FLUID MECHANICS & HEAT TRANSFER LABROTAROY MANUAL

4TH SEMESTER

DEPARTMENT OF BIOTECHNOLOGY

UCPES, BAM

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Experiment No. 1

Demonstrate Operation Of Reynolds's Apparatus And Find Out Critical Velocity

Aim:- To find critical Reynolds number for a pipe flow.

Apparatus Used:- Flow condition inlet supply, elliptical belt type arrangement for coloured fluid with regulating valve, collecting tank.

Formula Used:- Reynolds No = Inertia force/Viscous force

Theory:-

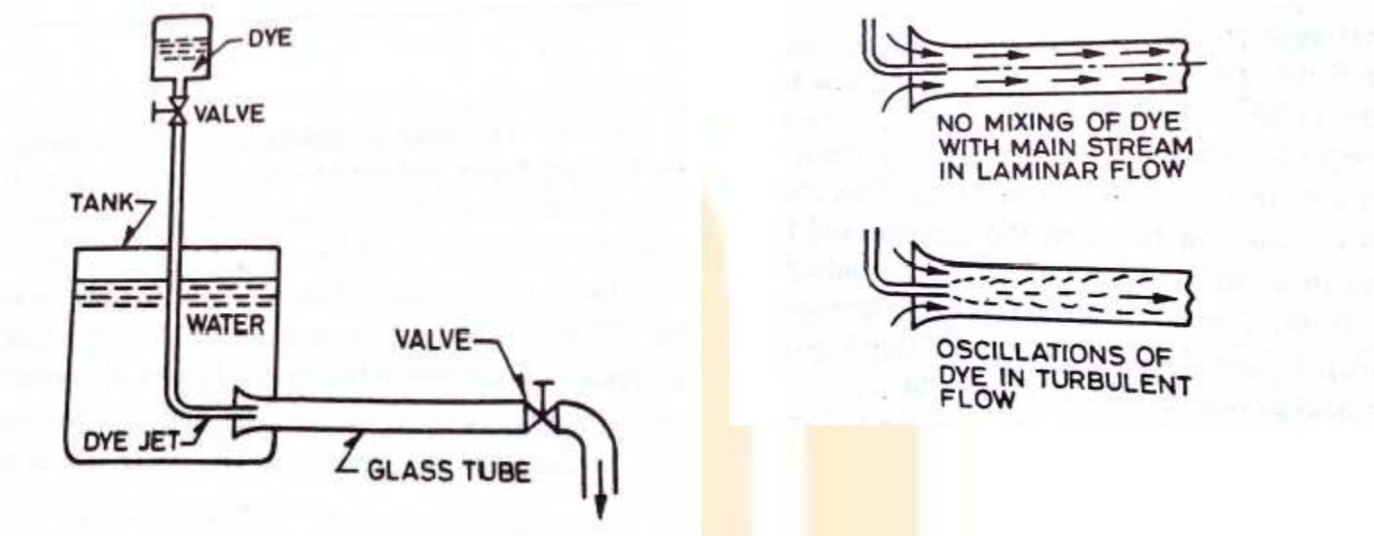

Figure: Reynold No. apparatus

Reynolds Number:- It is defined as ratio of inertia force of a flowing fluid and the viscous force of the fluid. The expression for
Reynolds number is obtained as:-

Inertia force (Fi) = mass . acceleration of flowing

= δ. Volume. Velocity/ time

= δ. ±5*3L4 27L4 Velocity

= δ.area .Velocity . Velocity

= $\delta.A.V^2$

Viscous force (Fv) = Shear stress . area

= τ. A

= μ. du/dy . A

= VA/τ

= δAV2/μ/t.A

= V.L /μ/s

= V.L /v { v = μ/ ρis kinematics viscosity of the fluid }

In case of pipe flow, the linear dimension L is taken as dia (d) hence Reynolds number for pipe flow is :-

Re = V .d /v or
Re = ρVd /v

Procedure:-

1. Fill the supply tank some times before the experiment.
2. The calculated fluid is filled as container.
3. Now set the discharge by using the valve of that particular flow can be obtained.
4. The type of flow of rate is glass tube is made to be known by opening the valve of dye container.
5. Take the reading of discharge for particular flow.
6. Using the formula set the Reynolds no. for that particular flow, aspect the above procedure for all remaining flow.

Observation:-

Type	Time	Discharge				$Q=m^3/3$	$R_e=4Q/\pi\Delta V$
		initial	Final	Difference	Volume		

Precaution:-

1. Take reading of discharge accurately.
2. Set the discharge value accurately for each flow.

Result:-

Viva Questions:-

1. Reynolds number importance?
2. Describe the Reynolds number experiments to demonstrate the two type of flow?
3. Define laminar flow, transition flow and turbulent flow?

Experiment No. 2

Verify Bernoulli's Equation

Aim:- To verify the Bernoulli's theorem.

Apparatus Used:- A supply tank of water, a tapered inclined pipe fitted with no. of piezometer tubes point, measuring tank, scale, stop watch.

Theory:- Bernoulli's theorem states that when there is a continues connection between the particle of flowing mass liquid, the total energy of any sector of flow will remain same provided there is no reduction or addition at any point.

Formula Used:-

HF GF ' HF/I ' KF/2

H = G + H/I + K/2

Procedure:-

1. Open the inlet valve slowly and allow the water to flow from the supply tank.
2. Now adjust the flow to get a constant head in the supply tank to make flow in and out flow equal.
3. Under this condition the pressure head will become constant in the piezometer tubes.
4. Note down the quantity of water collected in the measuring tank for a given interval of time.
5. Compute the area of cross-section under the piezometer tube.
6. Compute the area of cross-section under the tube.
7. Change the inlet and outlet supply and note the reading.
8. Take at least three readings as described in the above steps.

Observation table:

	1	2	3	4	5	6	7	8	9	10	11
Reading of piezometric tubes											
Area of cross section under the foot of each point											
Velocity of water under foot of each point											
$V^2/2g$											
p/ρ											
$V^2/2g + p/\rho$											

Precautions:-

1. When fluid is flowing, there is a fluctuation in the height of piezometer tubes, note the mean position carefully.
2. Carefully keep some level of fluid in inlet and outlet supply tank.

Result:-

Viva Questions:-

1. Briefly explain the various terms involved in Bernoulli's equation?
2. Assumption made to get Bernoulli's equation from Euler's equation by made?

3. What is piezometer tube?

Experiment No. 3

Demonstrate Operation Of Venturimeter And Determine The Venturi Co-Efficient

Aim:- To determine the coefficient of discharge of Venturimeter.

Apparatus Used:- Venturimeter, installed on different diameter pipes, arrangement of varying flow rate, U- tube manometer, collecting tube tank, vernier calliper tube etc.

Formula Used:-

. √

. .2A

Where

A = Cross section area of inlet

a = Cross section area of outlet

h = Head difference in manometer

Q = Discharge

Cd= Coefficient of discharge

g = Acceleration due to gravity

Theory:- Venturimeter are depending on Bernoulli's equation . Venturimeter is a device used for measuring the rate of fluid flowing through a pipe. The consist of three part in short

1. Converging area part
2. Throat
3. Diverging part

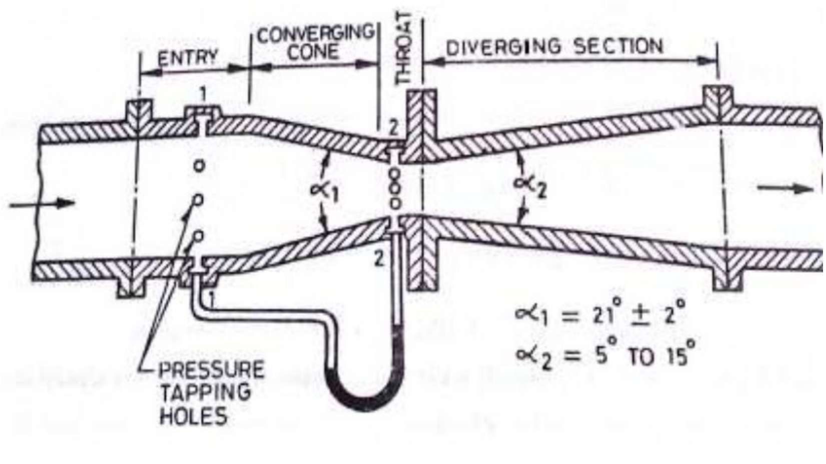

Figure: Venturimeter

Procedure:-

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.
2. Now start the supply at water controlled by the stop valve.
3. One of the valves of any one of the pipe open and close all other of three.
4. Take the discharge reading for the particular flow.
5. Take the reading for the pressure head on from the u-tube manometer for corresponding reading of discharge.
6. Now take three readings for this pipe and calculate the Cd for that instrument using formula.
7. Now close the valve and open valve of other diameter pipe and take the three reading for this.
8. Similarly take the reading for all other diameter pipe and calculate Cd for each.

Observations:-

Diameter of Venturimeter=
Area of cross section =
Venturimeter=
Area of collecting tank=

Discharge					Manometer reading				
Initial (cm.)	Final (cm)	Difference	Time (sec)	Discharge	H_1	H_2	H_2- H1	h=13.6(H_2- H_1)	= . √ – . . 2Δ

Result:-

Precautions:-

1.Keep the other valve closed while taking reading through one pipe.
2.The initial error in the manometer should be subtracted final reading.
3.The parallax error should be avoided.
4.Maintain a constant discharge for each reading.
5.The parallax error should be avoided while taking reading the manometer.

Viva Questions:-

1. Venturimeter are used for flow measuring. How?
2. Define co efficient of discharge?
3. Define parallax error?
4. Define converging area part?
5. Define throat?
6. Define diverging part?

Experiment No. 4

Demonstrate Operation of Orifice Meter And Determine The Orifice Co-Efficient

Aim:- To determine the coefficient of discharge of Orifice meter.

Apparatus Used:- Orifice meter, installed on different pipes, arrangement of varying flow rate, U- tube manometer, collecting tube tank, vernier calliper tube etc.

Formula Used: - ..Δ

Where

A = Cross section area of inlet

a = Cross section area of outlet

h = Head difference in manometer

Q = Discharge

Cd = Coefficient of discharge

g = Acceleration due to gravity

Theory:- Orifice meter are depending on Bernoulli's equation. Orificemeter is a device used for measuring the rate of fluid flowing through a pipe. It is a cheaper device than Venturimeter.

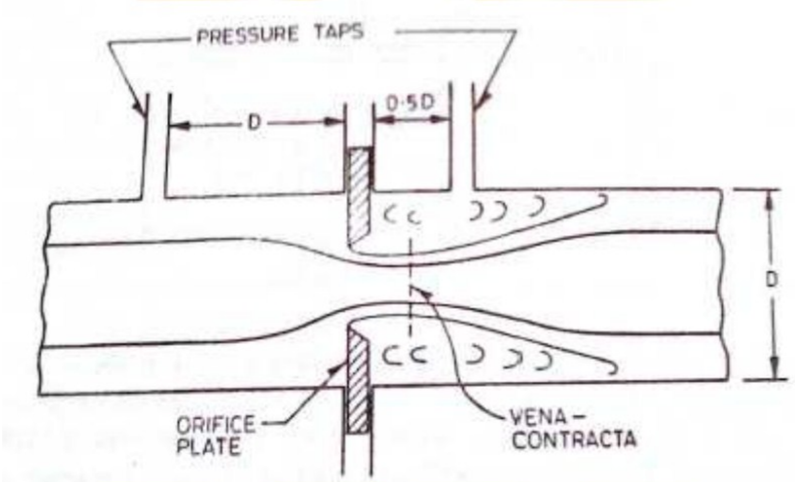

Figure: Orificemeter

Procedure:-

1. Set the manometer pressure to the atmospheric pressure by opening the upper valve.
2. Now start the supply at water controlled by the stop valve.
3. One of the valves of any one of the pipe open and close all other of three.
4. Take the discharge reading for the particular flow.
5. Take the reading for the pressure head on from the u-tube manometer for corresponding reading of discharge.
6. Now take three readings for this pipe and calculate the Cd for that instrument using formula.
7. Now close the valve and open valve of other diameter pipe and take the three reading for this.
8. Similarly take the reading for all other diameter pipe and calculate Cd for each.

Observations:-

Diameter of Orifice meter =

Area of cross section =

Area of collecting tank =

Discharge					Manometer reading				
(cm.) Initial	(cm) Final	Difference	(sec) Time	Discharge	H_1	H_2	H_2-H_1	h=13.6(H_2-H_1)	= . √ . . 2Δ

Result:-

Precautions:-

1. Keep the other valve closed whiletaking reading through one pipe.
2. The initial error in the manometer should be subtracted final reading.
3. The parallax error should be avoided.
4. Maintain a constant discharge for each reading.
5. The parallax error should be avoided while taking reading the manometer.

Viva Questions:-

1. Orificemeter are used for flow measuring. How?
2. Difference between Orificemeter and Venturimeter?

Experiment No. 5

Demonstrate Operation of a Rota Meter And Determine Rate Of Flow Through Rota Meter

Aim: To calibrate the given rotameter and draw its calibration curve.

Apparatus: The apparatus consists of a fluid circuit which includes sump tank, monoblock pump, rotameter and measuring tank connected in series with the help of pipeline to form a fluid flow circuit. Further, control valves are provided to regulate the flow of water (or any liquid). A stop watch is provided in order to measure the time taken for filling the tank with water up to a specific desired level.

Theory: Rotameter is an instrument used for fluid flow measurement. Rotameter is a variable area flow meter. In head flow meters the restriction size remains constant, due to which the differential pressure across it varies with the differential flow rate through it. But in variable area flow meters the restriction size or flow area of restriction is allowed to vary with the fluid flow rate so as to maintain the differential pressure across it constant. Thus any change in the fluid flow rate can be measured in terms of change of flow area, hence the name variable-area flow meter.

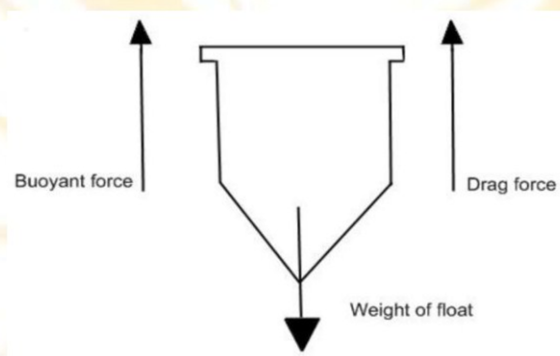

Fig. 1.1 Forces acting upon a rotameter float

Construction: Rotameter consists of a tapered glass tube mounted vertically with smaller end on lower side. The glass tubes are used for metering low temperature and pressure fluids, but for high temperature and pressure service metal tubes are used. A float is installed in the tube after the meter is mounted in the flow line. Floats are usually made of corrosion resistant metals like aluminum, bronze, monel, nickel, stainless steel etc. Usually a series of slanting notches are cut in the underside of the float rim that gives rotation to float so as to reduce the friction. Float material decides the flow-range of the rotameter. Float may have different float shapes. Flow scale is marked on the glass-tube or it is mounted close to the metering tube. Rotameter is installed in the pipe line by means of flanges or threads alongwith the inlet and

outlet piping supports in brackets. The meter must be installed vertically within about 2 geometrical degrees so as to centre the float in the fluid stream.

Working: When no fluid flows through rotameter float rests at the bottom of the tube. As fluid enters the lower side of the tube, float rises due to buoyant and differential pressure force and allows fluid to flow through annular space between float edge and the metering tube. As fluid flow rate increases, float rises in the tube, thus increasing the flow area keeping differential pressure across it constant. On the other hand as fluid flow rate decreases, float falls in the tube, thus decreasing the flow area with constant pressure drop across the float. At given flow rate, float stabilizers at certain fixed position in the tube. The variation in flow area with fluid flow rate can be measured in terms of change in float position. Thus any change in fluid flow rate through rotameter can be measured in terms of change in float position on the scale calibrated in terms of flow rate.

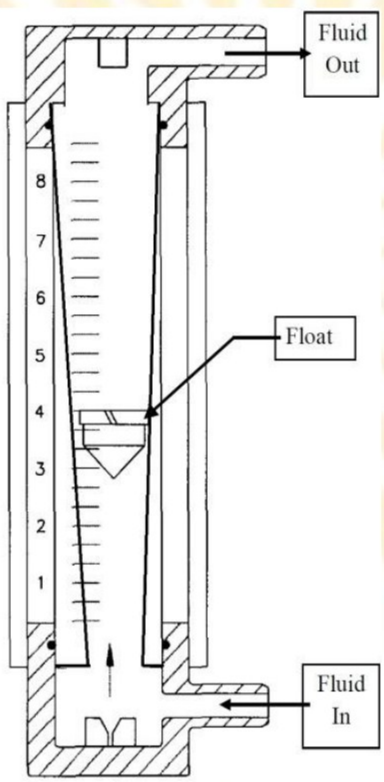

Fig 2Rotameter

Procedure:

1. Start the pump.
2. Operate the valve for flow of fluid through rotameter apparatus and keep it slightly open.
3. Slowly adjust the valve so that the flow of fluid through rotameter is sufficient enough so that the float shows displacement.
4. Measure the flowrate of fluid and corresponding float position in rotameter.
5. The flowrate can be calculated by knowing the time taken for filling the tank for a known level. Hence measure the time taken for filling of tank upto a particular level.
6. Increase the flowrate by opening the valve further.
7. Take the reading for different flow rates.
8. Plot a graph of float position vs. flowrate.

Observation Table:

Obs. No.	Flowrate by Rotameter Q_a (m^3/s)	Measuring Tank reading Z (mm)	Time t (s)	Flowrate Q_a (m^3/s)	Difference in Flowrate Q_a (m^3/s)
1					
2					
3					
4					

Calculations:

To measure discharge (flowrate) Q_a,

$$Q_a = \frac{Volume}{Time} = \frac{L \times B \times Z}{t} \ m^3/s$$

Where,

L = Length of measuring tank in meters,

B = Breadth of measuring tank in meters,

Z = Height (level) in piezometer tube of measuring tank in meter which is under consideration,

t = time taken for filling of water in tank till decided height in seconds, say for ‘Z’ mm.

Result:

Conclusion: