Experiment No.

TITLE: REYNOLDS APPARATUS

AIM: To determine the flow type and critical Reynold number

<u>THEORY:</u>

Whenever a fluid is flowing through a pipe, the flow is either laminar or turbulent. When fluid is flowing in parallel layers or laminae, sliding past adjacent laminae, it is called laminar flow. When the fluid does not flow in parallel layers and there is intermingling of fluid particles then the flow is said to be turbulent. Existence of these two types was first demonstrated by ' OSBORN REYNOLDS ' in 1883.

The apparatus consists of a constant head supply tank supplied with a water. This tank is provided with a bell mouth outlet to which a transparent tube is fitted. At outlet of the tube a regulating valve is provided. A dye tank containing coloured dye is fitted above the supply tank. The water flows through pipe and dye is injected at the center of the pipe. When the velocity of flow is low, (i.e. flow is laminar) then dye remains in the form of straight filament. As the velocity of water (i.e. flow of water) is increased, a state is reached when the dye filament becomes irregular and water. With further increase of velocity of water through the tube, dye filament becomes more and more irregular and ultimately the dye diffuses over the entire cross section of the tube.

The velocity at which the flow changes from laminar to turbulant for the case of a given fluid at given temperature and in a given pipe is known as critical velocity. The state of flow between these two types of flow is known as ‘transition state’ or flow in transition.

The occurrence of laminar and turbulant flow is governed by relative magnitudes of inertia and viscous forces. Reynolds related the inertia forces to viscous forces and arrived at a diamensionless parameter now called 'Reynolds number'.

EXPERIMENTAL PROCEDURE

1. Fill up water up to the mark.
2. Fill up sufficient water in dye tank and put a small amount of potassium paramagnet in to water.
3. Prime pump (remove the end plug & fill up water, remove all the air. Then tight the plug. Fitted near the flow control valve.) Connect the electric supply and start pump. Adjust the water flow. Flow to about 2 lpm. Start the dye injection.
4. Wait for some time. A steady line of dye will be observed. Adjust dye flow, if required.
5. Slowly increase the water flow see that water level in supply tank remains constant. At particular flow rate, dye line will be disturbed note down this flow rate. By using 1lit measuring flask and stop watch.

6. Further increase the flow. The disturbances of dye line will go on increasing and at certain flow, the dye line diffuses over the entire cross section. Note down this flow.

7. Slightly increase the flow and then slowly reduce the flow. Note the flow at which diffused dye tends to become steady, (beginning of transition zone while reducing velocity.)

8. Further reduce the flow and note the flow at which dye line becomes straight and steady.

9. After completion of experiment drain all the water. [Drain plug is bottom of the sump tank] and tight the drain plug. Also clean the dye contener.

OBSERATION TABLE –

Sr. NO.	Flow Type	Time / 0.5 lit . (sec.)
1	laminar	
2	Just start of transformation from Laminar to Turbulent	
2	Turbulent	

OBSERATIONS

1. Increasing velocity
   a) Flow at begining of transition
   b) Flow at begining of turbulance.
2. Decreasing velocity
   a) Flow at begining of transition
   b) Flow at begining of laminar region.

CALCULATIONS

1. I. D. of pipe = 20 mm, cross sectional area of pipe

$\therefore$ A = 3.14 x $10^{-4} m^2$

Let, time required for 1 liter in measuring flask be 't' sec.

then, flow, $Q = \dfrac{0.001}{t}$ m^3 / sec

velocity, $V = \dfrac{Q}{A}$ m /sec

then, Reynolds number,

$$Re = \frac{\rho V L}{\mu}$$

$$Re = \frac{VD}{\nu}$$

Where, ρ = Density of fluid = 1000 Kg/ m^3

V = Velocity, m / sec

L = Characteristic linear dimension

D = Diameter of the pipe = 0.02 m.

ν = Kinematic viscosity of fluid = 0.805 x 10^{-6} m^2/s

μ = 801.2 x 10^{-6} N - s / m^2

While increasing the velocity, laminar flow is disturbed at slightly higher velocity. But at the time of reducing the velocity, the flow does not turn to laminar at this velocity, but becomes laminar at still lower velocity is called lower critical velocity.

Lower critical Reynolds number flow is always laminar and above upper critical Reynolds number flow is always turbulent. Practically, upper critical

Reynolds number lies between 2700 to 4000 and lower critical Reynolds, number is approximately 2000. Between Reynolds number 2000 and 4000 the transition region exists.

EXPERIMENTAL PROCEDURE

1. Fill up sufficient water in dye tank and put a small amount of potassium permanganate in to water.
2. Start water supply & adjust the water flow to about 2 lpm. Start the dye injection.
3. Wait for some time. A steady line of dye will be observed. Adjust dye flow, if required.
4. Slowly increase the water flow, see that water level in supply tank remains constant. At particular flow rate, dye line will be disturbed note down this flow rate.
5. Further increase the flow. The disturbances of dye line will go on increasing and at certain flow; the dye line diffuses over the entire cross section. Note down this flow.
6. Slightly increase the flow and then slowly reduce the flow. Note the flow at which diffused dye tends to become steady, (beginning of transition zone while reducing velocity.)
7. Further reduce the flow and note the flow at which dye line becomes straight and steady.