Surface Potential Energy (S.P.E): Since the liquid molecules laying on the free surface are in presence of a cohesive force field hence due to their position in the field they possess potential energy. The potential energy of all the molecules laying on the free surface of the liquid is known as surface potential energy (S.P.E).

Thus for a given liquid (i.e. cohesive force is constant) the surface Potential energy depends on the number of molecules laying on the free surface i.e. on the area of the free surface.

$$\therefore \quad \text{S.P.E} \propto \text{area of free surface}$$

We know that nature favors minimum energy state. In the position of equilibrium S.P.E of the liquid should be minimum i.e. area of the free surface is minimum.

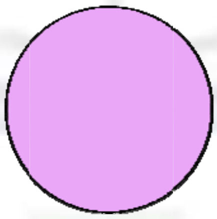
We know that surface area is minimum when the shape is spherical. Hence generally it is found that the shape of the free surface of a liquid is curved.

Free Surface Energy : Since surface tensions tends to contract the surface hence in order to increase are of surface work is to be done against this surface tension force which is stored in the free surface (the surface in contact with air) in the form of Free Surface Energy.

Free Surface Energy = Surface Tension x change in surface area = S x dA

If there are two free surfaces then Free surface energy = 2 x S x dA

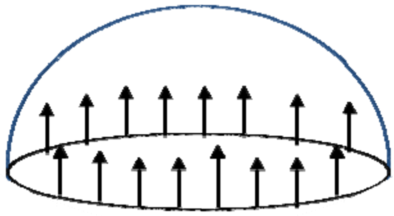
Excess pressure inside a soap bubble:



If we consider an element of the soap bubble the surface element is curved. This curvature indicates that the pressure on the two sides of the element are not same, pressure on the concave side is greater than the pressure on the convex side. Due to the pressure difference a force acts on the element but since the element is in equilibrium the resultant force on the element must be zero i.e. the force due to excess pressure must be balanced by the force due to surface tension.

Hence there is a definite relation between the excess pressure and surface tension.

Relation between excess pressure and surface tension:



Given:

r = radius of the bubble

S = surface tension of soap bubble

P = excess pressure inside the bubble

= Pressure on the concave side – Pressure on convex side

Let us imagine a section of bubble by a horizontal plane.

The length of the boundary of the circular section = $2\pi r$

Hence the total force acting on the section due to surface tension = $(S \times 2\pi r) \times 2$

(This factor 2 arises because there are two free surfaces)

The area of the circular section = πr^2

Force acting on the surface due to excess pressure = $P \times \pi r^2$

Since the surface is in equilibrium force due to surface tension must be balanced by the force due to excess pressure.

$$P \times \pi r^2 = 2 S \times 2 \pi r$$

$$P = \frac{4S}{r}$$

Equation gives the relation between excess pressure and surface tension.