Experiment 3

OSBORNE REYNOLDS DEMONSTRATION

INTRODUCTION:

The flow of real fluids can basically occur under two very different regimes namely laminar and turbulent flow. The laminar flow is characterized by fluid particles moving in the form of lamina sliding over each other, such that at any instant the velocity at all the points in particular laminar is the same. The laminar near the flow boundary move at a slower rate as compared to those near the center of the flow passage. This type of flow occurs in viscous fluids, fluids moving at slow velocity and fluids flowing through narrow passages.

The turbulent flow is characterized by constant agitation and intermixing of fluid particles such that their velocity changes from point to point and even at the same point from time to time. This type of flow occurs in low density Fluids; flow through wide passage and in high velocity flows.

OBJECTIVE:

To perform Reynolds experiment for determination of different regimes of flow

APPARATUS:

- Osborne Reynolds' apparatus (F1-10)
- Dye
- Thermometer
- Stopwatch
- Graduated cylinder

THEORY:

Reynolds conducted an experiment for observation and determination of these regimes of flow. By introducing a fine filament of dye in to the flow of water through the glass tube, at its entrance he studied the different types of flow. At low velocities the dye filament appeared as straight line through the length of the tube and parallel to its axis, characterizing laminar flow. As the velocity is increased the dye filament becomes wavy

throughout indicating transition flow. On further increasing the velocity the filament breaks up and diffuses completely in the water in the glass tube indicating the turbulent flow.

After conducting his experiment with pipes different diameters and with water at different temperatures Reynolds concluded that the various parameters on which the regimes of flow depend can be grouped together in a single non dimensional parameter called Reynolds number. Reynolds number is defined as, the ratio of inertia force per unit volume and is given by

$$\mathbf{Re = \rho vD / \mu = VD/\nu}$$

Where;

Re: Reynolds number

V: velocity of flow

D: characteristic length=diameter in case of pipe flow

ρ: mass density of fluid

μ: dynamic viscosity of fluid

ν :kinematic viscosity of fluid

Reynolds observed that in case of flow through pipe for values of Re<2000 the flow is laminar while offer Re>40000 it is turbulent and for 2000<Re<4000 it is transition flow

PROCEDURE:

1. Obtain the Reynolds' Apparatus and rest it on the top channel of the Hydraulics Bench.
2. Position the outlet pipe and the overflow pipe in the well of the Hydraulics Bench.
3. Securely connect the inlet quick release connector on the Hydraulics Bench to the inlet valve on the Reynolds' apparatus. If the ball bearings on the quick connect are showing the piping is not secure.
4. The feet are adjustable so that the assembly can be leveled.
5. Check that ALL the valves on the Hydraulics Bench are completely CLOSED (clockwise).
6. CLOSE the Flow Control Valve on the Reynolds' apparatus.

7. Turn the motor switch to ON.

8. OPEN the Hydraulics Bench flow control valve found on the front of the Hydraulics bench.

9. Slowly fill the head tank to the overflow level, and then CLOSE the hydraulics bench flow control valve.

10. Open and close the flow control valve on the Reynolds' apparatus to admit water to the flow visualization pipe.

11. Allow the apparatus to stand at least 10 minutes before proceeding.

12. Adjust the height of the dye reservoir assembly such that the hypodermic needle is close to the bell mouth entrance of the visualization tube.

13. Open the inlet valve slightly until water trickles from the outlet pipe.

14. Slowly open the dye flow control valve of the dye reservoir [Note: It takes a while for the dye to exit the hypodermic needle. Do not loosen or tighten the reservoir screw too much, or the thread could be damaged.].

15. Once the flow regime is identified, close the dye flow control valve.

16. The flow rate can be measured using a graduated cylinder and the stopwatch.

17. The temperature can be recorded using a thermometer.

18. Other flow regimes (and flow rates) can be obtained by regulating the flow control valve on the Reynolds' apparatus.

19. When the experiment is finished, turn the pump motor OFF.

20. Disconnect the Reynolds' Apparatus from the Hydraulics Bench and return it to the storage area

TABLE OF OBSERVATIONS AND CALCULATIONS:

Volume collected $V(m^3)$	Time to collect t(s)	Temperature (^oC)	Pipe Area $A(m^2)$	Volume flow rate $Q(m^3/s)$	Kinematic Viscosity $\upsilon(m^2/s)$	Reynolds Number

CONCLUSION AND RECOMMENDATIONS:

- Dose the flow condition observed occur within the expected Reynolds's number range for that condition?
- Describe the velocity profile for laminar and turbulent flows. Dose the profile differs between these two types of flow?