Effect of Temperature and Alcohol on the Determination of Critical Micelle Concentration of Non- Ionic Surfactants in Magnetic Water

*Aamer A. Al-Hatem**   *Marwa M. Ali*

Abstract:

The determination of critical micelle concentration of selected non-ionic surfactants (Tween 20,40 and 80) have been investigated using magnetic water(MW)as an aqueous medium.Conductometry technique is used to determine critical micelle concentration.The effect of alcohol addition and temperature variation at the range(293.15 -303.15K) are also pursued. It is concluded that the process of micellization is spontaneous and endothermic because of the observed free energy of micellization ($\Delta G^o m$) , enthalpy change of micellization ($\Delta H^o m$), and entropy change of micellization ($\Delta S^o m$) for the system was also studied.The properties of the non-ionic surfactants were studied, both in absence and presence of alcohol. The results obtained were explained in light of hydrophobic-hydrophilic interactions and chain length of alcohol.The temperature change has slight effect on the micellization process. .

Key words: Conductometry magnetic water, Non-ionic surfactant, Tweens (20,40 and 80).

Introduction:

Surfactants have a great importance in surface chemistry [1]. They are amphiphilic in nature having surface active molecules containing hydrophilic head which may be anionic, cationic, non-ionic, or zwitter ion and hydrophobic tail which may be linear or branched [2,3]. In aqueous solution, it tends to aggregate, self-associate and frequently assembled at interfaces to form what is called critical micelle concentration [4]. The concentration of surfactant molecules at the interface is called adsorption, while their assembly in the solution is called aggregation [5]. Both of these processes are monitored through the hydrophobicity of the tail group which belongs to the surfactant molecules. Solvent properties have been known to produce a noticeable change in the critical micelle concentration[6,7]. Many techniques such as, surface tension , conductivity, viscosity, fluorescence and ion-selective electrodes [8-13], have been used to estimate the critical micelle concentration of ionic and non-ionic surfactants using different organic or aqueous media.In this study, magnetic water (MW) is used, due to its multilateral usage in different fields[14] such as: industry [15], agriculture [16], irrigation [17], and medicine [18].

It has the ability of changing the physical properties of pure water [19] to give an aqueous solution having more acidity i.e. its new pH becomes 7.4-12% more than before which means causing more hydration and less aggregation leading to increasing the critical micelle concentration value. Also, it lowers the surface tension of the normal water by about 4.6-18% [20]. Tween 20,40 and 80 (polyoxyethylenesorbitan fatty acid esters) have been chosen to be the suitable non-ionic surfactants for this study.The interaction between (MW) molecules which is pure water exposed to a homogeneous magnetic field of 2000G over the region through which the water is allowed to stay in a calculated time , and the surfactants has been investigated via measuring the electrical conductance over a temperature range of 20 °C to 35 °C and were extensively studied in relative to its micellization using electrical conductivity[21]. Micellization is affected by various factors including surfactant species (hydrophobic volume chain length, head group area), temperature, pressure, ionic strength, pH..etc.

Temperature change affects the micellization of ionic and amphoteric surfactants due to the relative change in the interaction of the hydrophobic and hydrophilic groups in the surfactant. critical micelle concentration is a distinguishing characteristic property of surfactants as well as the Krafft temperature which is defined

Department of Chemistry, College of Education for Women, University of Mosul, Mosul, Iraq.
* Corresponding author: aaalhatem@gmail.com
* ORCID ID: 0000-0002-0900-7378

as the minimum temperature at which micellization occurs (22).The aim of this work is to find out some new properties of surfactants that is created under the influence of magnetic water and the study of the

effects of some alcohols on the micellization process of Tweens surfactant.

The chemical name, chemical formula and struxture of Tweens are listed in Table 1 and Fig.1 below

Table 1. Structures of Tweens series surfactants

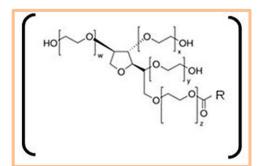| Surfactant	Chemical name	Chemical formula	n	Oxyethylene (OCH_2CH_2) w+x+y+z
Tween 20	Polyoxyethylene(20) Sorbitanmonolaurate	C_nH_{2n+2}	11	20
Tween 40	Polyoxyethylene(20)Sorbitanmonopalmitate	C_nH_{2n+1}	15	20
Tween 80	Polyoxyethylene(20)Sorbitanmonooleate	C_nH_{2n-1}	17	20

Figure 1. Structure of Tween series surfactants.

Materials and Methods:
Conductometic Apparatus:
The conductometric measurements are taken with a WTW inolab cond 7110(made in Germany) conductometer using a cell with a cell constant of $0.476 cm^{-1}$ with an accuracy measurement within $0.01 \mu S$.The surfactant conductance was measured after thorough mixing and temperature equilibration. The break point in the plot of specific conductivity ($\mu S.cm^{-1}$) versus the total surfactant concentration is taken as the (critical micelle concentration) value.

Chemicals:
Polyoxyethylene (20,40 and 80) Sorbitan monolaurate, Sorbitanmono palmitate, Sorbitanmono oleate respectively (Tweens is the commercial name) were supplied by Oxford LABORATORY REAGENT –INDIA and it is used as received from the source. Solutions of individual surfactants were prepared using doubly distilled and deionized water. All the solutions were measured under the thermostated conditions at 293.15, 298.15, 303.15 and 308.15 K with an accuracy of ($\pm 0.1℃$). Alcohol is used without any further purification.

Preparation of Solutions:
250 ml (0.1M) of Tween (20,40 and 80) were prepared as stock solution by dissolving 30.675,32.05,32.75 g/250ml respectively,by a minimum amount of distilled deionized water and then completed to the mark using volumetric flask.

A series of solutions of the desired concentrations of Tweens were prepared using a 25ml volumetric flasks.After maintaining the desired temperature by using the thermostating bath(the type HAKKE Nk22 was used to control the temperature of the solutions), conductometric measurements were carried out.

Distilled Deionized Magnetized Water
All conductance measurements were done using triple distilled deionized water with a conductance equal to (0.8-1.0 µS/cm). The water used was prepared using simple distillation method. A 1.5L of distilled water is placed in a round bottomed flask with1.0g of $KMnO_4$. The process was repeated three times .The obtained water was left for 24 hrs with a stack permanent magnets to acquire a magnetic field more than 2000G.

Determination of Critical Micelle Concentration:
Surfactants are considered as surface active molecules containing hydrophilic head and hydrophobic tail in aqueous solution. It tends to aggregate to form what is called critical micelle concentration (23).This process depends on several factors such as the interaction between hydrophilic and hydrophobic groups of the alkane chain(24). This noteworthy unique structural feature of micelle makes it capable for interactions with hydrophobic and hydrophilic molecules).When the surfactant dissolves in solution it takes some sort of modification to minimize its volume occupied throughout the whole solution, which in turn minimize the interaction between hydrophobic tails of the non-polar groups, hence it shows a large value of critical micelle concentration at low temperature(25). The repulsion electrostatic forces between the non-polar groups lead to minimize the formation of critical micelle concentration. Temperature increments cause plugging out of water molecules from the ethoxylic surfactant molecule due to the low hydrogen–bond energy(29 Kcal/mol.)which leads to a decrease in the affinity

of the non-polar groups for hydration. (26). The solvent plays an important role in the formation of critical micelle concentration, which in turn depends on the physical properties of the applied solvent. The dielectric constant of the solvent have a prominent role in the formation of critical micelle concentration (27,28)

Results and Discussion:
Surface Tension Measurements

The surface tension of the solvent plays an important role in determination of critical micelle concentration of the surfactant due to the interaction between the solvent and the surfactant molecules. The higher the surface tension, the higher interaction between water polar atoms and surfactant polar and non-polar groups.It facilitates the aggregation of surfactant species. Any change in surface tension up and down may cause an increase

or a decrease in aggregation process respectively. In case of magnetic water, it shows a decrease in the surface tension by about(4.62-18% of the normal water)(20). Unfortunately, the results obtained using surface tension technique were not satisfactory enough to be discussed on the basis of the published literature(21,29). It is preferred to refer to it in this simple discussion because the study of surface tension of magnetized water requires high precision and sensitive equipment to be effective under special conditions (21).Surfactants are amphiphilic molecules. They are present in a dynamic equilibrium in magnetized water and associate at a low concentration solution to form a spherical or ellipsoidal shaped micelles. Accordingly, the micelle which is composed of a number of surfactant molecules has a duality property (polar–non polar) that start to dictate the geometry and size of micellization(30)

Table 2. Experimentally obtained CMC (M) of Tween(20,40 and 80)in presence of different types of alcohl with their specific conductance.

Surfactant	Alcohol	CMC_1 mM	CMC_2 mM	$\mathcal{K}_1$ µS.cm^{-1}	$\mathcal{K}_2$ µS.cm^{-1}
Tween - 20	Methanol	0.0475	0.0485	94.6	162
	Ethanol	0.0475	—	107.4	—
	Propanol	0.0475	—	170.9	—
Tween - 40	Methanol	0.0460	0.0480	116	121
	Ethanol	0.0465	0.0490	130.1	135.4
	Propanol	0.0475	—	281.5	—
Tween - 80	Methanol	0.0460	0.0480	49.1	62.4
	Ethanol	0.0470	—	51.1	—
	Propanol	0.0475	—	56.4	—

Conductance Measurement:

The electrical Conductance of Tweens solution continuously increases with surfactant concentration and suddenly changes the slope versus surfactant concentration at critical micelle concentration inflection point. The changed slope (from steep to smooth,) for electrical conductance indicates that the solution losses ionic charges. However, electrical Conductance of the solution still increases with increasing surfactant concentration after critical micelle concentration (micelle formation), because the additional surfactants are considered to form micelles (1), the increased electrical Conductance suggests that micelles are charged particles (aggregated). For nonionic surfactants, the activities of two forms of surfactants (monomer and micelle) should be the same at and above the critical micelle concentration and their activities should be unity, since the micelle form is essentially the reference state. A study has been done using the electric conductance technique to find out the interaction behavior and association of different molecules of surfactant in

the system under study(31). Tables 3,4 and 5 indicates the values of critical micelle concentration for different Tweens in magnetized water solutions through a plot of concentration- Conductance diagram. The values of CMC are estimated from the break point of the linear relationship in the curve for each temperature. The table. shows a direct relationship between the conductance and concentration. It is obvious from the diagram that there are two regions with two linear segments. The above concentration line refers to the post-miceller region, while the other one is called pre-miceller region. The values of critical micelle concentration versus concentration are stated in Table 6. It shows a decrease in conductance for the sequence (Tween20 >Tween 40>Tween 80) at a given temperature, which is due to the increase in carbon atoms or hydrocarbon tail for surfactant molecule and the missing free ions responsible for Conductance.

Effect of Temperature

Many researches have been engaged in studying the effect of temperature changes on surfactant solutions (25, 32). Non-ionic surfactants, and polyoxyethylenesorbitan fatty acid esters (polysorbate) are chosen to investigate the effect of temperature change (293.15 – 308.15 K) on the critical micelle concentration determination using magnetic water,as shown in the results tabulated in Tables 3,4,5. To simulate the reality, temperatures similar to the living reality are chosen 20 to 35°C (293.15 – 308.15K). Mesophiles, which comprise most of the species commonly found in waste water treatment processes, grow within the range of 10 to 45°C (283.15- 318.15K), with an optimum of approximately 30 to 35°C (303.15– 308.15K) . As

the temperature changes in the waste water, one group of microorganisms will slow down until it dies. This diversity and adaptability in the number of microbes to the temperature of water continues at 35°C (308.15K). When the temperature is above 35°C, the combined capacity of many microorganisms decreases and optimum conditions are lost in the biological system(33).By increasing temperature up to $35^{\circ}C(303.15K)$ Tweens (20, 40 , 80) show a gradual decrease in values of critical micelle concentration. This may be due to i) Temperature elevation that may lower hydration of hydrophilic groups and favor micellization ii) Association and interaction of hydrophobic groups with each other which reduce critical micelle concentration values of Tweens (32,33)

Table 3. Specific Conductance.(μS.cm^{-1}) at. Concentration (Mol/L) at different temperatures for Tween- 20

Tween-20 Conc.(M)	T=293.15K Sp.Cond.(μS.cm^{-1})	T=298.15K Sp.Cond.(μS.cm^{-1})	T=303.15K Sp.Cond.(μS.cm^{-1})	T=308.15K Sp.Cond.(μS.cm^{-1})
0.09	307	340	378.2	421.1
0.08	266	315	360	401.3
0.07	237	271	340	384.4
0.06	219	244	315	350
0.05	191.5	223	273	316
0.04	164.7	196	245	293
0.03	130.3	167.8	224	275
0.02	89.4	132.8	195.6	245
0.01	47.5	91.2	167.2	195.6
0.008	39.4	71.1	133.2	168.1
0.006	30.3	55.9	91.1	132.3
0.004	21.4	37.4	68.1	101.1
0.002	12.1	21.6	40	65.3
0.001	9	11.9	30.6	40

Table 4. Specific Conductance.(μS.cm^{-1}) at. concentration(Mol./ L) at different temperatures for Tween- 40

Tween -40 Conc. (M)	T=293.15 K Sp.Cond. (μS.cm^{-1})	T=298.15 K Sp.Cond. (μS.cm^{-1})	T=303.15 K Sp.Cond. (μS.cm^{-1})	T=308.15 K Sp.Cond. (μS.cm^{-1})
0.09	159.5	169.9	180	189
0.08	154.4	169.1	178.1	187
0.07	149.5	163.3	172.3	182.1
0.06	143.8	157.4	165.1	175
0.05	138	150.7	158.5	169.1
0.04	125.6	141.7	150.5	160
0.03	118.4	132.7	142	150.6
0.02	100.7	115.7	128.9	140.6
0.01	80.3	100.8	112.1	127.2
0.008	59.5	88.1	104	120.1
0.006	51.8	58.5	85	101
0.004	42.7	51	56.4	81.7
0.002	32.5	42.6	49.2	54.3
0.001	11.4	32.3	41.2	47.8

Table 5. Specific Conductance.(μS.cm^{-1}) at. concentration(Mol./ L) at different temperatures For Tween- 80 .

Tween -80 Conc. (M)	T=293.15 K Sp.Cond. (μS.cm^{-1})	T=298.15 K Sp.Cond. (μS.cm^{-1})	T=303.15 K Sp.Cond. (μS.cm^{-1})	T=308.15 K Sp.Cond. (μS.cm^{-1})
0.09	100.5	135.6	140	146.8
0.08	90	120.5	128.3	132.8
0.07	85.3	108.3	115.5	121.1
0.06	78.5	97.4	105.1	98.4.5
0.05	71.3	80.6	93.1	95.2.2
0.04	60.4	73.2	83.5	93.1
0.03	54.1	66.3	73.9	85.4
0.02	45.4	56.2	65.2	78.1
0.01	28.8	42.2	53.6	60.2
0.008	26.1	32.6	41.1	55
0.006	20.2	26.3	33.3	42.5
0.004	13.2	18.1	26.4	30.5
0.002	9.1	13.7	14.9	16
0.001	2.2	4.3	5.5	6.1

Aggregation and critical micelle concentration values are dependent on the environmental conditions. Micellization, as well, is affected by various factors including surfactant nature (chain length, polar head group and hydrophobic volume), solvent, temperature, additives, pressure, ionic strength, pH,…etc (32).The results tabulated in Table 6 are compatible with the literature information (33)whereas the critical micelle concentration of each surfactant individually shows a slight increase in their values with respect to the corresponding temperature. In case of Tween 40, the critical micelle concentration shows very slight increase in values while it remains approximately constant in Tween 80 at temperatures used. The constancy in value may be attributed to two reasons Just as follows: first,the temperature increments causes plugging out of water molecules from the ethoxylic surfactant molecule due to the low hydrogen –bond energy(29 kcal/mol.)which leads to a decrease in the affinity of the non-polar groups for hydration (34), and the second reason, the small range of temperature used to minimize the effect of temperature on magnetic water to keep its ability for conversion, the increase in temperature favors the disorder of water phase .

Effect of Alcohol

Recently, the micellization of surfactants in the presence of different alcohols with different carbon atoms has been reviewed. (29,35).Surfactants that have low molecular weight tend to have true solutions with low concentration. The small molecules and ions are aggregated in groups to form micelles. The effect of the additives on the behavior of the surfactants has a great attention (36-39)and it has been widely studied due to the alcohol ability to bind to the micelles in the surface region which penetrates between the ionic groups belong to the surfactant molecules and decreases the surface area per head group which finally increases the ionization, and its presence causes a decrease in the dielectric constant at the micellar interface because of replacement of water by alcohol molecules in the interface region,(30).The shape of the alcohol molecule has a good chance to interact with the surfactant molecules and penetrates between the molecules of the agent, causing the surface tension of the surfactant to be reduced to as much as 70%, as well as lowering dielectric constant of the Tweens, as well as the interference of the low hindrance factor that allows these molecules to intervene in favor of the interest interaction between the surfactant and the alcohol molecules(26).The micellization depends on the composition of the surfactant and the alcohol concentration in the medium concerned also. The difference in composition and nature of the alcohol and surfactant determines the micelle composition which gives an explanation about the aggregation number.

Addition of Methanol

The mutual influence of non-ionic surfactant (Tweens 20,40,80)and methanol, ethanol and 1-propanol are considered on their behavior in the magnetic water. The consideration was based on the conductance measurements of the aqueous solutions of (Tweens) and alcohol mixture at 293.15K in the whole range of alcohol concentration and in the presence of the surfactant (Fig. 2). It is obvious from the Figure, that alcohols considerably affect the critical micelle concentration of (Tweens). The diagram shows the logical relationship between the Tween concentration and methanol (alcohol) as an additive. The graph shows that the addition of methanol to Tween-20 leads to an increase in the hydrophilic effect which increases the values of Conductance to values up to 170 ($\mu S.cm^{-1}$), while during the addition of methanol to Tween-80, the hydrophopic effect shows a predominant property which favors micellization process and leads to a decrease in the conductance of about70($\mu S.cm^{-1}$). In the case of Tween-40, the process seems to be balanced in both cases and we got a straight line.
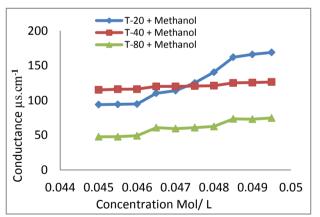

Figure 2. Effect of Methanol added to Tweens-surfactant(20,40,80) at 293.15K in magnetized water.

Addition of Ethanol

Khalil RA et al. has pointed out the growth of wormlike micelles formed through addition of different concentrations of ethanol to a mixture of ionic surfactants at temperature ranges (293.15-308.15K). The increase in growth of wormlike micelles is attributed to the (cross linking) of ethanol between the chains of wormlike micelles. The addition of low concentration of ethanol will increase the viscosity of the solution which

consequently promotes the process of micellization and micelle formation by gathering and overlapping the oppositely charged surfactant molecules through the effect of hydrophobic and electrostatic attraction, and by increasing the concentration of alcohol(8), the steric effect will act as a new factor of disrupting the electrostatic attractive forces between polar groups of the surfactant and alcohol molecules. The temperature has a great role in the process of micellization, increasing temperature leads to increase the kinetic energy of the surfactant molecules which causes a spread of the molecules out of the zone of aggregation.In the presence of different alcohol concentration, Fig. (2, 3 and 4), the curves show up and down values giving more than one critical micelle concentration which explain disfavoring micellization specially at high temperature. Disturbance in the curves may be attributed to the former reasons explained before, the interaction is in the sequence (Propanol > Ethanol > Methanol) i.e. increasing hydrophobicity of the molecules added.
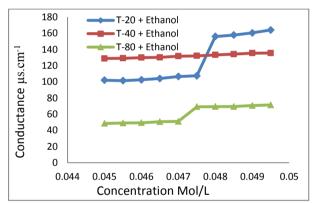

Figure 3. Effect of ethanol added to Tweens-surfactant(20,40,80) at 293.15K in magnetized water

Addition of Propanol:

Propanol is an alcohol with three carbon atoms. It tends to increase the hydrophobicity of the surfactant molecules which in turn decreases the critical micelle concentration value and enhances aggregation. It is suggested that propanol molecules tend to penetrate between the Tweens head groups which lead to a decrease the surface area of the micelles per head group leading to an increase in the ionization(30). Consequently, the conductance shows a large increase in value. In the case of Tween 40, it seems that the compound suffers ionization more than others and have high conductance value as shown in Fig.4. Moreover, the shape and modulation of the molecule plays a role

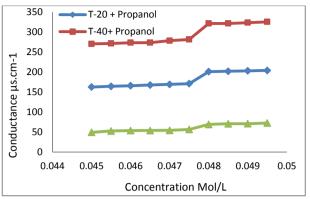in the process away from giving any role to the type of alcohol.

Figure 4. Effect of propanol added to Tweens-surfactant(20,40,80) at 293.15K in magnetized water.

Mechanistic Study

At low surfactant concentration the molecules adsorb at air water interface with the hydrophobic tail groups pointing away of the water surface, by increasing the surfactant concentration the molecules are tend to aggregate in a several dozens of simple molecules of surfactants to form a spherical collection of micelles named critical micelle concentration(CMC)with hydrophobic molecules toward the core of the sphere . Critical micelle concentration can be determined from the observed change in the plot of some physico-chemical properties as conductance of the solution, against the surfactant concentration. Increasing surfactant concentration leads to formation of more micelles which results in a decrease in the average distance between the micelles and increase the inter-micellar repulsion,hence the spherical micelles may transform into worm like micelles which cause the molecules to spread of out of the zone of aggregation (13), thereby increasing the conductance of the species up to a maximum value as indicated in Figures (2,3,4). The temperature, also has a great role in increasing the electrical conductance of surfactant species by increasing the kinetic energy of the surfactant molecules.

Thermodynamics of Micelle Formation:

Table 7,8,9 shows the values of free energy ΔG^{o}_{m}, enthalpy ΔH^{o}_{m} and entropy ΔS^{o}_{m} calculated, at temperature range 298.15-303.15 K.They are investigated by conductance techniques using the following relationships:
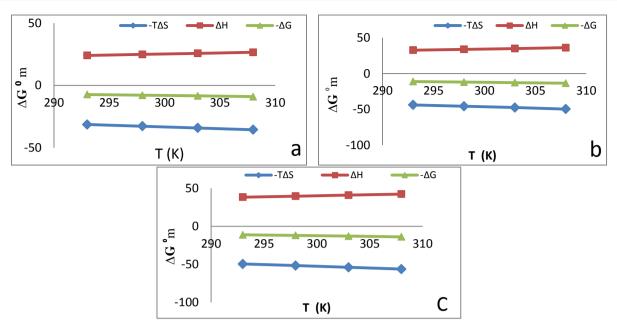
Figure 5. Thermodynamic parameters variation as a function of temperature for studied Tweens surfactant a)Tween 20 ,b) Tween 40 , c) Tween 80.

$\Delta G^{o}m = RT \ln C_{cmc} \ \ldots \ldots \ldots (1)$
$\Delta H^{o}m = -RT^{2} d\ln C_{cmc}/dT \ldots \ldots \ldots (2)$
$\Delta S^{o}m = (\Delta H_{m} - \Delta G_{m})/T \ \ldots \ldots \ldots \ldots (3)$

A plot of $\ln C_{cmc}$ against temperature gives a good straight line Fig. 6.
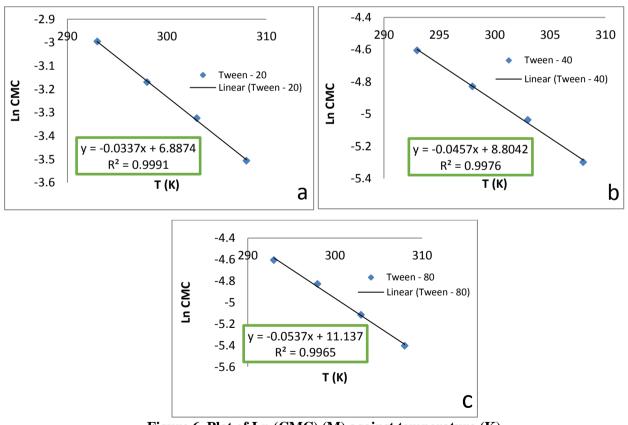

Figure 6. Plot of Ln (CMC) (M) against temperature (K).

As shown in Table 6., the system temperature shows a decrease in the values of critical micelle concentration by increasing the temperature. Due to decreasing in hydrophilicity of the surfactant, molecules may cause a decrease in critical micelle concentration with temperature, which corresponds to reported review of non-ionic surfactant (33). The increase in temperature facilitates the reduction in hydration of the hydrophilic oxyethylene group, which favors

micellization process .It is widely known in surface chemistry that increasing temperature lead to an increase in the breakdown of the hydrogen bonds of water molecules surrounding the hydrophobic groups which disfavors micellization process(40).

Table 6. Experimentally obtained CMC(M) against temperature in magnetized water

Temp.(K)	Tween-20		Tween-40		Tween-80	
	CMC(M)	Ln CMC	CMC(M)	Ln CMC	CMC(M)	Ln CMC
293.15	0.05	-2.9957	0.01	-4.6051	0.01	-4.6051
298.15	0.042	-3.1700	0.008	-4.8283	0.008	-4.8283
303.15	0.036	-3.3242	0.0065	-5.0359	0.006	-5.1159
308.15	0.03	-3.5065	0.005	-5.2983	0.0045	-5.4036

There are some aspects that govern the relation between surfactant molecules and alcohol in aqueous solution such as, hydrogen bonding, hydrophobic interaction and hydration which are reflected in the enthalpy and entropy contributions in the free enthalpy of solution (39). ΔG^{o}_m is the sum of the enthalpic (ΔH^{o}_m)and entropic ($-T\Delta S^{o}_m$) contributions.) contributions. By increasing the temperature the enthalpic contribution to the free energy increasing also and minimizing the entropic contribution (40).

Table 7. $\Delta G^{°}_m$ of Tween (20,40,80) as a function of temperature.

$\Delta G^{°}_m$ (KJ. Mol^{-1})				
Surfactant	T = 293.15K	T = 298.15K	T = 303.15K	T = 308.15K
Tween – 20	-7.2975	-7.8539	-8.3741	-8.9791
Tween – 40	-11.2180	-11.9624	-12.6861	-13.5674
Tween – 80	-11.2180	-11.9624	-12.8876	-13.8370

Table 8. $\Delta H^{°}_m$ of Tween (20,40,80) as a function of temperature .

$\Delta H^{°}_m$ (KJ. Mol^{-1})				
Surfactant	T = 293.15K	T = 298.15K	T = 303.15K	T = 308.15K
Tween – 20	24.0533	24.8812	25.7`232	26.5791
Tween – 40	32.6183	33.7410	34.8828	36.0435
Tween – 80	38.3282	39.6475	40.9892	42.3531

Table 9. $\Delta S^{°}_m$ of Tween (20,40,80) as a function of temperature.

ΔS^{o}_m(KJ.Mol^{-1}.K^{-1})				
Surfactant	T = 293.15k	T = 298.15k	T = 303.15k	T = 308.15k
Tween – 20	0.1069	0.1098	0.1125	0.1154
Tween – 40	0.1496	0.1533	0.1569	0.1610
Tween – 80	0.1690	0.1731	0.1778	0.1824

Conclusion:

It can be concluded here that the micellar behavior of nonionic surfactant, polyoxyethylene (Tweens 20, 40 and 80), sorbitanmonolaurate in magnetized water in the presence of methanol, ethanol and propanol at a range of temperature 293.15-308.15K. The process was investigated with the help of c technique. The critical micelle concentration and of the micelles were determined from the conductance measurements at different temperature ranges. It has been observed that the temperature change does not mean much to us, perhaps because of the use of the magnetized water, which has changed many of the general properties of the substances under study. The presence of hydrophilic head and hydrophobic tail in the surfactant interact with any species present in solution taking advantage of the interference and adsorption properties of the surface active substances, which in turn affects in one form or another on the critical micelle concentration for alcohols. A systematic change observed in case of methanol and ethanol, but this is not true in the case of propanol which shows an unusual attitude. Effect of alcohol series in general was dependent on the hydrophobic character, hydrocarbon chain

length, modification and shape of the alcohol molecule. The shape and modulation of the molecule play a role in the process away from giving any role to the type of alcohol. It seems that Tween 40 surfactant suffers ionization more than others and has high conductance value in presence if propanol.The study showed that there is a clear lack of practical results of surface tension where the study needs highly sensitive and more advanced equipments.

Conflicts of Interest: None.

References:

1. Azarmi R, Ashjaran A. Type and Application of Some Common Surfactants. J. Chem. Pharm. Res. 2015; 7(2):632-640.
2. Schramm LL, Stasiuk EN, Marangoni DG. Surfactants and their Applications. Annu. Rep.Prog.Chem. Sect. C: Phys. Chem. 2003;99: 3–48.
3. Rasoolian M, Takhsha R, Sarani O. Saravani Y. Evaluation of Magnetic Field on Water Hardness and Some Characteristics of Concrete. Intl. Res. J. Appl. Basic. Sci. 2014; 8(11): 1886-1890.
4. Tennoouga L,Mansri A, Medjahed K, Chetouani A,Varad I .The Micelle Formation of Cationic and Anionic Surfactants in Aqueous Medium: Determination of CMC and Thermodynamic Parameters at Different Temperatures. J.Mater. Environ.Sci. 28 Sept 2015;6(10): 2711-2716.
5. Khalil RA, Alsamarrai LH. The Role of Surfactants Head Group in The Formation of Self-Assembled Supramolecular Aggregate. Arab J. Phys. Chem. 2015;2(1):7-13
6. Mondal MH, Malik S, ROY A, Saha R, Saha B. Modernization of Surfactant Chemistry in The Age of Gemini and Bio- Surfactants: A Review. RSC Adv.15 Oct. 2015;5:92707–92718
7. Demissie H , Duraisamy H. Effect of Electrolyte on The Surface and Micellar Characteritics of Sodium Dodecyl Sulphate Surfactant Solution. J.Sci.Inno.Rese. 2016;5(6):208-214.
8. Schramm, L L. Surfactants: Fundamentals and Applications in Petroleum Industry. 2000; Cambridge University Press, Cambridge.
9. Li P, Du Z, Ma X, Wang G, Li G. Synthesis, Adsorption and Aggregation Properties of Trisiloxane Room-Temperature Ionic Liquids. J.Mol.Liq. 2014;192:38-43
10. Li P, Wang W, Du Z, Wang G, Li E, Li X. Adsorption and Aggregation Behavior of Surface Active Trisiloxane Room-Temperature Ionic liquids. Colloids Surf A Physicochem Eng Asp. 20 may 2014;450: 52-58.
11. Piñeiro L, Novo M,Al-Soufi W. Fluorescence emission of pyrene in surfactant solutions.Adv Colloid Interface Sci. Jan 2015;215:1-12.
12. Khalil RA, Alsamarrai LH., Study The Effect of Ethanol on The Formation of The Wormlike Micelle

For A Mixture of Ionic Surfactants. Asian J. Sci.Tech. Dec 2015;06, 12: 2117-2121
13. Fatma N, Panda M, Ansari W, Kabir-ud-Din, Environment-friendly ester bonded gemini surfactant: Mixed micellization of 14-E2-14 with ionic and nonionic conventional surfactants. J Mol Liq. 2015;211: 247-255
14. Saddam MA, Effect of Magnetic Water on Engineering Properties of Concrete. AREJ. Feb.2008; 17(1):71-82.
15. Reddy BSK, Ghorpade VG, Rao HS. Influence of Magnetic Water on Strength Properties of Concrete. Indian J Sci Technol.Jan 2014; 7(1): 14–18.
16. El Sayed H , El Sayed A. Impact of Magnetic Water Irrigation for Improve the Growth, Chemical Composition and Yield Production of Broad Bean (Vicia faba L.) plant. Am. J. Exp. Agr. Apr 2014;4(4): 476-496.
17. Hilal MH, El-Fakhrani YM, Mabrouk SS, Mohamed AI, Ebead BM. Effect of Magnetic Treated Irrigation Water on Salt Removal From a Sandy Soil and on The Availability of Certain Nutrients. Inter.J.Eng.Appl.Sci. Feb 2013; 2(2):36-44.
18. Mousa AM , Hmed AS.The Effect of Magnetic Water on Dissolving Kidney Stones. Eng. Tech. 2008; 26(5):579-586.
19. Pang XF , Shen GF. The Changes of Physical Properties of Water Arising From The Magneting Field and Its Mechanism. Mod Phys Lett B. Dec 2013;27(31):1350228.
20. Hasaan AS, Hadi ZL, Rasheed KA .Experimental Study of the Interaction of Magnetic Fields with Flowing Water . IJBAS. 2015;3(3):1-8.
21. Amiri MC, Dadkhah AA. On reduction in the surface tension of water due to magnetic treatment. Colloids Surf A Physicochem Eng Asp. 20 Apr 2006;278: 252–255
22. Bouchal R, Hamel A, Hesemann P, In M, Prelot B, Zajac J. Micellization Behavior of Long-Chain Substituted Alkylguanidinium Surfactants . Int. J. Mol. Sci. 6 February 2016; 17: 223-238
23. Ali A,Tasneem S, Bidhuri P, Bhushan V, Malik NA.Critical Micelle Concentration and Self aggregation of Hexadecyltrimethylammonium Bromide in Aqueous Glycine and Glycylglycine Solutions at Different Temperatures. Russ. J. Phys. Chem. A . 27 Oct 2012; 86(13): 1923–1929.
24. Khalil RA, Hammad FJ.Critical Intermolecular Forces:A New Physical Insight for the Formation of Wormlike Micelles. J. Chem. Soc. Pakistan. Apr 2014;36:211-214.
25. Khoshnood A, Lukanov B, Firoozabadi A.Temperature Effect on Micelle Formation: Molecular Thermodynamic Model Revisited. Langmuir. 8 Feb 2016; 32 (9):2175–2183
26. Gil PS, Lacks DJ. Effect of surfactant shape on solvophobicity and surface activity in alcohol-water systems. J. Chem. Phys. November 2016;145(20): 204705
27. Das S, Mondal S, Ghosh S. Physicochemical Studies on the Micellization of Cationic, Anionic, and Nonionic Surfactants in Water–Polar Organic Solvent

Mixture. J. Chem. Eng. Data. 8 Aug 2013; 58 (9):2586–2595.

28. Bhattarai A ,Shah SK, Yadav AK., Effect of Solvent Composition on the Critical Micelle Concentration of Cetylpyridinium Chloride in Ethanol-Water Mixed Solvent Media. NJST. 2012;13(1): 89-93

29. Smith GN, Brown P, Rogers SE, Eastoe J. Evidence for a Critical Micelle Concentration of Surfactants in Hydrocarbon Solvents.Langmuir. 15Feb2013; 29 (10):3252–3258.

30. Sidim T, Acar G. Alcohol Effect on Critica Micelle Concentration of Polysorbate 20 and CetylTrimethyl Ammonium Bromine Mixed Solutions. J. Surfact. Deterg. 5 *Jan* 2013;16(4):601-607

31. Muhammad MT, Khan MN. Study of electrolytic effect on the interaction between anionic surfactant and methylene blue using spectrophotometric and conductivity methods. J.Mol.Liq. 2017; 234 :309-314.

32. Rehman N, HidayatUllah AS, Jan A, Khan SW, Tariq M. Surface and thermodynamic study of micellization of non ionic surfactant/diblock copolymer system as revealed by surface tension and conductivity. JMES. 15 Jan 2017; 8 (4): 1161-1167

33. Mahmood ME, Al-koofee DAF. Effect of Temperature Changes on Critical Micelle Concentration for Tween Series Surfactant.*GJSFR* (B). 2013;13(4) :249-256

34. Chodzińska A, Zdziennicka A, Jańczuk B. Volumetric and Surface Properties of Short Chain Alcohols in Aqueous Solution–Air Systems at 293 K. J Solution Chem. Dec 2012; 41(12): 2226–2245

35. April NH, Phwey SG,Daniel JL,Surface Activity of Octanoic Acid in Ethanol-Water Solutions From Molecular Simulation and Experiment. J. Chem. Phys. 28 Feb 2015;142(8):084702.

36. Chauhan S,Kaur M,Kumar K,Chauhan MS.Study of the effect of electrolyte and temperature on the critical micelle concentration of dodecyltrimethylammonium bromide in aqueous medium. J. Chem. Thermodyn. November 2014; 78:175–181.

37. Salem JK, El-Nahhal IM, Najri BA, Hammad TM, Kodeh F. Effect of Anionic Surfactants on The Surface Plasmon Resonance Band of Silver Nanoparticles: Determination of Critical Micelle Concentration. J. Mol. Liq. November 2016; 223:771-774.

38. Chauhan S, Kaur M. Modulation of Aggregation Behaviour of Anionic Surfactant in the Presence of Aqueous Quaternary Ammonium Salts. J Surfactants Deterg. 22 March 2017;20(3):599-607

39. Chauhan S,Sharma K. Effect of Temperature and Additives on The Critical Micelle Concentration and Thermodynamics of Micelle Formation of Sodium Dodecyl Benzene Sulfonate and Dodecyltrimethylammonium Bromide in Aqueous Solution: A Conductometric Study. J. Chem. Thermodyn. April 2014; 71:205-211.

40. Chidi O, Adebayo IV. Determination of Critical Micelle Concentration and Thermodynamic Evaluations of Micellization of GMS. Mod Chem Appl. 10 April 2018; 6 (2):251-255.

تأثير درجة الحرارة والكحولات على تركيز المذيل الحرج للمواد النشطة سطحيا الغير ايونية في الماء الممغنط

عامر عبد الحميد الحاتم   مروة محمد علي

قسم الكيمياء، كلية التربية للبنات، جامعة الموصل، الموصل، العراق.

الخلاصة:

تم تقدير التركيز الماسيلي الحرج (CMC) لبعض المواد الفعالة سطحيا غير الايونية المنتخبة وهي (Tween 20,40 80) لقد تم متابعة التقدير باستخدام تقنية التوصيلية الكهربائية في الوسط المائي الممغنط. كما تم دراسة تأثير إضافة الكحولات بتغير درجة الحرارة في المدى (303.15K- 293.15). ومن خلال الثوابت الثرموداينمكية (ΔG°m ، ΔH°m) تبين ان عملية التجمع المايسيلي تلقائية وماصة للحرارة كما تم دراسة وتعيين قيم الانتروبي(ΔS°m)، وتم كذلك دراسة النظام الغير ايوني بوجود وغياب الكحولات. كما تم تفسير النتائج على ضوء التداخلات الهيدروفوبية والهيدروفيلية بين الجزيئات إضافة الى طول السلاسل الكحولية ،وقد بينت الدراسة فشل الدرجات الحرارية في اثبات أي تغير ملموس على تقدير التجمع المايسيلي.

الكلمات المفتاحية: ماء المواصلة الممغنط، المواد النشطة سطحيا الغير ايونية، سلاسل توينات.