2.2 CLASSIFICATION AND TYPES OF FLOW

The fluid flow is classified as:

i) Steady and unsteady flows.

ii) Uniform and Non-uniform flows.

iii) Laminar and Turbulent flows.

iv) Compressible and incompressible flows.

v) Rotational and Ir-rotational flows.

vi) One, Two and Three dimensional flows.

i) Steady and Un-steady flows: Steady flow is defined as the flow in which the fluid characteristics like velocity, pressure, density etc. at a point do not change with time.

$$\frac{\partial V}{\partial t}_{x,y,z} = 0, \qquad \frac{\partial p}{\partial t}_{x,y,z} = 0, \qquad \frac{\partial \rho}{\partial t}_{x,y,z} = 0$$

Un-Steady flow is the flow in which the velocity, pressure, density at a point changes with respect to time. Thus for un-steady flow, we have

$$\frac{\partial V}{\partial t}_{x,y,z} \neq 0, \qquad \frac{\partial p}{\partial t}_{x,y,z} \neq 0, \qquad \frac{\partial \rho}{\partial t}_{x,y,z} \neq 0$$

ii) Uniform and Non-uniform flows: Uniform flow is defined as the flow in which the velocity at any given time does not change with respect to space. (i.e. the length of direction of flow)

For uniform flow

$$\frac{\partial V}{\partial s}_{t=const} = 0$$

Where ∂V = Change of velocity

∂s = Length of flow in the direction of – S

Non-uniform is the flow in which the velocity at any given time changes with respect to space.

For Non-uniform flow

$$\frac{\partial V}{\partial s}_{t=const} \neq 0$$

iii) Laminar and turbulent flow: Laminar flow is defined as the flow in which the fluid particles move along well-defined paths or stream line and all the stream lines are straight and parallel. Thus the particles move in laminas or layers gliding smoothly over the adjacent layer. This type of flow is also called streamline flow or viscous flow.

Turbulent flow is the flow in which the fluid particles move in a zigzag way. Due to the movement of fluid particles in a zigzag way, the eddies formation takes place, which are responsible for high energy loss. For a pipe flow, the type of flow is determined by a non- Dimensional number (VD/v) called the Reynolds number.

Where D = Diameter of pipe.

V = Mean velocity of flow in pipe.

v = Kinematic viscosity of fluid.

If the Reynolds number is lessthan2000, the flow is called Laminar flow.

If the Reynolds number is more than 4000, it is called Turbulent flow.

If the Reynolds number is between 2000 and 4000 the flow may be Laminar or Turbulent flow.

iv) Compressible and Incompressible flows: Compressible flow is the flow in which the density of fluid changes from point to point or in other words the density is not constant for the fluid.

For compressible flow $\rho \neq$ Constant.

In compressible flow is the flow in which the density is constant for the fluid flow. Liquids are generally incompressible, while the gases are compressible.

For incompressible flow ρ = Constant.

v) Rotational and Irrotational flows: Rotational flow is a type of flow in which the fluid particles while flowing along stream lines also rotate about their own axis. And if the fluid particles, while flowing along stream lines, do not rotate about their own axis, the flow is called Ir-rotational flow.

vi) One, Two and Three – dimensional flows:

One dimensional flow is a type of flow in which flow parameter such as velocity is a function of time and one space co-ordinate only, say ‘x’. For a steady one- dimensional flow, the velocity is a function of one space co-ordinate only. The variation of velocities in other two mutually perpendicular directions is assumed negligible.

Hence for one dimensional flow **u = f(x), v = 0 and w = 0**

Where u, v and w are velocity components in x, y and z directions respectively.

Two – dimensional flow is the type of flow in which the velocity is a function of time and two space co-ordinates, say x and y. For a steady two-dimensional flow the velocity is a function of two space co-ordinates only. The variation of velocity in the third direction is negligible.

Thus for two dimensional flow **u = f1 (x, y), v = f2 (x, y) and w = 0.**

Three – dimensional flow is the type of flow in which the velocity is a function of time and three mutually perpendicular directions. But for a steady three-dimensional flow, the fluid parameters are functions of three space co-ordinates (x, y, and z) only.

Thus for **three- dimensional flow u = *f1 (x, y, z), v = f2 (x, y, z), z = f3 (x, y, z).***