BIRZEIT UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MECHATRONICS ENGINEERING

First Semester 2024

Fluid Mechanics Lab ENME312

Exp (6): flow measuring apparatus

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Eng. Ahmad Abu Baker 1st,2024

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ABSTRACT

The aim of this experiment is to find the mass flow rate by three devices which are venture meter, orifice meter and the rotameter and then compare the results and the accuracy.

The main results from the experiment are the actual flow rate, the ideal flow rates from venture, orifice and rotameter also the discharge coefficients which are less and very near to one.

Eng. Ahmad Abu Baker 1st,2024

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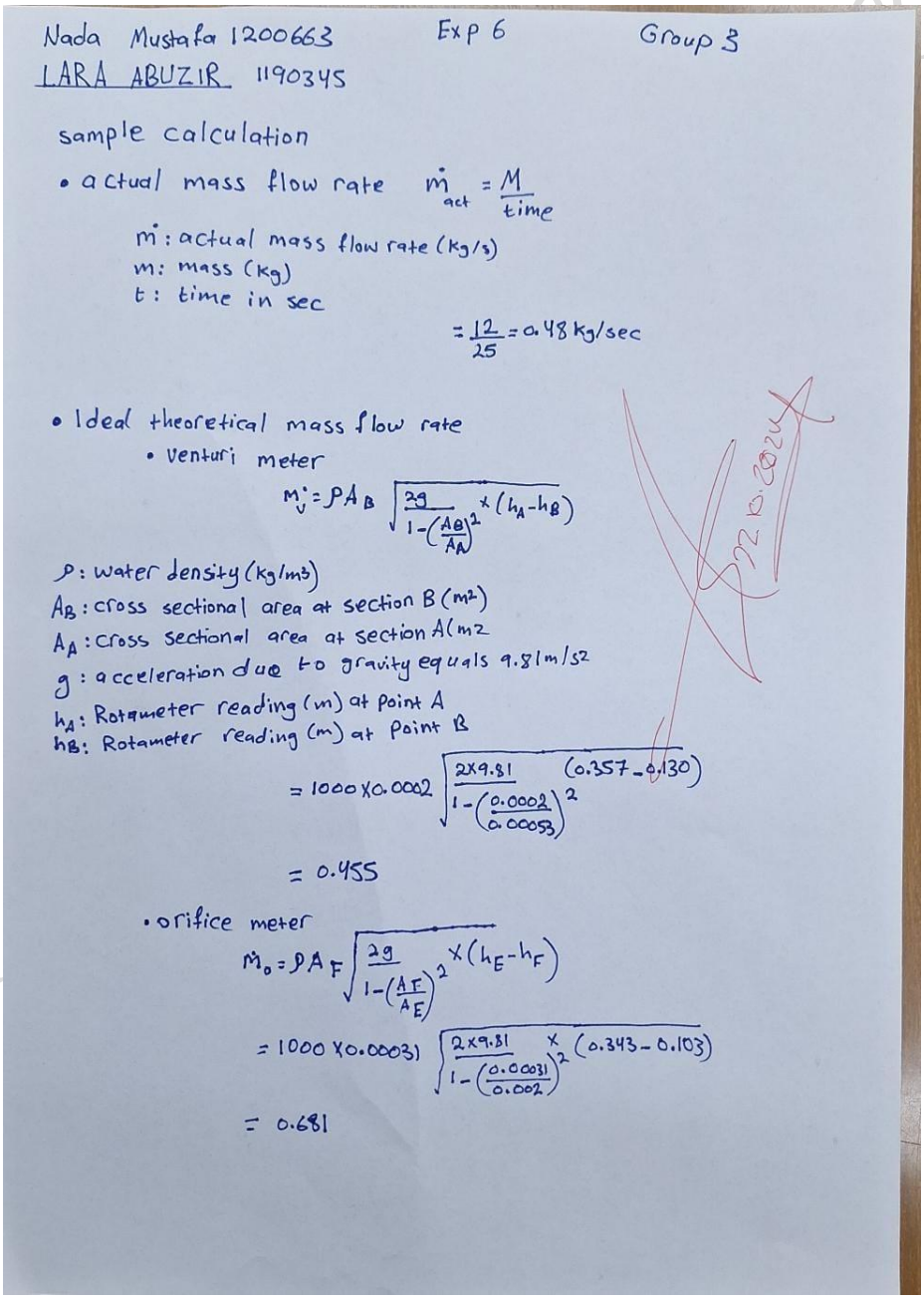
OBJECTIVES & MEASUREMENT METHOD'S

The aim of this experiment is to find the mass flow rate by three devices which are venture meter, orifice meter and the rotameter and then compare the results and the accuracy.

This done by changing the flow rates of water by the control valve and then read the heights of water from rotameter, venture and the orifice, after that the time was measured using the phone timer

SAMPLE CALCULATIONS



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sample calculation

- actual mass flow rate $\dot{m}_{act} = \frac{M}{time}$

$\dot{m}$: actual mass flow rate (kg/s)
m: mass (kg)
t: time in sec

$= \frac{12}{25} = 0.48$ kg/sec

- Ideal theoretical mass flow rate
  - venturi meter

$$\dot{M}_V = \rho A_B \sqrt{\frac{2g}{1-\left(\frac{A_B}{A_A}\right)^2} \times (h_A - h_B)}$$

ρ: water density (kg/m3)
A_B: cross sectional area at section B (m^2)
A_A: cross sectional area at section A (m^2)
g: acceleration due to gravity equals 9.81 m/s2
h_A: Rotameter reading (m) at point A
h_B: Rotameter reading (m) at point B

$$= 1000 \times 0.0002 \sqrt{\frac{2 \times 9.81}{1-\left(\frac{0.0002}{0.00053}\right)^2} (0.357 - 0.130)}$$

$= 0.455$

- orifice meter

$$\dot{M}_o = \rho A_F \sqrt{\frac{2g}{1-\left(\frac{A_F}{A_E}\right)^2} \times (h_E - h_F)}$$

$$= 1000 \times 0.00031 \sqrt{\frac{2 \times 9.81}{1-\left(\frac{0.00031}{0.002}\right)^2} \times (0.343 - 0.103)}$$

$= 0.681$

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- Coefficient of Discharge

$$C_{d_{venturi}} = \frac{\dot{m}_{Act}}{\dot{m}_{th\,venturi}}$$

C_d : coefficient of discharge

$\dot{m}_{Act}$: The actual flow rate which is calculated using the hydraulic bench ~~ma~~ (kg/sec)

$$= \frac{0.48}{0.455} = 1.055$$

$$C_{d_{orifice}} = \frac{0.48}{0.681} = 0.7048$$

22.10.2021

2024

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PRESENTATION & RESULTS

Table 1: data

	venturi		orifice			
Run	ha (mm)	hb (mm)	he (mm)	hf (mm)	time (sec)	rotameter (cm)
1	357	130	343	103	25	20.1
2	342	139	328	111	28	19.1
3	325	145	313	121	29	18
4	310	150	300	131	30	16.9
5	288	158	279	141	34	15.2
6	268	165	260	154	39	13.2
7	257	170	250	158	45	12
8	242	175	236	167	52	10
9	234	179	227	172	55	8.9
10	222	183	218	177	64	7.1

Table 2: mass flow rate(m') for venturi and orifice meter (kg/sec

rotameter ideal mass flow rate (kg/s)	actual mass flow rate (kg/s)	ideal mass flow rate orifice (kg/s)	ideal mass flow rate venturi (kg/s)	cd venturi	cd orifice
0.48	0.480	0.681	0.455	1.055	0.705
0.42	0.429	0.648	0.430	0.996	0.662
0.38	0.414	0.609	0.405	1.021	0.679
0.36	0.400	0.571	0.382	1.047	0.700
0.325	0.353	0.516	0.344	1.025	0.684
0.27	0.308	0.453	0.306	1.004	0.680
0.26	0.267	0.422	0.282	0.947	0.632
0.22	0.231	0.365	0.247	0.934	0.632
0.2	0.218	0.326	0.224	0.974	0.669
0.17	0.188	0.281	0.189	0.994	0.666

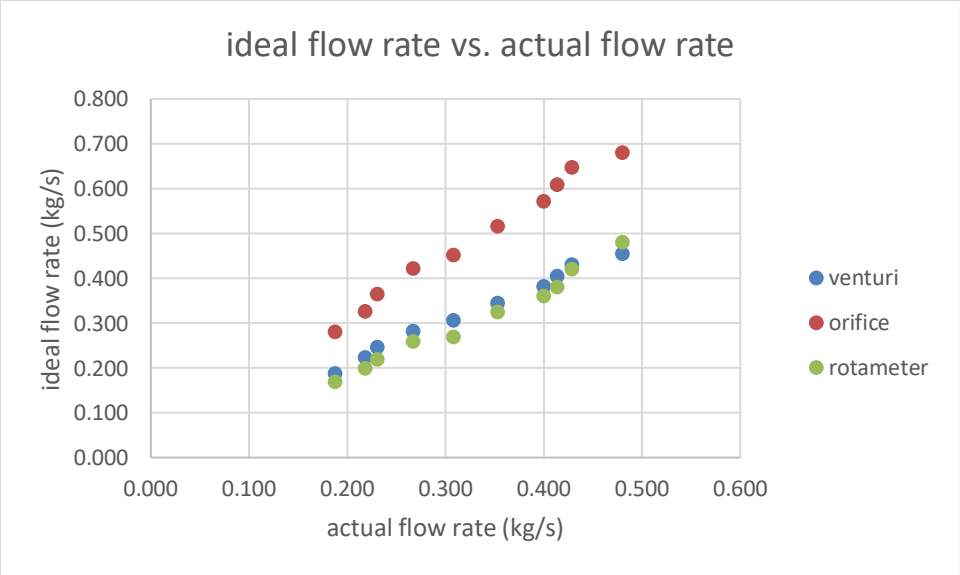

Figure 1: ideal flow rate vs. actual flow rate

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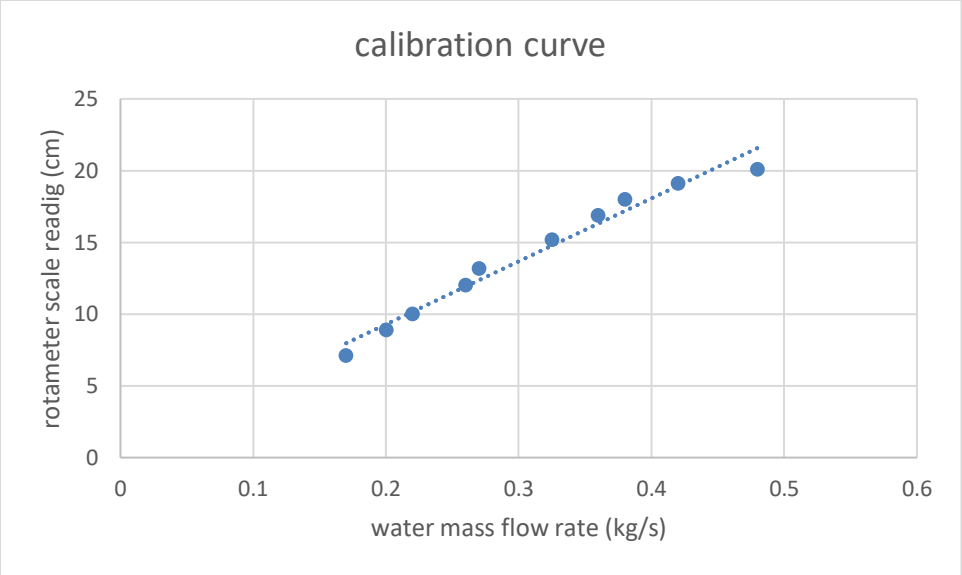

Figure 2: calibration curve

DISCUSSION OF RESULTS

The coefficient of discharge was calculated in many method venture , orifice ,rotameter and the value must be less than 1 but in table (2) the coefficient of discharge venture in some run more than 1

In figures shown above (graph one and two) the relation between them is approximately linear with some errors, these errors can be systematic or random errors like errors in reading the value of water level because the instability of water in tubes also in the time recorded it is maybe not exact.

The relationships between the dependent and independent parameters are direct relationship and this is obvious from figures above

CONCLUSIONS

In conclusion, the experiment highlights the importance of effective flow measurement in understanding fluid behavior, and the system can be used reliably for future applications in both research and industrial environments.

It is used in water supply systems

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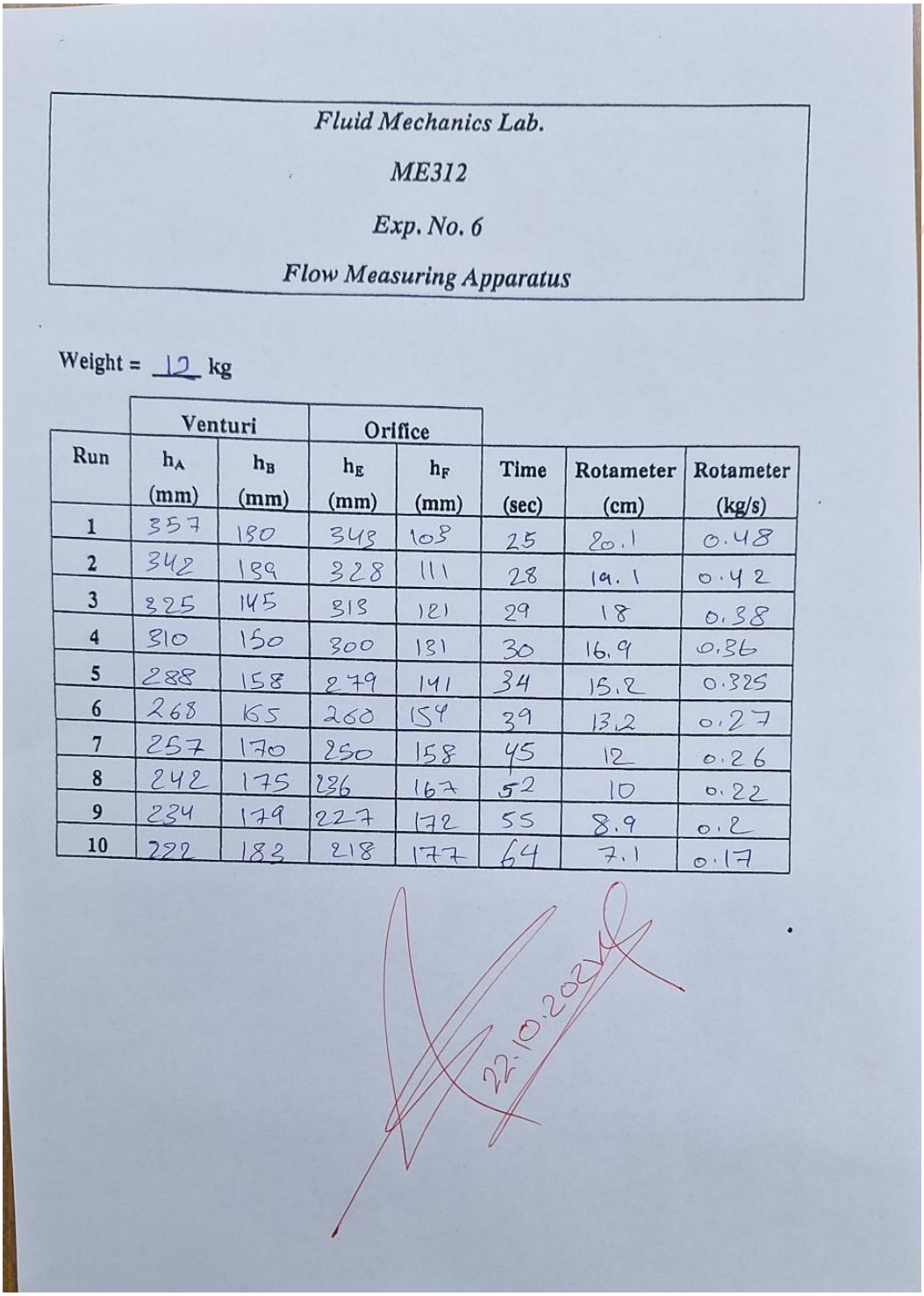
APPENDICES

- **Excel sheet**
- Fluid mechanics laboratory manual-ENME 312, march 2022.

Data sheet



Fluid Mechanics Lab.

ME312

Exp. No. 6

Flow Measuring Apparatus

Weight = 12 kg

Run	Venturi		Orifice		Time	Rotameter	Rotameter
	h_A (mm)	h_B (mm)	h_E (mm)	h_F (mm)	(sec)	(cm)	(kg/s)
1	357	180	343	108	25	20.1	0.48
2	342	189	328	111	28	19.1	0.42
3	325	145	313	121	29	18	0.38
4	310	150	300	131	30	16.9	0.36
5	288	158	279	141	34	15.2	0.325
6	268	165	260	159	39	13.2	0.27
7	257	170	250	158	45	12	0.26
8	242	175	236	167	52	10	0.22
9	234	179	227	172	55	8.9	0.2
10	222	183	218	177	64	7.1	0.17

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