Review on Orifice Meter

Samarth S. Patil[1], Shaurya V. Kumbhar[2], Manish S. Ghatge[3], Siddesh A. Shinde[4], Niteen S. Mali[5], Vishal D. Shinde[6]

[1,2,3,4]Student of Mechanical Engineering, Dr. D. Y. Patil Polytechnic, Kolhapur
[5]HOD of Mechanical Department, Dr. D. Y. Patil Polytechnic, Kolhapur
[6]Teaching staff Mechanical Engineering Dr. D. Y. Patil Polytechnic, Kolhapur

Abstract:
The orifice meter is a crucial instrument for measuring fluid flow rates using fluid dynamics principles. This study focuses on the fabrication, assembly, and testing of an orifice meter test rig. It applies Bernoulli's theorem to analyse pressure and velocity changes. The setup consists of an orifice plate, pressure taps, and a flow measurement system. The research details the construction process and test procedures. Flow rate calculations are performed to evaluate the meter's performance. Experimental results confirm the meter's accuracy in measuring flow rates. The study highlights its importance in engineering applications such as pipelines and industrial fluid transport. It demonstrates the efficiency of the orifice meter in practical scenarios. The findings suggest improvements to enhance accuracy and reliability.

Keywords: Orifice meter, Flow measurement, Fluid dynamics, Bernoulli's principle, Pressure drop, Velocity change, Test rig fabrication, Flow rate calculation, Industrial applications, Pipeline systems, Fluid transport, Experimental analysis, Accuracy and efficiency, Pressure taps, Calibration and testing

INTRODUCTION

Bernoulli's theorem is a fundamental principle that explains how fluids behave when they move, and it plays a crucial role in various aspects of daily life. It states that as the speed of a fluid increases, its pressure decreases. This simple concept helps us understand how airplanes fly, how we breathe, and even how sports balls curve in the air. Bernoulli's theorem is a way of understanding how fluids (like air and water) behave when they move. It tells us that when a fluid speeds up, its pressure drops, and when it slows down, its pressure increases. This simple rule has many surprising effects in everyday life.

WORKING

An orifice meter is a flow-measuring device that works based on Bernoulli's principle and the orifice effect. It measures the flow rate by detecting the pressure drop across an orifice plate installed in a pipeline. As the fluid flows through the pipeline, it encounters the orifice plate, which has a precisely machined hole. The fluid is forced through this narrow opening, causing its velocity to increase and its pressure to decrease, in accordance with the Venturi effect. This results in a pressure difference between the upstream and downstream sides of the plate.

The orifice meter is equipped with two pressure taps—one placed before the plate (high-pressure region) and the other after it (low-pressure region). The pressure drop (ΔP\Delta PΔP) between these taps is measured using a manometer or differential pressure gauge. This drop is directly proportional to the flow rate of the fluid.

As the fluid continues past the orifice, the pressure partially recovers, but due to friction and turbulence, it does not return to its original value, resulting in permanent pressure loss.

Orifice meters are widely used in industrial applications, such as oil and gas pipelines, chemical plants, and water distribution systems, due to their simplicity, reliability, and accuracy. However, they are less suitable for low flow rates and cause energy losses due to the permanent pressure drop.

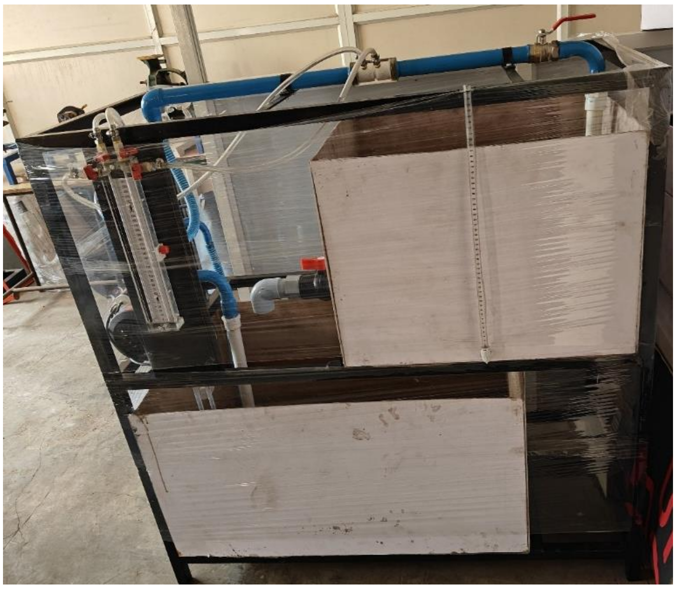

Fig. No. 1 Actual Setup Diagram

Drawings of various components

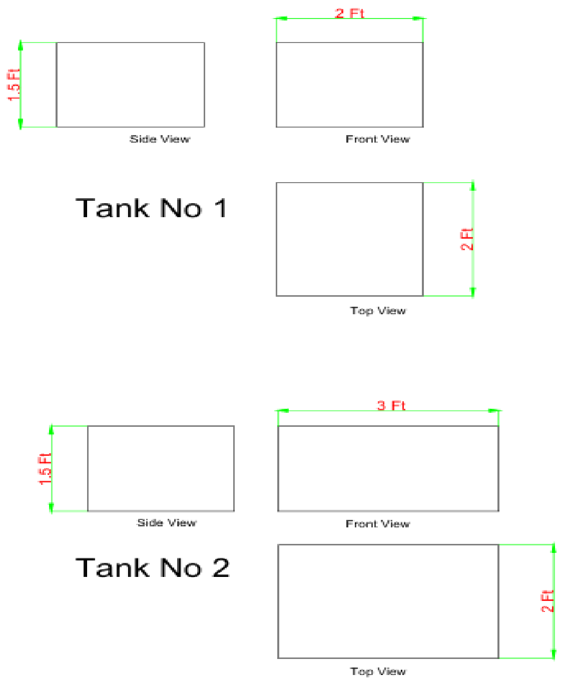

Fig No. 2. (2D Diagram of Tank 1 & 2)

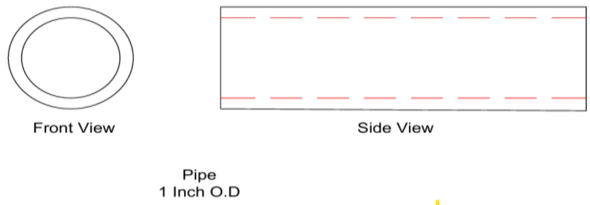

Fig No. 3. (2D Diagram of Pipe)

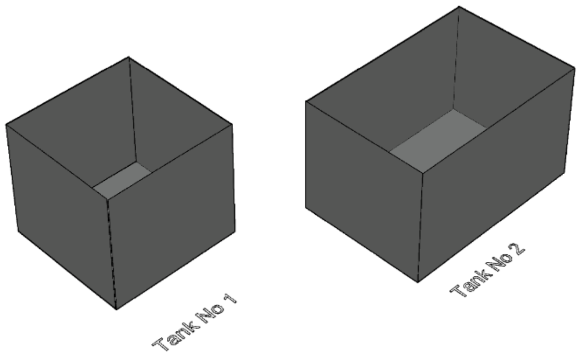

Fig No. 4. (3D Diagram of Tank 1 & 2)

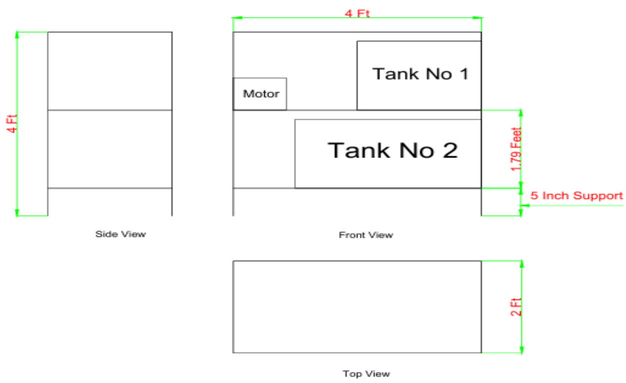

Fig No. 5 (2D Diagram of Frame)

Test ring setup its working

Water Flow Initiation:

Water is drawn from the storage tank using a pump or gravity-fed system.

The valves control the amount of water flowing through the system.

Flow Through the Orifice Meter:

Water passes through a narrow orifice plate within the pipe.

This restriction causes an increase in velocity and a drop in pressure after the orifice.
Pressure Measurement:
Manometer tubes connected before and after the orifice measure the pressure difference (ΔP).
The height difference in the manometer fluid (water or mercury) indicates this pressure drop.

Testing Results

Sr. No.	Rise of water level of measuring tank 'H'		Deflection of mercury column of the manometer			Converted water columns height h=H hg(13.6-1)	Time to collect the water in measuring tank(t)
			H throat	H pipe	H hg=$\frac{(Ht-Hp)}{100}$		
	cm	m					
1	5	0.05	125	140	0.15mm	1.89	49.34
2	5	0.05	120	140	0.2mm	2.25	33.54
3	5	0.05	120	146	0.26mm	3.27	37.71

Conclusion

1. Actual Discharge = Qact = 3.70×10^{-4}
2. Theoretical Discharge = Qth= $\frac{a1a2\sqrt{2gh}}{\sqrt{a1^2 - a2^2}} = \frac{2.54\times10^{-4}\times6.15\times10^{-4}\times\sqrt{2\times9.81\times0.189}}{\sqrt{(2.54\times10^{-4})\times(6.15\times10^{-4})}}$= 3.008×10^{-4}
3. Coefficient of Discharge = Cd = $\frac{Qact}{Qth}$ = 0.58

References

1. F. Montagna, E. Schena, C. Massaroni, C. Caciotti, D. L. Presti and S. Silvestri, "Influence of the length of lead lines on the response of a variable orifice meter: analysis of sensitivity and settling time," 2018 IEEE International Symposium on Medical Measurements and Applications (MeMeA), Rome, Italy, 2018, pp. 1-6, doi: 10.1109/MeMeA.2018.8438738.
2. M. Li, G. Yang, Q. Ma and S. Jin, "Research on the Effect of Orifice Plate Parameters on Reducing Airflow Pulsation in Piping System," 2017 International Conference on Computer Technology, Electronics and Communication (ICCTEC), Dalian, China, 2017, pp. 214-217, doi: 10.1109/ICCTEC.2017.00053.
3. Z. Bai, Z. Hongxin, H. Xinyang, G. Zheng, S. Jiajia and W. Dongliang, "Simulation Analysis and Experimental Research on Differential Pressure Flow between Venturi and Orifice," 2022 5th World Conference on Mechanical Engineering and Intelligent Manufacturing (WCMEIM), Ma'anshan, China, 2022, pp. 287-297, doi: 10.1109/WCMEIM56910.2022.10021344.
4. H. Mandal, S. K. Bera, P. K. Sadhu and S. C. Bera, "Further Study of the Sensing Ring Position on the Orifice-Type Capacitive Flow Sensor," in IEEE Transactions on Instrumentation and Measurement, vol. 69, no. 4, pp. 1812-1820, April 2020, doi: 10.1109/TIM.2019.2913060.
5. V. Sravani and S. KV, "Transient Behavior Analysis for Orifice Flow Meter Performance for Variation in Sensor Dimension," 2021 International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT), Bhilai, India, 2021, pp. 1-7, doi: 10.1109/ICAECT49130.2021.9392500.