32nd lecture

B.Sc. (Chemistry Hons) III

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The Liquid State

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Surface Tension

We already know that liquids do not have a shape of their own, they take the shape of a container. Despite its undefined shape we know that the drop of any liquid looks like a sphere. Why is it so? The answer is due to the surface tension of liquids. Surface tension is the property specific to liquids.

The molecules in a liquid experience an equal intermolecular ~~force~~ force between the molecules on surface is exerted perpendicularly downwards and this is called the surface tension of the liquid. The surface tension of the liquid depends on intermolecular forces directly, greater the force higher the surface tension. As compared to other molecules in the container, the surface molecules are the most active and energetic. Despite being less in number than the other molecules their pressure and

energy are high and hence exert a downward force towards the liquid. Now if the surface is distorted and the surface of the liquid pulls another molecule from the bulk then it takes energy to rebuild the surface area. The energy required to rebuild the surface tension is called surface energy. The unit for surface tension is Jm^{-2} and it is denoted by γ.

Effect of Temperature →

The surface tension depends on the surface area. The lower the surface area the lower shall be the surface tension of the surface molecules towards downwards. Surface tension is also inversely proportional to the temperature. The kinetic energy between the molecules tends to increase with the increasing temp. but decreases the force of attraction between the molecules. This decreases the surface tension of the liquid.

Viscosity

The viscosity of a liquid substance is a measure of resistance to

flow. The intermolecular forces and internal friction between the moving molecules in the liquids make them viscous to flow. When a liquid flows, the molecules in contact with the surface are stationary. While the upper layer tends to move, the velocity of this moving layer increases with the distance of layers from the stationary layer.

This implies that the farther the moving layer, the faster it moves. This kind of increasing velocity is termed as Laminar flow. The lower layer nearest to the surface retards the movement of the layer above it, this results in viscosity in liquids.

Co-efficient of Viscosity :—

As we already know that viscosity is the resistance to flow shown by molecules. Now the flow of layer requires force to get away with the resistance between layers. This force helps to maintain the flow of molecular layers and is directly proportional to the area of contact of layers and velocity

gradient. The ratio of changed velocity (du) and original velocity (dx) is termed as the velocity gradient.

Now $F \propto A$

$F \propto du/dx$ (velocity gradient)

$F \propto A(du/dx)$

$\Rightarrow F = \eta A(du/dx)$

Here η is the proportionality constant and is called as the co-efficient of viscosity. The unit of η in SI System is 1 Newton per second sq. metre ($1\ N\ s\ m^{-2}$)

Effect of Physical changes in Viscosity :-

The viscosity of the aqueous substance decreases with increasing temperature. At high temperature the forces of attraction between the molecules decreases and due to the high kinetic energy in the molecules the intermolecular forces slip past each other in the layer. This results in decreased viscosity.

X—Y