Cover Sheet

ME 3414 Experiment #1 – SPRING 2026

Printed name: Zachary Rohloff

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onday (2/16/26) B-3 - 6:30PM

Flow through a Venturi and a Rotameter

Note: Handwritten solutions may be submitted for the following questions.

1. Assuming V_A and V_B are the flow speeds at locations A and B in Figure 2, do the following:
   (a) Use the steady-state continuity equation to write a symbolic expression for the speed ratio, V_B/V_A, in terms of geometric parameters. Show all your work.
   (b) Obtain a numerical value of V_B/V_A for the apparatus described in Figure 2.
   (c) Explain the trend of the change in the velocity from A to B in terms of the change in pressure at those points. Explain why it decreases or increases.

$A_1V_1 = A_2V_2$ $\quad \frac{\pi D_1^2}{4} V_1 = \frac{\pi D_2^2}{4} V_2$ $\quad \frac{V_B}{V_A} = \left(\frac{D_A}{D_B}\right)^2$ sub in values ≈ 2.64

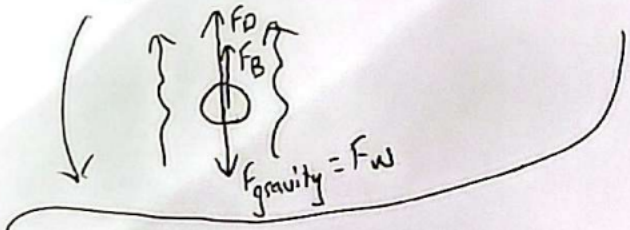
Velocity increases from A to B because the area is decreasing and as such to maintain a steady volumetric flow rate the fluid accelerates.

2. Consider a hypothetical rotameter having a spherically-shaped float of radius, R. When the float is in equilibrium at a given flow rate, show that the ratio of the float density, ρ_F, to the water density, ρ_w, is given by

$$\frac{\rho_F}{\rho_w} = 1 + \frac{3}{8}\frac{V^2 C_D}{gR}$$

where V = flow speed, g = acceleration due to gravity, and C_D = drag coefficient. The drag coefficient allows one to compute the drag force, F_D, on the sphere due to viscous shear stresses, i.e., $F_D = \rho_w V^2 A C_D/2$, where A = cross sectional area of the sphere. Show all your work, including a free body diagram.

$F_D + F_B - F_w = 0$



$W = mg = \rho V g = \frac{4}{3}\pi R^3 \rho_w g$

$F_B = \rho_{water} g (V) = \frac{4}{3}\pi R^3 \rho_w g$

F_D given above

$\frac{1}{2}\rho_w V^2 \pi R^2 C_D$ / $\frac{4}{3}\pi R^3 g$ $\quad \frac{3}{8}\frac{V^2 C_D}{Rg}$

Sub in

$\frac{\frac{1}{2}\rho_w V^2 (\pi R^2) C_D + \frac{4}{3}\pi R^3 \rho_w g}{\rho_w \left(\frac{4}{3}\pi R^3 g\right)} = \frac{\frac{4}{3}\pi R^3 \rho_F g}{\left(\frac{4}{3}\pi R^3 g\right)\rho_w}$ $\quad \Rightarrow \frac{\rho_F}{\rho_w} = 1 + \frac{3}{8}\frac{V^2 C_D}{Rg}$

CamScanner

Raw Data

Data Sheet for ME3414 Experiment #1 (Must be included in your formal report, with signatures).

CRN and Group: 22639 B-3 Date and time: 2/16/26 6:30 PM

Printed names of bench members: Zachary Rohloff Lollin Lyons

Signatures of bench members: Zachary Rohloff Lollin Lyons

Trial #1

Rotameter Float Height	Manometer column height				Q Digital Readout
	A	B	C	D	
(mm)	(mm)	(mm)	(mm)	(mm)	(liters/s)
175	318	92	282	290	0.451
150	296	132	270	278	0.389
110	272	182	255	260	0.288
80	260	212	250	254	0.212
50	255	232	250	250	0.145
35	255	242	250	250	0.115
20	255	248	255	255	0.083
10	256	254	258	258	0.063

Trial #2

Rotameter Float Height	Manometer column height				Q Digital Readout
	A	B	C	D	
(mm)	(mm)	(mm)	(mm)	(mm)	(liters/s)
175	314	98	230	290	0447
150	294	132	263	278	0.385
110	272	184	256	260	0.283
80	262	210	252	254	0.210
50	254	232	252	250	0.149
35	256	242	252	252	0.113
20	258	250	254	254	0.081 → 0.081
10	258	254	258	258	0.063 → 0.063

Trial #3

Rotameter Float Height	Manometer column height				Q Digital Readout
	A	B	C	D	
(mm)	(mm)	(mm)	(mm)	(mm)	(liters/s)
175	314	92	282	290	0.450
150	296	130	270	278	0.387
110	270	182	258	262	0.285
80	262	210	252	256	0.214
50	255	232	250	252	0.147
35	255	240	252	252	0.116
20	255	250	254	254	0.081
10	258	254	256	256	0.062

Table 1. Experimental measurements.

Calculated Values

Rotameter Float Height	Average Pressure Differences By Lettered Column Pair			Average Flow Rate (Q) Digital Readout
	A-B	A-C	D-C	
(mm)	(mm H_2O)	(mm H_2O)	(mm H_2O)	(L/s)
175	221.333	221.333	8.667	0.449
150	164.000	164.000	8.667	0.387
110	88.667	88.667	4.333	0.285
80	47.333	47.333	3.333	0.212
50	22.667	22.667	0.000	0.147
35	13.667	13.667	0.000	0.115
20	6.667	6.667	0.000	0.082
10	4.000	4.000	0.000	0.062

Rotameter Float Height	Predicted Flow Rate(Q)	Venturi Discharge Coef. (C_V)	Velocity at Point C (V_C)	Average Dynamic Pressure at Point	Pressure Recovery Coef. (C_P)	Ideal Pressure Recovery Coef. (C_{PID})
(mm)	(L/s)	Unitless	(m/s)	(mm H2O)	Unitless	Unitless
175	0.457527371	0.982090606	0.846315043	36.50607295	0.237403423	0.93701691
150	0.393836164	0.982642113	0.728910804	27.08006936	0.32003857	
110	0.289583531	0.985323068	0.537422609	14.72084915	0.294367077	
80	0.211581267	1.001979065	0.399299976	8.126425611	0.410184439	
50	0.146415649	1.003991041	0.276873096	3.907171837	0	
35	0.113690708	1.008584335	0.215973572	2.377399779	0	
20	0.079405035	1.028482226	0.153818387	1.205917234	0	
10	0.061506875	1.01343684	0.117404238	0.702535939	0	

Figure 1

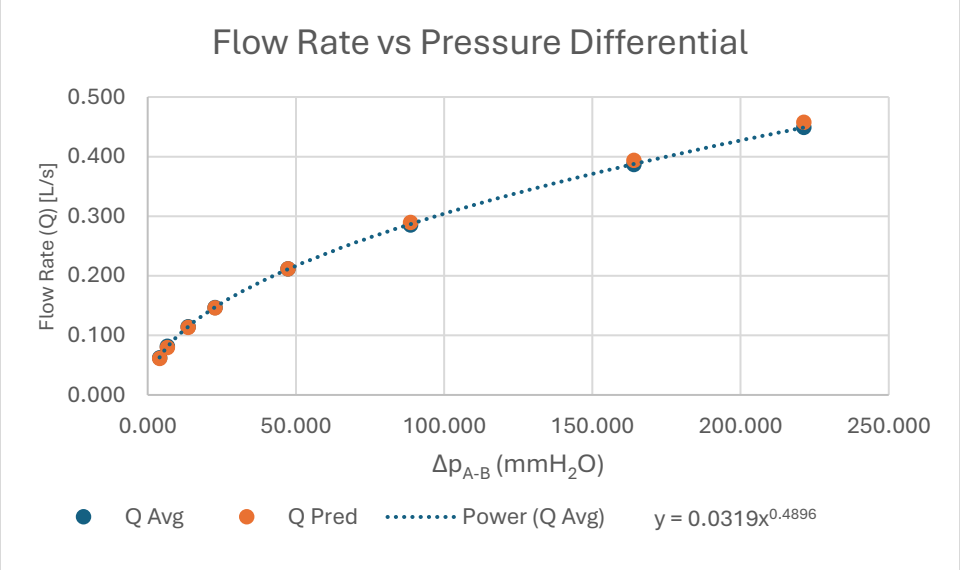


Figure 2

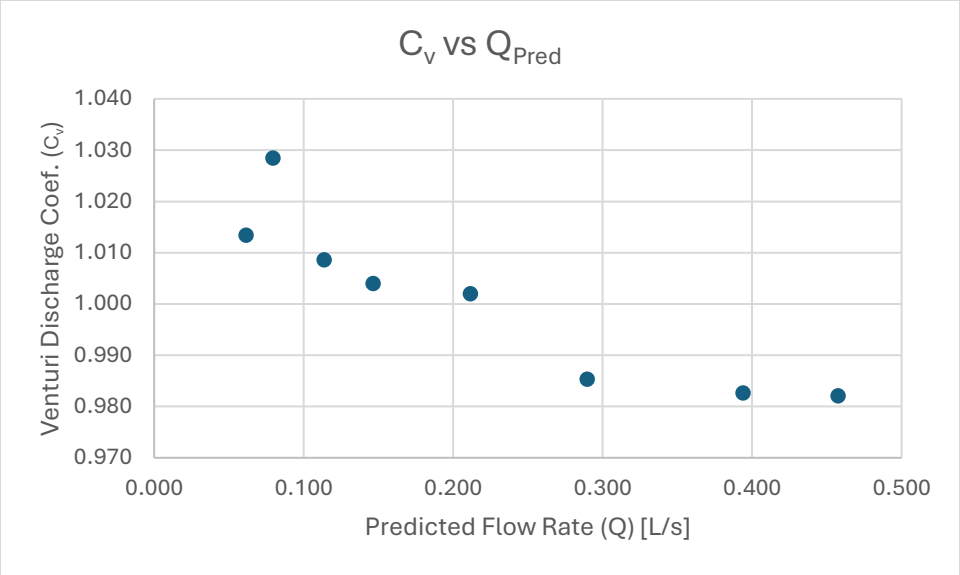


Figure 3

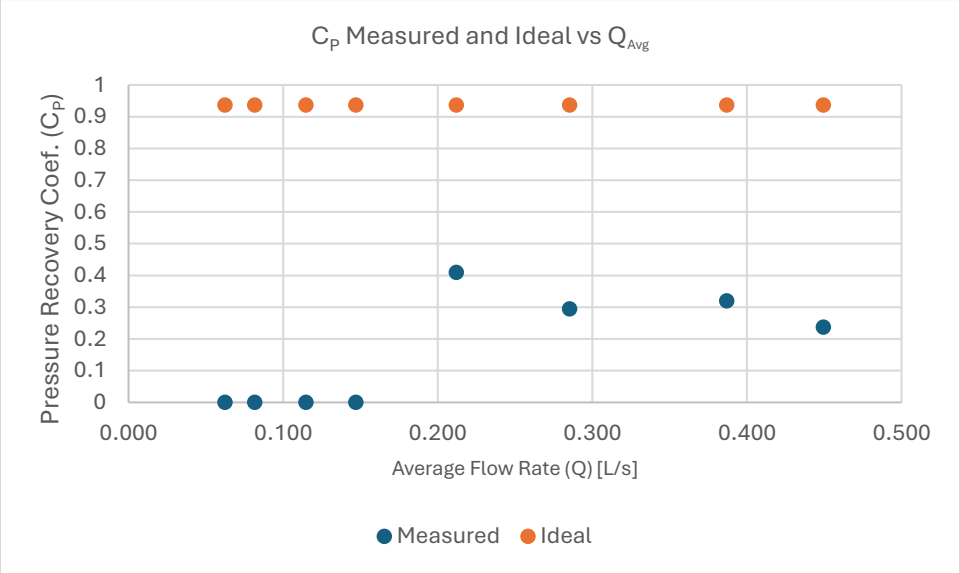
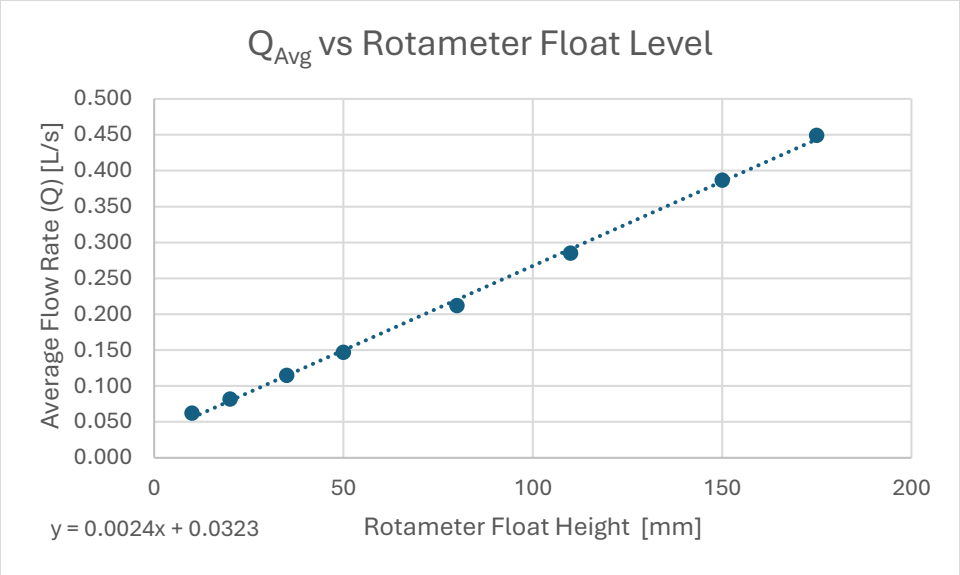


Figure 4


Q_{Avg} vs Rotameter Float Level
Average Flow Rate (Q) [L/s]
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0
50
100
150
200
y = 0.0024x + 0.0323
Rotameter Float Height [mm]