LIQUID STATE

It represents the intermediate phase between the gaseous and solid states. Liquids exhibit characteristics of fluidity akin to gases while maintaining incompressibility akin to solids.

Key properties of liquids include:

(i) Composed of molecules, except for elemental mercury Hg(I), which exists in an atomic state.

(ii) The intermolecular forces of attraction within liquids are relatively substantial.

(iii) Liquids lack a definite shape but possess a definite volume due to the robust cohesive forces.

(iv) Compared to gases, liquids demonstrate slower diffusion.

(v) Evaporation:

Evaporation is the process wherein a liquid transform into a vapor state at a specific temperature. This phenomenon is accompanied by cooling, as the average kinetic energy of the remaining molecules decreases. The rate of evaporation is contingent upon the strength of intermolecular forces, also known as cohesive forces. Liquids with lower intermolecular forces exhibit a faster rate of evaporation.

For instance, Ether evaporates more quickly than alcohol, and alcohol evaporates more rapidly than water, with the order of intermolecular forces being Ether < Alcohol < Water.

The rate of evaporation is directly proportional to the surface area and temperature. Additionally, the flow of air aids in moving molecules away from the liquid surface, thereby accelerating the evaporation process.

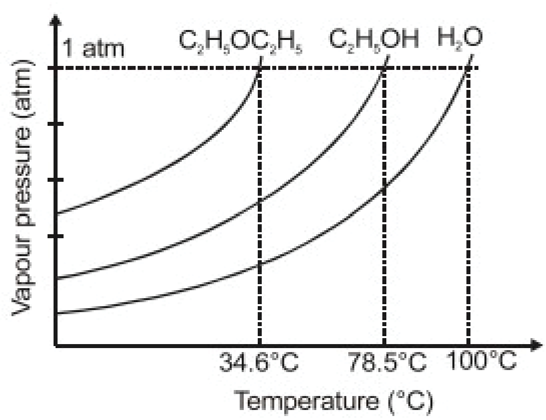
(vi) Vapor Pressure:

In a sealed container, when the rate of evaporation equals the rate of condensation, establishing equilibrium, the pressure exerted by the vapors of the liquid on its own surface is termed vapor pressure.

The magnitude of vapor pressure hinges on the following factors:

(a) Nature of Liquid: Vapor pressure is contingent upon the inherent characteristics of the liquid. A lower presence of intermolecular forces between the liquid molecules corresponds to a higher equilibrium vapor pressure.

(b) Temperature of Liquid: With an increase in temperature, an augmented number of molecules possess kinetic energies above the average. Consequently, the number of molecules escaping from the liquid surface rises. Therefore, the vapor pressure of a liquid increases with a rise in temperature.



The Clausius-Clapeyron Equation is expressed as: $\log \frac{P_2}{P_1} = \frac{\Delta H}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

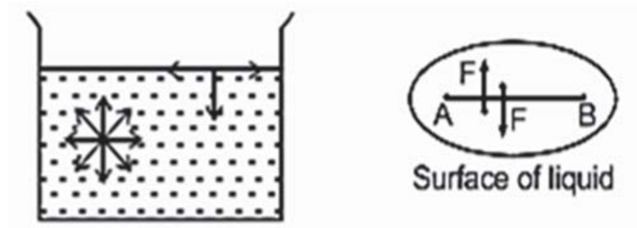
(vii) Boiling Point: The boiling point of a liquid is the temperature at which the vapor pressure of the liquid equals the atmospheric pressure.

Normal Boiling Point: Due to variations in atmospheric pressure with altitude and other conditions, boiling points are typically reported at 1 atm. Consequently, the normal boiling point of a liquid is the temperature at which the vapor pressure of the liquid equals 1 atm. For instance, the normal boiling point of water is 100°C.

Standard Boiling Point: The standard boiling point refers to the temperature at which the vapor pressure of the liquid is 1 bar. For example, the standard boiling point of water is 99.6°C. Notably, the standard boiling point of a liquid is slightly lower than its normal boiling point.

(viii) **Surface Tension:**

Surface tension is defined as the force acting on the surface at right angles to any line of unit length. Another perspective on this property involves the tendency of a liquid to minimize its surface area.

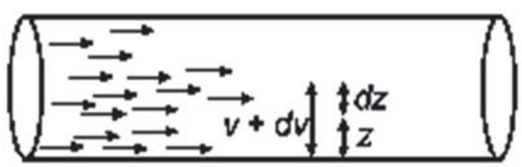


Mathematically, surface tension (S) is expressed as $S = \frac{F}{1}$ Nm^{-1}

where F represents the common magnitude of forces exerted by the two parts of the surface on each other across a line of length 1.

(ix) **Viscosity:**

Viscosity is the property of liquids that characterizes their resistance to flow. The forces between the layers that resist the relative motion between them are known as viscosity forces. Therefore, viscosity can be viewed as the internal property of a fluid in motion.



Consider v as the velocity of the layer at a distance 'z' from the pipe, and v + dv as the velocity at a distance z + dz.

The quantity $\frac{dv}{dz}$ is termed the velocity gradient.

The forces of viscosity, denoted by F, are proportional to $\frac{dv}{dz}$,

and mathematically expressed as $F \propto A$ (area of the layer),

where $F = -n A \frac{dv}{dz}$.

The negative sign indicates that the force is frictional and opposes relative motion, and 'n' is the coefficient of viscosity, measured in Nm^{-2} or poise, where 1 poise equals 0.1 Nm^{-2} s.

Fluidity (ϕ):

The reciprocal of the coefficient of viscosity is termed fluidity,

represented by the equation $\phi = \frac{1}{n}$.