International Journal of Applied Chemistry.
ISSN 0973-1792 Volume 20, Number 2 (2024) pp. 33-37

http://www.ripublication.com

The Interfacial Tension at the Liquids Junction of Nepalese Commercial Petrol and SDS Solution

Akash Deo* and Bikash Dev

Brainycube Research Organization, Maitidevi, Kathmandu, Nepal

Abstract

The interfacial tension between two different liquids namely water-Sodium Dodecyl Sulfate (SDS) solution and Nepalese commercial petrol were calculated at their interface using MansinghSurvismeter at room temperature. The concentration of petrol used was not changed whereas the concentrations of SDS solution were varied from 0 to 0.0083225833 mol/L. The experiment aims to study how the interfacial tension at the junction layer changes and also describesthe overall behaviour of liquids at junction point with varying concentration of SDS solution. The results showed that the interfacial tension at the junction point decreases with the increase in concentration of aqueous SDS. The interfacial tension plays an important role in many processes and phenomena where different phases touch one another.

Keywords: Sodium Dodecyl Sulfate; Interfacial Tension, Mansingh Survismeter, Critical Micelle Concentration (CMC)

Introduction

The behavior of the liquids at junction layer is a function of interfacial tension. And, interfacial tension is an important parameter to determine the consequences due to the presence of immiscible organic liquids like petroleum and oil that exists as separate entity in the aqueous environment due to their low solubility value [1].

Fortunately, there are various methods to measure values for interfacial tension such as Donahue and Bartell method [2], methods from Fu et al [3], and Ramey and Foroozabadi method [4]. But, instead of those, we chose Man Singh Survismeter and his formula to calculate interfacial tension for our research. The Survismeter is an easy, effective and efficient apparatus which requires very little amount of sample to give accurate result. This is a single apparatus with multiple functionality that offers to calculate surface tension, interfacial tension, viscosity and other various liquid`s behavioral parameters.

The interfacial tension is the function of temperature, pressure and the composition of each phase.With the change of medium that is just above the liquid, the surface tension of the whole system changes. For example, in case, if the medium above the liquid (say water) is air, then surface tension value will be higher than for vapour medium . And, if there is any oily liquid above the free surface of water, the surface tension value will gofurther down.

The interfacial tension affects the emulsifiability and the tendency for the phases to separate. It is an important parameter to test the quality of hydrophobic liquids such as transformer oil and petroleum because the ageing of these liquids usually depends upon the interfacial tension with water. Moreover, in case, there is decrease in interfacial tension by dissolved surfactant, the hydrophobic phase can be mobilized after flooding with water. Surfactants are generally used as detergents, wetting agents, emulsifiers, dispersants and foaming agents. Theoptimization of surfactants in aqueous solution is an important part of the formulation ofmany commercial cleaning products [5].

Materials and Methods

Triple distillate water was used to make SDS solution whereas double distillate water and chromic acid were used to wash the glass apparatus. The first distilled water was mixed with potassium permanganate and then a continuous two times steam distilled process was run to get pure triple distillate water. The chromic acid was prepared by mixing Potassium Dichromate and concentrated Sulphuric acid together. After washing, the glass apparatus was rinsed with pure acetone (company and purity) followed by drying in microwave oven.

SDSis an anionic surfactantwhich was purchased from Merck Specialties Private Limited, India. Before SDS was used, it was dried and recrystallized for many times for purification and to eliminate water content. The Nepalese petrol used, was purchased from government certified retailer whose concentration was not changed. In this experiment, interfacial tensions at the interface of SDS solutions with concentration ranging from 0 to 0.0083225833 mol/L and petrol were calculated using MansinghSurvismeter and his formula.

The interfacial tension was calculated using following formula;

$$\gamma_{IFT} = \left(\left(\frac{n_{HDL \quad in \quad air}}{n_{HDL \quad in \quad LDL}} \right) \left(\frac{\rho_{HDL} - \rho_{LDL}}{\rho_{HDL}} \right) \right) \gamma_{HDL}$$

Where,

γ_{IFT} = Interfacial tension

γ_{HDL} = Surface tension of HDL (High Density Liquid)

n_{HDL}= Number of drops of HDL (High Density Liquid)

n_{LDL}= Number of drops of LDL (Low Density Liquid)

ρ_{HDL} = Density of HDL (High Density Liquid)

ρ_{LDL} = Density of LDL (Low Density Liquid)

For this experiment, we use commercial petrol as LDL whereas pure water and SDS solution as HDL

Result and Discussion

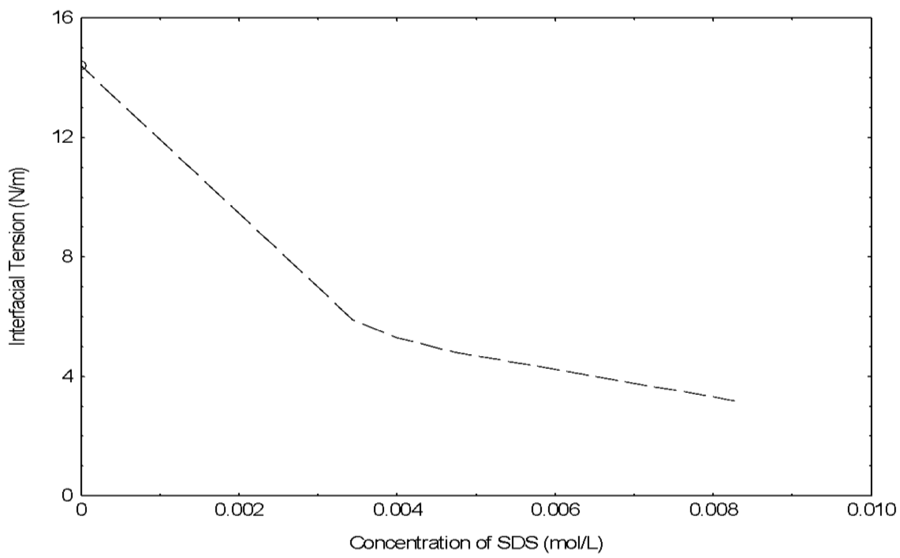

Figure 1: Concentration dependence of the interfacial tension at interface for Petrol-SDS solution medium at room temperature.

Table 1: The value for concentration of SDS in water and the interfacial tension from figure 1.

Readings	Concentrations (mol/L)	Interfacial Tension (N/m)
1	0	14.398
2	0.00344356	5.893
3	0.00398856	5.299
4	0.0047	4.829
5	0.0082	3.215
6	0.00832258	3.17092

The figure 1 shows that the interfacial tension is maximum at the lowest concentration level and minimum at the highest concentration level. In fact, we can see a break in the lower concentration range representing the value for CMC. The interfacial tension is dependent on the concentration of the SDS. All the experimental values of interfacial tension corresponding to the concentration of SDS are presented in table 1.

The graph between interfacial tension and concentration of SDS solution revealed that there is a sharp decrease of interfacial tension with the increasing value of concentration of SDS solution until it reaches to critical micelle concentration (CMC). Once the value reached to CMC, there is decrease in interfacial tension represented by a line with lower slope, on further increase of SDS concentration. The Critical Micelle Concentration (CMC) is an important property that describes the behavior of surfactant in liquids and is a function of temperature, pressure and concentration of surfactants or other surface active compounds. It is defined as the concentration of surfactants above which micelles form and all additional surfactants added to the system go to micelles [6].

In oil and petroleum industry, surfactants are introduced into the oil reservoir in order to improve Enhanced oil recovery (EOR) application.The surfactant will work at lowest interfacial tension

and therefore it is necessary to consider concentration of surfactant higher than CMC [8]. For SDS, the value of CMC at 298 K is $8x10^{-3}$mol/L [9].

Conclusion

The result is according to the trends. Whenever, a surfactant is introduced into the system, the surfactant decreases the surface tension of the system by decreasing the system's free energy. Meaning, surfactant either reduces the energy of the interface or restrict the hydrophobic parts of the surfactant molecule from the contact of water. With the addition of surfactant, there is increase in surface area coverage by surfactants, thereby decreasing the surface energy of the system. While, at the same time, surfactant starts to aggregate and finally transform into micelles when concentration reach to CMC and therefore again decreases the surface energy (surface tension) by lowering the chances that the hydrophobic parts of the surfactant molecule make contact with water [7].At CMC, any further addition of surfactant or any surface active compounds in the system will just increases the number of micelles and therefore the decrease is surface tension becomes steady and represented by line with lower slope.

References

[1] Avery H. Demond' and Angela S. Llndner. Estimation of Interfacial Tension between Organic Liquids and Water, *Environ. Sci. Technol.* 1993, *27,* 2318-2331.

[2] Donahue, D. J.; Bartell, F. E. *J. Phys. Chem.* 1952, 56,480.

[3] Fu, J.; Li, B.; Wang, Z.*Chem. Eng. Sci.* 1986, 41 (lo), 2673.

[4] Firoozabadi, A. and Ramey Jr., H.J. 1988. Surface Tension of Water-Hydrocarbon Systems at Reservoir Conditions. J Can Pet Technol 27 (May–June): 41–48.

[5] J.D. Hines, R.K. Thomas, P.R. Garrett, G.K. Rennie, J. Penfold, J. Phys. Chem. B., 101 (1997) 9215.

[6] A. D. McNaught and A.Wilkinson. IUPAC Compendium of Chemical Terminology, 2nd ed. (the "Gold Book"), Blackwell Scientific Publications, Oxford (1997)

[7] Hakiki, Farizal. A Critical Review of Microbial Enhanced Oil Recovery Using Artificial Sandstone Core: A Mathematical Mode. Paper IPA14-SE-119. Proceeding of The 38th IPA Conference and Exhibition, Jakarta, Indonesia, May 2014.

[8] Ana Domínguez, Aurora Fernández, Noemí González, Emilia Iglesias, and Luis Montenegro "Determination of Critical Micelle Concentration of Some Surfactants by Three Techniques", Journal of Chemical Education, Vol. 74 No. 10 October 1997, p. 1227-1231.

[9] Hakiki, F., Maharsi, D.A. and Marhaendrajana, T. (2016). Surfactant-Polymer Coreflood Simulation and Uncertainty Analysis Derived from Laboratory Study. Journal of Engineering and Technological Sciences. 47(6):706-724.