Research Journal of Chemical Sciences _____ E-ISSN 2231-606X
Vol. **6(7),** 25-28, July **(2016)** *Res. J. Chem. Sci.*

Study the Effect of PVSA on the CMC of Brij-56 using Dye Solubilization Method

Jadhav V.B.
Department of Chemistry, JET's ZulalBhilajirao Patil College, Deopur, Dhule - 424002 (MS) India
vbj1966@rediffmail.com

Available online at: www.isca.in, www.isca.me
Received 22nd March 2016, revised 11st June 2016, accepted 25th June 2016

Abstract

The micellization and solubilization phenomenon of non-ionic surfactants has been studied by various methods such as cloud point determination, surface tension measurement, dye solubilization etc. in presence and in absence of additives. The solubilization phenomenonfor non-ionic surfactant Brij-56 with the water insoluble orange OT dye has been discussed. The effect of additive polyelectrolyte PVSA on the critical micelle concentration (CMC) of non-ionic surfactant Brij-56 has been studied in aqueous medium by measuring the absorbance of the pure Brij-56 aqueous system as well as Brij-56 and PVSA mixed aqueous system with Orange-OT dye using dye solubilization method. The absorbance increases with increasing concentration of pure Brij-56 in aqueous medium with Orange-OTdye. The absorbance of Brij-56 and PVSAmixed aqueous systems with Orange-OTdye also show same trend. The results of the investigation verify that, the CMC of pure Brij-56 decreases with increasing concentration of additive PVSA in aqueous medium. Therefore the effect of additive PVSA on the CMC of Biij-56 support to made probable evidence that the dye solubilization is complex phenomenon of micelles aggregation of surfactant monomers so as to perform various surface activities.

Keywords: Critical Micelle Concentration (CMC), Brij-56 (Bj-56), Polyvinylsulphonic acid (PVSA), 1-o-tolyl azo- 2-naphthol (Orange-OT), Dye Solubilization, Absorbance (A), Dye Micellization, millimole (mM).

Introduction

The surfactant molecule composed of a polyoxyethylene chain having no electrical charges and such surfactant referred as non-ionic surfactant. The surfactant molecules can aggregate to form ordered agglomerates called as micelles, provided that their concentration is sufficiently high. At lower concentration of the surfactant molecules in water are unassociated (monomers) whereas in isotropic solution just above that concentration, unassociated surfactant molecules start to aggregate to form micelles. This concentration is known as critical micelle concentration (CMC), which is important property of the surfactants. Several researchers have reported various methods[1-3] to determine CMC's of surfactants in aqueous solutions. The solubilization method is used to determine CMC for non-ionic surfactants in aqueous medium[4] or also in non-aqueous medium[5]. In the past several years, critical micelle concentration of technical grade non-ionic surfactants has been determined by three different methods[6] such as turbidity, surface tension and iodine solubilization technique[7].

The colligative properties like clouding, surface tension and iodine solubilization measurements are also used to determine of CMC's of surfactants on the basis of sharp change in the above mentioned properties which accompanied with some disadvantages[8] in comparison with the dye solubilization method. The solubilizing power is unique fundamental performance property of surfactants. The CMC's of the numbersurfactantshave been determiningon the basis of solubilization of water insoluble dye in the micelles of surfactants to a different extent.

The main functions of Brij-56 are as Oil/Water co-emulsifier, Oil/Water emulsifier, wetting agent. The important applications of Brij-56 are in creams and lotions, conditioning, hair styling, hair treatment, colouring, facial make-up etc. It is used as a dispersant and affects the micelle formation due to its compatibility with anionic surfactant to form micelles[9]. The Brij-56 is used in the preparation of proton conducting tungsto-silicate mesoporous materials[10]. Brij-56 used to prepare thin films of bicontinuous cubic meso structured silicaas a structure-directing agent[11]. The additive polyelectrolyte PVSA contain negatively chargedsulphonate groups. Many researchers have showed the usefulness of incorporation of negatively charged sulphonate groups in aqueous solutions[12].

Since last few decades, the polymer and surfactant interactions in aqueous media found many industrial applications such as in the cosmetic products, personal-care, food, pharmaceutical preparations, detergents, and mineral processing[13-15].

This research work provides valuable data to study the effect of PVSA on CMC of pure Brij-56 by dye solubilization method. These studies has much more importance in the area of detergents, pharmaceutical preparations, agro based chemicals etc.

Materials and Methods

Materials: The Brij-56 (M.W. 682) is the product of E-Merck (Germany). The polyelectrolyte PVSA (M.W. 5000) is the products of Sigma-Aldrich, USA. Both these were used as received. The water insoluble dye Orange-OT (M.W. 262.3) prepared from o-toluidine and 2-naphthol by diazotization reaction. Further obtained product was purified by acetone solutionand with water, finally subjected to recrystallization with ethanolin order to obtain pure product.

In dye solubilization method, the structures of molecular speciesare represented in Figure-1.

For this investigation, all the required surfactants as well as additive solutions of different concentrations were prepared using double distilled water with specific conductance 2-4 μScm^{-1}.

Method - Dye Solubilization: In the present investigation,the CMC of pure Brij-56 aqueous system as well as Brij-56 and PVSA mixed aqueous system has been determined by dye solubilization method described as, the Orange-OT dye was shaken with pure Brij-56 aqueous solutions for 48 hours at room temperature with the help of mechanical stirrer. The un solubilized dye was remove by centrifugation and filtration. Then filtered solutionwas used to measure absorbance using the digital Spectrophotometer (Eqiptronicsmake Model number EQ-820)by setting wavelength 470nm at 303.15K. Similar procedure was used to obtain absorbance of Brij-56 and PVSA aqueous mixed system in presence of orange OT dye.

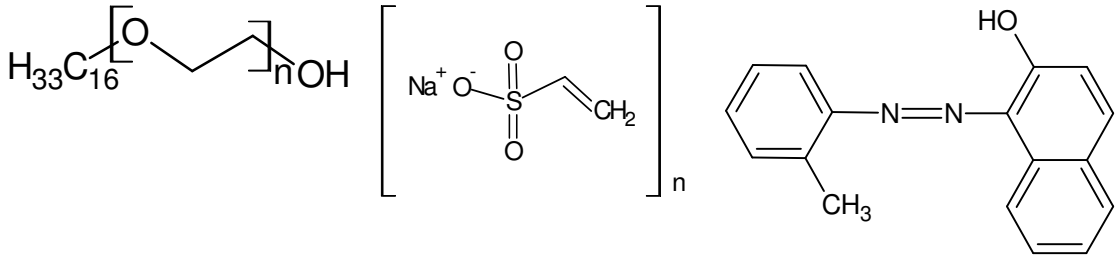
Results and Discussion

For pure non-ionic surfactant Brij-56 aqueous system inpresence of orange OT dye: The graph of absorbance values obtained at wavelength 470nm for varied concentrations of pure Brij-56 aqueous solutions Versus [Brij-56] in millimoleplotted to measure the extent of dye solubilized in the micelles of surfactant Brij-56. In general, as concentration ofsurfactant Brij-56 increases the absorbance increases depicted in Figure-2, which means that the extent of increase in the absorbance is small below the CMC whilethe extent of increasein absorbance is sharp above the CMC for pure Brij-56 aqueous solution. Thusincrease in absorbance occurs over a specific range of surfactant concentration was to a different extent. It is well known fact that, for non-ionic surfactant the micelle formation isless sharperthan for cationic and anionic surfactant. In the graph of absorbance Vs concentration (Figure-2), the curve shows flat portion at higherconcentration of Brij-56 surfactant because the orange- OT dye solubilize sufficient amount of Brij-56 surfactant forms micelles and as a result of thisprocess continuous-phase dyedepleting. The CMC of Brij-56 was obtained by extrapolating linear portion of steeper part of the curve with respect to the point where the absorbance of the orange OT dye in aqueous medium without addition of surfactant Brij-56. The observed CMC value for Brij-56 was 0.033mM which is close to reported value[16].

For non-ionic surfactant Brij-56 and polyelectrolyte PVSA aqueous mixed system inpresence of orange OT dye: The graph ofabsorbance values obtained at wavelength 470nm for varied concentrations of Brij-56 and PVSA aqueous mixed solutions Versus [Brij-56] in millimoleplotted to measure the extent of dye solubilized in the micelles of surfactant Brij-56 in presence of PVSA at specific concentration depicted in Figure 3, which means that the extent of increase in the absorbance is small below the CMC while the extent of increase in absorbance is sharpabove the CMC for surfactant Brij-56 and PVSA aqueous mixed systems.

The orange OT dye solubilized in the mixed aqueous system increases slowly up to the CMC, while after that orange OT dye forms micelles with the mixed aqueous system in the bulk indicates sudden and sharp increase in the absorbance.

The effect of PVSA on CMC of non-ionic surfactant Brij-56 at different concentration of PVSA has been formulated in the Table-1 and these measurements were made at wavelength 470nm and at 303.15K.



Structure of Brij-56 **Structure of PVSA** **Structure of Orange-OT dye**

Figure-1
Structures of molecular species

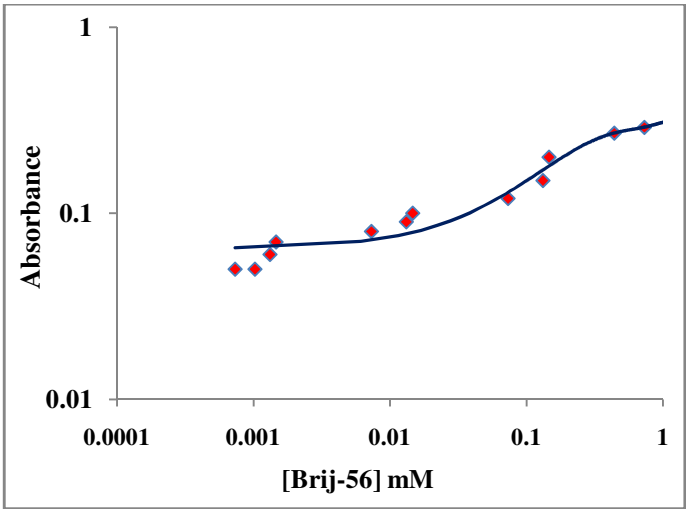


Figure-2
Absorbance Vs concentration of Brij-56 in mM

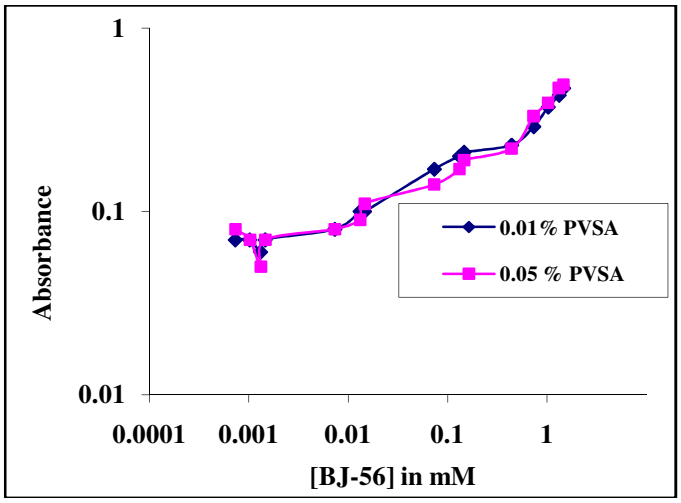


Figure-3
Effect of PVSA on Brij-56

Table-1
Effect of PVSA on CMC of non-ionic surfactant Brij-56 at different [PVSA] ;at wavelength470nm and at 303.15K

[PVSA] wt.% in Bj-56+PVSA Mixed aqueous system	CMC(mM) of Bj-56+PVSA Mixed aqueous system
0.01	0.0021
0.05	0.0018

The data represented in the Table-1 and CMC of pure Brij-56 in aqueous medium revealed that, as the concentration of additive PVSAincreasesthe CMC of surfactant Brij-56 was decreases, which evidenced that the solubilizing power of surfactant Brij-56 enhanced (affected) due to increasing concentration of additive PVSA. This is supported that, CMC of cationic and anionic or non-ionic surfactants get affected (decreased) by the addition of salts[17].

Conclusion

This investigation has a focus on solubilization of orange OTdyein non-ionic surfactant Brij-56 solutions. The interaction between dyes and surfactants is a subject of interest nowadays. The phenomenon of solubilization is important role in the area of detergency, dyeing process in textile industries, in pharmaceutical applications etc. The dye solubilization method is simple and easy methods for determination the CMC of non-ionic surfactant Brij-56 using Orange-OT dye on the basis of the factors Below the CMC of the surfactant little or no dye was solubilized in the micelles of surfactant. Forhigher concentrations of surfactant saturated with dye, only one dye molecule was solubilized per micellesurfactant.

The CMC of Brij-56 decreases due to addition of PVSA indicates enhancement of solubilizing power of surfactant Brij-56 due to addition of PVSA. This effect of additive polyelectrolyte PVSA on the absorbance and CMC of non-ionic surfactant Brij-56 support to made probable evidence that the dye solubilization is complex phenomenon of micelleaggregation of surfactant monomers so as to perform various surface activities such as emulsifier, thinner, thickener etc.

References

1. Shoji N., Ueno M. and Meguro K. (1976). Determination of critical micelle concentrations of some surfactants by keto-enoltautomerism of benzoylacetone. *Journal of The American OIL Chemist's Society*, 53, 165-167.
2. Dominguez A., Fernandez A., Gonzalez N., Iglesias E. and Montenegro L. (1997). Determination of Critical Micelle Concentration of Some Surfactants by Three Techniques. *Journal of Chemical Education*, 74 (10), 1227-1231.
3. Shinoda K. and Nakagawa T. (1963). Colloidal Surfactants: Some Physicochemical Properties. Academic Press, New York, 9-15. Library of Congress Catalog Card no.62-13114.
4. Goto R., Koizumi N., Hayama N. and Sugano T. (1953). Micelle Formation of Non-ionic Surfactants. (I) Properties of Aqueous Solution of Polyoxyethylene mono-alkyl Ether. *Bulletin of the Institute for Chemical Research, Kyoto University* , 31(4), 285-294.
5. McBain J.W., Merrill Jr. R.C. and Vinograd J.R. (1940). Solubilizing and detergent action in non-ionizing solvents. *J.Am. Chem. Soc.*, 62, 2880 -2881.
6. Becher P. (1967). Non-ionic Surfactants. M J Schick, Ed., Marcel Dekker, New York, N.Y.,478-482, , ISBN-0-8247-7530-9.

7. Ross S. and Olivier J.P. (1959). A New Method for the Determination of Critical Micelle Concentrations of Un-ionized Associations Colloids in Aqueous or in Non-aqueous Solution. *J. Phys. Chem.*, 63(10), 1671–1674.

8. Patil A.A. and Patil T.J. (2011). Measurement of Critical Micelle Concentration of Technical Grade Non-ionic Detergent in Presence of Chloramine-T using Dye Solubilization Technique. *Orient. J. of Chem.*, 27(2), 753-756.

9. Han Lu. Qianru, Chen. Wang, Yu. Chuanbo, Gao. and Shunai. Che. (2011). Synthesis of amino group functionalized monodispersedmesoporous silica nanospheres using anionic surfactant. *Microporous and Mesoporous Materials*, 139(1-3), 94-103.

10. Feng F., Coutinho D., Yang Z., Ferraris J.P. and Balkus Jr. Kenneth (2005). Synthesis of proton conducting tungstosilicatemesoporous materials and polymer composite membranes. *Microporous and Mesoporous Materials*, 81 (1-3), 217-234.

11. Hayward R.C., Peter Alberius C.A., Kramer E.J. and Chmelka B.F. (2004). Thin Films of Bicontinuous Cubic Mesostructured Silica Templated by a Nonionic Surfactant. *Langmuir*, 20(14), 5998-6004.

12. Pourjavadi A. and Ghasemzadeh H. (2007). Carrageenan-g-Poly (Acrylamide) / Poly (Vinylsulfonic Acid, Sodium Salt) as a Novel Semi-IPN Hydrogel: Synthesis, Characterization and Swelling Behavior. *Polym. Engg. and Sci.*, 47(9), 1388-1395.

13. Li J., Li H.Z., Yang H.Y., Zhu P.P. and He P.S. (2008). Effects of NH4Cl on the interaction between poly(ethylene oxide) and ionic surfactants in aqueous solution. *Chinese Journal of Polymer Science*, 26(1), 31-37.

14. Goddard, E. D. and Ananthapadmanabhan, Kavssery P. (1993). Interactions of surfactants with polymers and proteins. CRC, Boca Raton, FL. pp123, ISBN-9780849367847.

15. Saito S. (1989). Non-ionic surfactants- Physical chemistry. Edited by M.J. Schick, Marcel Decker Inc. New York, 881-890, ISBN-0-8247-7530-9.

16. Egan R.W. (1976). Hydrophile-Lipophile Balance and Critical Micelle Concentration as Key Factors Influencing Surfactant Disruption of Mitochondrial Membranes. *J. Biol. Chem.*, 251(14), 4442-4447.

17. Patel J., Varade D. and Bahadur P. (2004). Effect of tetraalkylammonium bromides on micellar behaviour of ionic and non-ionic surfactants. *Ind. J. of Chemistry*, 43(A), 715-721.