IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 7, Issue 3 Ver. I (May. - Jun. 2015), PP 63-66
www.iosrjournals.org

Studies on Density, Viscosity, Partial Molar Volume, Excess Molar Volume, and Excess Viscosity of Panadol in Methanol + Water System At 309.15 K

*1Dikko A. B., 2Eyube E. S., 3Eke E.
1,2,3*Department of Physics, Modibbo Adama University of Technology, Yola, Nigeria*

Abstract: *Density and Viscosity of Panadol in various aqueous mixtures of m ethanol-water binary system have been determined at 309.15 K. The density and viscosity data have been analyzed for the evaluation of partial molar volume, molar excess volume, excess viscosity. It can be noticed from these studies that this drug acts as a structure-making compound due to hydrophobic hydration of drug molecules. The values of partial molar volume, Φv and excess molar volume, V^E show that as the concentration of Panadol increases the values of Φv decreases and increases with percentage of methanol. The excess molar volume over all concentration range of Panadol is found to be negative. The excess viscosity increases with increase in the molarity of Panadol and over the entire percentage range of methanol in the binary system.*

Keywords*: *Density, Viscosity, Excess mmolar volume, Excess viscosity, Partial molae volume Panadol, methanol+ water System.

I. Introduction

Panadol is one of GlaxoSmithKline's trade names for paracetamol (INN) which is an analgesic (pain reliever) and antipyretic (fever reducer). Panadol is a paracetamol based analgesic and provides fast, effective temporary relief of pain and discomfort associated with: headache, tension headache, period pain, cold and flu symptoms, migraine headache, muscular aches, arthritis/osteoarthritis, backache, and toothache. According to GlaxoSmithKline, Panadol is marketed in 85 countries, Panadol is sold in different formulations and packaging with different names, including. [1]

Panadol, Panadol Extra, Panadol Rapid, Panadol Night, Panadol Extra Strength (sold in Latin America-based countries), Panadol Multi-Symptom (sold in Latin America-based countries), Panadol Osteo, Panadol Extend Tablets, Panadol with Optizorb (sold in the Philippines), Panadol Rapid Handipak (sold in Australia), Panadol Cold and Catarrh (sold in Nigeria), Panadol Cold and Flu (sold in Greece, United Kingdom and some parts of Latin America), Panadol Fever and Congestion (sold in Ireland, Panadol ActiFast (sold in Malaysia)..[1]

Panadol Extra, an S2 pharmacy-only medicine in Australia, combines 65 mg of caffeine (65 mg) with 500 mg of paracetamol per tablet. Caffeine may improve the analgesic effect of paracetamol. Studies have reached conflicting conclusions regarding the clinical significance of this incremental pain relief. [2].

Panadol Osteo and Panadol Extend Tablets are modified-release formulations of paracetamol. Panadol Osteo is marketed in Australia and New Zealand; its immediate to sustained release ratio is 33% to 66%.[3]..

Panadol with Optizorb reduces the time for pain-relieving levels of paracetamol to reach the blood stream to five minutes, according to GlaxoSmithKline.[4].

Panadol Rapid Handipak is Panadol Rapid packaged in a slim, stylish, plastic container of ten 500 mg caplets, designed to appeal to Australian women who are 20–35 years of age.[5]

Panadol Cold and Catarrh contains three active ingredients: paracetamol, phenylephrine hydrochloride as a nasal decongestant, and chlorpheniramine maleate to prevent certain allergies.[1]

Panadol Cold and Flu and Panadol Fever and Congestion both combine paracetamol with phenylephrine hydrochloride as a nasal decongestant.[6].

The thermophysical properties of liquid systems like density and viscosity are strictly related to the molecular interactions taking place in the system. These interactions decides the drug actions i.e. drug reaching to the blood stream its extent of distribution, its binding to receptors and producing physiological actions. The interactions are of different types such as ionic or covalent, charge transfer, hydrogen bonding, ion-dipole and hydrophobic interactions. There are various papers appeared recently which use viscometric method to access thermodynamic parameters of biological molecule and interpreteted the solute-solvent interactions [7]. Therefore we decided to study the density and viscometric properties of panadol in mixed solvent system.

II. Materials And Method

Methanol + water was selected as the binary solvent for the study. Double distilled water is used for preparation of solution mixture.. Densities of liquids and various solutions were measured at 309.15K by using specific gravity bottle of 10 cm^3 capacity. A single pan electronic precision balance with a precision of 0.0001 gm was used for weighing purpose. The weighing was repeated thrice to ensure the accuracy in weights with a little interval of time [8].

Viscosity measurements were carried out using Ostwald's viscometer with precision ± 0.1 %. The viscometer was clamped vertically in a thermostatically controlled water-bath, whose temperature was maintained constant at 309.15 K . A fixed volume of the solution was delivered into the viscometer. The viscometer was kept for 20 minutes in the thermostatically controlled water-bath to achieve constant temperature. The experimental measurements of flow time of the solution between two points on the viscometer were performed at least three times for each solution and the average results were noted [8].

III. Results And Discussion

The densities and viscosities of methanol- water binary mixture from 20 % to 100 % range were measured and recorded in Tables 1 and 2 respectively and used for determination of partial molar volume.

Table 1 Density ρ (g cm^{-3}) of Panadol in binary system at 309.15 K.

v/v% (Met-OH)	0.02 M	0.04 M	0.06 M	0.08M	0.10 M
20	0.8849	0.8873	0.8913	0.8943	0.8971
40	0.8610	0.8637	0.8669	0.8689	0.8729
60	0.8346	0.8376	0.8405	0.8434	0.8467
80	0.7950	0.7981	0.8011	0.8041	0.8071
100	0.7031	0.7059	0.7093	0.7119	0.7153

From Table 1 the density of Panadol in the binary system increased with increase in molarity of Panadol and decreased with percentage increase of methanol.

Table 2 Viscosity η (m Pa. s) of Panadol in binary system at 309.15 K.

V/V% Met-OH)	0.02 M	0.04 M	0.06 M	0.08M	0.10 M
20	1.5675	1.5701	1.5804	1.5847	1.5945
40	2.1539	2.1578	2.1625	2.1751	2.1835
60	2.2976	2.3058	2.3278	2.3395	2.3574
80	1.8417	1.8564	1.8684	1.8794	1.9206
100	1.0175	1.0284	1.0353	0.9358	1.0631

From Table 2 the viscosity of Panadol in the binary system increased with increase in molar mass of Panadol and increased with percentage increase of methanol from 20 to 55 and thereafter decreased to 100.

The partial molar volume Φ_v were calculated from density results using equation 1and presented in Table 3.

$$\Phi = (1000/c)(d_0 d) + M/d \qquad (1)$$

Where do is the density of pure solvent & d is the density of solution, c is molar concentration, M is molar mass of drug [7].

The excess molar volumes V^E were calculated by using the relation in equation 2 and presented in Table 3.

$$V^E = \{(x_1M_1 + x_2M_2)/\rho\} - (x_1V_1 + x_2V_2) \qquad (2)$$

Where, ρ is the density of mixture, M_1, x_1, V_1 and M_2, x_2 & V_2 are the molecular weight, mole fraction and molar volumes of methanol & water respectively.[7]

Table 3 The partial molar volume**,** Φ_v in cm^3 mol^{-1} and excess molar volume, V^E in cm^3 mol^{-1} of Panadol in binary mixture at 309.15 K

v/v%(Met-OH)	0.02M		0.03M		0.06M		0.08M		0.10	
	Φ	V^E	Φ	V^E	Φ	V^E	Φ	V^E	Φ	V^E
20	140.2694	-0.7995	140.4512	-0.8579	139.5124	-0.9176	137.4842	-0.9783	136.6754	-1.0326
40	145.0002	-1.4711	143.1245	-1.5358	142.8563	-1.6174	141.1965	-1.6834	140.1238	-1.7542
60	147.9314	-2.4334	147.2674	-2.5219	146.4702	-2.6081	144.5134	-2.6944	143.2187	-2.7907
80	157.2858	-3.5045	154.3472	-3.6303	153.0834	-3.7483	152.1012	-3.8675	151.1134	-3.9871
100	175.8941	-2.1702	171.8452	-2.3637	170.2114	-2.5972	170.0011	-2.7674	168.6356	-3.0104

From Table 3, the values of Φv and V^E show that as the concentration of Panadol increases the values of Φv decreases and increases with percentage of methanol. The excess molar volume over all concentration range of Panadol is found to be negative. Comparing values of V^E of methanol-water, the values of drug is more in negative direction. It further increases in negative direction with increase in concentration of Panadol. The literature survey reveals that excess molar volume of binary system becomes more negative for methanol and other non-electrolyte.[7],[10], [11]

Viscosity is found to maximum at around 55% (V/V) in aqueous mixtures of alcohol. It seems that some kind of structural organization of water surrounding the hydrocarbon chain of alcohol is the most likely explanation of the observed dependence of viscosity on solvent composition.

The measured values of viscosities of liquid mixtures and those of pure components were used to calculate the excess viscosity η^E (table 4) in the liquid mixtures using the relation in equation 3.

$\eta^E = \eta mix – (x_1\eta_1 - x_2\eta_2)$ …………………………..3

Where, ηmix, η_1 & η_2 are the viscosities of liquid mixtures, component 1 & 2 respectively and x_1 & x_2 are the mole fractions of component 1 & 2 respectively.[7].

Table 4 Excess Viscosities (η^E) : - (mPas) Methanol-water + Panadol

v/v% Met-OH	0.02M	0.04 M	0.06 M	0.08 M	0.10M
20	0.8502	0.8527	0.8632	0.8674	0.8783
40	1.4119	1.4158	1.4204	1.4333	1.4598
60	1.5192	1.5276	1.5602	1.5613	1.5802
80	1.0045	1.0192	1.0311	1.0421	1.0812
100	0.0679	0.0787	0.0857	0.0974	0.1201

The excess viscosity of the system shows that these values are maximum in presence of additive where as minimum in absence of any additive. This shows that excess viscosity increases with addition of Panadol to m ethanol - water system. Excess viscosities are positive over the entire molarities of Panadol range and entire percentage of methanol at temperature of 309.15 K. The excess viscosity increases with increase in the molarity of Panadol and over the entire percentage range of methanol in the binary system. The viscosity behaviour of these mixtures is mainly due to changes in the liquid associated structures of alcohols, [9]

These mixtures show no negative values of excess viscosity, indicating that the interactions are highest in these mixtures. In other words, as the molecular size increases, the magnitude of the excess viscosity increases, that is, becomes more positive. Various molecules may mix and dissolve in each other if they have approximately the same type of polarity. In the case of water and alcohol, this is the situation. The hydrogen of the -OH group on alcohol is polar as it is in the water molecule. Also, in solvents such as alcohol, which can take part in hydrogen bond formation, the self-association of alcohols may be increased in favour of hydrogen - bonded forms between solute and solvent,[9] .

IV. Conclusion

The negative values of excess molar volume suggest specific interaction between mixing compound in mixture. It indicates intermolecular hydrogen bonding and also the interstitial accommodation of mixing components because of difference in molar volume. These mixtures show no negative values of excess viscosity, indicating that the interactions are highest in these mixtures. The viscosity behaviour of these mixtures is mainly due to changes in the liquid associated structures of alcohols.

References

[1]. Okonta, Chuks Udo; Agboola, Toba (25 December 2008). "GlaxoSmithKline unveils Panadol Cold & Catarrh". The Nation.

[2]. Derry CJ, Derry S, Moore RA; Derry; Moore (2012). "Caffeine as an analgesic adjuvant for acute pain in adults". Cochrane Database Syst Rev 3

[3]. Graudins, Andis; Pham, Hanh Ngoc; Salonikas, Chris; Naidoo, Daya; Chan, Betty (2009). "Early presentation following overdose of modified-release paracetamol (Panadol Osteo) with biphasic and prolonged paracetamol absorption". New Zealand Medical Journal 122 (1300): 64–71. ISSN 1175-8716.

[4]. Graudins, A.; Chiew, A.; Chan, B. (2010). "Overdose with modified-release paracetamol results in delayed and prolonged absorption of paracetamol" (PDF). Internal Medicine Journal 40 (1): 72–76..

[5]. Weiner, Carl P.; Buhimschi, Catalin (2009). Drugs for Pregnant and Lactating Women. Elsevier Health Sciences. p. 37. ISBN 1-4377-2136-2.

[6]. [6] Mathewson, Nicole (20 March 2014). "Flu remedies pose dosage risk". The Press (Fairfax Media Digital). Retrieved 25 March 2014.

[7]. Muktar Sheilkh, Mohd Shafiq, Mazahar Farooqui. Density And Viscosity Studies Of Paracetamol In Ethanol + Water System At 301.5 K Journal Of Advanced Scientific Research, 2011; 2(2): 21-26, Copyright ©2011 by ScienSage Publications ISSN: 0976-

9595

[8]. Dikko A. B. , Alkasim A.,Oriolowo N. Z. Design and Construction of a Simple and Reliable Temperature Control Viscometer and its Application for Measurement of Viscosities of Liquids and Liquid Mixtures, The International Journal Of Engineering And Science (IJES) || Volume || 4 || Issue || 3 || Pages || PP.57-65|| 2015 || ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

[9]. Dikko A. B., Ahmed A. D., Pascal T., Alkasim A, Variations Of Excess Viscosities Of Alcohol-Water And Alcohol-Alcohol Mixtures With Temperature, International Journal Of Scientific & Technology Research VOLUME 3, ISSUE 9, SEPTEMBER 2014 ISSN 2277-8616

[10]. Hossein A, Zarei, Densities, excess molar volumes and partial molar volumes of the binary mixtures of acetic acid + alkanol (C_1–C_4) at 298.15 K J of Mol Liquids, 2007; 130: 74-78.

[11]. Chaudhari Ankan, Jha Anupam & Roy Mahendra Nath. J Indian Chem Soc, 2003; 80: 632 Paliwal, Ankur (8 December 2011). "Govt prescribes placebos for drug price control, charge activists". Business Standard.