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Surface Tension

Surface Tension-Surface Energy

- **1.** Every surface of a liquid behaves like a stretched elastic membrane and thereby develops surface tension.
- 2. The force acting on the surface of the liquid per unit length on its either side is called surface tension

$$T = \frac{Force(F)}{length(l)} N / m$$

- 3. The maximum distance up to which the cohesive force between two similar molecules exists is called molecular range (about 10^{-9} m).
- **4.** An imaginary sphere around a liquid molecule with molecular range as radius is called sphere of influence.
- **5.** Every molecule on the surface of a liquid has maximum potential energy. In minimizing this PE, the molecule on the surface tries to acquire minimum surface area. Thereby surface tension is developed.
- **6.** Small mercury drops acquire spherical shape to minimize the surface potential energy.Bigger mercury drops are flat at the upper side, to minimize the gravitational potential energy.

7. Factors influencing surface tension

- a. Highly soluble impurities increase the S.T. of a liquid. Ex.: Salt water.
- b. Less soluble (or) insoluble impurities decrease the S.T. of a liquid. Ex: Camphor in water, oil on water etc.
- c. Organic solvents decrease the surface tension of water ex: soap water.
- d. Electrification reduces the surface tension of a liquid.
- e. As temperature increases, the S.T. of a liquid decreases. $T = T_0(1 \alpha \theta)$

 α - Temperature Coefficient of S.T

Ex.: 1) Hot soup is tastier than cold soup 2) Hot water bath is preferable to cold water bath.

- f. For molten copper and cadmium, as temperature increases, S.T. increases.
- g. At critical temperature, at Boiling point and at absolute zero S.T. of a liquid is zero
- 8. A metallic wire of density d floats horizontally on water. If the surface tension of water is T. Then the maximum radius of the wire so that the wire may not sink.

$$r=\sqrt{\frac{2T}{\pi dg}}$$

9. Surface Energy

a. The surface energy of a liquid film is the work done to increase the surface area of the film by unit amount

W =T(A₂ – A₁) or
$$T = \frac{W}{A} J/m^2$$

- **b.** Work done to blow a soap bubble of radius $r W = 8\pi r^2 T$
- c. Work done to increase the radius of the soap bubble from r_1 to r_2 is, $W = 8\pi T (r_2^2 - r_1^2)$
- **d.** If two soap bubbles of radius r_1 and r_2 combine under isothermal conditions in vacuum then the radius of the single bubble $r^2 = r_1^2 + r_2^2$
- e. If two liquid drops of radius r_1 and r_2 combine into a single under isothermal conditions its radius is $r^3 = r_1^3 + r_2^3$.
- f. n identical drops of same size each of radius r combine into a single drops of radius R

i) Energy released (or) works done is given by $W = 4 \pi r^2 (n - n^{2/3})$

V - Volume of the drop

ii) W =
$$4\pi T (nr^2 - R^2) = 4\pi R^3 \left(\frac{1}{r} - \frac{1}{R}\right)^T$$
 (Or) W = $4\pi R^2 T (n^{1/3} - 1) = 3VT \left(\frac{1}{r} - \frac{1}{R}\right)^T$

iii) The rise in temperature is $\Delta t = \frac{3T}{dJs} \left(\frac{1}{r} - \frac{1}{R}\right)$

s-Specific heat of the liquid

d – Density of the liquid

J – Joules constant

iv) If this energy is completely converted as the KE of the single drop, then the velocity of the single drop $v = \sqrt{\frac{6T}{d} \left(\frac{1}{r} - \frac{1}{R}\right)}$

v) Surface area decreases

g. The work done to blow a soap bubble is w. The work done in increasing the bubble to n times the initial volume $\Delta w = w(n^{2/3} - 1)$

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