To Design and calibrate an instrument to measure pressure, velocity, flow rate and Discharge in a high pressure pipe

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ABSTRACT

In any industry such as nuclear power plant, Gas turbine plants, Steam turbine plants, Chemical industries where fluid flow is a major activity and the overall production takes place due to this fluid flow, safety of the plant totally depends on the flow parameters that affect the flow while the liquid is flowing through the pipes. These parameters include the pressure with which the fluid is flowing, its velocity, flow rate and discharge required. All these parameters are needed to be kept under continuous observation by taking periodic readings. Hence we would try to design and calibrate such an instrument which can measure all these parameters in just a single reading at the same point of line and at the same time. At the same time we would try to make it user friendly, economic and cost effective.

Keyword: - *Pressure measuring instrument / Flow parameter measuring device / velocity measurement / flow measurement / discharge measurement / gas flow through a pipe / fluid flow through a pipe.*

1. INTRODUCTION

1.1 Problem statement

In any industry where fluid flow is a major cause for the production, the safety of the plant as well as the workers and accuracy of readings are of great importance as any deviation in its control parameters may lead to accidents or even a blast. These control parameters include

(1) Pressure

(2) Temperature

(3) Velocity

(4) Discharge

(5) Mass flow rate

Hence, continuous and time to time measurement of these parameters and their periodic checking is of great importance in order to avoid accidents. There are a number of instruments available in the market for the measurement of these control parameters. These instruments include various mechanisms to measure the parameters.

But as human behavior is completely focused on improvements and modification, an urge to develop a single device for measuring most of the parameters at the same point with more accuracy, less overall cost and without any impact on the flow process inspired us to take this as our project.

So In this semester we would try to develop, design and calibrate an instrument to measure the control parameters of a fluid flowing through a high pressure pipe. These parameters include pressure, velocity, mass flow rate and discharge. Our main aim is to reduce the cost of operation and to give accurate results without using any external power source.

1.2 Aims and objectives

To design and calibrate an instrument to measure pressure, velocity, discharge and mass flow rate of a fluid flowing through a high pressure pipe at the same point.

Objectives

(1) To measure pressure, velocity, discharge and mass flow rate of a fluid flowing through a high pressure pipe at the same point.

(2) To make the instrument economical

(3) To make it work without using any external source

(4) To make it more accurate

(5) To design it in such a way that it will not affect the actual fluid flow

2. DESIGN & MECHANISM

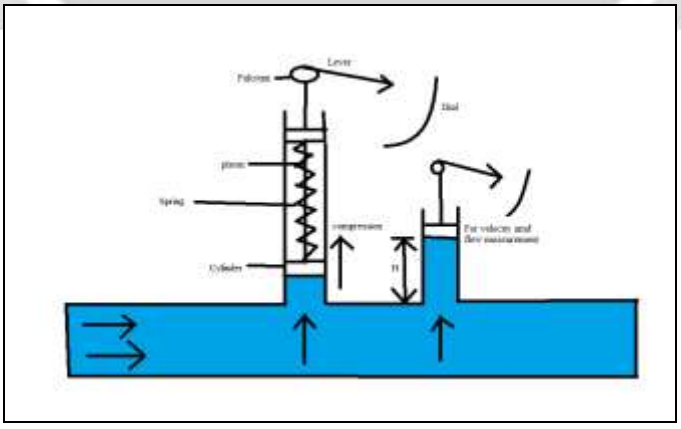


Fig -1 : Model

We studied about the various mechanisms used for measuring pressure velocity and discharge in flowing fluid. Out of these mechanisms we selected a few which can serve our purpose properly.
(1) The height of fluid in a column that can be used to show the pressure on a calibrated scale. Another such column can be used to get the velocity of flow. From this velocity we can find out the flow rate and discharge through the pipe.
(2)The second method includes the measurement of the repulsion of two magnets that is created the fluid column moves up the magnet upwards and is repelled by a same pole magnet on the upper side.
(3) The third method includes the measurement of parameters by measuring the flow of electrons caused due to flow of charges.
(4)The next mechanism includes the matching of the frequency of pendulum
Out of all these methods we have selected the spring based mechanical method based on the various parameters affecting the instrument and by comparing it for all the alternative mechanisms. Benefits of spring based mechanism are as follows
(1) Purely mechanical elements
(2)No electrical components
(3)No external power source
(4)Low maintenance cost
(5)High range of measurement
(6)Can be used for both liquid and gas

2.1 Mechanism

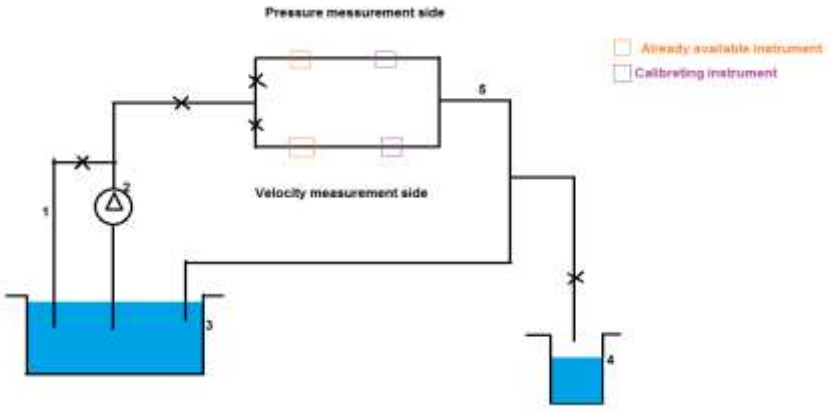
When the liquid enters the pipe it impacts a vertical thrust in the first column due to which the piston is forced upwards. This upward displacement of the piston is recorded and is transferred onto a lever which in turn shows the pressure on a dial.
This column uses the formula of pressure = density *gravity*Height of compression
In the case of velocity, the height of liquid column is calculated and is calibrated on a scale as per the formula velocity = sqrt. (2gh)
This instrument doesn't have any impact on the fluid flowing through the pipe and hence there is no energy loss in this instrument.The main purpose of the spring is to stop the deflections due to variation in flow and pressure and to bring the piston back to its original shame in case of zero pressure.

2.2 Components along with their functions

(1)Piston: - It will transfer the upward motion of the fluid to the lever so that it shows the desired reading depending upn the displacement.
(2) Spring: -It is used to bring back the piston to the initial position once the pressure or velocity drops down to zero. IT also acts as a sensing element.
(3)Cylinder:- It serves as a column for the fluid to flow in and also houses all the other components.
(4)Lever: -It converts the vertical displacement of fluid into radial motion and magnifies the same.
(5)Dial: - It houses the calibrated dial indicator which gives us the actual reading of the parameter

2.3 Circuit Diagram

1. Bypass line
2. Pump
3. Tank
4. Discharge measuring tank
5. Pipe lines



3. EXPERIMENTAL PROCEDURE

[1] Connect all the parts as shown in circuit diagram.
[2 priming the centrifugal pump.
[3] poured the tank with sufficient water.
[4]Test all the valves are working properly.
[5]Check bypass line and pump is properly working or not.
[6]Now first open the main valve as well as pressure instrument calibration valve slowly.
[7] First take reading at small flow rate and then gradually increase the flow rate.
[8]Calibrate pressure measuring instrument.
[9]Now again open bypass line and close the main valve and other valves.
[10]Now open again main valve and velocity calibration side valve, close bypass line.

4. ADVANTAGES

(1) Less time consuming
(2)All in one measurement
(3)No external power source
(4)It can measure even high pressure
(5)High range of measurement
(6) Economic
(7)Easy to design and manufacture
(8) Operating cost is almost negligible and very less maintenance cost
(9)Does not depend on atmospheric pressure or any other parameter
(10) Gravity and fluid Density does affect the reading
(11) Even change in parameter is obtained directly and calibration isn't to be worried about as it can be installed at more than one locations
(12) It can measure pressure, velocity, flow rate and discharge of fluid at the same point
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5. DISADVANTAGES

(1) The mobility of the instrument is a major issue in case of change of location or passage of flow.
(2) The maintenance may cause damage to the internal components of the instrument hence skilled labor is required.

(3)The fluid density may affect the reading of the instrument and even other instrument can prove to be economical in case of individual measurement.

6. APPLICATIONS

It can be used in industries to measure parameters of fluid in high pressure pipe. These industries include Cemical industries, oil refineries, gas plants etc. it can be used for learning in colleges and for measurement.

7. SCOPE OF FUTURE WORK

We opt for redesigning the instrument because further modifications can be made depending up on the applications in the chosen mechanism as well as in the areas of application of the instrument.

8. CONCLUSIONS

(a)The height of fluid column is directly proportional to the pressure force
(b)The height of fluid column is directly proportional to the number of active tern of the spring
(c)The height of fluid column is inversely proportional to the sensitivity factor
(d)The height of fluid column is inversely proportional to the Modulus of rigidity.
(e) The height of fluid column is inversely proportional to fourth power of wire diameter.
(f) The height of fluid column is directly proportional to cube of mean coil diameter

9. REFERENCES

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