

Lab Report on Thermodynamic and Fluid Dynamic Principles

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This report analyzes the main processes of engineering, and we will look at the application of thermodynamic and fluid dynamic principles. We also measured all important parameters so that we could assess the trend of the temperature-based fluid dynamic test rig. Starting with definition thermodynamics is described as a subject that related with energy and it is used as a tool in understanding physical universe and play significance role in our live.

Fluid flow is described as a liquid in motion, and it is a significant aspect of many processes, which include transporting objects from one destination to another, combining things, and chemical reactions. Also, this paper will demonstrate the investigation that was being done for fluid flow in a pipe network during an experiment that explore several methods using (a manometer, orifice plate, or Venturi meter) in our measurement for the rate of fluid flow. During this experiment, we explored the impact of skin friction, pipe networks, and pipe fittings on pressure.

The first method is using a venturi tube, which is described as a device used to measure the rate of fluid flowing on the pipe. When fluid is flowing along the pipe, it automatically increases the rate of moving toward the tapering contraction as well as increases velocity along the throat of the venturi. Then, after that, there will be a decrease in pressure, which depends on the rate of fluid flow. The rate of flow is basically inferred as a change in pressure from the measurement taken from the upstream of the throat using piezo meters. The main impact that is associated with the measurement is the change in pressure, which can be described as the Venturi effect. Furthermore, a venturi meter is also used to mix the liquid with gas. When the pump is forcing liquid to move via the tube that is connected with a system that consist a venturi, then it automatically increases the rate of liquid flowing as diameter reduce, and on the other hand venturi decreases speed as the pipe gets wider again.

Venturi experimental set-up:

The main objectives of the experiment

The key and main objectives of this experiment is to get calibration curve for the Venturi meter, find the effect on pressure starting from inlet to the throat at different rate of flow and finally is to present result using non-dimensional form so that they can be used to access the flow via similar meter.

Theory

This section demonstrate the effect that Venturi has, For an example jet has same structure as air funnel, also it can be described as a thumb on a garden hose. From this theory, we normally find that the velocity of the fluid in a Venture tube increases when the cross-sectional area reduces, and at the same time, pressure decreases correspondingly. The laws that govern fluid dynamics say that a fluid's velocity will automatically increase when it passes via a constriction in order to achieve the principle of continuity, and at the same time, the pressure decreases in order to attain the principle of conservation and mechanical energy. When there is an increase in kinetic energy, the fluid flowing might arise because of an increase in velocity via a constriction, and it is negated by a decrease in pressure. The equation of the decrease in pressure resulting from the Venturi effect might be obtained from both Bernoulli's principle and the continuity equation. The Venturi effect is limited when the fluid reaches a state of choked flow, and this is the position where the fluid velocity is getting near the speed of sound. In addition, in this state, the rate of mass flow won't increase in conjunction with a drop in the downstream pressure environment.

The flow rate of the mass for a compressible fluid increased due to an increase in upstream pressure, and at the same time, it automatically increases the density of fluid via constriction (via the velocity, it always retained constant). An increment in the source temperature automatically increases the local sonic velocity, and thus, it increases the flow rate of the mass. Putting into consideration the flow of an incompressible and also an inviscid fluid via a convergent-divergent Venturi meter and also having both velocity and piezo meter where the head is always constant over all of the sections that have been considered, I assumed that when flowing in one-dimensional, both velocity and piezo metric head will only vary in the direction of the tube length. Let's now treat the convergent-divergent pipe as a stream tube and finally apply Bernoulli's theorem, starting in section one and continuing up to section six.

The Continuity equation is given by

When substituting equation 1 for U_1 in equation 2 gives

This signifies that

Finally, we find that velocity head at the throat of the Venturi tube can conveniently be used in expressing the non-dimensional way by expressing the distribution of piezo metric head along the length of the Venturi meter. Accordingly, the Piezo meter Head Coefficient.

Apparatus

Points for the measurement of the static pressure P

Fan

Figure 1: Air tunnel design illustration

1. Orifice Plate Measurement.

Figure 2: Experimental set-ups

Experimental Procedure

A thermometer is used to record the ambient temperatures of the laboratory together with pressure obtained from a mobile phone app (or otherwise). Then use a tape measure to measure the circumferences of each of the salient parts, i.e., the throat, inlet, and outlet diameters, of the Venturi (Fig. 2b). Connect the device to the electricity plug, set the end-plate flush with the outlet of the air-tunnel. Measure the pressures (Fig. 2a) from inlet {4} and {3}, copy and complete Table 1, with incremental movements to the end plate (Measurements can be taken with a ruler). Repeat the readings for better accuracy and calculate the average for each position of the end plate. Calculate the diameter of the orifice plate (Fig. (2b)) located between points {1} and {2} from a suitable number of independent measurements of the pressure across these points. (Hint: You will need to use the continuity equation).

Room Temperature [oC]	Room Pressure [kPa]	Room density [kg/m ³]

Table 1: Lab pressure and Temperature

	Test #1		Test #2 (Repeat)		Test #3 (Repeat)	
	Position [cm]	ΔP /[Inches]	Position [cm]	ΔP /[Inches]	Position [cm]	ΔP /[Inches]
1	0.5	0.44	0.5	0.41	0.5	0.38
2	1.0	1.72	1.0	1.43	1.0	1.34
3	1.5	3.70	1.5	3.42	1.5	3.10
4	2.0	5.90	2.0	5.10	2.0	4.80

5	2.5	7.61	2.5	6.90	2.5	6.40
6	3.0	9.40	3.0	8.62	3.0	7.80
7	3.5	10.50	3.5	9.80	3.5	9.21
8	4.0	11.28	4.0	10.32	4.0	9.90
9	4.5	11.91	4.5	10.90	4.5	10.20
10	5.0	12.50	5.0	11.45	5.0	10.90
11	6.0	13.22	6.0	12.10	6.0	11.45
12	7.0	13.80	7.0	12.80	7.0	11.78
13	8.0	14.10	8.0	13.00	8.0	12.00
14	9.0	14.30	9.0	13.23	9.0	12.21
15	10.0	14.50	10.0	13.78	10.0	12.31

Analysis

Temperature = 19.0⁰c

Local air pressure = 997.0 hPa

Inlet = 13 cm (square) 14 cm (around)

Throat = 10.8 cm

Outlet = 14 cm

Thickness = 2 mm.

Conclusion

From all the curve, we find that pressure increases gradually with respect to an increase in distance. Despite having this increment there is also a sudden decrease in pressure. Also, it clear that a rise in pressure is caused by position of the liquid in the tube.

References

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