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Liquid Diffusion - Measurement and Correlation of Diffusion Coefficient in Acetic acid - Carbon tetra chloride System

B.Karunanithi[1], **K.Bogeshwaran**[2]

[1]**Department of Chemical Engineering, SRM University, Kattankulathur Chennai, India**
[2]**Department of Petroleum Engineering, Dhaanish Ahmed College of Engineering, Chennai , India**

Abstract : The diffusion experiment was conducted involving the study of diffusivities of associating solute (Acetic Acid) in non associating solvent (Carbon Tetra Chloride), A New model equation for predicting diffusivities at infinite dilution has been derived for the case of associating solutes diffusing as dimmer. This model equation satisfactorily explains the wide discrepancy in predicting the diffusivities of such associating solutes by the conventional correlations proposed in the literatures. The model equation $D_{AB} = [D_{A1} + D_{A2} [\sqrt{(1 + 4KX_A)} - 1]]/\sqrt{(1+4KX_A)}$. The model parameter K remains nearly constant for the range of concentrations (up to 5%) studied, and that a mean value of K (290.85) could be used satisfactorily in the proposed model equation. The results also indicates that the conventional diapharm cells could be used satisfactorily for experimental determination of liquid diffusivities up to a concentration of 5%. The Cell constant is 0.3624. The experimental diffusivity is 1.4945 x 10^{-5} cm^2/sec.

Keywords : Diffusivity, Acetic Acid - Carbon Tetra Chloride system, diapharm Cell, Associating solute, Model Parameter.

1. Introduction

Estimation of liquid diffusivities is of considerable interest in understanding the mechanism of solute transport in liquids specially in liquid liquid extraction, distillation, crystallization, absorption and chemical reaction.

If a solute is partitioned between two immiscible solvents, there is diffusion in liquids was clarified by Thomas Graham, even though he has failed to put his experiments on a quantitative basis. Following graham's work Fick has described diffusion on the same mathematical basis as Fourier's law of heat conductance or ohm's law of electrical conduction. This anology is still a useful pedagogical tool.

Fick has defined the total one dimensional flux J_1 as $J_1 = - D (\partial c_1 / \partial x)$ where c_1 is the concentration of the solute and x is the distance. The term D, which Fick calls "the constant depending on the nature of the substances" is of course, the diffusion coefficient.

Diffusion coefficient for liquids are at least one thousand times smaller than those in gases. Theoretical estimation of diffusion in liquids are much less accurate than those for gases.

The various theoretical approaches to diffusion in liquid mixtures have helped to provide a greater insight into the diffusion process. The intermolecular forces, the shape and size of molecules are all important factors. However, these attempts have not been very successful when complex interactions between the molecules in the liquid state occur. In view of the difficulties in formulating the exact theory, model approaches such as cell model, free volume model and hard sphere model have been resorted to.

However, correlations based on experimental measurements predicts diffusivities better than those by theoretical predictions. Owing to the complex nature of liquids correlations based on semi theoretical considerations also do not always give satisfactory predictions on account of complex molecular interactions as in high viscous solutes / solvents as also association tendencies in the solute – solvent systems.

Theories of Diffusion

2.1 General

Notwithstanding a great deal of difficulty encountered in the formulation of a satisfactory theoretical equation to explain the phenomenon of diffusion, attempts have been made to explain the mechanism of diffusion on the basis of the following theories :

1.Hydrodynamic theory, 2.Eyring's absolute reaction rate theory,3.Statistical mechanical theory

4.Theory of irreversible thermodynamics.

3.1 Semi Empirical Correlations

There are number of semi empirical correlations reported for the prediction of diffusivities in liquids. Most of the correlations do not take association or complex formation between solute and solvent molecule into consideration. Recently some of the investigators have studied systems involving simple binary solute solvent interaction.Studies involving semi empirical correlations are discussed in some where else[54]

3.5 Conclusions from Literature Review

The above literature review indicates that little attention has been paid towards studying systems, where solute association affect diffusivity values, as for example in the case of acetic acid solute where association may occur.

Hence it would be of interest to study diffusivities of solute systems which exibit solute association, and to check the applicability of the correlation of Laddha – Smith for water as solute (a highly associating solute) and that of Lusis. A new attempt at deriving a model to take into account the solute association will be useful.

Scope of Present Work

The earlier investigations viz., that of Kamal and Canjar[22], Lusis and Ratcliff [30], Sitaraman etal[43], Laddha and Smith[27], Reddy and Duraiswamy[38], Schiebel[42] with the exception in Wilke and Chang[51] have not given much importance to the effect of association on diffusivity predictions though the deviations from experimental measurements for such systems involving association were high. Wilke and chang have introduced a parameter for association of the solvent molecules in their correlation. They have not, however, taken into account, these systems which show association of the solute molecules or complex formation between solute and solvent molecules. Ratcliff and Lusis[37], considered those systems which have shown complex formation between the solute and solvent molecules. Kuppuswamy and Laddha[25] have reported an improved correlation of Ratcliff and Lusis by studying the diffusivities with systems which have shown simple binary complexes between solute and solvent molecule.

A careful review of diffusion literature indicated that there has been no attempt at investigating association in the solute in non associating solvents. An attempt is made in this work to study the diffusivities of an associating solute (viz. acetic acid) into non associating solvent.

Experimental Techniques

5.1 General

Available experimental diffusivity data for associating solutes in non associating solvents are megre and there is need for reliable data in view of the inadequacies in the various semi empirical and empirical correlations. Diffusion coefficients are not difficult to measure out. Sophisticated equipment and accessories are needed for accurate determination within 1% accuracy. However, results within 5% accuracy can be accomplished with less sophisticated and conventional diaphragm cells. Diffusion coefficients at various concentrations of the solute could be obtained using Diaphragm cell with reasonable accuracy under pseudo steady state conditions.

5.2 Pseudo steady state Diffusion

The establishment of a steady concentration gradient across a porous diaphragm separating two miscible solutions of different compositions constitutes Pseudo steady state diffusion. After a known period of diffusion the concentration of the two solutions are analysed to determine the diffusivity. Because of its simplicity and efficiency, the method is widely used.

5.2.1 Experimental Techniques

Almost all methods employ Fick's Law for determining diffusion coefficients. The difference between the methods lies mainly in the boundary conditions and in the analytical procedures used. Four types of techniques are in practice and they are discussed briefly here.

Diaphram Cell technique

First developed by Northrup and Auron[33] later improved by Gordon and Stokes , the diaphragm cell technique has been recognized as a satisfactory method for measurement of diffusion coefficients. This technique and its application have been discussed at length in succeeding chapters.

Isotope Effects

Intra diffusion coefficients have been measured using radioactive isotope methods but an elaborate and complicated apparatus is necessary for successful utilization. One advantage of these tracers is that they can be assayed accurately even when they are present in very small concentration. Very precise determination of radiotracer concentrations has not been possible until the development of liquid scintillation counter.

Nuclear Magnetic Resonance Method

The discovery of NMR phenomenon has found its successful use for diffusivity measurements.This method can be used only when the system contain certain atomic nucleus with both magnetic momentum and angular momentum. Diffusion coefficients, which were beyond the scope of steady gradient method, have been measured down to the order of 10^{-10} cm^2/sec.

Some of the Application of Diffusion :

Carbon dioxide capture is mainly by diffusion process[56],Penetration of water Absorption by blended Concrete[58],Chromizing of steel[60],Removal of Dyes[69],Adsorption of Fluoride[71,63], Removal of Heavy metal ions[67],Synthesis of Copper Nano particles[65] are some of the papers published based on the diffusion.

Diaphram Cell and Cell Equation

6.1 Diaphram cell

Experimental determination of diffusion coefficients are accomplished to a great extent by the diaphragm cell technique. The solution of Fick's Law has been used with varying boundary conditions for this purpose. Diaphram cell technique was now recognized as an exact method for diffusivity determination. This technique was first developed by Northrup and Auron (33) and subsequently improved by others. This technique is undergoing various modifications from time to time incorporating the latest design and accessories.

Gorden has reviewed the use of diaphragm cell with reference to the following

1.The cell volume 2.The assumption of quasi steady state in the diaphragm 3.Mechanism of transport in the diaphragm 4.Calibration of the diaphragm cell, and 5.The relationship between the integral and differential diffusion coefficients.

The diaphragm eliminates error due to convection which often arise during diffusion in liquids. It offers an effective cross sectional area, Ae, and a path length Ie, to the diffusing medium which must be determined experimentally by studying a system whose diffusivity is known. Thus the cells are calibrated. Appropriate equations developed from Fick's Law (which assumes a linear concentration gradient across the diaphragm) are used to calculate diffusivity. A. lvarez[1] has shown that the influence of non linear concentration gradient is small and is, in effect, corrected by calibration. Gardon , in his review, has ruled that the measured integral coefficient could be taken to be equal to the true differential coefficient at very low concentrations.

So as far as the diffusion coefficient measurements are concerned, diaphragm cell technique presents an elegant method.

6.2 Cell Equation

For binary diffusion and unidirectional transfer, Fick's law gives

$J_A = - D_{AB}\, dc/dz$ --- (26)

$J_A = ds/Ae\, dt$ --- (27)

Where J_A is the mass flux of solute

dc/dz is the concentration gradient

And $ds = - D_{AB}\, Ae\, dc\, dt / dz$ ---- (28)

Here s is the moles of solute diffusing and Ae is the total effective cross sectional area of pores.

For quasi – steady state and linear concentration gradient

$dc / dz = \Delta c / le = (c1 - c2) / le$ ----(29)

substituting equation

$ds = - D_{AB}\, Ae\, (c1 - c2)\, dt / le$ ----(30)

Here le is the effective pore length of the diaphram and subscripts 1 and 2 refer to the two compartments of the cell, top and bottom respectively.

A material balance of component A yields

$V_1\, d_{c1A} = - V_2\, d_{c2A} = ds$ ---(31)

Combining Equation, we have

$D_{c1A} = - D_{AB}\, Ae\, (c_{1A} - c_{2A})\, dt /(V_1\, le)$ ---(32)

$D_{c2A} = - D_{AB}\, Ae\, (c_{1A} - c_{2A})\, dt / (V_2 le)$ ---(33)

Addition of the above two equation yields

$D_{c1A} - D_{c2A} = - D_{AB}\, Ae\, (1/V_1 + 1/V_2)(c_{1A} - c_{2A})\, dt /(le)$ ---(34)

Ae and le are not available directly but Ae,le,V1 and V2 are constants for a given cell.

Putting $Ae(1/V_1 + 1/V_2) = \beta$ and $c_{1A} - c_{2A} = c^0$

We get $d_{c1A} - d_{c2A} = - D_{AB} C^0 dt$ ----(35)

Integrating the above equation between the limits ΔC^0 and ΔC^F, We obtain

Int d (C^0) / C = - Int 0 to t βD_{AB} dt ---- (36)

Or $D = (1/\beta t) \ln \Delta C^0 / \Delta C^F$ ---- (37)

Here ΔC^0 is the initial concentration difference = $C_1^0 - C_2^0$

ΔC^F is the final concentration difference = $C_1^F - C_2^F$

The assumption involved in the working equation (36) are -

1.The unidirectional form of diffusion has been shown to be valid by Toor if Ae / le depends only upon the internal diffusion path of the diapharm.

2.Barnes has provided the assumption of quasi – steady state to be quite valid so long as the following two conditions are met.

a) The total pore volume should be less than 1% of the total cell volume, and

b) The preliminary period of diffusion is sufficient enough to disappear the original constant concentration gradient, which is about 4 to 5 hours.

A cell of normal dimensions satisfies the first condition. The ratio of the effective cross sectional area to the volume of the cell should be minimum or else quasi steady state condition is not valid. It is essential to note that the solute transfer is only by diffusion and not due to bulk flow or surface transport. The solutions are assumed to be of uniform concentration.

The diffusion of the cell factor suggests that as long as the volume of each solution is the same during the calibration and actual runs, the actual solution volume on either side of the diaphragm are immaterial. For low concentrations Gordon has shown that the time averaged integral diffusion coefficient is not different from the ordinary integral diffusion coefficient, the error being only 0.3%.

Experimental Set up and Procedure

7.1 Experimental setup:

The diapharm cell used for this investigation consists of a sintered silica diapharm of pore size 4 – 5 microns. The cell is divided into two compartments with the diaphragm at the center. Each compartment has a volume of about 50 ml and is provided with independent inlet and outlet connections. Through the outer surrounding jacket, water at constant temperature was circulated from a thermostat. (fig 1)

7.2 Calibration of Diaphram cell :

The calibration and standardization of the diaphram cell constitutes an important part of the experiment. There are two methods, in practice, principally used for the calibration of cells. One method is using 0.1 kcl as the solute species diffusing into pure water. The other is 0.1N Hcl solution diffusing into pure water with a reported[28] diffusivity value of 3.078 x 10^{-5} cm2/sec at 30^0C. The latter method was used here for the calibration of the cell.

Procedure

Initially the cell compartments are flushed with acetone to clean the pores and the inside of the cell. The cell is dried in a vacuum drier. Initially pure water is filled in the bottom compartment by applying vacuum in the top compartment. Water is withdrawn through the pores of the diaphram to the top compartment so as to drive out all the entrapped air. Then the top compartment is drained and filled with 0.1N Hcl after rinsing it well. Care is taken to avoid air bubbles in both the compartments. All the stop cocks are closed air tight.

Fig1 :

Diaphram cell Used for the determination of diffusion coefficient

The cell was clamped vertically. Water at the required temperature is circulated through the outer jacket of the diaphragm cell. After the preliminary period of diffusion, lasting about four to five hours, the cell was taken out carefully and the contents drained off.

The cell is again filled up with the respective solutions and clamped. The run was allowed for 36 to 72 hours after which the contents were taken out and analysed quantitatively for their concentrations. From the analysis of initial and final concentrations the cell constant β was calculated by using the cell equation[36]

Five runs were made under identical conditions and the mean value of the cell constant β was evaluated. In this manner the cell constant for all the five cells used in this study were obtained. Their values are given in Table 1 at the end of the result chapter with their respective 98% confidence limit, which have been calculated.

Table 1 : Cell Constant
System : 0.1N Hcl – Water **Temperature : 30°C**

S.No	Time $Tx10^{-5}$ sec	C1	C_1^F	C_2^F	ΔC	ΔC^F	D_{AB} x 10^5 cm^2/sec	Cell Constant B
1	1.707	0.1050	0.0590	0.0430	0.1050	0.0160	3.078	0.3581
2	1.716	0.1050	0.0600	0.0450	0.1050	0.0150	3.078	0.3684
3	1.719	0.1040	0.0600	0.0450	0.1040	0.0150	3.078	0.3659
4	1.518	0.1030	0.0600	0.0410	0.1030	0.0190	3.078	0.3618
5	1.758	0.1040	0.0590	0.0440	0.1040	0.0150	3.078	0.3578

Concentration in gmoles /litre Mean β = 0.3624

7.3 Experimental Method

Initially one percent solution of the solute in solvent was prepared, on volume basis. As before the cell was first filled with the solvent. The one percent solution was taken in the top or bottom compartment depending on whether the solute is heavier or lighter than the solvent respectively.

After the preliminary period of diffusion the cell was taken out, emptied and filled after rinsing both the compartments with the respective solutions. The run was continued with circulating water being maintained at 30^0C

After the stipulated time the contents of the top compartment and the bottom compartment were analysed accurately as given in section 7.4

The above procedure was repeated for studying the diffusivities at various solute concentrations. In each case the top and bottom compartments were analysed and the diffusivities are calculated.

7.4 Analytical procedure

Estimation of Acetic acid

Reagents : 1. Standard NaoH Solution
2. Phenolphthalein Indicator.

Procedure : 10 ml of the sample solution are pipetted out into the Iodine flask. A few drops of Phenolphthalein indicator is added. It is titrated against the standard sodium hydroxide. The end point is the appearance of pale pink colour. In the course of the titration, we have a two phase solution. However, this does not affect the results.

Result and Discussions

The system of Acetic acid – Carbon tetra chloride is chosen. Acetic acid is strongly associating solute and the solvent carbon tetra chloride fall in the class V category of solvents.

Table 2 gives the experimental values of the diffusion coefficients obtained with the use of conventional diaphragm cells for the systems Acetic acid – Carbon tetra chloride respectively covering concentration up to 5 %

Table 2 : Diffusivities of Acetic Acid in Carbon Tetra Chloride System At 30°c

S.No	Conc %	Time $Tx10^{-5}$ sec	Concentration gmoles/litre				Cell Constant B	Diffusion Coefficient D_{AB} x 10^5 Cm^2/sec
			Top Compartment		Bottom Compartment			
			Initial	Final	Initial	Final		
1	0.3	1.728	0.05241	0.04473	0.000	0.009939	0.1525	1.5275
2	0.5	1.584	0.08735	0.07842	0.000	0.017540	0.1525	1.4945
3	0.8	1.728	0.13980	0.10100	0.000	0.045480	0.3624	1.4722
4	1.0	1.728	0.17470	0.14410	0.000	0.024960	0.1525	1.4516
5	2.0	1.779	0.34940	0.25170	0.000	0.088920	0.3033	1.4149
6	5.0	1.850	0.87010	0.67530	0.000	0.217500	0.2499	1.3889

8.1 Comparison of Experimental diffusivities with Predicted values using conventional Correlations :

Table 3 shows a comparison of the diffusivity data predicted by three conventional correlations

1) Laddha – Smith (both correlations, covering water as solute and non aqueous solute system)

2) Wilke chang (taking into account the solvent association parameter to be unity)

3) Lusis (Incorporating the latent heats of vaporization of solute and solvent. It is seen from the error analysis given in table 3 that the calculated diffusivities by the conventional Lusis, Wilke chang, Laddha – Smith equations are less adequate in predicting the diffusivities of acetic acid in Carbon tetra chloride. This could be attributed to the associating nature of the solute in non associating solvent and hence requires further analysis based on a more satisfactory equation involving sound theoretical principles.

Table 3 : Comparison of Experimental Data with other Correlations

S.No	**D_{exp}x 10^5 cm^2 / sec**	**D_{wc} x 10^5 cm^2 /sec**	**% Error**	**D_{LS} x 10^5 cm^2/sec**	**% Error**	**D_L x 10^5**	**% Error**	**D $_{Predit}$ x 10^5 by equation 8.9**	**% Error**
Solute : Acetic Acid					Solvent : Carbon Tetra Chloride				
1	1.4945	1.780	19	(1.773)	(18.63)	1.8307	22.5	1.4964	+0.13

D_{exp} = Experimental Diffusivity
D_{wc} = Wilke – Chang
D_{LS} = Laddha – Smith
D_L = Predicted by Lusis
% Error = $[D_{exp} – D_{predict}]$ x 100 / D_{exp}

8.2 Derived model to account for solute association

Let us consider a case where the solute gives a dimmer in solution due to association as follows :

$$A_1 + A_1 \;===\; A_2 \qquad \text{--- (38)}$$

Where A1 represents the monomer and A2 represents the dimmer. From Fick's law, diffusional flux is given by

$$J_A = - D_{AB}\, \Delta C_A$$

Writing the above equation for the monomer and dimmer

$$J_{A1} = - D_{A1}\, \Delta\, C_{A1}$$

$$J_{A2} = - D_{A2}\, \Delta\, C_{A2}$$

D_{AB}, the diffusion coefficient of the solute may be affected by the diffusion of the monomer as well as the dimer. Hence we may write

$$D_{AB} = D_{A1}\, dx_{A1} / d_{xA} + D_{A2}\, dx_{A2} / dx_A \qquad \text{---- (39)}$$

Where x_{A1} is the mole fraction of monomer and x_{A2} is the mole fraction of dimmer. From equation (38) one may write the following on the basis of Law of Mass Action

$$K = X_{A2} / X_{A1}^2 \qquad \text{---- (40)}$$

$$X_{A2} = K\, X_{A1}^2$$

Since the initial solute concentration X_A may be written in terms of the monomer and dimmer concentration X_{A1} and X_{A2} we may write

$$X_A = X_{A1} + X_{A2} = X_{A1} + KX_{A1}^2 \qquad \text{-----(41)}$$

From equation

$D_{AB}\ d_{XA} = D_{A1}\ dX_{A1} + D_{A2}\ dX_{A2}$ ----- (42)

Substituting for XA from equation (39) and (40)

$D_{AB}\ d\ (X_{A1} + KX_{A1}^2) = D_{A1}\ dX_{A1} + D_{A2}\ d(KX_{A1}^2)$

$D_{AB}\ (d\ X_{A1} + 2\ KX_{A1}\ d\ X_{A1}) = D_{A1}\ dX_{A1} + 2\ KX_{A1}\ D_{A2}\ dX_{A1}$

$D_{AB}\ d\ X_{A1}\ (1 + 2\ KX_{A1}) = dX_{A1}\ (D_{A1} + 2\ KX_{A1}\ D_{A2})$

$D_{AB} = (D_{A1} + 2\ KX_{A1}\ D_{A2}) / (1 + 2\ KX_{A1})$ ---- (43)

Where D_{AB} = Actual diffusivity of solute

D_{A1} = Diffusivity of monomer solute (without association)

D_{A2} = Diffusivity of dimer solute (from association)

From equation (41) it follows that

$KX_{A1}^2 + X_{A1} - X_A = 0$

This is a quadratic equation in X_{A1} and solving

$X_{A1} = [-1 \pm \surd\ (1 + 4KX_A)] / 2K$

Since X_{A1} Cannot be negative, we have

$X_{A1} = [\surd\ (1 + 4KX_A) - 1] / 2K$ --- (44)

$2KX_{A1} = [\surd\ (1 + 4KX_A) - 1]$ --- (45)

substituting for X_{A1} by equation 44 we get

$D_{AB} = [DA1 + DA2\ [\surd\ (1 + 4KX_A) - 1]] / \surd\ (1 + 4KX_A)$ --- (46)

8.3 Evaluation of Model Parameter K from Experimental Data

From Equation 46 we get

$D_{AB} \surd\ (1 + 4KX_A) = DA1 + DA2\ [\surd\ (1 + 4KX_A) - 1]$

$D_{AB} \surd\ (1 + 4KX_A) = D_{A1} + D_{A2} \surd\ (1 + 4KX_A) - D_{A2}$

$D_{AB} \surd\ (1 + 4KX_A) - D_{A2} \surd\ (1 + 4KX_A) = D_{A1} - D_{A2}$

$(D_{AB} - D_{A2}) \surd\ (1 + 4KX_A) = D_{A1} - D_{A2}$

$\surd\ (1 + 4KX_A) = (D_{A1} - D_{A2}) / (D_{AB} - D_{A2})$

$(1 + 4KX_A) = [(D_{A1} - D_{A2}) / (D_{AB} - D_{A2})]^2$ --- (47)

From the above equation the value of K can be evaluated from a knowledge of the experimental diffusivity D_{AB} and the predicted values of D_{A1} and D_{A2}

By the following correlation based on Laddha – Smith Model for the monomer and modified Kuppuswamy – Laddha model for dimmer respectively.

$D_{A1} = 2 \times 10\ T(1/V_A)^{0.33}\ (V_B/V_A)^{0.16} / \eta_B$ --- (48)

And $D_{A2} = 2 \times 10\ T(1/2V_A)^{0.33}\ (V_B/2V_A)^{0.16} / \eta_B$ -- (49)

8.4 Application of the above model for the case of Acetic acid Diffusion

The Experimental diffusivity values were used for estimation of the constant K, of the model equation (47). The values of K obtained for the various concentrations of the Carbon tetra chloride solvent studied are shown in table 4. It is seen that the constant K does not vary widely over the concentration range studied and hence one could use the mean value of K for data analysis.

Table 4 : Model Parameter K System : Acetic Acid – Carbon Tetra Chloride

S.No	Concn %	Concn in mole fraction X_A	$D_{AB} \times 10^5$ cm^2/sec	K
1	0.3	0.00505	1.5275	329.4
2	0.5	0.00840	1.4945	298.4
3	0.8	0.01343	1.4722	256.7
4	1.0	0.01676	1.4516	287.4
5	2.0	0.03329	1.4149	307.5
6	5.0	0.08128	1.3889	265.7

Mean K = 290.85

Table 5 : Comparison of Predicted Values of Diffusion Coefficient by the Present Proposed Model System : Acetic Acid – Carbon Tetra Chloride

S.No	Concn %	$D_{ABexp} \times 10^5$ cm^2/sec	$D_{ABpred} \times 10^5$ cm^2/sec	% Error
1	0.3	1.5275	1.5381	- 0.69
2	0.5	1.4945	1.4964	- 0.13
3	0.8	1.4722	1.4642	0.55
4	1.0	1.4516	1.4509	0.05
5	2.0	1.4149	1.4172	-0.16
6	5.0	1.3889	1.3864	0.18

Table 6 : Properties of Chemical used

S.No	Chemicals	Density gm/cc	Viscosity at $30^{o}C$ Cp	Latent Heat of Vapourisation Kcal / gmole		Molecular volume cc / gmole	Molecular weight
1	Acetic Acid	1.049	1.065	5.813	6.663	68.4	60.05
2	Carbon Tetra Chloride	1.5925	0.8418	7.117	7.7169	101.2	153.84

The experimental diffusivities are compared with the diffusivities predicted by the present proposed model[46] using an average value of K obtained for each case of the solvent used. These are shown in Tables 5 which show good agreement with experimental values.

Hence it may be observed that the proposed model is amply adequate in taking into account the dimmer formation in Acetic acid solute.

However, further work is necessary before a satisfactory method is developed for analyzing the model parameter K for different solvent systems with a view to predicting the same for use with equation in the absence of any experimental data. It may be observed from the present results that the diaphragm cell could be satisfactorily used for determining diffusivity values involving concentration range as upto 5%

Conclusions

The Following conclusions are drawn based on the results of the present investigation involving the study of diffusivities of associating solute (Acetic Acid) in non associating solvent (Carbon Tetra Chloride)

1. A New model equation for predicting diffusivities at infinite dilution has been derived for the case of associating solutes diffusing as dimmer. This model equation satisfactorily explains the wide discrepancy in predicting the diffusivities of such associating solutes by the conventional correlations proposed in the literatures.
2. The model parameter K remains nearly constant for the range of concentrations (upto 5%) studied, and that a mean value of K could be used satisfactorily in the proposed model equation.
3. It is noted that the model parameter K varies with the solvent used for a given solute. This requires further study involving a wide range of solute solvent systems.
4. The results also indicates that the conventional diapharm cells could be used satisfactorily for experimental determination of liquid diffusivities up to a concentration of 5%.

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