1.1.5TYPES OF FLUIDS

The fluids may be classified as follows

1. Ideal fluid

An *ideal fluid* is a fluid which is incompressible and is having no viscosity and surface tension. It is an imaginary fluid since all fluids have its own viscosity, compressibility and surface tension. For an ideal fluids shear stress , $\tau = 0$.

2. Real fluid

A fluid which possesses viscosity, surface tension and compressibility is known as *real fluid*. In actual practice all fluids are real fluids.

3. Newtonian fluid

A real fluid in which shear stress is directly proportional to the rate of shear strain or velocity gradient is known as *newtonian fluid*.Or in other words a fliud which obeys the Newtons law of viscosity is known as newtonian fluid. For a newtonian fluid shear stress ,

$$\tau = \mu \frac{du}{dy}$$

4. Non-newtonian fluid

A real fluid in which shear stress is not proportional to the rate of shear strain or velocity gradient is known as *non- newtonian fluid*. It does not obey the Newtons law of viscosity for non -newtonian fluids shear stress , $\tau = \mu \left(\frac{du}{dy} \right)^n$ .If the value of n less than unity they are called *pseudo-plastics* while fluids in which 'n' is greater than unity are known as *dilatant*. .

5. Ideal plastic fluid

A fluid , in which the shear stress is more than the yield value and shear stress is proportional to the rate of shear strain (or velocity

gradient) , is known as *ideal plastic fluid* or *bingham plastic*. For an ideal plastic fluids shear stress , $\tau = \text{constant} + \mu\left(\frac{du}{dy}\right)$

6. Thyxotropic fluid

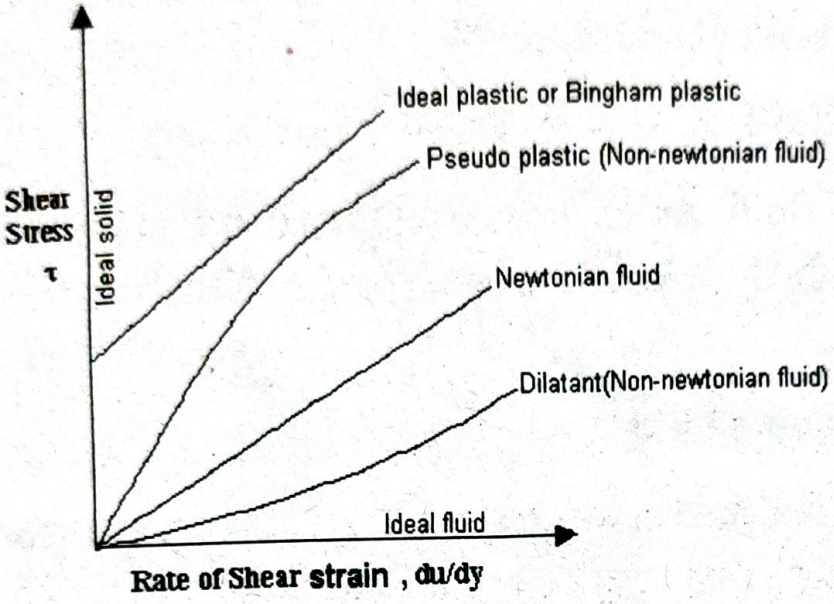

Fig 1.1.5 Classification of fluids

This is a fluid in which after reaching a yield value of shear stress, the fluid begins to flow. The fluid flows such that the relationship between the shear stress and the velocity gradient is not linear.

HIGHLIGHTS

1. A fluid is a substance that deforms or yields continuously when shear stress is applied to it, no matter how small it is.
2. Fluids can be subdivided into liquids and gases.
3. If a gas is subjected to normal stress, they change their volume considerably. So gases are compressible.
4. Liquids can be compressed to a small extent. For all practical purposes liquids are treated as incompressible.

5. Fluid Mechanics is a branch of physical science dealing with the action of fluids at rest or in motion

6. Fluid mechanics is applied in diverse fields such as aeronautics, chemical, civil, and mechanical engineering , meteorology, naval architecture , and oceanography .

7. Fluid mechanics can be subdivided into two major areas, fluid statics, which deals with fluids at rest, and fluid dynamics, concerned with fluids in motion.

8. Hydraulics deals with the application of fluid mechanics to engineering devices involving liquids, usually water or oil

9. Hydraulics deals with the laws governing the behavior of water at rest and in motion.

10. Hydrostatics deals with properties and laws governing the behavior of water at rest .

11. Hydrodynamics deals with the relationship between velocity and acceleration of a liquid and the force exerted by or on the liquid.

12. Hydrokinematics deals with the properties and the laws governing the behavior of ideal fluids.

13. Mass density or density is defined as the mass per unit volume.

i.e., $\rho = \frac{m}{V}$

14. Specific weight or weight density of a fluid is defined as the weight per unit volume . i.e.,$w = \rho g$

15. Specific volume is the reciprocal of mass density . i.e., $v = \frac{1}{\rho}$

16. Newtons law of viscosity states that , shear stress is proportional to the velocity gradient $\frac{du}{dy}$. i.e., $\tau = \mu \frac{du}{dy}$.

7. Dynamic viscosity is the ratio of shear stress to the velocity gradient. i.e., $\mu = \frac{\tau}{\frac{du}{dy}}$

8. Kinematic viscosity is the ratio of dynamic viscosity and density . i.e., $\nu = \frac{\mu}{\rho}$

19. S.I unit of viscosity is N-s / m^2 or Pa-s. In C.G.S. unit it is in poise (One poise = $\frac{1}{10}$ N-s / m^2)

20. S.I. unit of kinematic viscosity is m^2/sec. In CGS units kinematic viscosity is expressed in stokes. (One stokes = $\frac{1}{10^4}$ m^2/s)

21. To convert poise into SI units, the poise should be divided by 10 .

22. To convert stoke into SI units, the stoke should be divided by 10^4 .

23. Bulk modulus of elasticity is the ratio of compressive stress to the volumetric strain, i.e.,

$$K = \frac{\text{Compressive stress}}{\text{Volumetric strain}} = \frac{\sigma}{\varepsilon_v}$$

24. Compressibility is the reciprocal of bulk modulus of elasticity, i.e., Compressibility = $\frac{1}{K}$

25. In S.I. unit surface tension is expressed in N / m.

26. Capillary rise of a liquid drop is given by $h = \frac{4\sigma \cos\theta}{wd}$

$= \frac{4\sigma \cos\theta}{\rho g d}$, the value of θ for water is taken as zero and for mercury equal to 128^0.

27. The fluids may be classified into ideal fluid, real fluid, newtonian fluids, non - newtonian fluids, ideal plastic fluids and thyxotropic fluids.