

6. Surface Tension

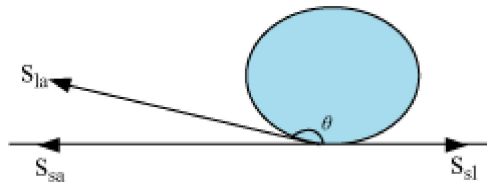
- **Surface tension** : Surface tension is the force acting per unit length on either side of an imaginary line on the water surface.

$$S = \frac{F}{l}; \text{ unit is } N/m$$

- Surface tension decreases the surface area to minimum.
- **Surface energy** : Change in surface energy is the product of surface tension and change in surface area under constant temperature.
 - To increase the surface area of liquid, work is done against the force of surface tension.
 - The work done is stored in a form of potential energy in liquid surface film.
 - Potential energy per unit area is called the surface energy of the surface film.

Angle of Contact

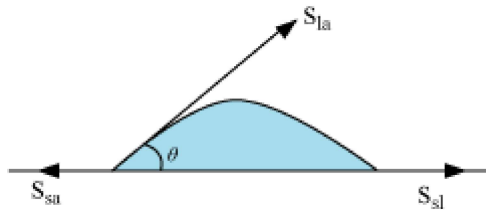
- The angle between the tangent to the liquid surface at the point of contact and the solid surface inside the liquid is called the angle of contact.
 - **Case I**



(Water and oily surface interface)

$$\cos\theta = \frac{S_{sa} - S_{sl}}{S_{la}}$$

- If $S_{sa} < S_{sl}$, then the angle of contact is obtuse and the molecules of the liquid are strongly attracted to themselves and weakly attracted to those of the solid.
- A lot of energy is used in creating the liquid–solid interface.
- **Case II**



(Water and glass surface interface)

- If $S_{sa} > S_{sl}$, then the angle of contact is acute and the molecules of the liquid are strongly attached to those of the solid.
- Not enough energy is required to create the liquid–solid interface.

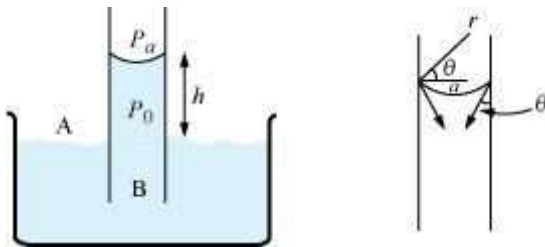
Excess Pressure

- For a curved surface in equilibrium, the concave side will have more pressure than the convex side.

- Excess pressure inside a liquid drop $= \frac{2S}{R}$

- Excess pressure inside a soap bubble $= \frac{4S}{R}$

Capillary Rise



$$h = \frac{2S \cos \theta}{a \rho g}$$

Effect of Impurities on Surface Tension of Liquid

- When a liquid consists of soluble impurities, the surface tension of the liquid increases.
- When a sparingly soluble impurity like phenol is dissolved in water, the surface tension decreases.

Effect of Temperature on Surface Tension of Liquid

- The surface tension of liquid decreases with increase in the temperature of the liquid.