Properties of Liquid

Unit: 5.1

Thrust: Thrust of a liquid is defined as the total force acting on the surface of a solid with which the liquid is in contact.

Thrust has the same units as force.

We consider a liquid of density ρ in a beaker up to height h. If the area of cross-section of the beaker is A, then the total weight of the liquid is

$= (Ah)\rho g = Ah\rho g$

This total force acting on the base of the beaker is called thrust.

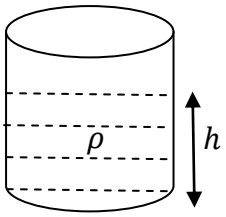

Fig. 5.1.1

Pressure: Pressure of a liquid at a point is defined as the thrust per unit area at that point.

Pressure = $\frac{\text{Total thrust}}{\text{Total area}} = \frac{Ah\rho g}{A} = h\rho g$

SI unit of pressure is **Nm^{-2}** or **pascal** (Pa)

Pascal's law: It states that pressure is transmitted equally in all directions inside a liquid and acts perpendicular to the wall of the container.

Hydraulic press (Bramah press): It is based on the principle of Pascal's law. It is used for compressing bales of cotton, paper, cloth, etc.

Hydraulic press consists of a water pump in communication with a chamber containing water [Fig. 5.1.2]. There are two plungers P and Q known respectively as pump plunger and press plunger. The area of cross section of the pump plunger is a and that of the press plunger is A. A bale of cotton, cloth or paper is placed on the platform of the press plunger. There is a fixed ceiling at the top.

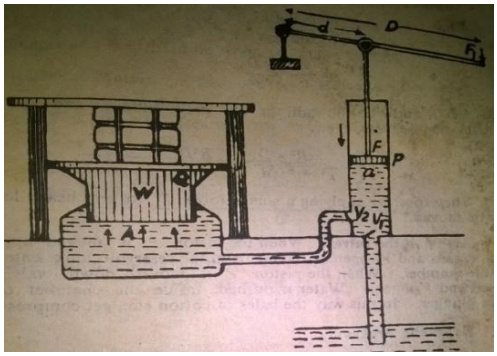

Fig. 5.1.2 Hydraullic press

Let us suppose that F is the downward force applied on the plump plunger. The pressure applied is F/a. This pressure is transmitted with undiminished magnitude to the press plunger. The upward thrust acting on the press plunger is

W=pressure x area=(F/a)x A

Due to this large thrust acting on the press plunger, the cotton bale is compressed.

Q.1 The length, breadth and depth of a water tank are 6 m, 2 m and 2 m respectively. When the tank is full of water, then calculate the total thrust on the bottom of the tank.

Q.2 The diameters of the pistons of a hydraulic press are 4 cm and 40 cm respectively. The arms of the lever are in the ratio of 6:1. Find the total force produced on the larger piston when a force of 75 kg is applied at the end of the longer arm of the lever.

Unit: 5.2

Buoyancy: The upward force exerted by a liquid that opposes the weight of an immersed object into it is called buoyancy.

Archimedes' principle: It states that when a body is immersed in a liquid, it experiences an upward thrust (loses weight) equal to the weight of liquid displaced by it.

Density: The mass per unit volume of a substance is called the density of the substance.

SI unit of density is **kg m^{-3}**

Specific gravity (relative density): The specific gravity of a substance is the ratio of the weight of any volume of the substance to the weight of an equal volume of water at 4^0 C.

$$\text{Specific gravity} = \frac{\text{Weight of V cc of the substance}}{\text{Weight of V cc of water at } 4^0\text{ C}}$$

$$= \frac{\text{Mass of V cc of the substance}}{\text{Mass of V cc of water at } 4^0\text{ C}}$$

$$= \frac{\text{Mass of unit volume of the substance}}{\text{Mass of unit volume of water at } 4^0\text{ C}}$$

$$= \frac{\text{Density of the substance}}{\text{Density of water at } 4^0\text{ C}}$$

The specific gravity of a substance may also be defined as the ratio of the density of the substance to the density of water at 4^oC. It is also known as *relative density*.

Since specific gravity is the ratio of two same quantities, it is a pure number having no unit.

Relation between specific gravity and density:

Specific gravity, $S = \frac{\text{density of the substance}}{\text{density of water at } 4^0\text{C}} = \frac{\sigma}{d}$

or

$\sigma = Sd$

Q.1 A piece of metal weighs 60 gf in air and 54 gf when immersed in oil of specific gravity 0.8. Find the specific gravity of the metal.

Q.2 The weight of a piece of gold, alloyed with silver is 20 gf in air and 18.7 gf in water. If the specific gravity of gold and silver are 19.3 and 10.5 respectively, how much gold is there in the piece?