured all values of densities (d) and refractive indices (n) indicated in observation table. The calculated R1 and R and its differences are also reported in table-2.The comparisons of specific refraction of binary mixtures of organic liquids between Lorenz and Lorentz and suggested (DDJ) formula have been shown. By experimental values of densities (d) refractive indices (n) and the comparisons of specific refraction have been shown graphically. The graphs were plotted for percentage composition of binary mixtures of organic liquids against specific refraction of organic liquid

Table-2

Sr. No	Liquid	Density gm/cm2	Refractive Index N	$R_1 = \frac{n^2-1}{n^2+2} \times \frac{1}{d}$ L&L	$R = \frac{0.0843}{d} \times (n^3 - 0.0045)$ SUGGESTED (DDJ)	$R_1 - R$
1	Acenaphthylene, 5-bromo-1,2-dihydro5-Bromoacenphthene	1.4392	1.6565	0.2554	0.2660	-0.0105
2	Acenaphthylene, 5-bromo-1,2-dihydro-5-chloroacenaphthene	1.1954	1.6169	0.2927	0.2978	-0.0051
3	Acenaphthylene, 1,2-dihydro- Acenaphthens	1.222	1.6048	0.2818	0.2848	-0.0030
4	Acenaphthylene, 1,2-dihydro-5-iodo-5-Iodoacenachthene	1.5	1.6909	0.2551	0.2714	-0.0164
5	Acetaldhyde, ethoxy - Ethoxyacetaldehyde	0.942	1.3956	0.2548	0.2429	0.0120
6	Acetamide , Ethanamide	0.9986	1.4278	0.2575	0.2453	0.0122
7	Acetamide, N-acetyl-N-ethyl-	1.0092	1.4513	0.2670	0.2550	0.0120
8	Acetamide, N-acetyl-N-methyl-	1.0663	1.4502	0.2521	0.2408	0.0114
9	Acetamide, N-butyl-	0.896	1.4388	0.2934	0.2798	0.0136
10	Acetamide, N-butyl-N-phenyl-	0.9912	1.5146	0.3040	0.2951	0.0089
11	Acetamide, N,N-diethyl-	0.913	1.4374	0.2872	0.2738	0.0134
12	Acetamide, N,N-diethyl-N,N-Dimethylethanamide	0.9366	1.438	0.2803	0.2672	0.0130
13	Acetamide, N,N-dipropyl-	0.8992	1.4419	0.2942	0.2806	0.0136
14	Acetamide, N-ethyl- N-Ethylacetamide	0.942	1.4338	0.2763	0.2634	0.0130
15	Acetamide, N-(2-hydroxyethyl)-	1.1079	1.4674	0.2506	0.2401	0.0106
16	Acetamide, N-methyl-	0.9371	1.4301	0.2757	0.2627	0.0130

Fig-1



Comparison of specific refractive index of Lorentz & Lorenz and DDJ by graphical plot.

IV. Conclusion

The applicability of the suggested formula (DDJ) is that it gives the values which are very close to Lorentz and Lorenz formula. It is also observed that 99.80% substances give the variation of ± 0.01, which is shown in Table – 2, whereas 99.97% organics substances give the variation of ± 0.0199 from the theoretical values of Lorentz and Lorenz formula of specific refraction. The suggested formulas are also applicable to all known mono, binary, ternary, quaternary liquids mixtures systems.

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References

[1]. Bauer, Fajans in Weisberger, Technique of organic chemistry, Inter science publishers Inc., New York, 2(1),1949,chap-2.
[2]. Daniels, Alberty, physical chemistry, john willey and Sons, Inc., New York 1955.
[3]. Gibb, Optical Methods of Chemical Analysis, McGraw-Hill Book Company, Inc., New York 1942.
[4]. Pulfrich, Ztschr., Phys. Chem. 18,1895,204.
[5]. Gladstone, Dale, Phil. Trans. , 153,1863,317.
[6]. Bauer, Fajans in Weisberger,; Physical method of organic chemistry, New York,3(1) 1949, 28.
[7]. N. Bauer, K. Fajans, J. Ame. Chem. Soc., 64,1942, 1163-1164.
[8]. Eykman, Chem. Weckbel, 3,1906, 383-385.