INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

LAB-MANUAL

Experiment No:-5

Study of Flow Measurement using Rotameter

TRANSDUCERS AND INSTRUMENTATION

VIRTUAL LAB

Experiment No:-5

Aim: - Study of Flow Measurement using Rotameter

Apparatus Requirement: -

- Personal computer
- Lab view 2009 Runtime engine
- Internet facility (for online experiment and for offline experiment just download the executable file from the experiment download link given in website)

Theory:-

Rotameter:-

A **Rotameter** is a device that measures the flow rate of liquid or gas in a closed tube. It belongs to a class of meters called variable area meters, which measure flow rate by allowing the cross-sectional area the fluid travels through to vary, causing some measurable effect.

The rotameter is based on the variable area principle: fluid flow raises a float in a tapered tube, increasing the area for passage of the fluid. The greater the flow, the higher the float is raised. The height of the float is directly proportional to the flow rate. With liquids, the float is raised by a combination of the buoyancy of the liquid and the velocity head of the fluid. With gases, buoyancy is negligible, and the float responds to the velocity head alone.

The float moves up or down in the tube in proportion to the fluid flow rate and the annular area between the float and the tube wall. The float reaches a stable position in the tube when the upward force exerted by the flowing fluid equals the downward gravitational force exerted by the weight of the float. A change in flow rate upsets this balance of forces. The float then moves up or down, changing the annular area until it again reaches a position where the forces are in equilibrium. To satisfy the force equation, the rotameter float assumes a distinct position for every constant flow rate. However, it is important to note that because the float position is gravity dependent, rotameter must be vertically oriented and mounted.

Measuring Principles of Variable Area Flow meters:-

- Flow Rate Analysis.
- The forces acting on the bob lead to equilibrium between:
- The weight of the bob(F_W) $\rho_b g V_b$ acting downwards
- The buoyancy force (F_b) $\rho g V_b$ and
- The drag force F_d acting upwards.

$$F_W = F_b + F_d$$

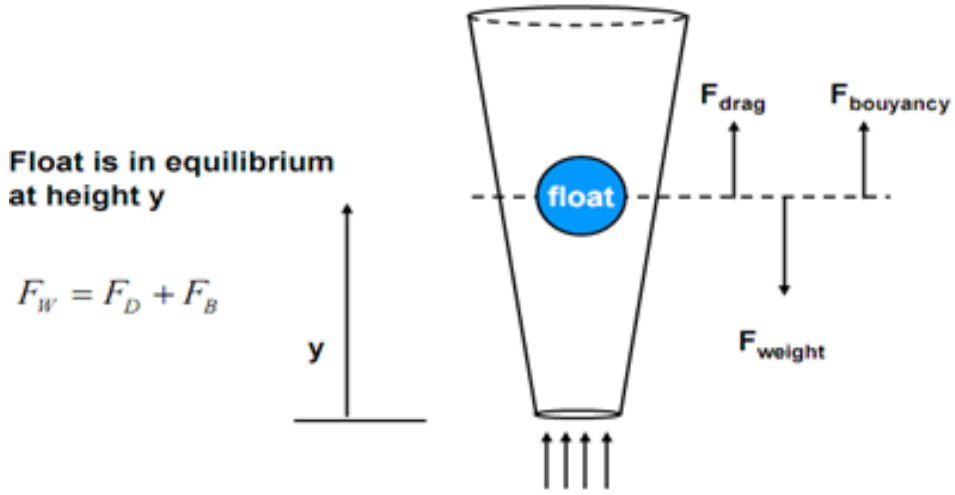
Therefore,

$$\rho_b g V_b = \rho g V_b + F_d$$

$$F_d = \frac{C_T \rho A_f U^2}{2}$$

Where,

V_b = is the volume,
A_f = is cross section area,
C_T = is drag coefficient,
ρ_b =is the density of the bob,
ρ =is the density of the fluid
g = is the gravitational acceleration
U = flow Velocity



The flow rate through a rotameter is given by:

$$u = \sqrt{\frac{2(g)(V_b)}{C(A_0)} \times \frac{\rho_b - \rho_f}{\rho_f}}$$

$$Q = (A)(U)$$

$$A = f(y)$$

Where,

U= flow velocity

ρ_b =density of the bob

ρ_f = density of the fluid

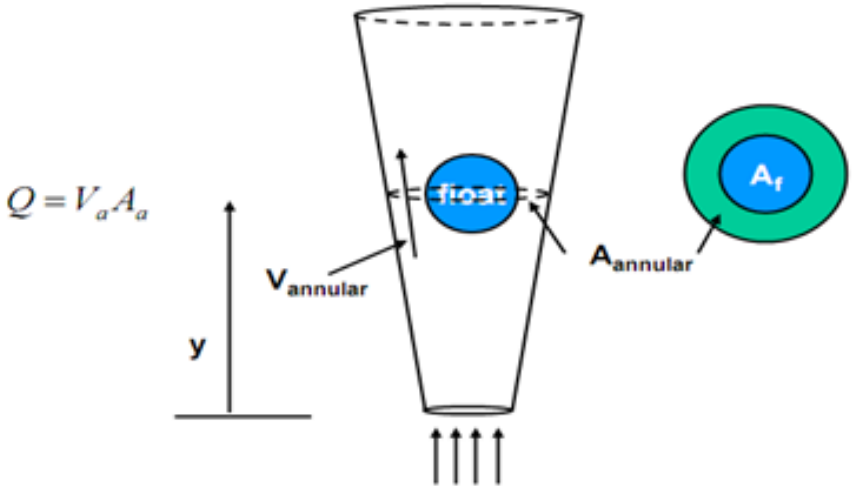
A = area of the annulus between the bob and tube wall

y = distance from the bottom of the meter

$f(y)$ = the function the defines the tube taper

C = a drag coefficient

Q = volumetric flow rate



If the cross-sectional area of the tube is made to increase linearly with length,

Procedure: -

Select the experiment, (Study of Flow Measurement using Rotameter).

1. Click on Start Switch.
2. Now, to change the Cross section Area of Tube so that flow will increase.
3. Check the Flow Velocity (u) and Volumetric Flow rate (Q), and find out the status of float.
4. Finally, Plot the Graph between the volumetric Flow Rate and Flow Velocity, and observe that the graph is linear.
5. If you want the reading of the experiment then click on Getdata. Through this find a table where the reading of experiment will show.
6. Finally Stop the Experiment.

Observational table: -

Sr. No.	Flow Velocity	Volumetric Flow Rate
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Plot the graph between Flow Velocity and Volumetric Flow Rate and study the graph.

Result: -The experiment has been successfully implemented. Through graph we can observe the relation in Flow Velocity & Volumetric Flow Rate. If the cross sectional area of tube is increase then volumetric Flow rate is decrease.

Precaution: -

- Follow instructions carefully.
- For fetching correct value, wait until the process gets complete.
- Runtime engine should be properly installed.