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VERIFICATION OF BERNOULLI'S THEOREM.

Aim :- To verify that in a pipe flow if the incompressible fluid flows then it will be the sum of the terms in Bernoulli's equation and the total head will be constant at all point using piezometer tubes.

Apparatus Required :-

→ A tank to supply water
→ Measuring Tank
→ A tappened pipe fitted with piezometer tubes
→ Stop Watch.

THEORY

Bernoulli's equation uses the principle of conservation of energy to study about fluid flow. It tells us that in a steady flow, non-viscous fluid and the flow is irrotational, the sum of the potential head, pressure head and kinetic head is same at all points.

The Bernoulli's equation can be expressed as:-

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

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where,
P = Pressure (N/m^2)
ρ = density of the fluid. (kg/m^3)
g = gravity / acceleration due to gravity (m/s^2)
v = fluid velocity (m/s)
Z = vertical elevation of the fluid. (m)

So actual discharge, $Q_{ac} = \frac{a \times H}{t}$ m^3/s

a = area of the tank (m^2)
H = height difference of the water column (m)
t = time taken to rise H meter (sec)

Velocity of flow at A is, $V = \frac{Q_{AC}}{A_a}$

Velocity Head, $H_{va} = \frac{V_a^2}{2g}$

Pressure Head, $H_p = \frac{P}{\rho g}$

Rate of flow $Q = \frac{V}{t}$ → Volume
→ time

As, the height or elevation(z) is constant everywhere because of horizontal pipe, so, we can conclude that at a single point of cross section

Pressure Head (H_p) + Velocity Head (H_v) = constant.

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PROCEDURE

* Note down the values of area of the cross section of collecting tank and dimensions of convergent and divergent ducts.

* Adjust the flow of outlet and inlet valve to make the head constant in supply tank. At the constant head, causing

* Note down the readings of the water level of each piezometer tube which are nothing but pressure heads at different points of tapered tube.

* Calculate the Rate of flow from the quantity of water collected and time taken to collect the amount of water.

* Change the flow rate to repeat the experiment.

CALCULATIONS

Volume of Water collected = $a \times H$

Discharge $Q = \frac{V}{t}$ Velocity flow = $\frac{Q}{A}$

Velocity head = $V^2/2g$

Total head = $\frac{P}{\rho g} + \frac{V^2}{2g} = \left(h + \frac{V^2}{2g}\right)$

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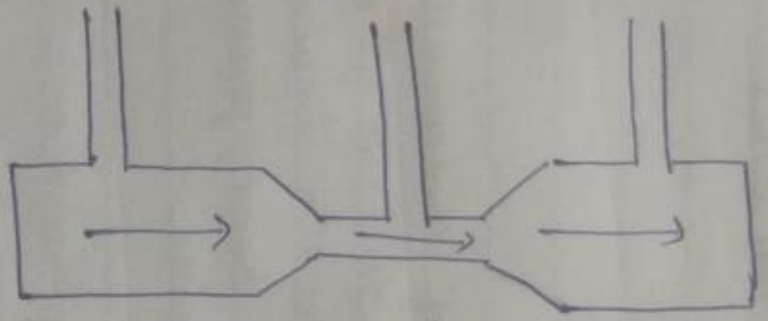
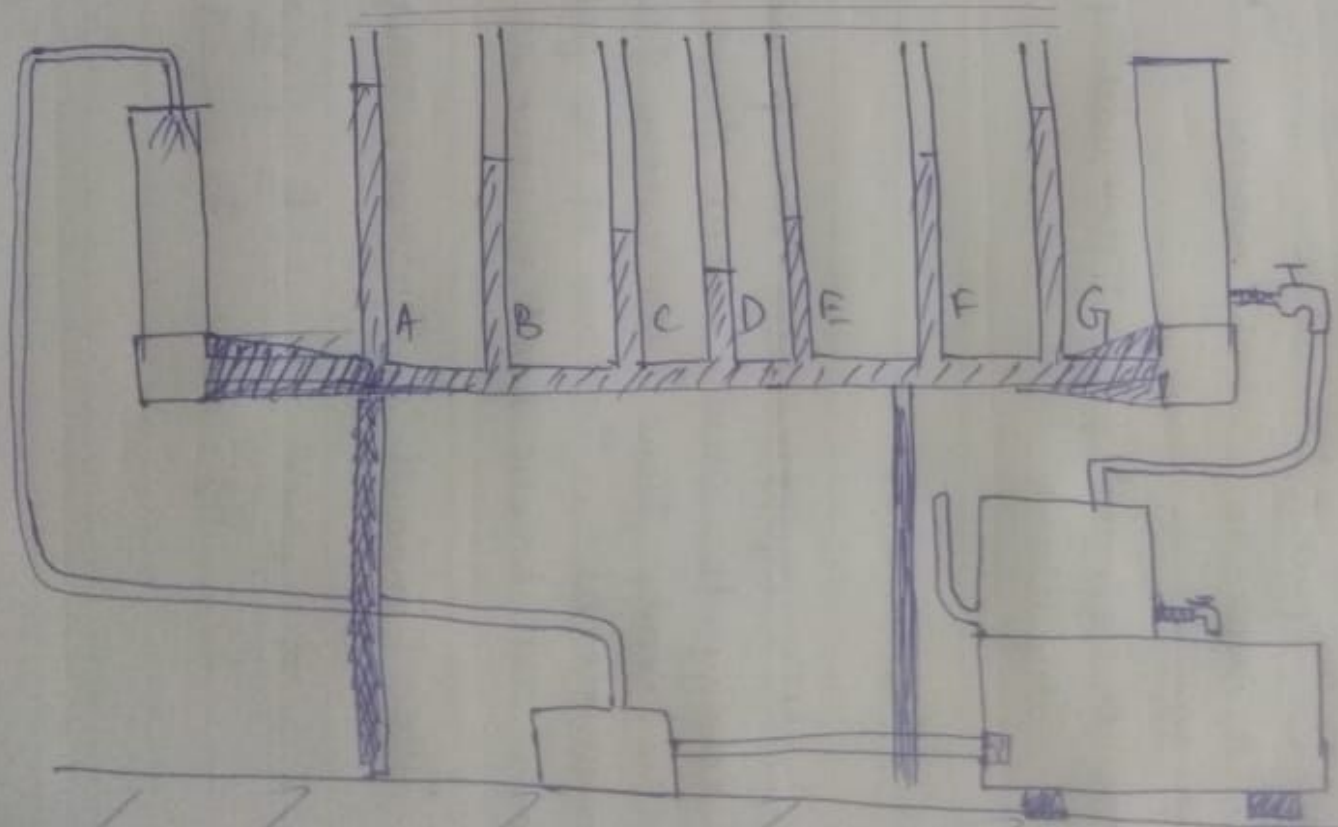


(Bernoulli's Apparatus)



SNo	Head H (cm)	Head cm	Time for collecting $V m^3$ of water in Tank (sec)	Duct NO	Area A	Velocity $\frac{Q}{A}$ (m/s)	Velocity Head $V^2/2g$ (m)	Pressure Head. m	Hp + Hv
1	High	22.3	60	1	0.394	0.81	0.033	0.223	0.256
		21.6		2	0.176	1.12	0.064	0.216	8.279
		16.6		3	0.109	1.81	0.1607	0.166	0.833
		8.9		4	0.0985	2	0.203	0.089	0.292
		8		5	0.109	1.81	0.167	0.080	0.247
		13.6		6	0.176	1.12	0.064	0.136	0.200
		15		7	0.394	0.5	0.012	0.15	0.162
2	Low	27.5	60	1	0.394	0.25	0.0032	0.276	0.280
		27.7		2	0.176	0.56	0.016	0.277	0.232
		27		3	0.109	0.895	0.8	0.270	0.350
		26.2		4	0.0985	0.99	0.98	0.262	1.242
		26		5	0.109	0.895	0.8	0.26	1.06
		26.1		6	0.176	0.56	0.015	0.261	0.276
		26.3		7	0.394	0.25	0.002	0.263	0.266

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RESULT

The Bernoulli's Equation is verified and the variation in total head is due to frictional loss.

PRECAUTION

→ Discharge should be kept constant throught observation.
→ Depth should be observed.

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