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Research Article

Miceller Behaviour of Non-Ionic Surfactant Tween-20 in Presence of Myo-Inositol at Different Temperatures by Surface Tension

Rajendra Chautmal[1]*, T. J. Patil[2], V. B. Jadhav[2], Premchand Patil[2] and Dhiraj Nikam[3]

[1]Department of Chemistry, GET's Arts, Commerce and Science College, Nagaon, (Tal. and Dist. Dhule)
[2]Department of Chemistry, JET's , Z. B. Patil College, Dhule
[3]Zenvision Pharma, MIDC TTC Industrial Area, Mahape Navi Mumbai

Abstract

In the present investigation micellar behaviour of surfactant-additive system in aqueous medium using additive Myo-Inositol and non-ionic surfactant Tween-20 has been studied in aqueous medium by measuring the surface tension at different temperatures. Studies on surface tension of Tween-20 in presence and in absence of Myo-Inositol at 298, 303, 308 and 312 K are reported. The values of critical micelle concentration (CMC), maximum surface excess concentration (Γ_{max}) and minimum area per molecule (A_{min}) were evaluated. It has been found that CMC values of additive-surfactant system are higher than that of pure surfactant system. Thermodynamic parameters of micellization and those of adsorption have been also evaluated. For the present study, the negative values of standard (ΔG^0_m), positive values of enthalpy (ΔH^0_m) as well as entropy (ΔS^0_m) were obtained which favours the process of micellization.

Keywords: Critical Micelle Concentration (CMC), Tween-20 (TW-20), maximum surface excess concentration (Γ_{max}), maximum area per molecule (A_{min}).

***Correspondence**
Author: Rajendra Chautmal
Email: rajendra.chautmal@rediffmail.com

Introduction

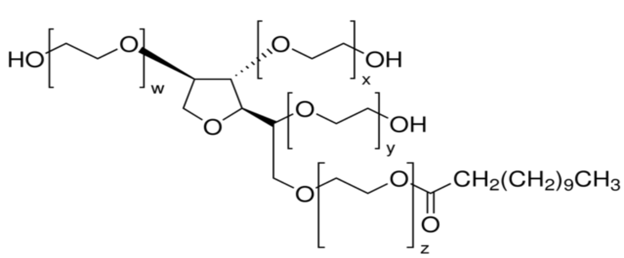
Non-ionic surfactant contains both hydrophobic group (hydrocarbon chain) and hydrophilic group (polar head) in the same surfactant molecule [1-3]. Non-ionic surfactant belonging to polyethylene oxide family, typically abbreviated as CiEj which is widely used as detergents, solubilizer, emulsifier and pharmaceutical preparations [4, 5] their practical importance has triggered a significant effort to gain the fundamental understanding of their micellization characteristics as well as their phase behaviour in both aqueous and non-aqueous medium [6].

Inositol has high reactivity which control many cellular processes in living organism [7] i.e. in animal and human metabolism. Myo- Inositol shows biological activity [8]. Myo-inositol is widely used for analytical as well as in pharmaceuticals, plant growing, food industry and variety of biotechnological processes. Myo-inositol is key function in maintaining normal brain function [9]. Myo-Inositol often referred as *Vitamin B*-8.

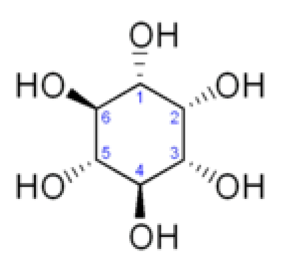
Therefore, studies on the interaction between non-ionic surfactant and Inositol in aqueous medium are valuable for interpreting the influence of surfactant on physiological behavior.

In the present investigation, the data of surface parameter such as surface excess concentration (Γ_{max}), minimum area per molecule (A_{min}) have been reported. Thermodynamic parameters for micellization as standard free energy (ΔG^0_m) and positive values of enthalpy (ΔH^0_m), entropy (ΔS^0_m) values for Tween-20 with and without additive Myo-Inositol at 298, 303, 308 and 312 K have been evaluated. The critical micelle concentration (CMC) values for pure Tween-20 and with additive Myo-Inositol are determined at above mentioned temperature.

Material and Method



Tween-20 (W+X+Y+Z=20) (M.W. 1227.54)



Myo-Inositol (M.W. 180.16)

For the preparation of all solutions of different concentrations doubly distilled water with specific conductance 2-4 µs cm^{-1} at 303K was used.

Surface tension of liquid can be determined with the help of modified stlagmometer by drop number method. The stlagmometer consisting of a pipette with capillary outflow tube, the end of which was flattened out and polished in order to give a large dropping surface. The necessary drop corrections were applied. It was calibrated using standard liquids such as toluene and double distilled water. Reproducibility of measured surface tension was within ± 0.2 mNm^{-1} of the literature values. The temperature control of thermostatic bath was within $\pm 0.1^0C$

Results and Discussion

The critical micelle concentration (CMC) values for pure Tween-20 and with additive Myo-Inositol are obtain from the break point of surface tension versus log C [surfactant] plot. The CMC values are found to be well agreement with published data [10, 11].

Table 1 CMC, surface excess concentration (Γ_{max}), minimum surface area per molecule (A_{min}) and Thermodynamics parameters of Pure Tween-20

Temp. (K)	CMC mM	Γ_{max} x 10^{10} ($molcm^{-2}$)	A_{min} x 10^2 (nm^2)	$-\Delta G^0_m$	ΔH^0_m	ΔS^0_m
298	0.0116	0.96	1.73	38.11	11.07	165.05
303	0.0100	0.93	1.78	39.12	11.45	166.91
308	0.0095	0.91	1.83	39.90	11.83	167.96
313	0.0091	0.89	1.87	40.66	12.22	168.94

The CMC values for pure Tween-20 decreased with increased temperature due to reduction in hydration of oxyethylene group which favours the process of micellization. This behaviour may be taken as typical characteristics of non-ionic surfactants [12]. It is well known fact that, the London dispersion forces are main attraction forces in the formation of micelle and the micelle formation is supposed to be result of hydrophobic interaction [13, 14].

The maximum surface excess concentration Γ_{max} describe adsorption tendency of surfactant molecule at air-liquid interface have been calculated as [15].

$$\Gamma_{max} = 1/nRT\ (d\gamma/dlnC)_T \qquad (1)$$

n is the number of particles per molecule of surfactant and n=1 for non-ionic surfactant, R is gas constant (0.008314 KJ $mo1^{-1}$) and ($d\gamma/dlnC$) is slope of surface tension (γ) versus log C plot at temperature T.

Γ_{max} value for Pure Tween-20 decreased with increase in temperature which may be due to the enhanced thermal agitation at higher temperature. The decrease in Γ_{max} value becomes more significant at higher concentration of additive due to stronger affinity of surfactant molecules with additive in comparison to water [16]. This leads to shifting of surfactant molecule from air-liquid interface to the bulk of the solution. Hence decrease in Γ_{max} value is observed.

Table 2 CMC, surface excess concentration (Γ_{max}), minimum surface area per molecule (A_{min}) for Tween-20 + Myo-Inositol mixed system

[Myo-Inositol] mM	CMC mM				Γ_{max} x 10^{10} ($molcm^{-2}$)				A_{min} x 10^2 (nm^2)			
	298K	303K	308K	313K	298K	303K	308K	313K	298K	303K	308K	313K
1	0.0120	0.0123	0.0126	0.0130	0.99	0.96	0.93	0.91	1.68	1.72	1.79	1.83
3	0.0125	0.0129	0.0133	0.0137	0.97	0.94	0.91	0.89	1.71	1.77	1.82	1.86
5	0.0128	0.0132	0.0135	0.0139	0.95	0.92	0.89	0.86	1.75	1.81	1.86	1.92
7	0.0132	0.0136	0.0140	0.0143	0.93	0.90	0.87	0.84	1.78	1.84	1.90	1.97

The minimum area per molecule (A_{min}) at liquid-air interface calculated using the equation as

$$A_{min} = 10^{14} / N\ \Gamma_{max} \qquad (2)$$

where N is Avogadro's number.

A_{min} increases both with the increase in temperature as well as concentration of Myo-Inositol. This behaviour can be explained in terms of the enhanced compatibility of surfactant with solvent in presence of additive thereby causing shift of surfactant molecule from air-liquid interface to the bulk phase.

The standard Gibb's free energy of micellization (ΔG^0_m) standard enthalpy of micellization (ΔH^0_m) and standard entropy of micellization (ΔS^0_m) for the present work is evaluated using equations [17, 18].

$$\Delta G^0_m = RT\ln X_{cmc} \quad (3)$$

$$\Delta H^0_m = - RT^2/(d\ln X_{cmc}/dT)_p \quad (4)$$

$$\Delta S^0_m = (\Delta H^0_m - \Delta G^0_m) / T \quad (5)$$

Where X_{cmc} is the CMC expressed in terms of mole fractions of surfactant at the CMC.

Table 3 CMC and Thermodynamics parameters of the micellization forTween-20 + Myo- Inositol mixed system

[Myo-Inositol] mM	CMC mM				$-\Delta G^0_m$ ($KJmol^{-1}$)				ΔH^0_m	ΔS^0_m
	298K	303K	308K	313K	298K	303K	308K	313K	($KJ\ mol^{-1}$)	($Jmol^{-1}K^{-1}$)
1	0.0120	0.0123	0.0126	0.0130	38.03	38.60	39.18	39.73	3.88	139.98
3	0.0125	0.0129	0.0133	0.0137	37.92	38.48	39.04	39.60	4.63	142.12
5	0.0128	0.0132	0.0135	0.0139	37.87	38.42	39.00	39.56	3.88	139.42
7	0.0132	0.0136	0.0140	0.0143	37.79	38.35	38.91	39.48	3.88	139.16

The ΔG^0_m values are found to be negative. In absence of additive, the free energy of micellization (ΔG^0_m) becomes more negative with increased temperature indicating spontaneous formation of micelles. The negative value of ΔG^0_m also increased with increase in temperature and also with additive concentration, even though CMC value increased with temperature. This indicates that change in magnitude of logarithm of CMC in terms is more than compensated by the change in value of the RT terms.

The standard entropy of micellization ΔS^0_m values are positive and it may be due to breaking of water structure when the surfactant hydrophobic chain transfers from bulk water to micellar core. The ΔS^0_m values are positive indicates that the process of micellization is favored by entropy gain [19]. Rosen et.al. [20] predicted that, steric factor is also responsible for the positive value of ΔH^0_m suggest that like entropy effect enthalpy change also favors the process of micellization.

The CMC obtained from plot of Surface tension Vs. [Non-ionic Surfactants] in mM for pure non-ionic surfactants TW-20 is represented in **Figure 1**.

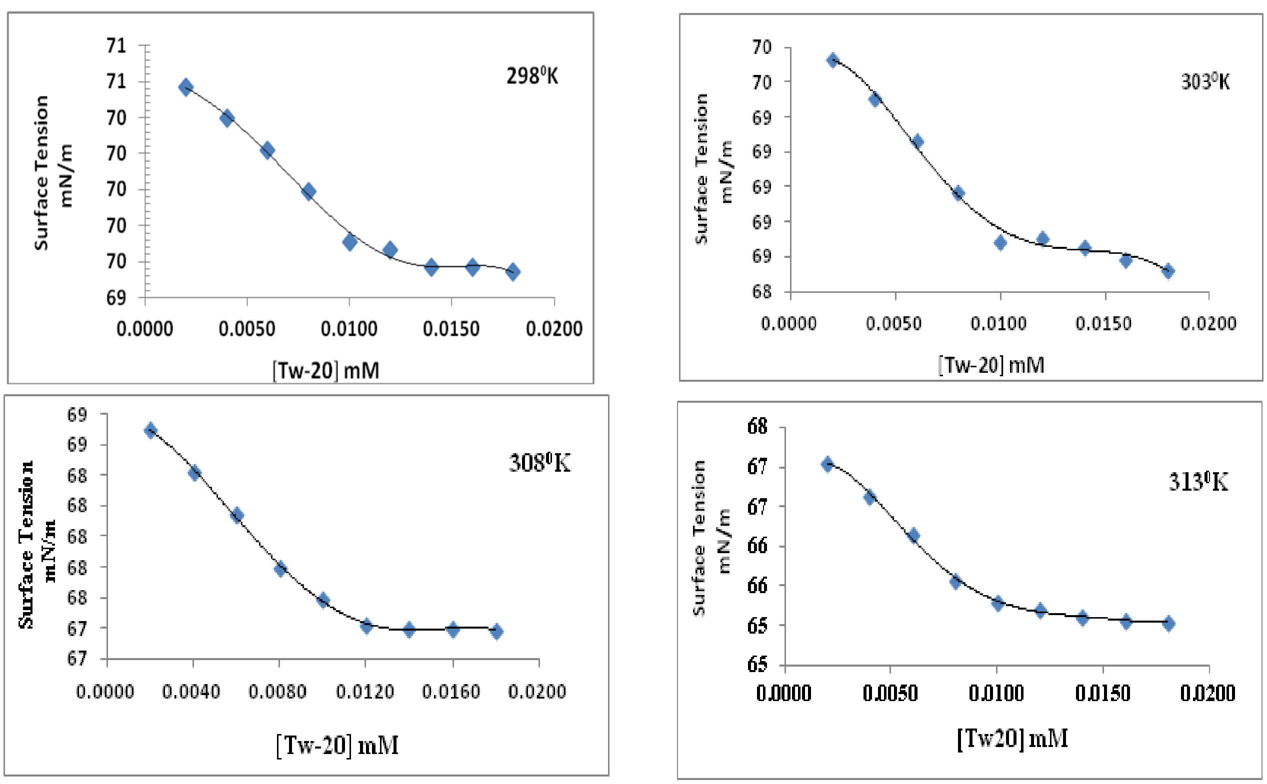


Figure 1 Graphical Representation of γ Vs C of Tween -20

The representative plot of Surface tension Vs. [Non-ionic Surfactants] in mM and 1 mM Myo-Inositol mixed system are depicted in **Figure 2**.

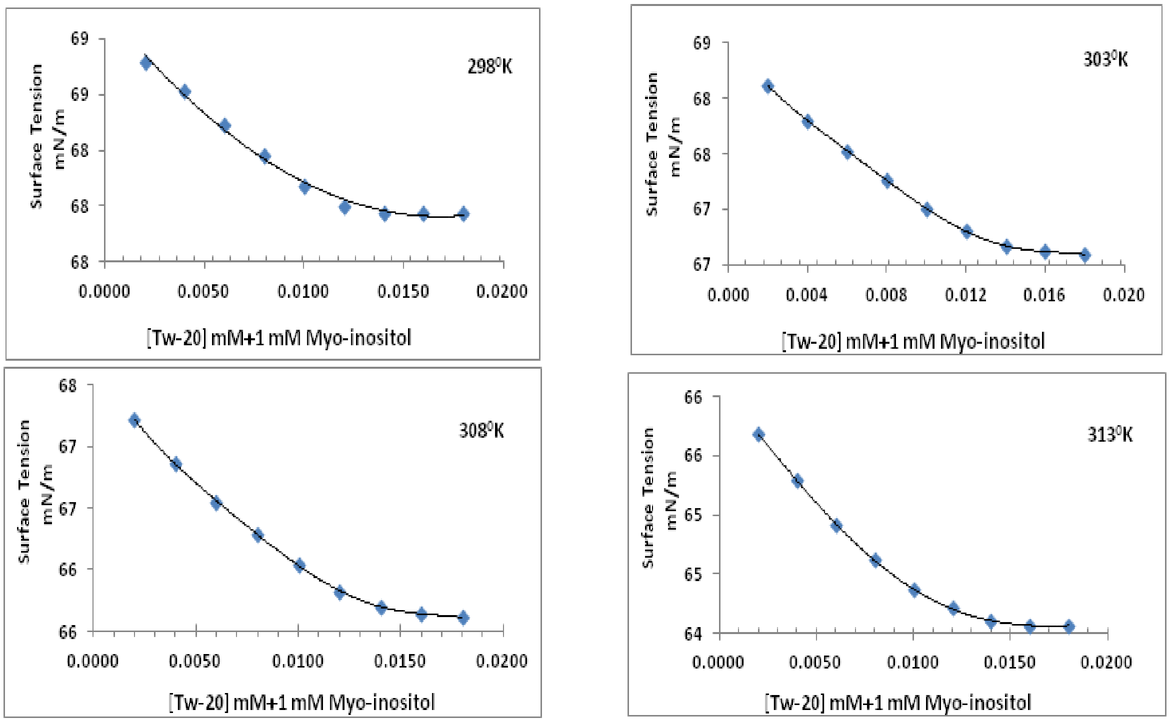


Figure 2 Graphical Representation of γ Vs C Tween- 20+1 mM myo-inositol

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