# MECHANICAL PROPERTIES OF FLUID

## SURFACE TENSION

Surface tension is the tendency of fluid surfaces to shrink into the minimum surface area possible. Have you noticed when you fill a glass up to the brim with water, you can still add a few more drops till it spills out? Or have you ever broken a thermometer and observed how the fallen mercury behaves? All these happen due to the surface tension of the surface. Let us understand the concept, surface tension definition along with its SI unit, formula and examples.

### **Surface Tension**

According to the definition of surface tension, it is the phenomenon that occurs when the surface of a liquid is in contact with another phase (it can be a liquid as well). Liquids tend to acquire the least surface area possible. The surface of the liquid behaves like an elastic sheet.

"Surface tension is the tension of the surface film of a liquid caused by the attraction of the particles in the surface layer by the bulk of the liquid, which tends to minimise surface area".

Surface tension not only depends upon the forces of attraction between the particles within the given liquid but also on the forces of attraction of solid, liquid or gas in contact with it. The energy responsible for the phenomenon of surface tension may be thought of as approximately equivalent to the work or energy required to remove the surface layer of molecules in a unit area.

Surface tension is typically measured in dynes/cm, the force in dynes is required to break a film of length 1 cm.

Liquid	Surface Tension (N/m)
Hydrogen	2.4
Helium	0.16
Water	0.072
Ethanol	22.0
Sodium Chloride	114

Given below in a table is the surface tension of various liquids:

Surface tension definition lets us know that the surface tension mainly depends upon the forces of attraction between the particles within the given liquid and also upon the gas, solid, or liquid in contact with it.

## **Causes Surface Tension**

Intermolecular forces such as Van der Waals force, draw the liquid particles together. Along the surface, the particles are pulled toward the rest of the liquid. Surface tension is defined as,

The ratio of the surface force F to the length L along which the force acts.

Mathematically, surface tension can be expressed as follows:

T=F/L

Where,

- F is the force per unit length
- L is the length in which force act
- > T is the surface tension of the liquid
- What is the Unit of Surface Tension?

The SI unit of Surface Tension is Newton per Meter or N/m. Check other units in the table provided below.

- ➢ SI Unit N/m
- CGS Unit
  dyn/cm

### **Dimension of Surface Tension**

As we know, surface tension is given by the formula,

Surface tension = F/L

We know that F = ma, substituting the value in the equation, we get

ma/L

Equating the fundamental quantities into the equation, we get

MLT-2L-1

Solving further, we get

MT<sup>-2</sup>

Hence, the dimensional formula of surface tension is MT<sup>-2</sup>.

#### **Examples of Surface Tension**

Water striders, which are small insects, can walk on water as their weight is considerably less to penetrate the water surface. Like this, there are various examples of surface tension which are found in nature. Some cases are provided below:

- Insects walking on water
- Floating a needle on the surface of the water.
- Rainproof tent materials where the surface tension of water will bridge the pores in the tent material

- Clinical test for jaundice
- Surface tension disinfectants (disinfectants are solutions of low surface tension).
- Cleaning of clothes by soaps and detergents which lowers the surface tension of the water
- ➢ Washing with cold water
- Round bubbles where the surface tension of water provides the wall tension for the formation of water bubbles.
- > This phenomenon is also responsible for the shape of liquid droplets.

### **Calculate Surface Tension**

Here is an example for calculating surface tension by using the formula.

Compute the surface tension of a given liquid whose dragging force is 7 N and the length in which the force acts is 2 m?

Solution:

Given,

F=7~N

$$L = 2 m$$

According to the formula,

T = F/L

 $\Rightarrow$  T = 7/2

 $\Rightarrow$  T = 3.5 N/m

### **Methods of Measurement**

Some methods of measurement of surface tension are given in the points below:

- Spinning drop method
- Pendant drop method

## PHYSICS

- Du Noüy–Padday method
- Du Noüy ring method
- ➢ Wilhelmy plate method
- Pendant drop method
- Stalagmometric method
- Capillary rise method
- Bubble pressure method
- Resonant oscillations of a spherical and hemispherical liquid drop
- > The vibrational frequency of levitated drops
- Sessile drop method