**Streamline, Laminar and Turbulent Flow**

**Stream line flow :** Stream line flow of a liquid is that flow in which each element of the liquid passing through a point travels along the same path and with the same velocity as the preceding element passes through that point.



A streamline may be defined as the path, straight or curved, the tangent to which at any point gives the direction of the flow of liquid at that point.

The two streamlines cannot cross each other and the greater is the crowding of streamlines at a place, the greater is the velocity of liquid particles at that place.

Path *ABC* is streamline as shown in the figure and ,  and  are the velocities of the liquid particles at *A*, *B* and *C* point respectively.

**Uniform & non-uniform Flow :**

A flow is said to be uniform at any instant of time, if the velocity (vector) does not vary along the direction of flow.



In non-uniform flow, velocity varies in the direction of flow.



. **Tube of flow**

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Consider an area S in a fluid in steady flow and draw streamlines from all the points of the periphery of S. A tube such made is known as tube of flow.

**Laminar flow :** If a liquid is flowing over a horizontal surface with a steady flow and moves in the form of layers of different velocities which do not mix with each other, then the flow of liquid is called laminar flow.

In this flow, the velocity of liquid flow is always less than the critical velocity of the liquid. The laminar flow is generally used synonymously with streamlined flow.

**Turbulent flow :** When a liquid moves with a velocity greater than its critical velocity, the motion of the particles of liquid becomes disordered or irregular. Such a flow is called a turbulent flow.

In a turbulent flow, the path and the velocity of the particles of the liquid change continuously and haphazardly with time from point to point. In a turbulent flow, most of the external energy maintaining the flow is spent in producing eddies in the liquid and only a small fraction of energy is available for forward flow. For example, eddies are seen by the sides of the pillars of a river bridge.

**Critical Velocity and Reynold's Number**

The critical velocity is that velocity of liquid flow upto which its flow is streamlined and above which its flow becomes turbulent.

Reynold's number is a pure number which determines the nature of flow of liquid through a pipe.

It is defined as the ratio of the inertial force per unit area to the viscous force per unit area for a flowing fluid.



If a liquid of density  is flowing through a tube of radius *r* and cross section *A* then mass of liquid flowing through the tube per second  volume flowing per second × density = 

 Inertial force per unit area =  =  = 

Viscous force per unit area 

So by the definition of Reynolds number



If the value of Reynold's number

(i) Lies between 0 to 2000, the flow of liquid is streamline or laminar.

(ii) Lies between 2000 to 3000, the flow of liquid is unstable and changing from streamline to turbulent flow.

(iii) Above 3000, the flow of liquid is definitely turbulent.