Ministry of Higher Education
& Scientific Research
Al-Isra'a University College
Civil Engineering
Fluid Mechanics Lab.

Second Class

Experiment

Flow Patterns

(Reynolds Number)

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Exp.: Flow Patterns

(Reynolds Number)

Introduction:

The flow pattern in fluids depends on the flow velocity and the physical properties, but the velocities and physical properties may change in the same conditions as the fluid changes. Therefore, the flow patterns of different fluids cannot be reliably measured based on velocity and physical properties. Hence the use of a set of alphanumeric called **Reynolds Number** (Re) which can be used to compare the flow patterns of different fluids regardless of the different velocity and physical properties.

Objective:

Identify fluid flow patterns by calculating flow velocity and Reynolds Number.

Theory:

The flow pattern depends on the specific standard it is Reynolds Number (Re), which is defined as the ratio of internal forces to viscous force, or mathematically as:

$$Re = \frac{\rho \, v \, D}{\mu}$$

Where:

ρ = mass density of fluid (kg/m^3)

v = velocity (m/s)

D = diameter of pipe (m)

μ = viscosity ($N.s/m^2$)

The discharge (flow rate) (**Q**) (m^3/s) is defined as:

$$Q = \frac{V}{t}$$

V = volume (m^3)

t = time (s)

Then,

$$v = \frac{Q}{A}$$

A = area for pipe cross section (m^2) = $\frac{\pi}{4} D^2$

The flow is considered:

- Laminar flow if $Re \leq 2000$
- Transition flow if $2000 < Re < 4000$
- Turbulent flow if $Re \geq 4000$

Apparatus and Devices:

The device used consists of a **transparent tube** connected to the **tank** filled with water at a constant level, a **compensating tank**, **pump**, **drainage pipes** and **flow control valves** as shown in Fig.1 and Fig.2. The device is used with a measuring vessel included (**beaker**) with a stopwatch (**Timer**).

Fig.1

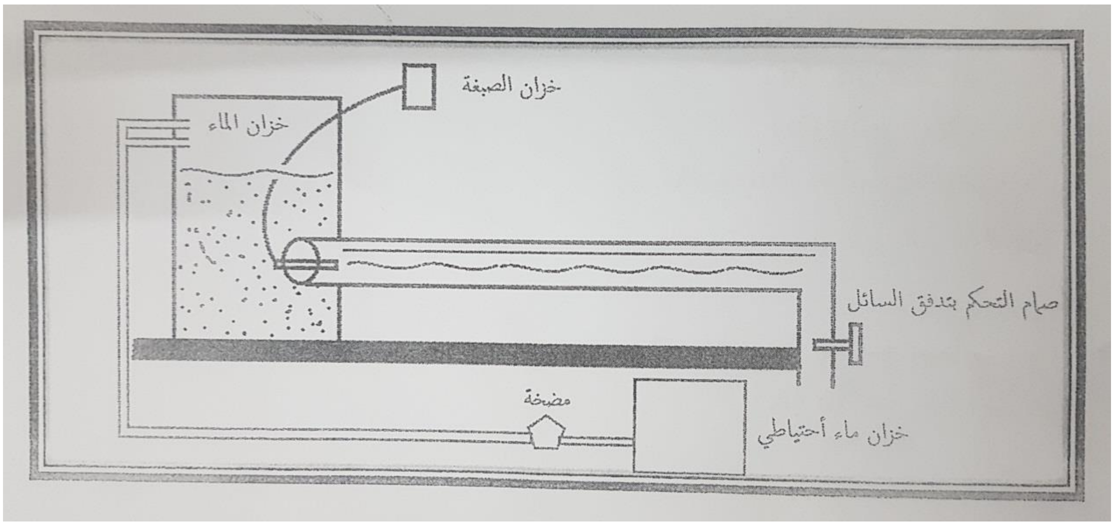

Fig.2

Procedures:

1. The small reservoir fills with dye.
2. Fill the top and bottom tank with water.
3. The flow control valve opens with a certain amount and constant until the flow state is confirmed and stabilized.
4. The control valve opens the dye to allow the pigment to flow in the water a little and paints the shape of the dye path.
5. The outlet valve is controlled so that the dye path is maintained.
6. The water is collected in an included cylinder and we calculate the time to assemble a certain volume in the inserted cylinder and confirm the time and amount of water.
7. We repeat the measurement process at least three times and take the rate to increase the accuracy of the readings. Make sure that the water calculated from the tank is activated by running the pump to raise the water from the compensatory tank.
8. Repeat steps 4 to 8 several times by increasing the flow rate through the control valve until the three cases appear in the dye path in the water.
9. Record the readings at each flow rate and plot the dye path.

Type	V (m^3)	t (s)	Q (m^3/s)	v (m/s)	Re
Laminar					
Transition					
Turbulent					

Discussion:

1. Define Reynolds number and explain its importance in fluid flow?

2. Explain why the water level must be constant in the tank?

3. What are Reynolds number units with the reason?

4. What is the effect of the value of viscosity and density on Reynolds number?