# A STUDY OF SOME PHYSICAL PROPERTIES FOR $B_{12}$ IN AQUEOUS SOLUTION AT FOUR TEMPERATURES

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## Abstract

Solute- solvent interaction was investigated in this study using the vitamin $B_{12}$ as solutes in water as a solvent at four different temperatures.

The densities and viscosities of solutions of $B_{12}$ in water at 293.15, 298.15, 303.15 and 308.15 K have been measured. The study covered calculations partial molal volume from densities measurements; the applicability of Jones-Dole equation has been discussed in terms of concentration and temperature effects and then related to the results of partial molal volume.

## Introduction

The study of solutions is of great importance because most of the interesting and useful chemical and biological processes occur in liquid solutions. The stability of bimolecular and the rate of dependent on the type and concentration of ions present. It is important to have at least qualitative understanding of the behavior of ions in solutions. [1, 2].The effect of elevated amounts of vitamins as solutes in the body is of significant importance; certain diseases could develop as a result of decreasing the concentration of some vitamin. This fact leads us to study first the nature of interaction between the vitamin $B_{12}$ (the solute) and the aqueous body fluids (the solvent). The study of viscosity and density properties of vitamins of mean of investigating the change in the solute-solvent interaction using aqueous and aqueous and mixed solvent.[3-7]

## Experimental

### *(a) Materials:-*

Vitamins $B_{12}$ (Cobalamin) obtained from the general company for drug industries and medical appliance, in Samarra-Iraq.Vitamin aqueous solutions in the concentration range of study have been prepared in the normal way.

### *(b) Measurements:-*

Densities were determined using Anton paar digital dens meter (DMA 60/601) with thermostatted bath controlled to ±0.001K. The overall precision of measurements was estimated to be better than±$2x10^{-6}$gm/ml.Viscositieswere determined using a suspended level ubbelohde viscometer. The flow times were recorded electronically with an electronic timer of precision ±0.015 and the temperature of the bath was controlled better than ± 0.01 K. The instrument was calibrated with distilled water flow times were reproducible to 0.015.

## Results and Discussions

Density values of aqueous solutions of vitamin $B_{12}$ is given (Table 1)_as a function of molal concentration at four different temperature. Using the following equation

$$\bar{V} = \frac{1}{m}\left[\frac{1000 + mM}{d} - \frac{1000}{d_0}\right] \quad ..........(1)$$

Where (M) is the molecular weight of the solute,(m) is the molality of the solution and solvent respectively. The apparent molal volume values of vitamin $B_{12}$ has been calculated and presented in (Table 2). Fitting the data of table 2 into equation

$$\bar{V} = \bar{V}^0 + am \quad ............................(2)$$

by using the method of least squares produced the limiting partial molal volume at each temperature of study as shown in table 2 is presented in graphical forms and shown in figure 1 for vitamin $B_{12}$ .By contrast, the viscosity of aqueous solutions of electrolytes had been studied in details. Jones and Dole [8] have reported a semi empirical formulas to describe the concentration dependence of aqueous solutions of electrolytes at constant temperature are given in table 4.

$$\eta_r = \eta_1 / \eta^\circ = 1 + A\sqrt{c} + Bc \;\ldots\ldots\ldots(3)$$

Where $\eta^\circ$ is the absolute viscosity of pure solvent, A & B are empirical coefficients & c is the molar concentration of solution. The coefficient A is always positive while the B coefficient can either be positive or negative depending on the nature of interaction between the solvent molecules and solute ions. The importance of the B coefficient can be illustrated by re-writing equation (3) in the form:-

$$[(\eta_1/\eta^\circ)-1]/\sqrt{C} = A + B\sqrt{C} \ldots\ldots\ldots\ldots (4)$$

By plotting $(\eta_r - 1)/\sqrt{C}$ values versus the square root $\sqrt{C}$ molar concentration as shown in figure (2). The estimated (B) coefficient values could be obtained from the slopes of linear lines are shown in Table (5).The impotance of (B) coefficient reflects the effect of size and geometrical shape of the solute molecules in addition to the structural effect induced as a consequence of solutes-solvent interaction. These values may be viewed through high solute – solvent interaction exhibiting the effect of structure building of solvent molecules arrangement by the molecules of the solute.

**Table (1)**
**Density values of vitamin $B_{12}$ as a function of molar concentration at different temperature (293-308) K.**

| C/mol.L$^{-1}$ | ρ/(g.cm$^{-3}$) | | | |
|---|---|---|---|---|
| | 293.15K | 298.15K | 303.15K | 308.15K |
| Solvent $H_2O$ | 0.99823 | 0.99707 | 0.99568 | 0.99406 |
| 0.0001 | 1.00054 | 0.99717 | 0.99665 | 0.99484 |
| 0.0002 | 1.00069 | 0.99721 | 0.99673 | 0.99499 |
| 0.0003 | 1.00080 | 0.99787 | 0.99689 | 0.99504 |
| 0.0004 | 1.00086 | 0.99726 | 0.99691 | 0.99531 |
| 0.0005 | 1.00092 | 0.99795 | 0.99695 | 0.99554 |

**Table (2)**
**Apparent molal volume values of $B_{12}$ in water at different temperature (293-308) K.**

| C/mol.L$^{-1}$ | 293.15 | | 298.15 | | 303.15 | | 308.15 | |
|---|---|---|---|---|---|---|---|---|
| | m | $V_o$ | m | $V_o$ | m | $V_o$ | m | $V_o$ |
| 0.0001 | 0.000102 | $2x10^4$ | 0.000102 | 350 | 0.00012 | $-8.2x10^3$ | 0.000102 | $6.5x10^3$ |
| 0.0002 | 0.000198 | $12x10^3$ | 0.00022 | 640 | 0.000202 | $4.2x10^3$ | 0.000208 | $3.2\ x10^3$ |
| 0.0003 | 0.000299 | $8x10^3$ | 0.00033 | 710 | 0.000302 | $2.8x\ 10^3$ | 0.000303 | $2\ x10^3$ |
| 0.0004 | 0.000398 | $5.8x10^3$ | 0.00041 | -620 | 0.000401 | $2\ x10^3$ | 0.000401 | $2.2\ x10^3$ |
| 0.0005 | 0.00049 | $4.2x10^3$ | 0.00051 | -410 | 0.000501 | $1.2\ x10^3$ | 0.000501 | $2.8\ x10^3$ |

**Table (3)**
**Limiting molal volume values of $B_{12}$ in water at different temperature (293-308) K**

| | V° (ml/mol) – (Limiting molal volume) | | | |
|---|---|---|---|---|
| **Vitamin** | 293.15 | 298.15 | 303.15 | 308.15 |
| **$B_{12}$** | -223.37 | -98.4225 | -85.8427 | -64.4604 |

**Table(4)**
**Viscosities of $B_{12}$ solutions in water as a function of molar concentration at different temperatures (293-298) K.**

| Vitamin | 293.15 | 298.15 | 303.15 | 308.15 |
|---|---|---|---|---|
| **$B_{12}$** | **12.0716** | **17.6519** | **23.098** | **28.28** |

**Table (5)**
**B-coefficient values for Vitamin $B_{12}$ at different temperature (293-308) K**

| $C/mol.L^{-1}$ Solvent $H_2O$ | η/cp | | | |
|---|---|---|---|---|
| | **293.15** | **298.15** | **303.15** | **308.15** |
| | 1.002 | 0.8909 | 0.79875 | 0.7194 |
| 0.0001 | 1.56048 | 1.5038 | 1.46076 | 1.41064 |
| 0.0002 | 1.64363 | 1.61631 | 1.51708 | 1.48184 |
| 0.0003 | 1.71928 | 1.67142 | 1.61867 | 1.56394 |
| 0.0004 | 1.81439 | 1.74599 | 1.67850 | 1.62829 |
| 0.0005 | 1.91222 | 1.83820 | 1.75147 | 1.68700 |

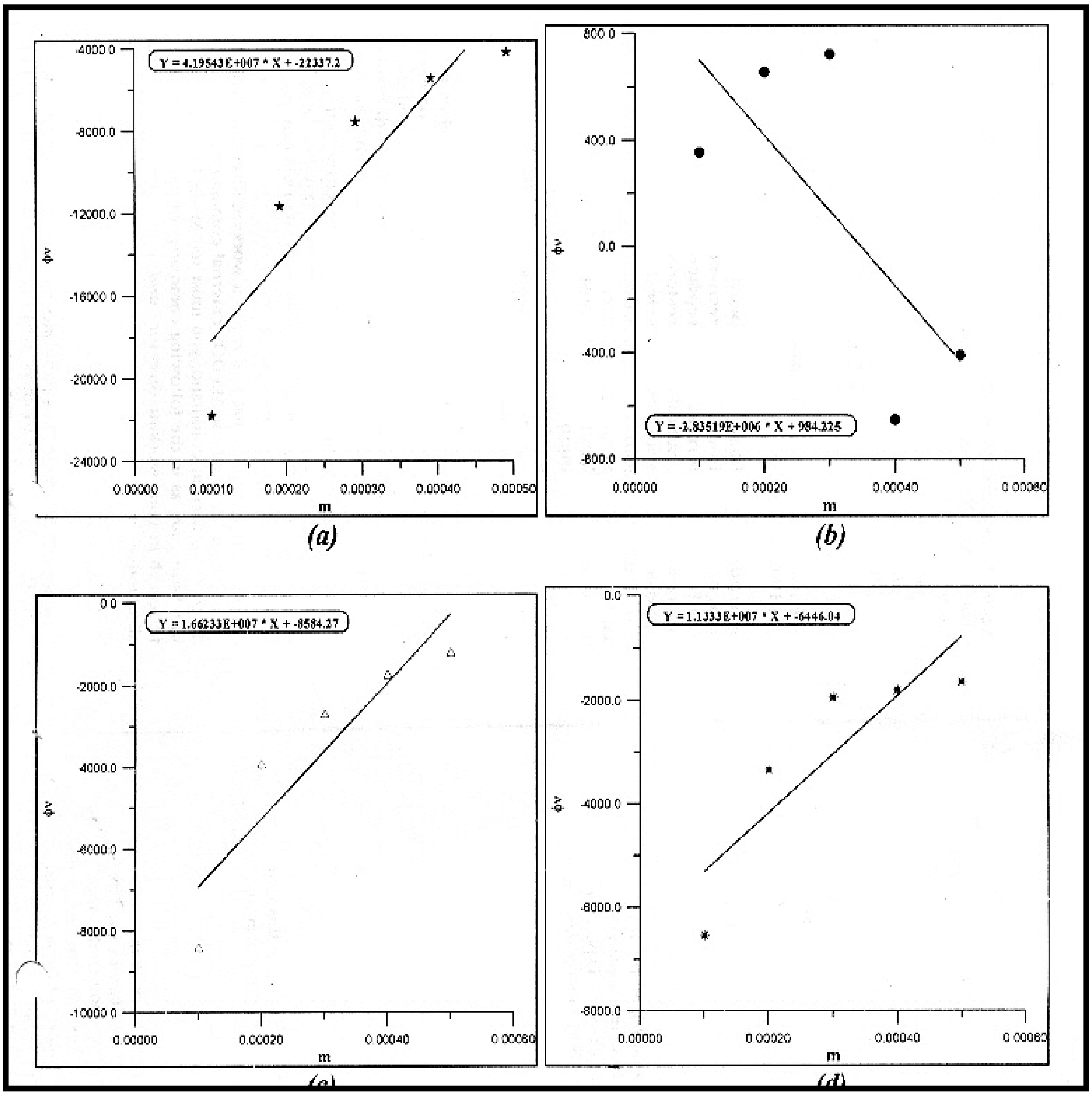


**Fig (1) apparent molal volume (Ø V°) for $B_{12}$ a (293.15) K, b (298.15) K, c (303.15) K, d (308.15) K**

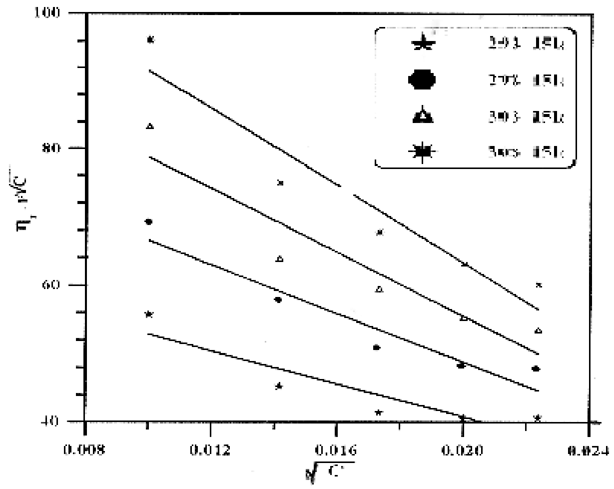


**Fig (2) (ηr -1)/ √C values versus √C for $B_{12}$ at different temperature (293-308) K**

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**الخلاصة**

تم دراسة تداخل المذاب–المذيب بأستعمال فيتامين$B_{12}$ كمذاب والماء كمذيب عند اربع درجات حرارية , تضمنت هذه الدراسة قياسات الكثافة واللزوجة للفيتامين $B_{12}$ في الماء بدرجات حرارية 293.15 , 298.15 , 303.15 , 308.15 . وشملت الدراسة الحسابات للحجم المولاري الجزئي .

وتم قياس اللزوجة للمحاليل المختارة و تطبيق معادلة جونز–دول و مناقشتها مع التراكيز و درجات الحرارة وعلاقتها مع الحجم المولالي,الجزئي.