Ministry of Higher Education and Scientific Research

Al-Mustaqbal University College

Chemical engineering and petroleum industries
(Fluid Flow Lab)

Experiment No. 2
(Calibration of a Pressure Gauge)

أعداد:

م.م. رند فاضل كاظم

م. زينة قاسم علوان

Number of Experiment: 2

Name of Experiment: Calibration of a Pressure Gauge

Purpose of Experiment:

1- To explain mechanism and operating Bourdon-tube pressure gauge.

2- To determine the percentage of error for Bourdon –tube pressure gauge by using a number of standard units of pressure.

Introduction:

A bourdon- tube gauge, (fig. 1), measures the pressure by sensing the deflection of a coil tube. The pressure gauge is composed of a metal tube of copper with one end closed and formed as 3/4 of a circle and the other end connected to the pressure source. The applied pressure causes a little expansion in the circular shape of the tube, moving with it an attached pointer that is calibrated to indicate the pressure. When the applied pressure is more than the atmospheric pressure, the closed

end will diverge causing an expansion in the circular shape of the tube. There is a connected mechanism of levers and gears to amplify the movement of the tube and transfer the action to a pointer that indicates a definite pressure.

When the pressure gauge is disconnected, the pointer must indicate zero pressure because in this case the pressure inside the tube is equal to the outside pressure which is the atmospheric pressure. The calibration of the pressure gauge is done according to this fact. The accuracy of the pressure -gauge is dependent on its calibration. The gauge must be calibrated from time to time especially after applying, high pressure.

Calibration, it is defined as the process of comparison of specific values of input and output of instrument with the corresponding reference standards.
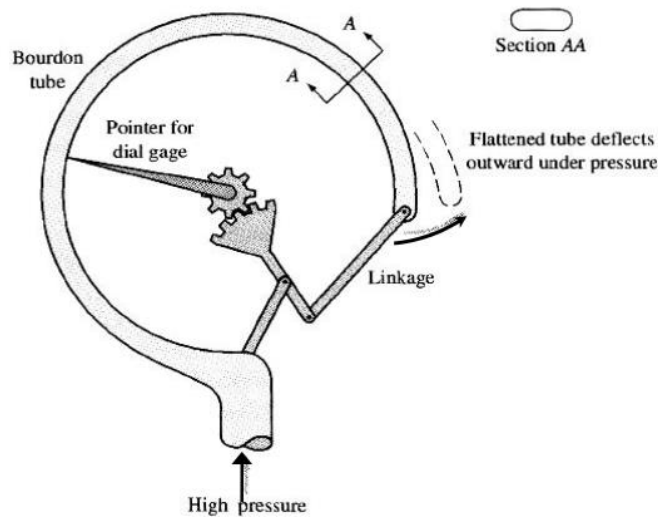

Figure 1. Schematic of a bourdon tube device for mechanical measurement

Theory:

To calculate the percentage of error:

$F = m \times g$

$A = \pi d^2 / 4$

standard pressure $(P) = F / A$

Average gauge pressure $(P_{g(av)}) = \dfrac{P\,g(add) + P\,g(lift)}{2}$

Percentage of error (%) $= \left| \dfrac{\text{standard pressure} - \text{Average gauge pressure}}{\text{standard pressure}} \right|$ x 100%

Description of Apparatus:-

The Bourdon gauge show in figure (2) has a transparent dial through which the construction may be viewed. It consists essentially of a thin-walled tube of oval cross-section, which is bent to a circular are encompassing approximately 270˚. It is rigidly held at one end, where the pressure is admitted. As you can see, both units are connected by means of a tube line. The seal between the piston and the cylinder is metallic with no other sealing elements. The fit has been very carefully designed to ensure that the piston operates almost entirely without friction, and with minimal oil leakage.
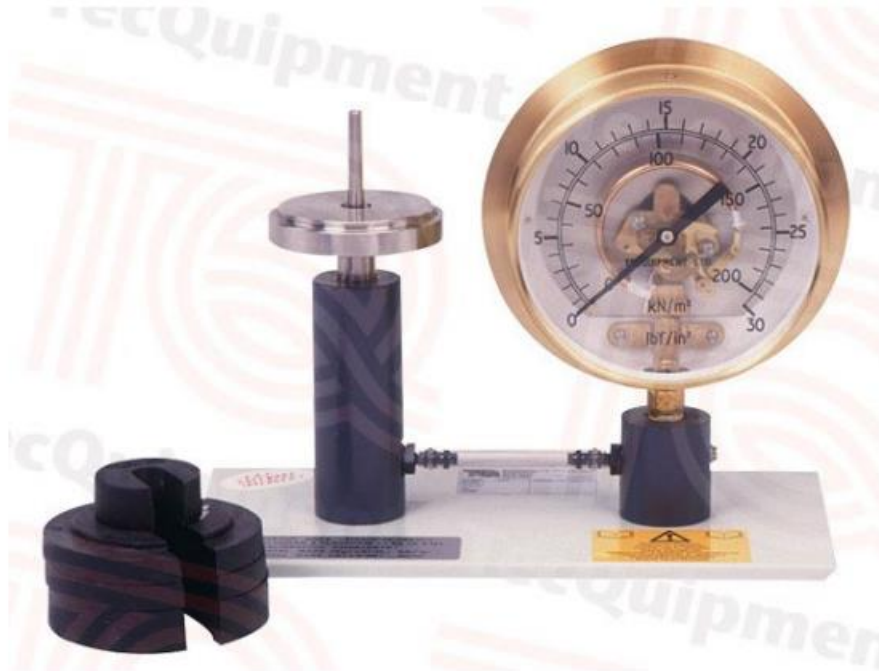
Figure 2. Description of Apparatus

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Procedure:-

1-Remove the piston from the cylinder by using the hand.

2- Adjust the oil level in the open cylinder until the cylinder is filled up to the edge.

3- The piston is re-inserted in to the cylinder of the pressure gauge unit.

4- Add the weights in convenient increments, and at each increment, observe the pressure gauge reading.

5- The gauge pressure reading is recorded.

6- Take the similar sets of readings with decreasing weights.

7- Record the results in table (1).

Reading:

Mass of piston = 1kg

Cross-sectional area = 243mm²

$g = 9.81 \text{N/m}^2$

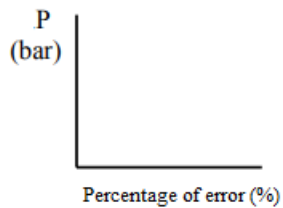| Mass (Kg)	P_g (add) (bar)	P_g (lift) (bar)
1	0.29	0.114
2	0.53	0.81
3	0.81	0.53
4	0.114	0.29

Calculation:

Results :

Case No.	Standard pressure (bar)	Gauge pressure add (bar)	Gauge pressure lift (bar)	Average Gauge pressure (bar)	Percentage of error (%)
1					
2					
3					
4					
5					
6					

Discussion:

1- 1. Plot and find the slope for :-

2- What are the advantage and disadvantage of bourdon –tube gauge?

3- What are the sources of error in the experiment?