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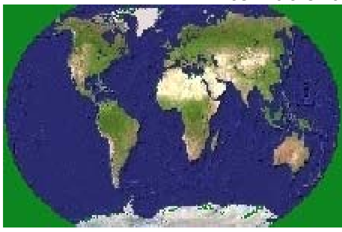

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Surface tension-viscosity relationship of powdered peak milk and distilled water solution at 309 K

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Abstract
Surface tension and viscosity coefficients of various solutions of powdered peak milk and distilled water were determined through a stalagmometric method and a simple constructed capillary viscometer respectively at 309 K. It was observed that the viscosity increased linearly with increase in milk concentration in water, while, the surface tension of the peak milk-water solution was not affected by any change in viscosity, in contrast to the expected result.

Keywords: Surface tension, viscosity, peak milk, distilled water, solution, mass concentration.

1. Introduction

Viscosity is a measurement of a frictional force (resistance) of a fluid. Fluids resist such an applied force (or another object's motion through the fluids) with each layer's motion with different velocities. Kinematic viscosity is a measure of a fluid's resistance under the influence of the force of gravity. Kinematic viscosity is usually measured by a capillary viscometer, in which by observing the fluid's velocity to reach the bottom of the long tube. Throughout many experiments, it was shown that the more viscous the fluid is the slower it travels; the less viscous the fluid is, the faster it travels, (Evelyn Kim, 2010). The equation that governs fluid flowing through a pipe or tube is known as Poiseuille's equation. It accounts for the fluids viscosity, although it really is valid only for streamline (non-turbulent) flow. Blood flowing through blood vessels in the human body isn't exactly streamline, but applying Poiseuille's equation in that situation is a reasonable first approximation, and leads to some interesting implications.

A law, derived by Isaac Newton, that describes the flow of almost all fluids of low relative molecular mass and also that of some solutions of macromolecules. A fluid moving between two parallel plates, in the x direction with a velocity v, is thought of as a number of infinitesimal layers, each of which slides along the adjacent one, the frictional resistance between adjacent layers generating an orthogonal velocity gradient, in the y direction. The frictional force, F, between the fluid layers is then proportional to the area, A, of the layers and to the velocity gradient between them, (Encyclopedia Britanica, 2014), such that

$$F = \mu A(\mathrm{d}v/\mathrm{d}y), \qquad (1)$$

where the constant μ is known as the coefficient of viscosity at the temperature of measurement; its reciprocal, $1/\mu$, is the fluidity.

Surface tension is a property of liquids such that their surfaces behave like a thin, elastic film. Surface tension is created by the inward pulling force exerted on the surface of a fluid. The surface tension can also be defined as the force F per unit length L tending to pull the surface back, (Wikipedia, 2013).

Surface tension is given by

$$\gamma = F/L, \qquad (2)$$

where F is the applied force and L is the unit lenght.

Equating (1) and (2), we get

$$\gamma = \mu A(dv/dy)/L \quad (3)$$

Looking at equation (3), by increasing the viscosity, it seems the surface tension will increase. The hypothesis is that if the viscosity of a fluid increased, then the surface tension would increase because the molecules are more tightly bonded. It is based on the idea that when the cohesion of the molecules in a fluid is higher, the viscosity of the substance will increase and will lead to the increase of surface tension because the water molecules on the surface show more cohesion. Hence the relationship between the two phenomena was investigated.

2. Materials and Method

Powdered peak milk and distilled water were the materials used in this study. For determination of milk mass concentration in water, different solutions containing different amounts of milk in a fixed volume of distilled water were prepared. The solution in each case was stirred very well to get a homogenous solution. The densities, the time of flow (t), of various solutions were determined and used calculate the viscosity coefficients (μ) and recorded in Tables (1) under average temperature of 309 K. The densities were determined by measuring the mass (m) of a given volume (v) of the solution and using the relation, $\rho = m/v$. Time t was measured by a digital stop-watch (sport timer) with accuracy of ±0.01 s. A capillary viscometer type, (Dikko, 2014), was used to study the viscosity of the solutions of powdered peak milk incrementally added to a fixed volume of water.

Drop volume method - stalagmometric method was used for the surface tension determination. For this purpose the several drops of the liquid leaked out of the glass capillary of the stalagmometer were weighed. The weight of each drop of the liquid was known, we can also count the number of drops which leaked out to determine the surface tension. The drops were formed slowly at the tip of the glass capillary placed in a vertical direction. The drop starts to fall down when its weight *W* is equal to the circumference (*2πr*) multiplied by the surface tension γ, (Sergey *et al*, 2002). Hence, we get

$$W = 2\pi r\gamma \quad (4)$$

Where: *W* is the drop weight, *r* is the capillary radius, and γ is the surface tension of the liquid. Corrections were made to the drop volume that may be left on the stalagmometer tip.

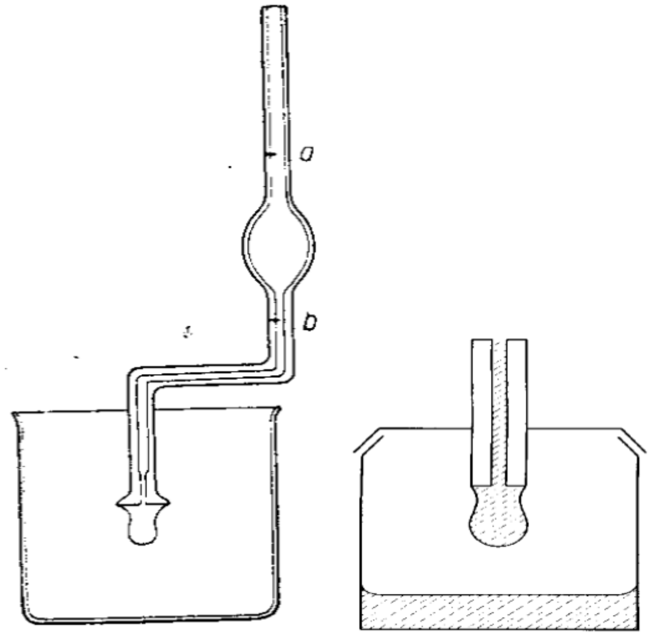

Fig 1: Stalagmometer and the stalagmometer tip

3. Results and Discussion

Three readings for the time of flow, t_s were recorded for Peak milk-water mixtures. For distilled water the average of three such readings was recorded to be t_w = 1544.12 ± 0.01 seconds. The temperature during the experiments was recorded at 309 K. To determine the viscosity coefficient of a given liquid mixture, we need the absolute value of μ_w of water at 309 K was found to be 7.22 millipoise from Hand book of Physical Constants, (Cutnell and Johnson, 1995). Using these values of μ_w, ρ_w, ρ_s and t_s/t_w, the viscosity coefficient μ_s of the Peak milk-water solutions were then calculated using the equation, (De and Dikko, 2012),

$$\mu_s = \frac{\mu_w \rho_s t_s}{\rho_w t_w} \quad (3)$$

and the values are given in Table (1).

Table 1. Variation of viscosity and surface tension with mass concentration of various amount of powdered peak milk added to a fixed amount of distilled water at 309 K.

Concentration of peak milk in solution Cg (g/cc)	Viscosity μ_s of the solution (10^{-4}Pa.sec) ±0.01	Surface tension γ (N/m)
1	7.46	0.0701
2	7.51	0.0701
3	7.57	0.0701
4	7.62	0.0701
5	7.67	0.0701
6	7.72	0.0701
7	7.78	0.0701
8	7.83	0.0701
9	7.87	0.0701
10	7.92	0.0701
11	7.98	0.0701
12	8.03	0.0701
13	8.08	0.0701
14	8.12	0.0701
15	8.18	0.0701

Density of Peak milk = 1.62 g/cc, t_w = 1544.12 sec, T = 309 K, μ_w = 7.22 (10^{-4}Pa.sec)

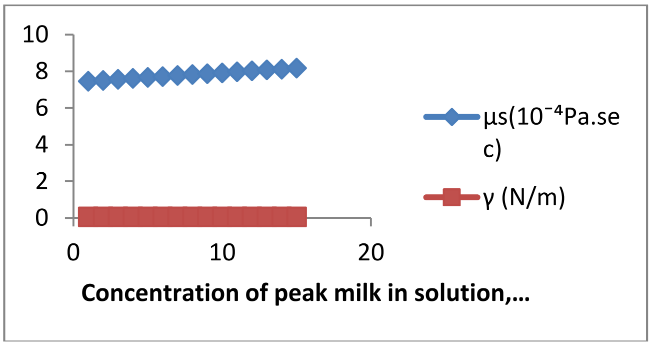

Fig 2. *Variation of viscosity and surface tension with mass concentration of peak milk in water*

For Peak milk-water solutions, (Table 1), the viscosity coefficients increase with increase in mass per volume concentration. As the concentration increases from 1 g/cc to 15 g/cc, (Fig 1), the viscosity coefficient Peak milk-water solution increases from 7.46 to 8.18 (10^{-4}Pa.sec). The relationship between the mass concentration of peak and viscosity of the solution as seen in Fig (1) is linear and can be expressed as $\mu_s = MC_g + K$. Using this equation we get the mass concentration, C_g as

$$Cg = \frac{\mu_s - K}{M} \qquad (4)$$

where T_{cal} is calibration temperature, 309 K, M is the slope and K is the intercept on the μ_s axis. M = 0.0514, K = 7.41, being determined from Fig 1. Hence, mass concentration of peak milk in water is given by

$$Cg = \frac{\mu_s - 7.41}{0.0514} \qquad (5)$$

From table (1) or Fig (2), the surface tension of the solution did not change with increase in mass concentration of peak milk in the solution. This reveals that increase in the viscosity of the peak milk-water solution did not alter the surface tension of the solution. Hence, the surface tension did not increase with increase in viscosity of the solution as expected by the hypothesis and the interpretation of equation (1). Therefore, the only option that equation (3) can hold, is that the factor (A(dv/dy)/L) in that equation changes reciprocally with changes in the viscosity of the solution.

4. Conclusion

Viscosity increases linearly with increase in mass concentration of peak milk in water. Unexpectedly, the increase of mass concentration of peak milk, that is, increase in viscosity of the peak milk-water solution does not affect its surface tension. Therefore, surface tension of a peak milk-water solution is virtually not related to its viscosity.

5. References

1. Cutnell JD, Johnson KW. PHYSICS 3^{RD} Edition, *John* Wiley & Sons, Inc., 1995, 367.
2. De DK, Dikko AB. An innovative technique of liquid purity analysis and its application to analysis of water concentration in alcohol-water mixtures and studies on change of activation energies of the mixtures, *Applied Physics Research,Canadian Center of Science and Education.* 2012; 4(4):98-114.
3. Dikko AB. Studies on the effects of miscible solute concentration and temperature on certain physical properties of liquids for applications in analysis of liquid mixtures, *Ph.D Thesis presented to the Department of Physics, Modibbo Adama University of Technology, Yola,* 2014, 21-22.
4. Britanica E, Absolute D, Viscosity K. Retrieved April14, 2014.
5. Kim E. Science One Program The University of British Columbia Vancouver, Canada, 2010.
6. Sergey V. Chichkanov, Victoriya E. Proskurina, Vitaly A. Myagchenkov. Estimation of Micelloformation Critical Concentration for Ionogenic and Non-Ionogenic Surfactants on the Data of modified Stalagmometric Method. *Butlerov Communications,* 2002, 3(9):33-35.
7. Wikipedia, the free encyclopedia, Mechanical definition of surface tension, Retrieved December 16, 2013.