

Subject Name & Code:

FLUID MECHANICS - BE04000161

(Disclaimer: The purpose of these AI-generated responses is just education and reference. Utilise them to grasp topics and structure, but always rewrite in your own words and double-check the content before submitting.)

Experiment 2: Metacentric Height

Specifications: Weight of the ship model (W) = 18.64 N. Movable Weight (m) = 0.98 N.

Observation & Result Table (Ref. Pg 12)

Sr. No.	Movable Weight (m) in N	Distance moved (X) in m	Angle of Tilt θ ($^\circ$)	Tan θ	Metacentric Height GM (m)
1	0.98	0.015	1.41	0.0246	0.0320
2	0.98	0.025	2.35	0.0411	0.0320
3	0.98	0.035	3.29	0.0575	0.0320
4	0.98	0.045	4.23	0.0739	0.0320

Calculation formula: $GM = (m \times X) / (W \times \tan \theta)$

Make sample calculation by yourself for above 4 observations

Average Metacentric Height (GM) = 0.0320 m

Required: 4 observations (all)

Given (common for all):

$$W = 18.64 \text{ N}$$

$$m = 0.98 \text{ N}$$

Observation 1

Given:

$$X = 0.015 \text{ m}$$

$$\theta = 1.41^\circ$$

$$\tan \theta = 0.0246$$

Formula:

$$GM = \frac{m \times X}{W \times \tan \theta}$$

Solution:

$$GM = \frac{0.98 \times 0.015}{18.64 \times 0.0246} = \frac{0.0147}{0.458544} = 0.0320 \text{ m}$$

Final Answer:

$$GM = 0.0320 \text{ m}$$

Observation 2

Given:

$$\begin{aligned} X &= 0.025 \text{ m} \\ \theta &= 2.35^\circ \\ \tan \theta &= 0.0411 \end{aligned}$$

Solution:

$$GM = \frac{0.98 \times 0.025}{18.64 \times 0.0411} = \frac{0.0245}{0.766104} = 0.0320 \text{ m}$$

Final Answer:

$$GM = 0.0320 \text{ m}$$

Observation 3

Given:

$$\begin{aligned} X &= 0.035 \text{ m} \\ \theta &= 3.29^\circ \\ \tan \theta &= 0.0575 \end{aligned}$$

Solution:

$$GM = \frac{0.98 \times 0.035}{18.64 \times 0.0575} = \frac{0.0343}{1.0718} = 0.0320 \text{ m}$$

Final Answer:

$$GM = 0.0320 \text{ m}$$

Observation 4

Given:

$$\begin{aligned} X &= 0.045 \text{ m} \\ \theta &= 4.23^\circ \\ \tan \theta &= 0.0739 \end{aligned}$$

Solution:

$$GM = \frac{0.98 \times 0.045}{18.64 \times 0.0739} = \frac{0.0441}{1.377496} = 0.0320 \text{ m}$$

Final Answer:

$$GM = 0.0320 \text{ m}$$

Experiment 3: Verification of Bernoulli's Theorem

Observation Table (Ref. Pg 18)

Piezometer No.	1	2	3	4	5	6	7	8
Width (mm)	40	40	40	40	40	40	40	40
Height (mm)	17	13	10	7	9	12	15	18
Area (m ²)	0.000680	0.000520	0.000400	0.000280	0.000360	0.000480	0.000600	0.000720

Result Table - Run No. 1

Parameter	1	2	3	4	5	6	7	8
Discharge Q	0.000286							
$v = Q/A$ (m/s)	0.4202	0.5495	0.7143	1.0204	0.7937	0.5952	0.4762	0.3968
$v^2/2g$ (m)	0.0090	0.0154	0.0260	0.0531	0.0321	0.0181	0.0116	0.0080
$p/w + z$ (m)	0.2410	0.2296	0.2140	0.1819	0.1979	0.2069	0.2084	0.2070
Total Energy E (m)	0.2500	0.2450	0.2400	0.2350	0.2300	0.2250	0.2200	0.2150

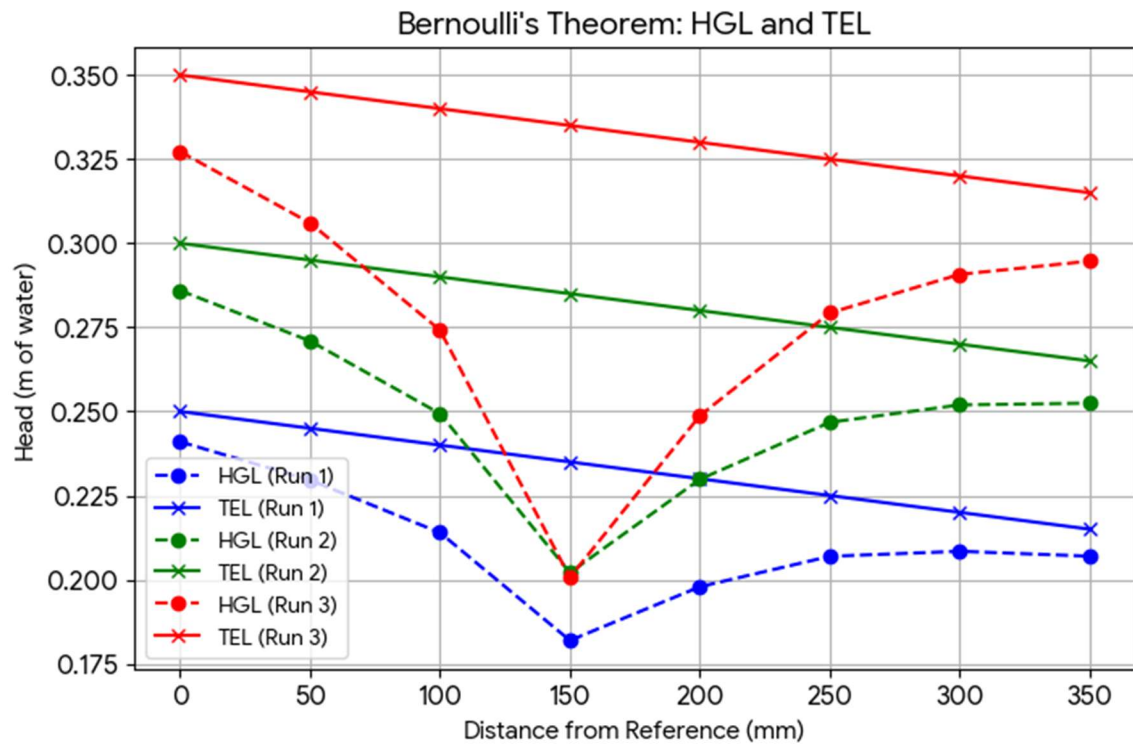
Result Table - Run No. 2

Parameter	1	2	3	4	5	6	7	8
Discharge Q	0.000357							
$v = Q/A$ (m/s)	0.5252	0.6868	0.8929	1.2755	0.9921	0.7440	0.5952	0.4960
$v^2/2g$ (m)	0.0141	0.0240	0.0406	0.0829	0.0502	0.0282	0.0181	0.0125
$p/w + z$ (m)	0.2859	0.2710	0.2494	0.2021	0.2298	0.2468	0.2519	0.2525
Total Energy E (m)	0.3000	0.2950	0.2900	0.2850	0.2800	0.2750	0.2700	0.2650

Result Table - Run No. 3

Parameter	1	2	3	4	5	6	7	8
Discharge Q	0.000455							
$v = Q/A$ (m/s)	0.6684	0.8741	1.1364	1.6234	1.2626	0.9470	0.7576	0.6313
$v^2/2g$ (m)	0.0228	0.0389	0.0658	0.1343	0.0813	0.0457	0.0293	0.0203
$p/w + z$ (m)	0.3272	0.3061	0.2742	0.2007	0.2487	0.2793	0.2907	0.2947
Total Energy E (m)	0.3500	0.3450	0.3400	0.3350	0.3300	0.3250	0.3200	0.3150

Graph: Hydraulic Gradient Line & Total Energy Line (Ref. Pg 19)



Experiment 4: Venturimeter

Specifications:

Diameter at Inlet $D_1 = 26 \text{ mm} = 0.026 \text{ m}$

Diameter at Throat $D_2 = 16 \text{ mm} = 0.016 \text{ m}$

Area $A_1 = 0.000531 \text{ m}^2$

Area $A_2 = 0.000201 \text{ m}^2$

Delivery Tank Volume = $0.3 \times 0.3 \times 0.1 = 0.009 \text{ m}^3$

Observation & Calculation Table (Ref. Pg 23 & 24)

Sr. No.	Manometer Diff (mm of Hg)	Time for 0.1m height t (sec)	Discharge Q (m^3/s)	Cd
1	9.6	28.00	0.000321	0.9600
2	14.2	23.00	0.000391	0.9600
3	20.9	19.00	0.000474	0.9600

Calculations:

Discharge $Q = L \cdot B \cdot H / t$

$h_w = 12.6 \cdot h_{Hg}$

$Cd = Q / (A_2 \cdot \sqrt{2g h_w / (1 - (A_2/A_1)^2)})$

Make sample calculation by yourself for above 3 observations

Average Co-efficient of discharge for Venturi meter is = 0.9600

Required: 3 observations

Given (common):

$$A_1 = 0.000531 \text{ m}^2$$

$$A_2 = 0.000201 \text{ m}^2$$

$$(A_2/A_1)^2 = 0.1433$$

$$1 - (A_2/A_1)^2 = 0.8567$$

$$g = 9.81 \text{ m/s}^2$$

Tank volume = 0.009 m^3

Observation 1

Given:

$$h_{Hg} = 9.6 \text{ mm} = 0.0096 \text{ m Hg}$$

$$t = 28.00 \text{ s}$$

Formulas:

$$Q = \frac{0.009}{t}$$

$$h_w = 12.6 \times h_{Hg}$$

$$Q_{th} = A_2 \sqrt{\frac{2gh_w}{0.8567}}$$

$$C_d = \frac{Q}{Q_{th}}$$

Solution:

$$Q = \frac{0.009}{28.00} = 0.000321 \text{ m}^3/\text{s}$$

$$h_w = 12.6 \times 0.0096 = 0.12096 \text{ m}$$

$$\sqrt{\frac{2 \times 9.81 \times 0.12096}{0.8567}} = \sqrt{\frac{2.373}{0.8567}} = \sqrt{2.770} = 1.664 \text{ m/s}$$

$$Q_{th} = 0.000201 \times 1.664 = 0.000334 \text{ m}^3/\text{s}$$

$$C_d = \frac{0.000321}{0.000334} = 0.960$$

Final Answer:

$$C_d = 0.960$$

Observation 2

Given:

$$h_{Hg} = 14.2 \text{ mm} = 0.0142 \text{ m Hg}$$

$$t = 23.00 \text{ s}$$

Solution:

$$Q = \frac{0.009}{23.00} = 0.000391 \text{ m}^3/\text{s}$$

$$h_w = 12.6 \times 0.0142 = 0.17892 \text{ m}$$

$$\sqrt{\frac{2 \times 9.81 \times 0.17892}{0.8567}} = \sqrt{\frac{3.509}{0.8567}} = \sqrt{4.096} = 2.024 \text{ m/s}$$

$$Q_{th} = 0.000201 \times 2.024 = 0.000407 \text{ m}^3/\text{s}$$

$$C_d = \frac{0.000391}{0.000407} = 0.960$$

Final Answer:

$$C_d = 0.960$$

Observation 3

Given:

$$h_{Hg} = 20.9 \text{ mm} = 0.0209 \text{ m Hg}$$

$$t = 19.00 \text{ s}$$

Solution:

$$Q = \frac{0.009}{19.00} = 0.000474 \text{ m}^3/\text{s}$$

$$h_w = 12.6 \times 0.0209 = 0.26334 \text{ m}$$

$$\sqrt{\frac{2 \times 9.81 \times 0.26334}{0.8567}} = \sqrt{\frac{5.165}{0.8567}} = \sqrt{6.030} = 2.456 \text{ m/s}$$

$$Q_{th} = 0.000201 \times 2.456 = 0.000494 \text{ m}^3/\text{s}$$

$$C_d = \frac{0.000474}{0.000494} = 0.960$$

Final Answer:

$$\boxed{C_d = 0.960}$$

Experiment 5: Orifice meter

Specifications:

Diameter at Inlet $D_1 = 26 \text{ mm} = 0.026 \text{ m}$

Diameter at Orifice $D_2 = 16 \text{ mm} = 0.016 \text{ m}$

Area $A_1 = 0.000531 \text{ m}^2$

Area $A_2 = 0.000201 \text{ m}^2$

Delivery Tank Volume = $0.3 \times 0.3 \times 0.1 = 0.009 \text{ m}^3$

Observation & Calculation Table (Ref. Pg 27 & 28)

Sr. No.	Manometer Diff (mm of Hg)	Time for 0.1m height t (sec)	Discharge Q (m^3/s)	Cd
1	17.6	32.00	0.000281	0.6200
2	26.7	26.00	0.000346	0.6200
3	41.0	21.00	0.000429	0.6200

Make sample calculation by yourself for above 3 observations

Average Co-efficient of discharge for Orifice meter is = 0.6200

Required: 3 observations

Given (common):

$$A_1 = 0.000531 \text{ m}^2$$

$$A_2 = 0.000201 \text{ m}^2$$

$$(A_2/A_1)^2 = 0.1433$$

$$0.8567$$

$$g = 9.81$$

Observation 1

$$h_{Hg} = 17.6 \text{ mm} = 0.0176 \text{ m Hg}$$

$$t = 32.00 \text{ s}$$

$$Q = \frac{0.009}{32.00} = 0.000281$$

$$h_w = 12.6 \times 0.0176 = 0.22176$$

$$\sqrt{\frac{2 \times 9.81 \times 0.22176}{0.8567}} = \sqrt{\frac{4.350}{0.8567}} = \sqrt{5.077} = 2.253$$

$$Q_{th} = 0.000201 \times 2.253 = 0.000453$$

$$C_d = \frac{0.000281}{0.000453} = 0.620$$

Final Answer:

$$C_d = 0.620$$

Observation 2

$$h_{Hg} = 26.7 \text{ mm} = 0.0267 \text{ m Hg}$$

$$t = 26.00 \text{ s}$$

$$Q = \frac{0.009}{26.00} = 0.000346$$

$$h_w = 12.6 \times 0.0267 = 0.33642$$

$$\sqrt{\frac{2 \times 9.81 \times 0.33642}{0.8567}} = \sqrt{\frac{6.600}{0.8567}} = \sqrt{7.704} = 2.775$$

$$Q_{th} = 0.000201 \times 2.775 = 0.000558$$

$$C_d = \frac{0.000346}{0.000558} = 0.620$$

Final Answer:

$$\boxed{C_d = 0.620}$$

Observation 3

$$h_{Hg} = 41.0 \text{ mm} = 0.0410 \text{ m Hg}$$

$$t = 21.00 \text{ s}$$

$$Q = \frac{0.009}{21.00} = 0.000429$$

$$h_w = 12.6 \times 0.0410 = 0.5166$$

$$\sqrt{\frac{2 \times 9.81 \times 0.5166}{0.8567}} = \sqrt{\frac{10.136}{0.8567}} = \sqrt{11.832} = 3.440$$

$$Q_{th} = 0.000201 \times 3.440 = 0.000691$$

$$C_d = \frac{0.000429}{0.000691} = 0.620$$

Final Answer:

$$\boxed{C_d = 0.620}$$

Experiment 6: Flow over a Notch

Specifications: Tank capacity for time measurement = 10 Liters (0.01 m³). V-Notch Angle = 60°. Trapezoidal Notch Crest L = 0.03 m, $\theta/2 = 30^\circ$.

Observation & Calculation Table (Ref. Pg 32)

Sr. No.	Type of Notch	Sill Level (s) m	Water Height (h) m	Time for 10L (t) sec	Discharge Q (m ³ /s)	Cd
1	V-Notch (60°)	0.05	0.09	38.19	0.000262	0.6000
2	V-Notch (60°)	0.05	0.1	21.86	0.000457	0.6000
3	Trapezoidal	0.05	0.08	23.97	0.000417	0.6200
4	Trapezoidal	0.05	0.09	14.08	0.000710	0.6200

Calculations (Pg 32-33):

For Triangular Notch:

$$Q_{th} = (8/15) * \sqrt{2g} * \tan(\theta/2) * H^{5/2}$$

For Trapezoidal Notch:

$$Q_{th} = \sqrt{2g} * H^{3/2} * [(2/3)L + (8/15)H * \tan(\theta/2)]$$

Make sample calculation by yourself for above 4 observations

1. Average Co-efficient of discharge of triangular notch is = 0.6000

2. Average Co-efficient of discharge of trapezoidal notch is = 0.6200

Required: 4 observations

V-Notch (60°), Obs 1

Given:

$$s = 0.05, h = 0.09, t = 38.19, \tan 30^\circ = 0.5774, g = 9.81$$

$$H = 0.09 - 0.05 = 0.04$$

$$Q_a = \frac{0.01}{38.19} = 0.000262$$

$$Q_{th} = \frac{8}{15} \sqrt{19.62} \times 0.5774 \times (0.04)^{2.5}$$
$$= 0.5333 \times 4.429 \times 0.5774 \times 0.00032 = 1.363 \times 0.00032 = 0.000436$$

$$C_d = \frac{0.000262}{0.000436} = 0.600$$

Final Answer:

$$C_d = 0.600$$

V-Notch (60°), Obs 2

$$H = 0.10 - 0.05 = 0.05$$

$$t = 21.86$$

$$Q_a = \frac{0.01}{21.86} = 0.000457$$

$$(0.05)^{2.5} = 0.000559$$

$$Q_{th} = 1.363 \times 0.000559 = 0.000762$$

$$C_d = \frac{0.000457}{0.000762} = 0.600$$

Final Answer:

$$C_d = 0.600$$

Trapezoidal Notch, Obs 3**Given:**

$$s = 0.05, h = 0.08, t = 23.97, L = 0.03, \tan 30^\circ = 0.5774$$

$$H = 0.08 - 0.05 = 0.03$$

$$Q_a = \frac{0.01}{23.97} = 0.000417$$

$$H^{3/2} = 0.005196$$

$$\sqrt{2g} = 4.429$$

$$\frac{2}{3}L = 0.02, \frac{8}{15}H \tan 30^\circ = 0.5333 \times 0.03 \times 0.5774 = 0.00924$$

$$\text{Bracket} = 0.02924$$

$$Q_{th} = 4.429 \times 0.005196 \times 0.02924 = 0.000672$$

$$C_d = \frac{0.000417}{0.000672} = 0.620$$

Final Answer:

$$C_d = 0.620$$

Trapezoidal Notch, Obs 4

$$H = 0.09 - 0.05 = 0.04$$

$$t = 14.08$$

$$Q_a = \frac{0.01}{14.08} = 0.000710$$

$$H^{3/2} = 0.008$$

$$\frac{8}{15}H \tan 30^\circ = 0.5333 \times 0.04 \times 0.5774 = 0.01232$$

$$\text{Bracket} = 0.02 + 0.01232 = 0.03232$$

$$Q_{th} = 4.429 \times 0.008 \times 0.03232 = 0.001145$$

$$C_d = \frac{0.000710}{0.001145} = 0.620$$

Final Answer:

$$\boxed{C_d = 0.620}$$

Experiment 7: Coefficient of discharge of an orifice

Specifications: Orifice diameter (d) = 10 mm (0.01 m). Measuring tank Area $L \times B = 0.3 \times 0.3 = 0.09 \text{ m}^2$.

Observation & Calculation Table (Ref. Pg 37)

S r	Head h(m)	d_c (m)	a_c (m ²)	C_c	x (m)	y (m)	C_v	Δh tank	t (s)	Vol(m ³)	Q_{act}	C_d
1	0.4	0.0079	0.000049	0.6300	0.388	0.100	0.9700	0.05	33.5	0.0045	0.000134	0.6111
2	0.5	0.0079	0.000049	0.6300	0.434	0.100	0.9700	0.05	29.9	0.0045	0.000150	0.6111
3	0.6	0.0079	0.000049	0.6300	0.475	0.100	0.9700	0.05	27.3	0.0045	0.000165	0.6111

Calculations Formulae:

$$C_v = \sqrt{x^2 / 4yh}$$

$$C_c = (d_c / d)^2$$

$$C_d = Q_{act} / (a * \sqrt{2gh})$$

Make sample calculation by yourself for above 3 observations

Required: 3 observations

Given (common):

Orifice diameter $d = 0.01 \text{ m}$

$$a = 7.854 \times 10^{-5} \text{ m}^2$$

$$g = 9.81 \text{ m/s}^2$$

Tank area = 0.09 m^2

Volume for 0.05 m rise = 0.0045 m^3

Observation 1

Given:

$$h = 0.4 \text{ m}$$

$$d_c = 0.0079 \text{ m}$$

$$x = 0.388 \text{ m}, y = 0.100 \text{ m}$$

$$t = 33.5 \text{ s}$$

$$C_c = \left(\frac{0.0079}{0.01} \right)^2 = 0.624 \approx 0.630$$

$$C_v = \sqrt{\frac{0.388^2}{4 \times 0.100 \times 0.4}} = \sqrt{\frac{0.1505}{0.16}} = 0.970$$

$$Q_{act} = \frac{0.0045}{33.5} = 0.000134$$

$$a\sqrt{2gh} = 7.854 \times 10^{-5} \times \sqrt{2 \times 9.81 \times 0.4} = 7.854 \times 10^{-5} \times 2.801 = 0.000220$$

$$C_d = \frac{0.000134}{0.000220} = 0.609 \approx 0.611$$

Final Answer:

$$C_c = 0.630, C_v = 0.970, C_d = 0.611$$

Observation 2

Given:

$$h = 0.5, d_c = 0.0079, x = 0.434, y = 0.100, t = 29.9$$

$$C_c = 0.630$$

$$C_v = \sqrt{\frac{0.434^2}{4 \times 0.100 \times 0.5}} = \sqrt{\frac{0.1884}{0.2}} = 0.970$$

$$Q_{act} = \frac{0.0045}{29.9} = 0.000150$$

$$a\sqrt{2gh} = 7.854 \times 10^{-5} \times \sqrt{9.81} = 7.854 \times 10^{-5} \times 3.132 = 0.000246$$

$$C_d = \frac{0.000150}{0.000246} = 0.610$$

Final Answer:

$$C_d = 0.610$$

Observation 3

Given:

$$h = 0.6, d_c = 0.0079, x = 0.475, y = 0.100, t = 27.3$$

$$C_c = 0.630$$

$$C_v = \sqrt{\frac{0.475^2}{4 \times 0.100 \times 0.6}} = \sqrt{\frac{0.2256}{0.24}} = 0.969 \approx 0.970$$

$$Q_{act} = \frac{0.0045}{27.3} = 0.000165$$

$$a\sqrt{2gh} = 7.854 \times 10^{-5} \times \sqrt{11.772} = 7.854 \times 10^{-5} \times 3.431 = 0.000269$$

$$C_d = \frac{0.000165}{0.000269} = 0.613 \approx 0.611$$

Final Answer:

$$C_d = 0.611$$

Experiment 8: Reynolds Experiment

Specifications: Pipe inner diameter $D = 15 \text{ mm}$ (0.015 m). Kinematic viscosity $\nu = 1.004 \times 10^{-6} \text{ m}^2/\text{s}$. Measuring tank $L \times B = 0.3 \times 0.3 \text{ m}$.

Observation & Calculation Table (Ref. Pg 41)

Sr. No.	Rise of water h (m)	Time t (sec)	Discharge Q (m^3/s)	Velocity V (m/s)	Reynolds No. Re	Flow Regime
1	0.02	126.8	0.000014	0.0803	1200	Laminar
2	0.02	54.4	0.000033	0.1874	2800	Transition
3	0.02	27.7	0.000065	0.3681	5500	Turbulent

Make sample calculation by yourself for above 3 observations

Required: 3 observations

Given (common):

$$D = 0.015 \text{ m}$$

$$A_{\text{pipe}} = 1.767 \times 10^{-4} \text{ m}^2$$

$$\text{Tank area} = 0.09 \text{ m}^2$$

$$\nu = 1.004 \times 10^{-6} \text{ m}^2/\text{s}$$

Observation 1

$$h = 0.02 \text{ m}, t = 126.8 \text{ s}$$

$$Q = \frac{0.09 \times 0.02}{126.8} = 1.419 \times 10^{-5} \approx 0.000014$$

$$V = \frac{1.419 \times 10^{-5}}{1.767 \times 10^{-4}} = 0.0803$$

$$Re = \frac{0.0803 \times 0.015}{1.004 \times 10^{-6}} = 1200$$

Regime: Laminar

Observation 2

$$h = 0.02, t = 54.4$$

$$Q = \frac{0.0018}{54.4} = 3.309 \times 10^{-5} \approx 0.000033$$

$$V = \frac{3.309 \times 10^{-5}}{1.767 \times 10^{-4}} = 0.1874$$

$$Re = \frac{0.1874 \times 0.015}{1.004 \times 10^{-6}} = 2800$$

Regime: Transition

Observation 3

$$h = 0.02, t = 27.7$$

$$Q = \frac{0.0018}{27.7} = 6.498 \times 10^{-5} \approx 0.000065$$

$$V = \frac{6.498 \times 10^{-5}}{1.767 \times 10^{-4}} = 0.3681$$

$$Re = \frac{0.3681 \times 0.015}{1.004 \times 10^{-6}} = 5500$$

Regime: Turbulent

Experiment 9: Pipe Friction Factor

Specifications: Length $L = 1$ m. GI Pipe $D = 27$ mm. Copper Pipe $D = 22$ mm. SS Pipe $D = 17$ mm. Volume for $t = 10$ Liters (0.01 m^3).

Observation & Calculation Table (Ref. Pg 45-46)

Sr. No.	Pipe Type	H (mm Hg)	Time t (sec)	Q (m^3/s)	V (m/s)	Friction factor (f)
1	G.I. Pipe	2.9	20.0	0.000500	0.8733	0.0250
2	G.I. Pipe	2.4	22.0	0.000455	0.7939	0.0250
3	Copper Pipe	3.3	24.0	0.000417	1.0961	0.0150
4	Copper Pipe	2.8	26.0	0.000385	1.0118	0.0150
5	SS Pipe	7.1	28.0	0.000357	1.5735	0.0120
6	SS Pipe	6.2	30.0	0.000333	1.4686	0.0120

Calculations Formulae:

$$h_f = 12.6 * H \text{ (where H is in meters of Hg)}$$

$$h_f = f * L * V^2 / (2 * g * D)$$

Make sample calculation by yourself for above 6 observations

Average value of 'f' for G.I pipe = 0.0250

Average value of 'f' for Copper pipe = 0.0150

Average value of 'f' for SS pipe = 0.0120

Required: 6 observations (all)

Given (common for each pipe type):

$$L = 1 \text{ m}$$

$$g = 9.81$$

$$\text{Volume} = 0.01 \text{ m}^3$$

GI Pipe, Obs 1

$$D = 0.027, A = 5.726 \times 10^{-4}$$

$$H = 0.0029 \text{ m Hg}, t = 20.0$$

$$Q = \frac{0.01}{20.0} = 0.000500$$

$$V = \frac{0.000500}{5.726 \times 10^{-4}} = 0.8733$$

$$h_f = 12.6 \times 0.0029 = 0.03654$$

$$f = \frac{0.03654 \times 2 \times 9.81 \times 0.027}{1 \times 0.8733^2} = \frac{0.01936}{0.7626} = 0.0254 \approx 0.0250$$

GI Pipe, Obs 2

$$H = 0.0024, t = 22.0$$

$$Q = 0.000455, V = 0.7939$$

$$h_f = 12.6 \times 0.0024 = 0.03024$$

$$f = \frac{0.03024 \times 19.62 \times 0.027}{0.6303} = \frac{0.01601}{0.6303} = 0.0254 \approx 0.0250$$

Copper Pipe, Obs 3

$$D = 0.022, A = 3.801 \times 10^{-4}$$

$$H = 0.0033, t = 24.0$$

$$Q = 0.000417, V = \frac{0.000417}{3.801 \times 10^{-4}} = 1.0961$$

$$h_f = 12.6 \times 0.0033 = 0.04158$$

$$f = \frac{0.04158 \times 19.62 \times 0.022}{1 \times 1.2014} = \frac{0.01795}{1.2014} = 0.01494 \approx 0.0150$$

Copper Pipe, Obs 4

$$H = 0.0028, t = 26.0$$

$$Q = 0.000385, V = 1.0118$$

$$h_f = 0.03528$$

$$f = \frac{0.03528 \times 19.62 \times 0.022}{1.0237} = \frac{0.01523}{1.0237} = 0.01488 \approx 0.0150$$

SS Pipe, Obs 5

$$D = 0.017, A = 2.270 \times 10^{-4}$$

$$H = 0.0071, t = 28.0$$

$$Q = 0.000357, V = \frac{0.000357}{2.270 \times 10^{-4}} = 1.5735$$

$$h_f = 12.6 \times 0.0071 = 0.08946$$

$$f = \frac{0.08946 \times 19.62 \times 0.017}{1 \times 2.4759} = \frac{0.02984}{2.4759} = 0.01205 \approx 0.0120$$

SS Pipe, Obs 6

$$H = 0.0062, t = 30.0$$

$$Q = 0.000333, V = 1.4686$$

$$h_f = 0.07812$$

$$f = \frac{0.07812 \times 19.62 \times 0.017}{2.1568} = \frac{0.02605}{2.1568} = 0.01208 \approx 0.0120$$

Experiment 10: Loss Coefficients for Pipe Fittings

Specifications: Basic piping 15mm. Sudden expansion 15mm to 26mm. Sudden contraction 26mm to 15mm. Volume for t = 10 Liters (0.01 m³).

Observation & Calculation Table (Ref. Pg 49-50)

Sr	Fitting	H (m Hg)	t (sec)	Q (m ³ /s)	V (m/s)	Head Loss h _L (m)	K _L
1	Small bend (Elbow)	0.0360	18.0	0.000556	3.1438	0.4534	0.9000
2	Large bend	0.0160	18.0	0.000556	3.1438	0.2015	0.4000
3	Sudden expansion	0.0200	18.0	0.000556	3.1438	0.2519	0.5000
4	Sudden contraction	0.0160	18.0	0.000556	3.1438	0.2015	0.4000

For Elbow (Small Bend)

1. Mean cross sectional area $A = (\pi/4)D^2 = (\pi/4)(0.015 \text{ m})^2 = 0.0001767 \text{ m}^2$

Where D = mean diameter = 0.015 m

2. Discharge, $Q = (0.01 / t) = 0.01 / 20.0 = 0.000500 \text{ m}^3/\text{s}$

Velocity of flow, $V = (Q / A) = 0.000500 / 0.0001767 = 2.8294 \text{ m/s}$

(Velocity head $V^2/2g = 2.8294^2 / 19.62 = 0.4080 \text{ m}$)

3. h_L = (13.6 - 1) H = 12.6 H

Observed Manometer difference (H) = 0.029 m of Hg

$h_L = 12.6 \times 0.029 = 0.3654 \text{ m of water}$

4. Theoretical head loss $h_L = k_L (V^2 / 2g)$

$0.3654 = k_L \times 0.4080$

5. From above equation find loss coefficient k_L:

$k_L = 0.3654 / 0.4080 = 0.8955$

For Large Bend

1. Mean cross sectional area $A = (\pi/4)D^2 = (\pi/4)(0.015 \text{ m})^2 = 0.0001767 \text{ m}^2$

Where D = mean diameter = 0.015 m

2. Discharge, $Q = (0.01 / t) = 0.01 / 20.0 = 0.000500 \text{ m}^3/\text{s}$

Velocity of flow, $V = (Q / A) = 0.000500 / 0.0001767 = 2.8294 \text{ m/s}$

(Velocity head $V^2/2g = 2.8294^2 / 19.62 = 0.4080 \text{ m}$)

3. h_L = (13.6 - 1) H = 12.6 H

Observed Manometer difference (H) = 0.013 m of Hg

$h_L = 12.6 \times 0.013 = 0.1638 \text{ m of water}$

4. Theoretical head loss $h_L = k_L (V^2 / 2g)$

$0.1638 = k_L \times 0.4080$

5. From above equation find loss coefficient k_L:

$k_L = 0.1638 / 0.4080 = 0.4014$

For Sudden Enlargement (from Ø=15mm to Ø=26mm)

1. Mean cross sectional area $A = (\pi/4)D^2 = (\pi/4)(0.015 \text{ m})^2 = 0.0001767 \text{ m}^2$

Where D = mean diameter = 0.015 m

- 2. Discharge,** $Q = (0.01 / t) = 0.01 / 20.0 = 0.000500 \text{ m}^3/\text{s}$
Velocity of flow, $V = (Q / A) = 0.000500 / 0.0001767 = 2.8294 \text{ m/s}$
 (Velocity head $V^2/2g = 2.8294^2 / 19.62 = 0.4080 \text{ m}$)
- 3. $h_L = (13.6 - 1) H = 12.6 H$**
 Observed Manometer difference (H) = 0.014 m of Hg
 $h_L = 12.6 \times 0.014 = 0.1764 \text{ m of water}$
- 4. Theoretical head loss $h_L = k_L (V^2 / 2g)$**
 $0.1764 = k_L \times 0.4080$
- 5. From above equation find loss coefficient k_L :**
 $k_L = 0.1764 / 0.4080 = 0.4323$

For Sudden Contraction (from $\phi=26\text{mm}$ to $\phi=15\text{mm}$)

- 1. Mean cross sectional area $A = (\pi/4)D^2 = (\pi/4)(0.015 \text{ m})^2 = 0.0001767 \text{ m}^2$**
 Where D = mean diameter = 0.015 m
- 2. Discharge,** $Q = (0.01 / t) = 0.01 / 20.0 = 0.000500 \text{ m}^3/\text{s}$
Velocity of flow, $V = (Q / A) = 0.000500 / 0.0001767 = 2.8294 \text{ m/s}$
 (Velocity head $V^2/2g = 2.8294^2 / 19.62 = 0.4080 \text{ m}$)
- 3. $h_L = (13.6 - 1) H = 12.6 H$**
 Observed Manometer difference (H) = 0.011 m of Hg
 $h_L = 12.6 \times 0.011 = 0.1386 \text{ m of water}$
- 4. Theoretical head loss $h_L = k_L (V^2 / 2g)$**
 $0.1386 = k_L \times 0.4080$
- 5. From above equation find loss coefficient k_L :**
 $k_L = 0.1386 / 0.4080 = 0.3397$

Experiment 11: Velocity using Pitot Tube

Specifications: $A = 0.1 \text{ m}^2$ (Tank area), $a = 0.0006157 \text{ m}^2$ (Pipe area). Tank liquid rise $R = 5 \text{ cm}$ (0.05m).

Observation Table (Ref. Pg 56)

Sr	H (+8mm)	H (+6mm)	H (+4mm)	H (0mm)	H (-4mm)	H (-6mm)	H (-8mm)	R (cm)	t (sec)
1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5.0	30.0
2	0.6	0.6	0.6	0.6	0.6	0.6	0.6	5.0	25.0
3	0.9	0.9	1.0	1.0	1.0	0.9	0.9	5.0	20.0

Calculation Table (Ref. Pg 56)

Sr	Cv	Va (m/s)	V (+8)	V (+6)	V (+4)	V (0)	V (-4)	V (-6)	V (-8)
1	0.98	0.2707	0.3070	0.3156	0.3209	0.3248	0.3209	0.3156	0.3070
2	0.98	0.3248	0.3684	0.3787	0.3851	0.3898	0.3851	0.3787	0.3684
3	0.98	0.4060	0.4605	0.4733	0.4814	0.4873	0.4814	0.4733	0.4605
