Study of Characteristic MPX5700AP Sensor For Pressure System Monitoring Based Various Units

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Abstract : Implementation of MPX5700AP sensor is very much among practitioners and academics to measure pressure. However, the sensor accuracy obtained is always far from the measurement due to reading errors. This study calculates the accuracy of the MPX5700AP sensor in reading measurements. The reading of this pressure measurement is measured by a standard measurement of environmental pressure, which is atmosphere pressure. From the research obtained, the MPX5700AP sensor has a voltage output with an accuracy of 98.81%. The reading accuracy for each measurement conversion is 96.08%, 95.95%, and 95.94% between kPa, Psi, and mmHg respectively.

Keywords: MPX5700AP sensor, Accuracy, Atmosphere Pressure.

1. Introduction

Measurement of pressure in a production process is very important because it involves the safety and quality of an industrial process. For example, a vacuum frying machine is a process device that is required to maintain pressure. The pressure in this vacuum frying machine must be at a certain value to get maximum results.

When the vacuum frying machine does not provide a pressure indicator, it is difficult to know the real condition of this machine. If the pressure is too high, the machine will be damaged or the production will be of low quality. Therefore, this study proposes a pressure monitoring prototype using the MPX5700AP sensor. This study aims to be able to monitoring of pressure measured using the MPX5700AP sensor on a personal computer. This research is useful for monitoring pressure and can be controlled if needed on a vacuum frying machine.

This study uses an experimental method of testing on the pressure prototype on the MPX5700AP sensor which is connected to the Arduino controller. The research stages are divided into two categories, hardware and software design. Arduino will be used to process input data from the MPX5700AP sensor and display the pressure of the test results.

Many researches using the MPX5700AP sensor have been carried out such as the Design of Air Pressure Monitoring Devices in Four-Wheel Vehicle Tires Using an Arduino-Based Air Pressure Sensor [1], in this study the MPX5700AP sensor produced an average good average accuracy is 99.49%. With an error value of 0.51%, the sensor value reading can be accurate and the tool can be brought to a speed of 50 km/hour.

The next research is the Design of Lung Volume Measuring Devices Based on the MPX5700DP Gas Pressure Sensor and Arduino Uno [2], in this study obtained a tool capable of measuring FVC (Forced Vital Capacity) and FEV1 (Forced Expiratory Volume) in One Second), with an error of 3.17% for FVC and 1.22% for FEV1 compared to measurements using a spirometer in a hospital.

The next research is the implementation of the DS18B20 Temperature Sensor and MPX5700AP Pressure Sensor using an Arduino Microcontroller on a Stress Level Detector [3]. In this study, the characterization of each tool has fluctuating values, but the average value obtained by the MPX5700AP temperature sensor is not much different from the Digital Tensimeter. This is evidenced by the magnitude of the average value of accuracy in both types of characterization, which is 96% and the average error value is 4%.

The working principle of the Vacuum Frying machine starts from putting 80 liters of cooking oil into the machine. Next turn on the stove from LPG and the oil is heated. After the oil is hot, then put the pineapple that has been cleaned and cut in such a way according to the desired size and shape into the frying machine. This Vacuum Frying machine is tightly closed so that no steam comes out. The principle of this Vacuum Frying machine is that it must be in an airtight or vacuum state. After the pineapple has been inserted into the machine, the pump motor will be turned on to suck the steam engine inside the Vacuum Frying machine. This aims to keep the pressure inside the machine stable. If the pressure is stable then the machine will not be damaged or explode

Figure 1: Vacuum Frying Machine

The international unit of pressure is the Newton per meters squared or N/m2 and is symbolized by letter P or p. In addition to units of N/m2, pressure is also has another unit of measurement, namely the pascal (Pa), then 1 Pa equal 1 N/m2.

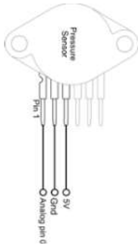

Figure 2 : MPX5700AP Sensor

The MPX5700AP sensor is single port, absolute silicon pressure sensor integrated in a 6 pin SIP package which is a sei Manifold Absolute Pressure (MAP) is pressure sensor that can read pressure air in a manifold. MPX5700AP sensor is equipped with network signal conditioning and temperature calibrator. Bipolar processing inside transistor provides an analog level signal Accurate output and comparable height with pressure applied, so that the sensor MPX5700AP has 2.5% error maximum over 0°C to 85°C, pressure range from 15Kpa to 700Kpa, supply voltage range from 4.75VDC to 5.25VDC, sensitivity 1.0 kPa (kiloPascal) equivalent to 0.145 Psi, and operating range temperature from -40°C to 125°C. This sensor is used to determine the air pressure in an object, be it in in bottles, in tires, etc., sensors it can measure with a range of 0 to 700 kPa (0 to 101.5 Psi) - 15 to 700 kPa (2.18 to 101.5 PSI), and the output voltage is in the range 0.2 to 4.7 volts.

Figure 3: Arduino R3

In the design and manufacture of this research, the Arduino Uno R3 board type was used. Arduino Uno is a board microcontroller based on ATmega328. As in figure 3. Arduino Uno R3 Specifications:

Microcontroller: ATmega328
Operating Voltage: 5V Voltage
Recommended input: 7-12V
Input Voltage Limit: 6-20V
Number of Digital I/O Pins : 14
Number of Analog Input Pins : 6
DC current per I/O pin : 40 mA
DC Current for Pin 3.3 V : 50 mA
Memory: 32 KB (ATmega328), approx.
0.5 KB used by bootloader
SRAM: 2 KB (ATmega328)
EEPROM : 1KB (ATmega328)
Clock Speed: 16 MH

2. METHODOLOGY

The Block Diagram of this research can be shown in Figure 4 below.

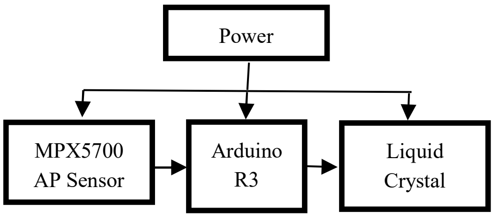

Figure 4 : Block Diagram Design

Sensor readings go to Arduino as analog data. Next, the Arduino ADC reads as decimal data. From this decimal data, it is converted into units of pressure.

Sensor calibration uses the formula contained in the sensor datasheet, the output of the sensor whose ADC value is converted first to Vout and then converted to the pressure value of the kPa unit with the formula (NXP Semiconductors, 2007):

$$Vout = \frac{ADC}{1023} * Vs \qquad (1)$$

$$kPa = \frac{\left(\frac{Vout}{Vs}\right) - 0{,}04}{0{,}0012858} \qquad (2)$$

After getting the pressure value in kPa units, then the pressure value is converted into psi units with the formula (SensorONE, 2021);

Psi = kPa x 0,145038 (3)

In addition to the kPa value converted to Psi, it is also possible to get the unit value for mmHg pressure using the formula:

mmHg = kPa x 0,00987 (4)

3. Result and Discussion

Tests were carried out to obtain data and research results, namely by conducting direct experiments on the sensor output that entered the Arduino. The tests carried out are the MPX5700AP Sensor Output Voltage, the Characteristics of the Kilopascal Unit Output, the Characteristics of the PSI Unit Output, and the mmHg Output. Exsperiment is carried out by directly measuring the voltage at the sensor output as shown in Figure 5 below.

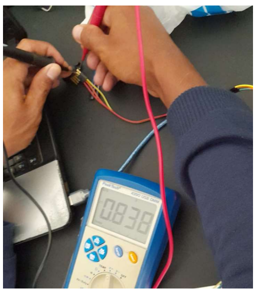

Figure 5 : Voltage Measurement

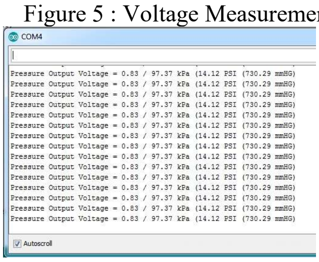

Figure 6 : Arduino Reading

Table 1. Experiment Voltage Output Sensor

No	Arduino Read (Volt)	Measurement Instrument (Volt)	Error (%)
1	0.83	0.838	0.95
2	0.83	0.838	0.95
3	0.83	0.838	0.95
4	0.83	0.838	0.95
5	0.82	0.838	2.15
6	0.83	0.838	0.95
7	0.83	0.838	0.95
8	0.83	0.838	0.95
9	0.83	0.838	0.95
10	0.82	0.838	2.15
Average Error Measurement			1.19

From the comparison of measurements using measuring instruments with Arduino output measurements, the smallest measurement is 0.82 Volt and the largest is 0.83 Volt. The average error of measurement is 1.19%. This shows that the voltage output on the MPX5700AX sensor has an accuracy of 98.81%.

The next experiment is the measurement of kilopascals (kPa). Here the measuring sensor can be seen as in figure 6 above. So that the data obtained as table 2 below.

Table 2. Experiment kPa Measurement

No	Sensor Measurement (kPa)	Unit Conversion (kPa)	Error (%)
1	97.37	101.3	3.88
2	97.37	101.3	3.88
3	97.37	101.3	3.88
4	97.37	101.3	3.88
5	96.91	101.3	4.33
6	97.37	101.3	3.88
7	97.37	101.3	3.88
8	97.37	101.3	3.88
9	97.37	101.3	3.88
10	97.37	101.3	3.88
Average Error Measurement			3.92

From the test data above, it can be obtained that the lowest measurement is 96.91 kPa and the highest is 97.37 kPa. The average difference in measurements using the MPX5700AP sensor is 3.92%. This shows that the sensor readings converted to kPa on the MPX5700AX sensor have an accuracy of 96.08%.

The next experiment is the measurement of units of Pounds per Square Inch (Psi). Here the measuring sensor can be seen as in figure 6 above. So that the data obtained as the table below.

Table 2. Experiment Psi measurement

No	Sensor Measurement (Psi)	Unit Conversion (Psi)	Error (%)
1	14.12	14.689	3.87
2	14.12	14.689	3.87
3	14.12	14.689	3.87
4	14.12	14.689	3.87
5	14.01	14.689	4.62
6	14.12	14.689	3.87
7	14.12	14.689	3.87
8	14.12	14.689	3.87
9	14.12	14.689	3.87
10	14.01	14.689	4.62
Average Error Measurement			4.02

From the test data above, it can be obtained that the lowest measurement is 14.01 Psi and the highest is 14.12 Psi. The average difference in measurements using the MPX5700AP sensor is 4.02%. This shows that the sensor readings converted to Psi on the MPX5700AX sensor have an accuracy of 95.98%.

The next experiment is the measurement of units of Millimeter Mercury Hydrargyrum (mmHg). Here the measuring sensor can be seen as in figure 6 above. So that the data obtained as the table below.

Table 2. Experiment mmHg measurement

No	Sensor Measurement (mmHg)	Unit Conversion (mmHg)	Error (%)
1	730.29	760	3.91
2	730.29	760	3.91
3	730.29	760	3.91
4	730.29	760	3.91
5	724.59	760	4.66
6	730.29	760	3.91
7	730.29	760	3.91
8	730.29	760	3.91
9	730.29	760	3.91
10	724.59	760	4.66
Average Error Measurement			4.06

From the experiment data above, the lowest measurement can be obtained that is 724.59 mmHg and the highest is 730.29 mmHg. The average difference in measurements using the MPX5700AP sensor is 4.06%. This shows that the sensor readings converted to mmHg on the MPX5700AX sensor have an accuracy of 95.94%.

4. Conclusions

Eksperiment above desire conclusion that, the MPX5700 sensor is capable of measuring pressure where indicated from voltage output accuracy 98,81%. Measurement MPX5700AP sensor for reading in kilopascal (kPa) have accuracy 96,08%, reading in Pounds per Square Inch (Psi) have accuracy 95,95%, reading in Milimeter Mercury Hydrargyrum (mmHg) have accuracy 95,94%.

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