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CHZ 224E SURFACE AND COLLOID CHEMISTRY

-SURFACE TENSION

-ZETA POTENTIAL

-CONTACT ANGLE

-ADSORPTION

-PAINT

-EMULSION

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1. INTRODUCTION

Surface tension is caused by the attraction between the liquid's molecules by various intermolecular forces. In the bulk of the liquid, each molecule is pulled equally in all directions by neighboring liquid molecules, resulting in a net force of zero. At the surface of the liquid, the molecules are pulled inwards by other molecules deeper inside the liquid and are not attracted as intensely by the molecules in the neighboring medium (be it vacuum, air or another liquid). Therefore, all of the molecules at the surface are subject to an inward force of molecular attraction which is balanced only by the liquid's resistance to compression, meaning there is no net inward force. However, there is a driving force to diminish the surface area, and in this respect a liquid surface resembles a stretched elastic membrane. Thus the liquid squeezes itself together until it has the locally lowest surface area possible. Three parameters that are affecting the surface tension are temperature, liquid type and impurity.

The mathematical model of surface tension is that the force per unit length.

Surface tension : F/L (N/m or dyne/cm)

2. MATERIALS AND METHOD

Du Noüy Ring method is the traditional one used to measure surface or interfacial tension. Wetting properties of the surface or interface have little influence on this measuring technique. Maximum pull exerted on the ring by the surface is measured. Surface or interfacial tension can be also determined by the profile of a drop of a liquid, which is suspended in another liquid or air, at mechanical equilibrium using an optical instrument. This profile is determined by the balance between gravity and surface forces.

In this experiment, the surface tension of solutions will be carried out by Krüss Ring Tensiometer for distilled water and sodium dodecyl sulfate (SDS) solutions at 10^{-3} and 10^{-4} M concentrations by platinum ring.

3. EXPERIMENTAL PROCEDURE

1. Before surface tension measurements, quickly dip the platinum ring into nitric acid followed by fast rinsing. Dip it into acetone, rinse it several times and flame the ring.
2. Take extreme caution that the solution is free of any contamination. Try surface tension measurement until the theoretical value of 72.75 mN/m at 20 °C is achieved.

3. Follow the same procedure for 10^{-3} M and 10^{-4} M of Sodium Dodecyl Sulfate (SDS) solutions and measure the surface tension of the solution.

4. REPORT

1. Explain step by step how you performed the experiment
2. Compare your results on “Du Noüy Ring” with those available in literature.
3. Why is it that you get differences in surface tension values of pure water and that with SDS.
4. Write about the importance of surface tension in mineral processing.
5. Explain why surface tension changes with temperature from the point of the interactions between molecules.

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1. GENERAL INFORMATION

Zeta potential is a term that refers to electrokinetic potential in colloidal dispersion. Zeta potential is defined as the difference in the potential between stern layer and neutral region of solution.

Nerst potential is the potential of the solid surface itself owing to the potential determining ions. Zeta potential is more important than nerst potential because the electrical double layer also moves when the particle is under motion.

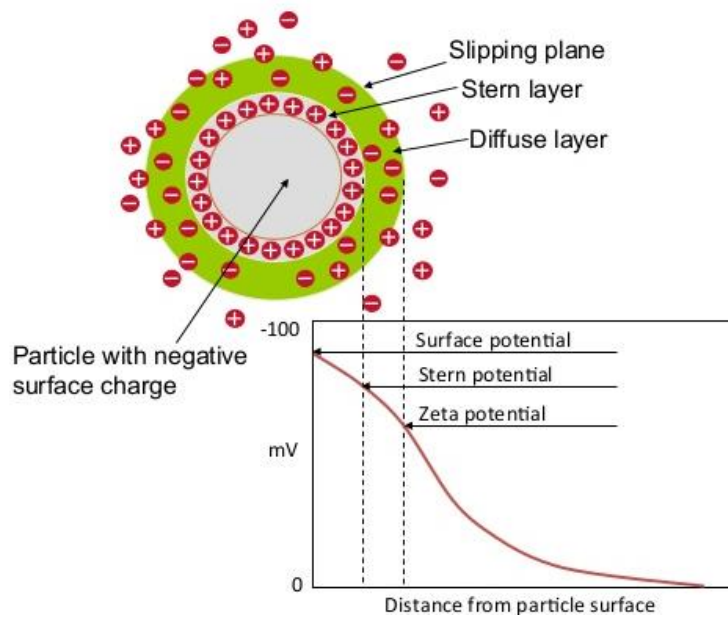


Figure 1. Schematic view of potentials of particle

Parameters affecting Zeta Potential

- In aqueous media, the pH of the sample is the most important parameter that affect zeta potential of sample. According to pH changes, zeta potential value can vary from positive to negative (low pH to high pH). There is a point that zeta potential become zero called as isoelectric point of material

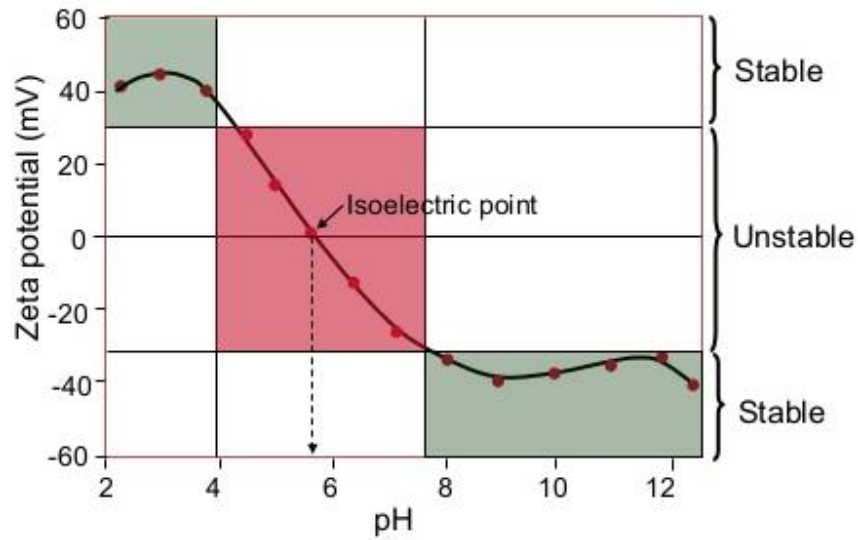


Figure 2. Effect of pH on zeta potential

In Figure 3, there is an visual about zeta meter and particle movement in the solution according to charge.

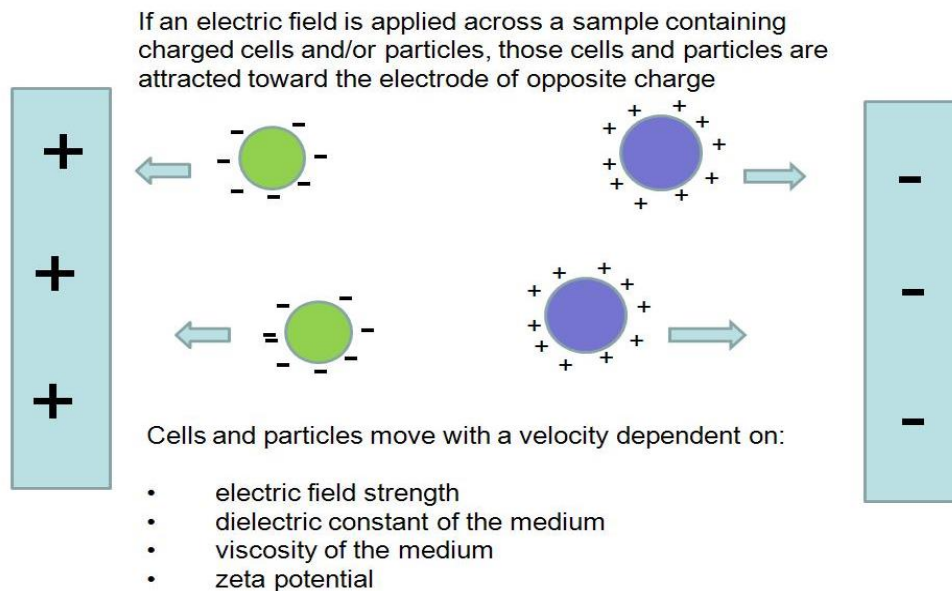


Figure 3. Schematic view of zeta meter and particles.

2. EXPERIMENT

2.1. The aim of the experiment

The aim of this experiment is to learn measurement of zeta potential and interpret the parameters effect on zeta potential.

2.2. Material & equipment

Material: min zeta meter, baker, magnetic stirrer, pipet

Equipment: mineral sample, distill water, pH regulators

2.3. Experimental procedure

- Carefully prepare the concentrations of salt solutions based on their molecular weight.
- Weigh 0.01 g sample and add it to 100 ml solution. Then mix the solution for 3 minutes by using magnetic bar on a mixing unit.
- Following the 2nd step, wait for 30 seconds in order to prevent the clodiness of solution which will have negative affect during zeta potential measurements.
- Measure the pH of solution before measurements.
- Take 25 ml of solution and carefully fill the zeta-potential cell.
- Insert the electrodes and check the position of light and measurement scale on monitor.
- Measure the specific conductance of solution. Adjust the voltage and measurement scale from zeta-meter 3.0 unit
- Energize the electrodes and watch the particles as they move accross a grid in your video display.
- Track one by simply pressing a keypad button and holding it down while your colloid moves across the grid. When you release the button, your particle's zeta potential is instantly displayed.
- After measurements, cut off energy, pour out the solution to another beaker and measure the final pH of the solution.

3. REPORT

- Give the general information about zeta potential and measurement methods of zeta potential.
- Draw the schematic view of potentials of negative loaded particle and show the potentials on schematic.
- Explain the effect of concentration and pH on zeta potential.
- Find a paper which include zeta potential study and make a brief summary about it.

4. REFERENCES

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1. GENERAL INFORMATION

In the case of a liquid in contact with a solid and a gas the equilibrium contact angle Θ_C forms at the three-phase contact line. The surface energy of the solid σ_S acts along the solid surface. The solid-liquid interfacial energy σ_{SL} acts in the opposite direction and the surface tension σ_L of the liquid acts tangential to the drop surface (Figure 1). The equality of vectorial forces can be described by a simple scalar equation. A vector projection on the contact plane between liquid and solid yields the Young equation:

$$\sigma_L \cos \Theta_C = \sigma_S - \sigma_{SL}$$

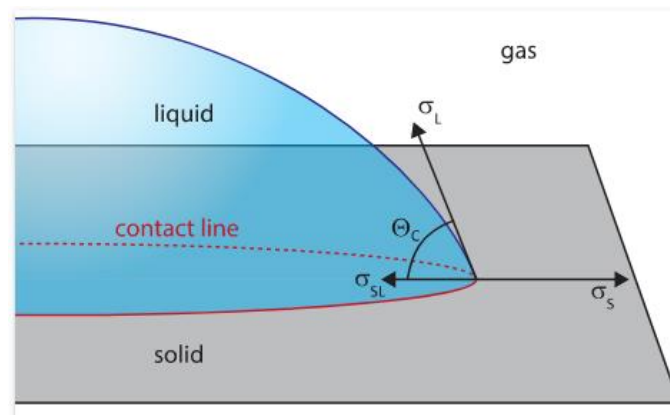


Figure 3. Contact angle at a solid-liquid-gas contact line

The equilibrium contact angle has two extrema. At 0° the drop of liquid is completely spread and forms a thin (monomolecular) film. This is called complete wetting. At an angle of 180° the drop forms a sphere and touches the solid in only one single point. This is called complete non-wetting. Depending on the application a contact angle as close as possible to either the minimal or maximal value is desired. An example for a material with a very high contact angle is ceramic with lotus effect which can be cleaned with little effort because water rolls off easily. An example for a small contact angle can be found in the dyes and varnishes industry which desires liquid formulations that distribute as evenly as possible. In Figure 2, relationship between contact angle and wettability is given visually. A small angle (less than 90 degrees) means the surface is favorable for wetting. If the angle is larger than 90 degrees the solid tends to be difficult to wet.

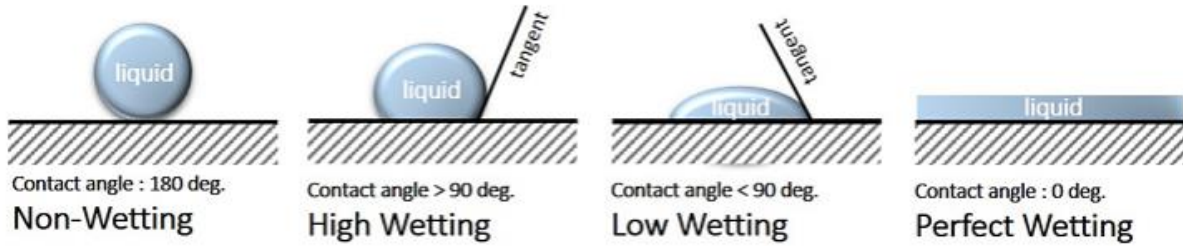


Figure 4. Relationship between contact angle and wettability

There are several measurement techniques to determine contact angle. One of them is sessile drop. In an experiment with using goniometer, contact angle will be measured. The measurement involves two steps: recording and analysis. The equipment required to perform a contact angle measurement can be very simple. The most common method uses three basic components: A light source, a camera and a tilting stage. The measurement process is as follows: In the first stage is flattened, so that the droplet does not move during deposition and then a droplet of liquid is deposited on to the stage. The droplet is illuminated from behind, and an image is recorded by the camera. The image is analyzed using code or software, and a contact angle measurement is determined. In Figure 3, simplified image of measurement device is demonstrated.

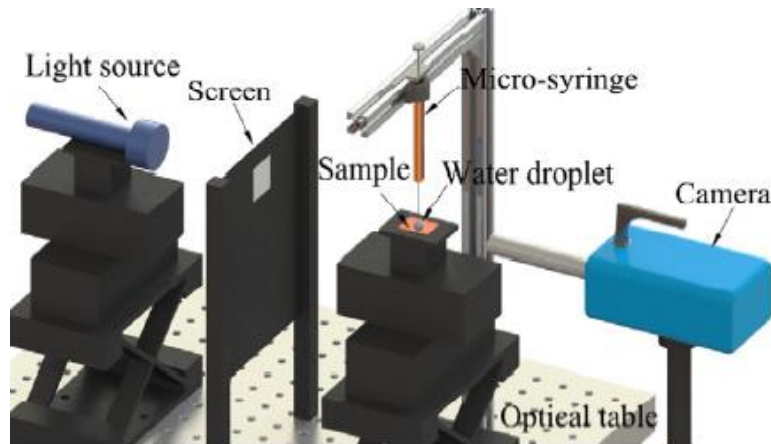


Figure 5. Image of contact angle measurement device

2. EXPERIMENT

a. The aim of the experiment

The aim of this experiment is to learn one of the measurement technique of contact angle and comprehend the importance of contact angle in surface chemistry.

b. Material & equipment

Material: distill water

Equipment: baker, pipet, glass surface, plastic surface, Dataphysics OCA 50 Contact Angle measurement device

c. Experimental procedure

Arrange the surface (glass/ plastic) on the measurement.

Drop water on the surface automatically benefited from device.

Draw the surface of the bubble using program.

Measure the contact angle and take note

3. REPORT

- Explain the terms: contact angle, surface tension, adhesion and cohesion forces, hydrophobic, hydrophilic, young equation, wettability, roughness in general information part **both in english and turkish language.**
- Explain and interpret the differences of contact angle between plastic and glass surface.
- Give at least 2 contact angle measurement techniques with brief explanation.
- Give an example about usage of contact angle in daily life

4. REFERENCES

Hanyang Gu, C. S. (2016). Investigation on contact angle measurement methods and wettability transition of porous surfaces. *Surface & Coatings Technology*, pp. 72-77.

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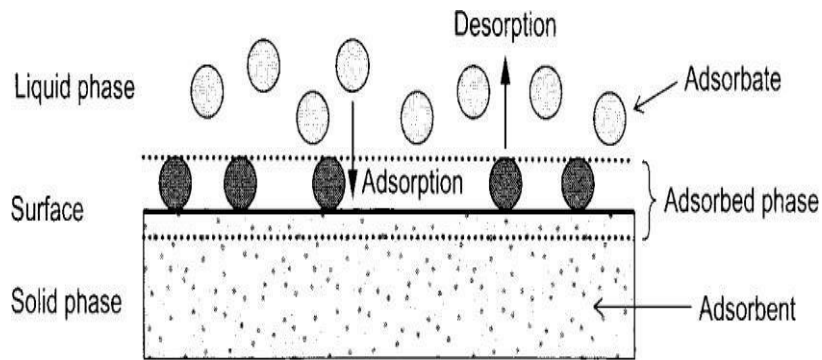
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1. INTRODUCTION

Adsorption is a phase transfer process that is widely used in practice to remove substances from fluid phases (gases or liquids) and collection on solid phase. Some examples of adsorbents commonly used in experiments of this kind are charcoal, silica gel, alumina, zeolites, and molecular sieves.

In adsorption theory, the solid material that provides the surface for adsorption is referred as *adsorbent*; the species that will be adsorbed are named as *adsorbate*. By changing the properties of the liquid phase (e.g. concentration, temperature, pH) adsorbed species can be released from the surface and transferred back into liquid phase. This reverse process is referred as **desorption**.



Basic terms of adsorption.

Figure 1. Schematic illustration of adsorption

Adsorption can result either from the universal van der Waals interactions *physical adsorption*, *physisorption* or it can have the character of a chemical process *chemical adsorption* or *chemisorption*. Contrary to physisorption, chemisorption occurs only as a monolayer. Physical adsorption can be compared to the condensation process of the adsorptive. As a rule, it is a reversible process that occurs at a temperature lower or close to the critical temperature of an adsorbed substance.

On the other hand, the adsorption isotherm is one of the most important criteria for an adsorption process that amount or pressure of reactant adsorbed for a given temperature is described by these parameters. However in this experiment, we will mainly focus on the adsorption mechanisms where the amount of adsorbate adsorbed on the adsorbent (*q_e*) is calculated from a mass balance:

$$q_e = (C_0 - C_e) \frac{V}{W}$$

Where C_0 is the initial adsorbate concentration (ppm), C_e is the final adsorbate concentration (ppm) V is the volume of the solution (L), and W is the mass of the adsorbent (mg).

2. MATERIALS AND METHODS

In this experiment, adsorption measurements will be carried out for activated carbon and methylene blue solution. The adsorption of methylene blue will be analyzed by UV Spectrophotometer.

3. EXPERIMENTAL PROCEDURE

- 1) Prepare 1L of methylene blue (MB) stock solution (20 ppm) and measure the absorbance of 20,10,5 ppm MB concentrations with UV Spectrophotometer.
- 2) Weigh 1 g activated carbon and place it in to flask.
- 3) Add 30 mL 20 ppm of methylene blue solution on to activated carbons.
- 4) Put flask into shaker and shake it for 5 min and finally 5 min to centrifugation to obtain pure solution.
- 5) Analyze the solution with UV Spectrophotometer for residual methylene blue concentration.
- 6) Calculate the quantity of methylene blue that was adsorbed by the activated carbon (mg of methylene blue adsorbed / gram of carbon).

3.1. Calculations

- 1) Plot the calibration curve by using absorbance data of standard solutions (concentration vs absorbance) and obtain the regression equation for calibration curve.
- 2) Calculate the final concentration of MB (C_e , mg/L). Calculate the residual MB concentration using this model.
- 3) Prepare tables showing the values of C_0 , V , W , C_e , q_e , $\log C_e$, $\log q_e$.

4. REPORT

- 1) Write step by step how you performed the experiment.
- 2) List possible reasons for measuring adsorption in a few sentences of your own words.
- 3) Comment on your result for each case.
- 4) What is the basic difference between Langmuir and Freundlich isotherms?

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İSTANBUL TEKNİK ÜNİVERSİTESİ

PAINT

1. INTRODUCTION

Paint is a good example for application of surface chemistry where it consist of many processes such as adsorption, viscosity, dispersion and etc. For this aim, the selection and the ratios of raw materials for paint production comes into prominent in terms of adjusting the quality of the product.

In this laboratory experiment, we will use various reagents which were listed in Table 1. As it can be seen from Tables that each additive has a particular role in paint mixture.

Material			
Water		<u>Calgon</u>	Wetting Agent and <u>decreases</u> the surface tension
Calgon		<u>Taylose</u>	A Viscosity Adjuster
TYLOSE 1000		<u>Amonniac</u>	pH adjuster
Ammoniac (25 wt. %)		<u>Foammaster</u>	For removing the foams during paint production
Foamaster 8034		<u>Dispex</u>	A dispersant agent
Dispex A40		<u>Orgal</u>	A kind of acrylic binder (Styrene Co- <u>Buytl</u> Acrylate) with high viscosity
PIGMENTS	1)TiO2	<u>Texanol</u>	Used as conditioner and removes the brush marks
	2)Calcite	MEG (Mono ethylene glycol)	Freeze Controller
	3) PCC B1	Butyl Glycol	Decreasing Agent for Water Evaporation Point
	4) Colemanite	DSX	Viscosity Adjuster
	Total Pigment		
Opac 204			
PST 50A			
Texanol			
MEG			
Butyl Glycol			
Rocima 623			
Foamaster 8034			
DSX 3256			
Water			
Total			

In addition, production of paint consists of different stages with different parameters such as mixing speed, addition ratio, etc. Of these, the most important one is the addition order where any kind of change for this parameter will definitely effect the characteristics of **paint product which in turn will result in undesired features of paints.**

2. EXPERIMENTAL

In this experimental study, a general information about paint production will be given where the stages of paint production will be briefly explained. After presentation of paint raw materials, the first and second stage will be shown consisting of preparation of suitable media

PAINT

for pigment addition, and pigment production by the addition of TiO_2 and CaCO_3 into the mixture.

Procedure for preparing experimental report for paint experiment.

- 1) Give brief introduction about paint, paint raw materials and paint production.
- 2) Briefly explain the stages performed in experimental studies.

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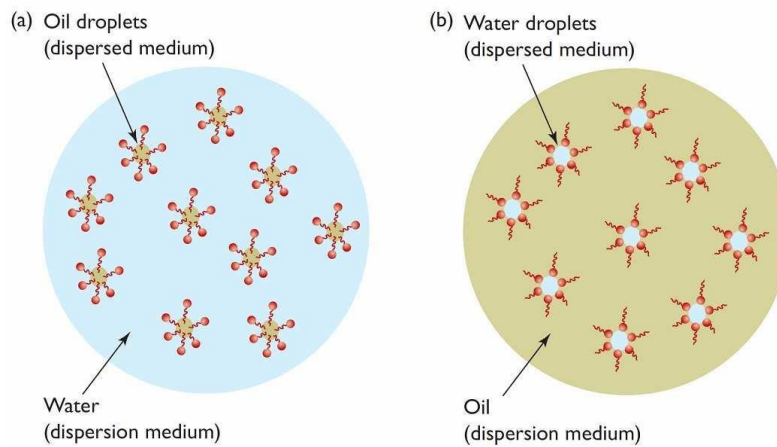
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EMULSION

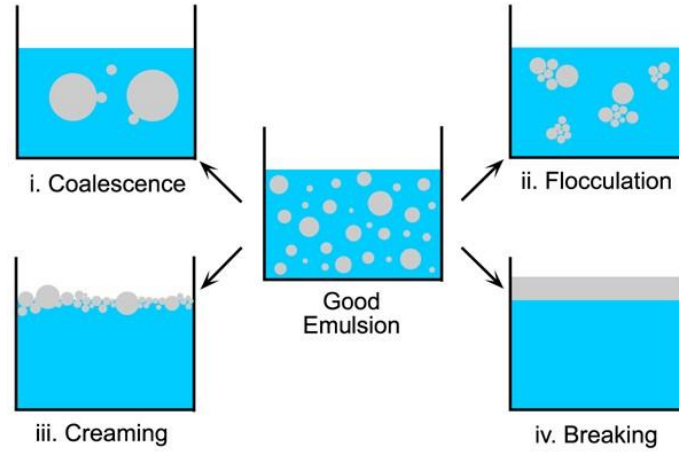
1. INTRODUCTION

An emulsion is a dispersed system in which the phases are immiscible or partially miscible liquids. In nearly all emulsions, one of the phases is aqueous and the other is an oil. If the oil is the dispersed phase, the emulsion is termed an oil-in-water (O/W) emulsion; if the aqueous medium is the dispersed phase, the emulsion is termed a water-in-oil (W/O) emulsion.

The practical application of emulsions and emulsion technology is considerable, and includes foodstuffs (milk, mayonnaise), pharmaceutical preparations, cosmetics, agricultural sprays and bituminous products.



In order to create an oil in water emulsion (one that remains stable for a long enough time), work must be done to overcome the interfacial tension between the two phases. This can be achieved by mixing; however mixing even at very high rates is not enough to provide long term *stability*. An *emulsifier* or combination of emulsifiers is needed to stabilize droplets of the dispersed phase. The materials which are most effective as emulsifying (and foaming) agents can be broadly classified as: 1. Surface-active materials 2. Naturally occurring materials. 3. Finely divided solids. The emulsifying agent forms an adsorbed film around the dispersed droplets which helps to prevent coagulation and coalescence.



All emulsifiers consist of a molecule that combines both hydrophilic and lipophilic groups. William C. Griffin developed a way to streamline the selection of surfactants by utilizing the ratio of the hydrophobic to the hydrophilic portion of the molecule. The HLB of an emulsifier is an expression of its Hydrophile-Lipophile Balance, i.e. the balance of the size and strength of the hydrophilic (water-loving or *polar*) and the lipophilic (oil loving or *non-polar*) groups of the emulsifier. Surfactants with high HLB values will be more water soluble and those with low HLB values are more oil soluble. The HLB for a nonionic surfactant can be calculated as follows:

$$\text{HLB} = \text{Weight \% Hydrophile} / 5$$

2. MATERIALS:

Diesel oil

Distilled water

Triton X-15 and Triton X-100 as emulsifiers (HLB values of these non-ionic surfactants are 4.9 & 13.4 respectively)

3. EXPERIMENTAL PROCEDURE

Pour 10 ml water and 10 ml diesel oil into both test-tubes, using a Pasteur pipette add a few drops of Triton X-15 to one of the test-tubes and a few drops of Triton X-100 to the other. Label the test-tubes. Shake the test-tubes just long enough until a stable emulsion forms. Using a

EMULSION

pipette place a drop of emulsion on a slide and cover it with a cover glass. Look at both emulsions under the microscope.

4. REPORT:

- Discuss whether an oil in water (O/W) or a water in oil (W/O) emulsion is formed upon your observations under the microscope. How does the HLB value of the emulsifier determines the type of emulsion.
- What is the chemical formula of Triton X type surfactants. Name the hydrophilic and hydrophobic parts. What are the molecular weights of these parts? Find the weight percentage of hydrophilic part of the Triton X-100 knowing that it has an average of 9.5 ethylene oxide units per molecule. Show that the HLB value of Triton X-100 is 13.4. Make the same calculation for Triton X-15 which has an average of 1.5 ethylene oxide units per molecule.
- What is the HLB value of 70/30 blend of these two emulsifiers?

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