Design and Analysis of Venturimeter

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Abstract: Venturimeter is a device used for measuring rate of flow of fluids through pipes. The application of various fields like aviation, Automobile, Chemical, Petro Chemical Industries, etc. In automotive industry venturimeter is used to measure the fuel and air distribution in carburetor. In this paper we study the flow simulation and pressure and temperature analysis on venturimeter. In the present work, an attempt was made to study, prepare a design and analyse a venturimeter, which can be used as an efficient and easy means for measuring the discharge.

Fluid flow characteristics of liquids, as well as of gases, play a vital role in the modern-day engineering field having extensive application in the industries. The investigation of fluid flow and its characteristics is essential to perform experimentation in engineering fields. Flow simulation using solid works through a pipe is done with the difference of pressure head available at different cross-sections of the pipe. The meter which performs the said computation of fluid flow termed as a venturimeter. Venturimeter finds useful in plumbing, fluid oil pipeline, automotive carburetor, petroleum chemical industries etc.

KEYWORDS: Simulation, discharge coefficient, analysis, computation of fluid flow.

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INTRODUCTION:

Venturimeter is a measuring device which can also be used as a metering device too in flow of fluid in a pipe. A Venturimeter may also be used to change the velocity of any type of fluid in a pipe at any particularsection. It basically works on the principle of Bernoulli's Equation. The pressure in a fluid moving through a small cross section drops suddenly leading to an increase in velocity of the flow. The fluid of the characteristics of high pressure and low velocity gets converted to the low pressure and high velocity at a particular section and again reaches to high pressure and low velocity. The point where the characteristics become low pressure and high velocity is called throat. Many venturi flow meters can be prepared as per our requirements because several commercial CFD codes are available in the market. It is possible to obtain more accurate results within a less possible time. These results can then be compared with the initial experimental results to calibrate the instrument. As fluid flows are widely used in piping systems in the industry, mining, and distribution of drinking water, a series of pipes are designed in such a way as to be able to meet the need for fluid distribution. Pipe fittings with different angles are used for pipe branching in piping systems to make flow distributions in different directions. Measurement of flow flowing through the closed channel is done by using venturi meters. The conditions encountered in thick liquid metering can be beyond the scope of application as per the industry standards (ISO 5167-1). The venturi meters have convergent cone inlets, cylindrical necks and divergent recovery cones. It has no projection to the liquid; there is no sharp angle and no sudden changes in the contour. The venturi meters with uniform cylindrical parts before converging. Due to convergent entrance speed of fluid flow increases and pressure decreases. In the middle of venturimeter (neck section) pressure or speed will not change. Thus, the pressure difference corelates with the fluid flow rate which can be demonstrated by Bernoulli's Equation.

The total energy at each point of the fluid is constant; the total energy co nsists of pressure energy, kinetic energy, and potential ener gy.

STRUCTURE OF PAPER

This paper is organized as follows: In Section 1, introduction to the paper is given along with the structure and objectives. In Section 2 we discuss principle of venturimeter and in Section 3 we have mentined complete information about flow simulation works. Section 4 shares information about the analysis by adding global surfaces and study of pressure and velocity. Section 5 tells us about the methodology and the process description. Last section tells us about the future scope and concludes the paper with acknowledgements and references.

OBJECTIVES

The objective of this analysis is to check the correct study of venturimeter inner surface of the convergent, divergent and throat surfaces effecting with the flow of different fluids through it If we use different types of materials for venturimeter what the change and this study and analysis will make a result to calibrate the material strength in the venturimeter of pressure, temperature and velocity effect on the surface global part. By using the Bernoullis equaton and continuity equation we can know the flow. To have a study on venturimeter structure and effect of pressure, velocity and temperature on the inner surface of the venturimeter.

II. PRINCIPLE OF VENTURIMETER

The working of venturimeter is based on the principle of Bernoulli'sequation.Bernoulli's Statement: It states that in a steady, ideal flow of an incompressible fluid, the total energy at any point of the fluid is constant. The total energy consists of pressure energy, kinetic energy and potential energy or datum energy.

Mathematically,

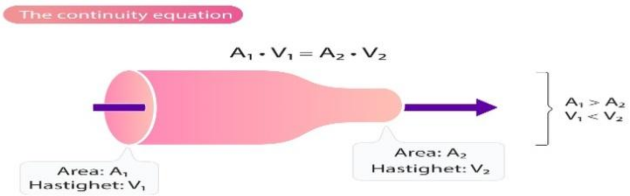
Pressure energy+kineticenergy+potentialenergy=constant

$$\frac{p}{\rho g} + \frac{v^2}{2g} + z = Constant$$

Here all the energies are taken per unit weight of the fluid. The Bernoulli's equation for the fluid passing through the twosection are given by.

$$\frac{p_1}{\rho g}+\frac{v_1^2}{2g}+z_1=\frac{p_2}{\rho g}+\frac{v_2^2}{2g}+z_2$$

According to the equation of contuinity,



$$v_2=\frac{a_1}{\sqrt{a_1^2-a_2^2}}\sqrt{2gh}$$

Now discharge= $$Q_{act}=C_d\,\frac{a_1a_2}{\sqrt{a_1^2-a_2^2}}\sqrt{2gh}$$

III.FLOW SIMULATION

Computational Fluid Dynamics or CFD is a technique that deals with the solution of fluid flow fields through numerical analysis. SOLIDWORKS Flow Simulation is a CFD software designed for the everyday SOLIDWORKS user and analyst. It provides dynamic feedback on the fluid flow and thermal performance of their products. With parametric optimization capabilities, users can automate the design and analysis process to discover the best iteration of their design within the familiar SOLIDWORKS CAD environment

Geometry

venturi design is a process with iteration to formalize final geometry model.in this study the iteration is done with the convergent and divergent surfaces of the venturimeter to get the design.the pipe diameter is kept 70 mm, the throat has 40mm and the total length of the venturimeter is 1900mm.

No slip wall condition for the mass and momentum considering wall roughness as A s 2 micrometer. The fluid flow considered for the experimental analysis is carried with water as a fluid medium.

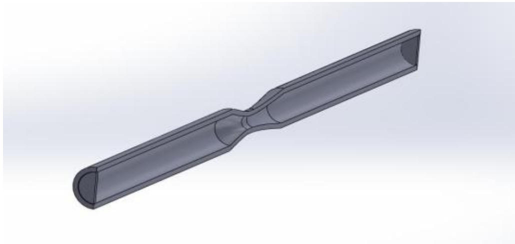


Fig-1: Isometric view.

The above design is the crosssection of a venturi with a grid on the inlet and outlet section. To know the pressure and temperature distribution through outbthe innersurface of the venturimeter we are going to find the discharge.

IV.BOUNDARY CONDITIONS

Symmetry and periodic boundary conditions in SOLIDWORKS Flow Simulation are used to reduce the size of the flow problem, thereby reducing analysis run time. Although these two computational domain boundary conditions are set up by editing the default computational domain, they both are very different.

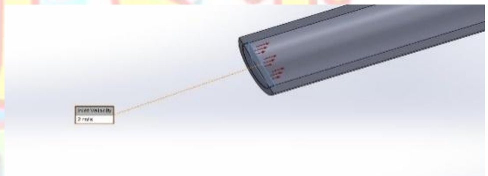


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Fig-2: Inlet boundary condition

Giving the inlet velocity as 2m/s the simulation starts with the type of fluid required, for this venturimeter we took water as a fluid. the pressure, velocity and temperature changes mayfollows.

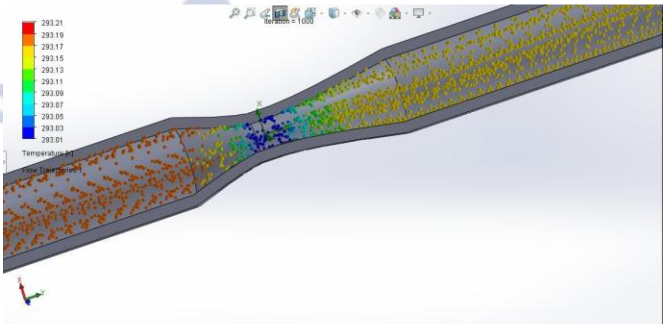

Fig-3: Temperature difference

Table-1: Temperature variation.

	Convergent	Throat	Divergent
Temperature(K)	293.19	293.01	293.15

Temperature analysis shows that in venturimeter the maximum temperature is at the inlet and the temperauture reduces at the throat and again reaches to some temperaturebut lower than the inlet temperature.the inlet temperature is 293.21k is at the inlet and at the throat it is 292.01k from the analysis.

Pressure

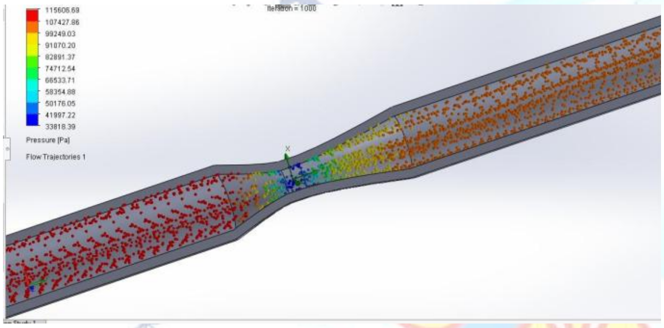

Fig-4: Pressure difference

Table-2: Pressure variation

	Convergent	Throat	Divergent
Pressure (KPa)	115606.69	33818.39	99249.03

In this pressure variance we can say that the pressure is reducing at the throat from the convergent cone its initial pressure drops at the throat with the minimum pressure in the venturimeter. The throat area has the min pressure with 33818.39pa

Velocity

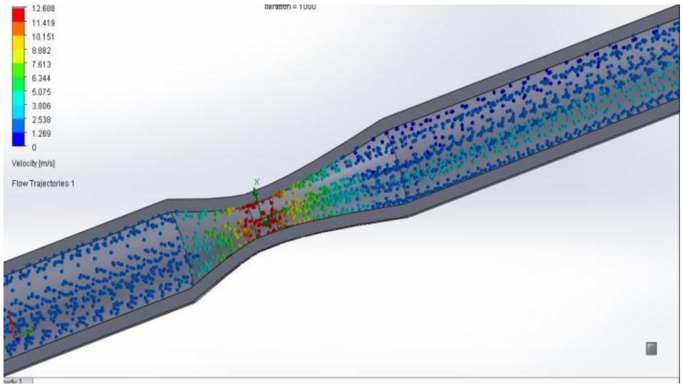

Fig-5: Velocity difference

Table-3: Velocity variation.

	convergent	throat	divergent
Velocity(m/s)	3.806	12.688	2.538

In the venturimeter we know that there is no change of the velocity of the fluid when it is placed inside a pipe to find the flow, but there is change of velocity at the throat it reaches to the maximum.

V.METHODOLOGY

The methodology uses Bernoulli's theorem and Continuity equation in the analysis of the Venturimeter. The design principle of the Venturimeter is based on the theory of discharge of a liquid flowing in apipe. During the flow of liquid through a pipe, there is an effect known as the Venturi effect. This effect is the reduction in fluid pressure that results when a fluid flows through a constricted section of the pipe. The fluid velocity must increase through the constriction to satisfy the equation of continuity, while its pressure must decrease due to conservation of energy: the gain in kinetic energy is balanced by a drop in pressure or a pressure gradient force. An equation for the drop in pressure due to Venturi effect is governed by Bernoulli's and continuity equations. Discharge sthrough a VenturimeterIn this study, the performance characteristics of a Veturimeter are determined. Applying Bernoulli's theorem and Continuity equation; and according to a Venturimeter through which some liquid is flowing as shown in above figures and for completeness.

VI.FUTURE SCOPE AND CONCLUSION

The project is aimed at building a perfect venturimeter from the analysis based on pressure, velocity and the temperature by means of which we can design a venturimeter at the respected values. The converging and diverging cones have a difference values of pressure and velocity Difference by which it we can find the discharge of the fluid through a pipe.

The Venturimeter flow was designed, constructed and tested. The project was successfully completed, and the aims achieved. The results were analysed analysis of flow flow discharge through Venturimeter and was in good agreement; hence confirming the usefulness of the Bernoulli's principles and continuity equation in the analysis of flow discharge through Venturimeter. The idea will be effective applied in the control and measurement of flow alone pipeline in oil field, for irrigation purposes, automotive industry, wastewater collection systems and treatment plants. The Venturimeter flow manufactured is portable with the capability of easy assembly and disassembly. This flow system is valuable for practical demonstration of fluid measurement and control in Fluid mechanics studies in Mechanical Engineering Laboratory. The cost is affordable due the used of locally available material; and the cost will further reduce significantly if the Venturimeter flow is mass produced.

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