INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

To Study of Pressure Measurement using Bourdon tube

Manual-Experiment No:-9

Transducers and Instrumentation
Virtual Lab

Experiment No:-9

Aim:-

To Study Pressure Measurement using Bourdon Tube.

Requirement: -

- Computer Facility
- Lab view 2009 Runtime engine
- Internet facility for performing (on-line experiment).
  For (off- line experiment) executable file of the experiment can be downloaded through the download link given on the website.

Theory:-

Pressure

Pressure is defined as force per unit area. For example, pressure, P, is a function of force, F, and area, A.

$$P = \frac{F}{A}$$

Pressure can be expressed as a relative pressure or an absolute pressure. The units of pressure are:

$$\text{SI Unit:} \qquad \frac{\text{N}}{\text{m}^2} \,(\text{or Pa})$$

$$\text{CGS Unit:} \qquad \frac{\text{dynes}}{\text{cm}^2}$$

$$\text{American Engineering Unit:} \quad \frac{\text{lb}_\text{f}}{\text{in}^2} \,(\text{or psi})$$

Other common units of pressure include atmospheres (atm), bars, inches of mercury (in Hg), and millimeters of mercury (mm Hg).

In a container full of gas contains innumerable atoms and molecules that are constantly bouncing of its walls. The pressure would be the average force of these atoms and molecules on its walls per unit of area of the container. Moreover, pressure does not have to be measured along the wall of a container but rather can be measured as the force per unit area along any plane. Air pressure, for example, is a function of the weight of the air pushing down on Earth.

Pressure is one of the most important process variables which are required to be measured and controlled in a process industry. This monitoring reflects certain performance criteria that must be controlled to produce the desirable results of the process and insure its safe operation. Boilers, refineries, water systems, and compressed gas systems are but a few of the many applications for pressure measurements.

Pressure Transducer:-

A pressure transducer converts a measured pressure into a mechanical or electrical signal. The transducer actually is a hybrid sensor-transducer. The primary is usually an elastic element that deforms or deflects under pressure, while the sensors like strain gauge, piezo-electric transducers, linear variable differential transformer, capacitive element, inductive element, etc act as secondary sensors to measure the positive or negative gauge pressure.

Several common elastic elements used as primary sensing elements include the bourdon tube, bellows, capsule and diaphragm. In many pressure measurements, Bourdon tubes are extremely popular as elastic elements in pressure gauges.
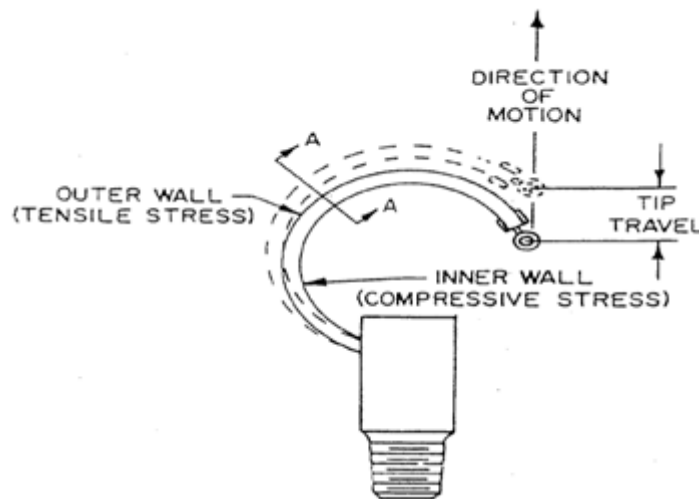
Bourdon Tube:-

FIGURE 1 BOURDON TUBE

Many pressure-measuring instruments are called gauges. The majority of pressure gauges in use have a Bourdon-tube as a measuring element. (The gauge is named for its inventor, Eugene Bourdon, a French engineer.) The Bourdon tube, shown in figure 1, is a device that senses pressure and converts the pressure to displacement. Bourdon gages are purely mechanical devices utilizing the **mechanical deformation** of a flattened but bent tube that winds or unwinds depending on the pressure difference between the inside and the outside. Since the Bourdon-tube displacement is a function of the pressure applied, it may be mechanically amplified and indicated by a pointer. Thus, the pointer position indirectly indicates pressure.

Formula Used:-

The displacement of the tip in the C-shaped bourdon gauge is given by:

$$\Delta a = 0.05 \frac{aP}{E} \left(\frac{r}{t}\right)^{0.2} \left(\frac{x}{y}\right)^{0.33} \left(\frac{x}{t}\right)^{3}$$

Where

Δa = Movement of Tip, mm

a= Length of the arc, mm

P= the Applied Pressure, $\dfrac{N}{m^2}$

E= Modulus of Elasticity

x= diameter of major axis, mm

y= diameter of minor axis, mm

t= thickness of the tube, mm

r= radius.

Procedure:-

➢ Initiate the experiment through run tab.
➢ Insert force through the slider.
➢ As per the force, true pressure is been calculated as shown in pressure indicator.
➢ That force will result in displacement of the tip of Bourdon Tube which is shown in displacement indicator.
➢ As per the displacement, the pressure is been calculated.

Observational table:-

S. No.	Force(lb)	True Pressure(PSI)	Measured Pressure(psi)	Error
1.				
2.				
3.				
4.				
5.				

Result:-

Through the above process, pressure output is been calculated as per the displacement of Bourdon Tube.

Precaution:-

➢ Follow instructions carefully.
➢ For fetching correct value, wait until the process gets complete.
➢ Runtime engine should be properly installed.