



ACTIVITY

AIM

To study the effect of detergent on surface tension of water by observing capillary rise.

MATERIAL REQUIRED

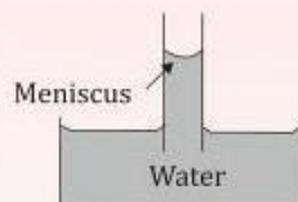
Capillary tube, beaker of 250 mL, small quantity of solid/liquid detergent, plastic scale 15/30 cm, rubber band, clamp stand and water.

THEORY

The substances that can be used to separate grease, dust and dirt sticking to a surface are known as detergents. When a detergent is added to the water, the cohesive force between water molecules is greatly reduced. Hence, surface tension of water is also reduced which can be easily observed by capillary rise method.

If a capillary tube is dipped vertically in a liquid, the capillary rise (h) of the liquid in a capillary tube is given by,

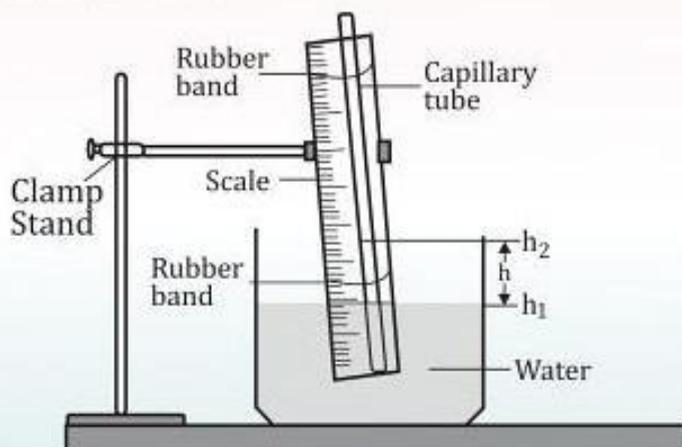
$$T = \left(h + \frac{r}{3}\right) \frac{r\rho g}{2\cos\theta}$$
$$T = \frac{r\rho gh}{2\cos\theta} \quad (\because h > r)$$
$$T \propto h$$



PROCEDURE

SETTING UP THE APPARATUS

1. Take a capillary tube of uniform bore. Clean and rinse it with distilled water. It should be ensured that the capillary tube is dry and free from grease, oil, etc. and it should be open from both the ends. Also, clean and rinse the beaker with water.



2. Pour water to fill the beaker up to half.
3. By using rubber bands, mount the plastic scale with the capillary tube.
4. Now, with the help of clamp stand, hold the scale with capillary in vertical position.
5. The half-filled beaker is placed below the lower end of the scale and gradually lowers down the scale till its lower end gets immersed below the surface of water in the beaker.

RISE OF WATER AND MIXTURE OF WATER AND DETERGENT IN THE CAPILLARY TUBE

1. Note the position of the water level inside h_2 and outside h_1 the capillary tube on the scale.
2. The rise of water in the capillary is $h = h_2 - h_1$
3. Rinse the capillary thoroughly in running water and dry it.
4. Take some quantity of detergent and mix it with water in the beaker.
5. Repeat the experiment with detergent solution and find the rise of mixture (water and detergent) in capillary tube again. Let it be h' . You will find that the value of h' will be less than that of h .

OBSERVATIONS

1. The position of water level inside that part of the capillary tube which is dipped in the water,
 $h_1 = \underline{\hspace{2cm}}$ cm.
2. The position of water level inside that the part of the capillary tube which remains outside the surface of water,
 $h_2 = \underline{\hspace{2cm}}$ cm.
3. The height to which water rises in the capillary tube,
 $h = (h_2 - h_1) \underline{\hspace{2cm}}$ cm.
4. The height to which the detergent solution rises in the capillary tube $h' = \underline{\hspace{2cm}}$ cm.

RESULT

The capillary rise of detergent solution h' is less than the capillary rise of water h . Thus, it can be concluded that the detergent reduces the surface tension of water.

PRECAUTIONS

1. The capillary tube should be kept vertical otherwise the reading of rising of water may get affected.
2. To avoid contamination by hand, we should not touch the inner surface of the beaker and the part of capillary tube to be immersed in water or solution.
3. Detergent solution should be prepared by stirring with a glass rod.
4. The beaker placed below the lower end of tube should not be disturbed.
5. The capillary tube should be clean and dry.
6. At the time of adding detergent to the water, it should be taken care that the concentration of detergent must not be made high, otherwise the density of solution will change substantially as compared to water. Moreover, two values of angle of contact between the surface of glass and solution may change substantially.

SOURCES OF ERROR

1. Contamination of liquid surface and the capillary tube cannot be completely ruled out.
2. Detergent solution may not be prepared by stirring with a glass rod.
3. The tube may not be open at both ends.
4. The capillary tube used may not be of uniform bore.



VIVA VOCE

Q1. Do all liquids rise in a capillary tube? Explain.

Ans. No, all liquids do not rise in a capillary tube. Liquids which make a convex meniscus in capillary tube are depressed, e.g., mercury is depressed in glass capillary tube.

Q2. How is the surface tension of water affected on dissolving a detergent in it?

Ans. The surface tension of water decreases on dissolving a detergent in it.

Q3. What is the value of surface tension of a liquid at critical temperature?

Ans. The value of surface tension of a liquid is zero at critical temperature.

Q4. What is the main cause of surface tension?

Ans. The main cause of surface tension is the interatomic force of attraction acting between liquid-liquid molecules.

Q5. Why is the surface tension a scalar quantity?

Ans. Surface tension is a scalar quantity because it has no specific direction for a given liquid.

Q6. What is the effect of temperature on surface tension of a liquid?

Ans. The surface tension of a liquid decreases with increase in temperature.

Q7. Surface tension of liquid is independent of the area of the liquid surface. Give reason.

Ans. According to surface tension, force is independent of the area of liquid surface. Thus, surface tension is also independent of the area of the liquid surface.