
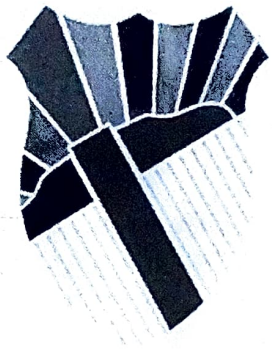

The University of Jordan

School of Engineering

Chemical Engineering Department

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Experiment Number (11)

Pressure gauge Calibrator

85/100

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Abstract:

This experiment was carried out to calibrate the bourdon pressure gauge and show how its works. We added weights up to 6 kg (including mass of piston) to weights to a platform on a dead weight tester therefore, the weights put a known force on to a piston which has a known area then we indicated the increasing gauge pressure reading, after reversing the procedure we recorded the degreasing pressure readings. We found that increasing the weight on the loading platform leads to an increase in gauge pressure readings. Also, there was a variance loss between the pressure applied the gauge pressure readings.

decreasing

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Results:

Table (1): Raw data of the experiment

mass (kg)	gauge reading ($KN.m^{-2}$)			Piston Area (m^2)
	increasing	decreasing	average	0.000315
1	29	30	29.5	Plunger and platform (kg)
2	55	56	55.5	1
3	84	89	86.5	Gravity acceleration (m^2/s)
4	122	124	123	9.81
5	165	154	159.5	k
6	185	185	185	31.143

Table (2): Calculated data of the experiment

Force (W) (N)	Applied Pressure ($KN.m^{-2}$)	average error ($KN.m^{-2}$)	error (% of full scale) %
9.81	31.143	1.643	0.82%
19.62	62.286	6.786	3.39%
29.43	93.429	6.929	3.46%
39.24	124.571	1.571	0.79%
49.05	155.714	3.786	1.89%
58.86	186.857	1.857	0.93%

Diagrams:

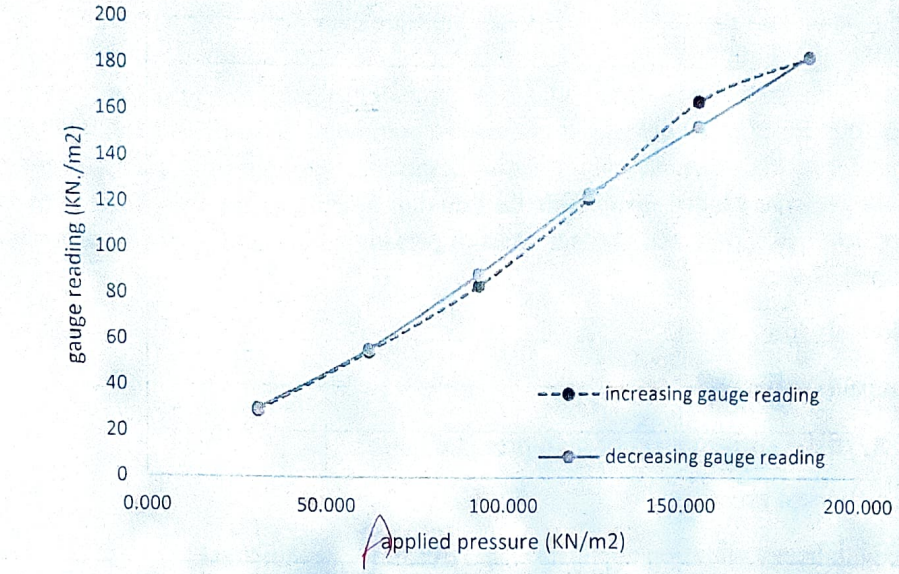

Figure (1): increasing and decreasing gauge pressure vs. applied pressure

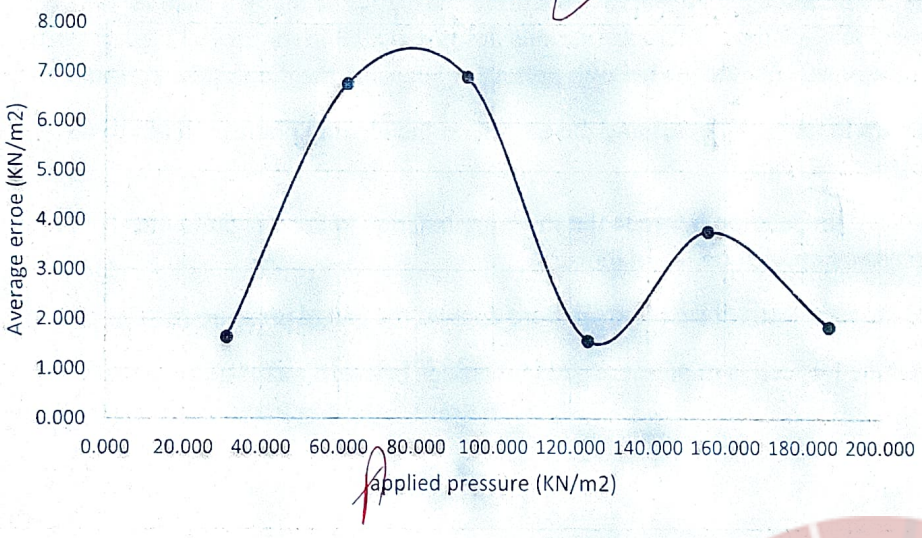

Figure (2): average error vs. applied pressure

Discussion:

A bourdon tube pressure gauge is a mechanical pressure measuring instrument that reads the pressure without requiring any electrical power. a flexible tube containing water transfers the pressure on the piston to the Bourdon tube. It is generally used for the measurement of pressure from 0.6 to 7000 bar (8 to 10000 psi). It is the most common type of pressure gauge and is used by industries for its high accuracy and precision, especially for high-pressure applications. Bourdon tube pressure gauges are suitable for liquid or gaseous media for vacuum, low and high-pressure applications. Compared to other types of pressure gauge, the bourdon tube pressure gauge advantages are:

- Relatively low cost
- Compact design
- Safety in the measurement of high-pressure ranges
- Measurement accuracy
- Use with heavy vibration application and dynamic pressure load

The bourdon tube pressure gauge exhibits high sensitivity to pressure changes, thus, ensures higher accuracy and precision in the reading. Furthermore, the vibration and corrosion resistance offered by the pressure gauge makes it the preferred choice of many industries for their pressure measurement applications. There are various designs available for pressure gauges besides the bourdon tube, these include the bellows pressure gauge and the diaphragm pressure gauge.

As we can see in table (1): increasing the weight on the loading platform leads to an increase in gauge pressure readings.

From table (2): the relation between the force applied due to the weight is linearly proportional with the pressure applied on the platform.

There is a variance loss between the pressure applied the gauge pressure readings.

There is a quite hysteresis in pressure gauge readings between increasing column and decreasing column.

Conclusion:

To conclude the bourdon tube pressure gauge is highly sensitive to pressure change. However, two types of errors occur one is due to the hysteresis in the gauge (average error) and the other is the reading error across the pressure gauge. Also ,the relation between the force applied is linearly proportional with the pressure applied on the platform.

References:

1.Website: Tameson; Technical Information Center; Product Information ; How do Bourdon Tube Pressure Gauges Work (31/8/2022).

https://tameson.com/bourdon-tube-pressure-gauge.html

2.Book: Chemical engineering laboratory "1" (0915361); University of Jordan; factual of engineering and Technology; Department of Chemical engineering.

Appendices:

Sample of calculations:

Taking the firs raw from:

table (1):

1. Average gauge pressure readings $= \frac{29+30}{2} = 29.5\ KN/m^2.$

table (2):

2. Force (weight) $= m * g = 1 * 9.81 = 9.81\ N.$
3. Applied pressure $= \frac{W}{A} = \frac{9.81}{0.000315} * 10^{-3} = 31.143\ KN/m^2.$

   Or

   $p = m * k = 1 * 31.143 = 31.143\ KN/m^2.$

4. Average error $= |Applied\ pressure - Average\ pressure| = 31.134 - 29.5 = 1.643\ KN/m^2.$
5. Error percentage of full scale $= \frac{average\ error}{200} * 100\% = \frac{1.643}{200} * 100\% = 0.82\%.$

where k = a constant found from g/A.

For example, for a piston area of 315 mm^2 (0.000315 m^2) and $g = 9.81\ m.s^{-2}$,

then $k = 31143$. Therefore:

Pressure (in $N.m^{-2}$) = mass (in kg) x 31143

Or

Pressure (in $kN.m^{-2}$) = mass (in kg) x 31.143

4. Procedure:

1. Create a blank table of results, similar to Table 1.

2. Note the cross-sectional area of the piston (indicated on the base of the equipment).

35 kN/m2

Table 1 Blank Results Table

pressure force

Mass (m) (kg)	Force (W) (N)	Applied Pressure (p) $kN.m^{-2}$	Piston Area (A): Gauge Reading ($kN.m^{-2}$)			Average Error ($kN.m^{-2}$)	Error (% of full scale)
			Increasing	Decreasing	Average		
29	1						
55	2						
84	3						
122	4						
165	5						
185	6						
154	5						
124	4						
89	3						
56	2						
30	1						

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