

## **Analysis of Flexitank Heating Pad Data Temperature Using Labview**

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**Abstract:** The heater pads are made to allow steam that has a low melting point and easily solidify when subjected to low temperatures, to be released using steam as a heating source. The heat pads for flexitanks are used to make the atmospheric condition suitable for the product being transported. It can maintain the desired temperature at the beginning of the loading right until it has to be unpacked at the asked place. Still, it has been proven that the high temperature of the steam is causing leakage and damage towards the heating pad in some conditions. Therefore, in this project, we will be able to study and analyse the necessary or maximum heat allowed to flow into the heat pad based on the data temperature obtained. This study focuses on analysing the temperature data and obtaining the mean, maximum and minimum values, standard deviation, and observing whether the temperature value is out of range of the required temperature so that we can improve the heating pad of the flexitank by taking necessary actions to maintain the condition of the heating pad. This project uses NI LabVIEW as a platform to analyse the raw data from MS Excel CSV files. Graphical User Interface (GUI) was developed on LabVIEW to let the user operate the system. There is no complete data for the heating pad of the flexitank due to the leakage at the flow tube. Thus, the data used for this analysis system is the temperature data obtained from the thermocouple sensor only in the input point. However, the analysis system can be used for future work.

**Keywords:** LabVIEW, Flexitank, Heating Pad, Analysis

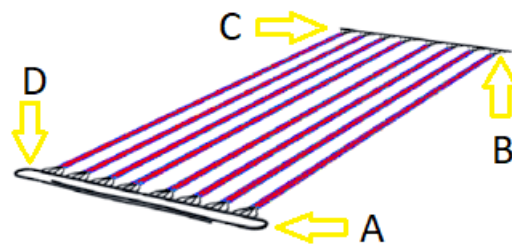
### **1. Introduction**

Flexitank is a large container or cargo made up of multiple layers of polyethylene and is used for transporting loads that are safe to ship from one location to another. Heater pads of the flexitanks are used to maintain the preferred temperature in the tank while evenly reheating the tank/cargo before unloading the load at the desired location. The heater pads are made to allow steam that has a low

melting point and easily solidify when subjected to low temperatures, to be released using steam as a heating source [1].

It was known that the use of the heating pad of the flexitank, is to unevenly overheat the payload before discharging. Generally, the heat pads are made to allow the heat, to be discharged using steam as a heat source [2]. The heat pads for flexitanks are used to make the atmospheric condition suitable for the product being transported. It can maintain the desired temperature at the beginning of the loading right until it has to be unpacked at the asked place. Still, it has been proven that the high temperature of the steam is causing leakage and damage towards the heating pad in some conditions [3].

This study focuses on analysing the temperature data and obtaining the mean, maximum and minimum values, standard deviation, and observing whether the temperature value is out of range of the required temperature so that we can improve the heating pad of the flexitank by taking necessary actions to maintain the condition of the heating pad. Therefore, the data trend obtained from this study can be used as a reference for future uses, for example by building the warning system to warn the user if the temperature went above the maximum temperature allowed in the flexitank.



**Figure 1: Heating pad**

This project analyses the data readings from four thermocouples on each corner of the heating pad (A, B, C, and D), as shown in Figure 1. Unfortunately, there is no complete data for the heating pad of the flexitank due to the leakage at the flow tube and the steam only flows to input points A. Thus, the data used for this analysis system is the temperature data obtained from the thermocouple sensor in input point A only.

### 1.1 Literature review

The previous papers used LabVIEW as the platform for data acquisition and data analysis obtained from the data input by adding an analysis application developed in LabVIEW which enables the presentation of measured values in real-time [4][5]. LabVIEW software allows graphical and numerical visualization of measurement values of temperature and is used to remote and display the temperature data analysed data and monitor the trend. Furthermore, we have obtained general ideas to be implemented into the study. For example, the data are obtained from the sensor and were stored into an array and converted into temperature data into LabVIEW [6]. The obtained data also can be continuously logged and stored into an MS Excel database file. The use of Graphical User Interface (GUI) also can help the user to easily understand how the system works while observing the analysis data obtained [7]. The previous paper also mentions the use of the limit alarm function, which will send out the warning alert to the user if the measured data exceeds the set value [8].

## 2. Methodology

This project will use NI LabVIEW as a platform to analyse the raw data from MS Excel CSV files. LabVIEW is a set specially designed for data acquisition and instrument control, data analysis and data presentation, and the design of graphical programming software, the data acquisition of general and instruments are combined, can the design of the virtual instrument. LabVIEW is the preferred tool of choice as it has unparalleled connectivity to the instruments, data acquisition capabilities, graphical programming with a data flow-based interface, scalability and complete overall function. Therefore, LabVIEW was used to acquire data, interact and analyse the data to extract the valuable information and make decisions or obtain the required results based on the input data. Graphical User Interface (GUI) was developed on LabVIEW to let the user operate the system [8]. Graphical User Interface (GUI) can help the user to easily interact with the data by manipulating the controls, plotting graphs and displaying the 3D visualization tools.

### 2.1 LabVIEW

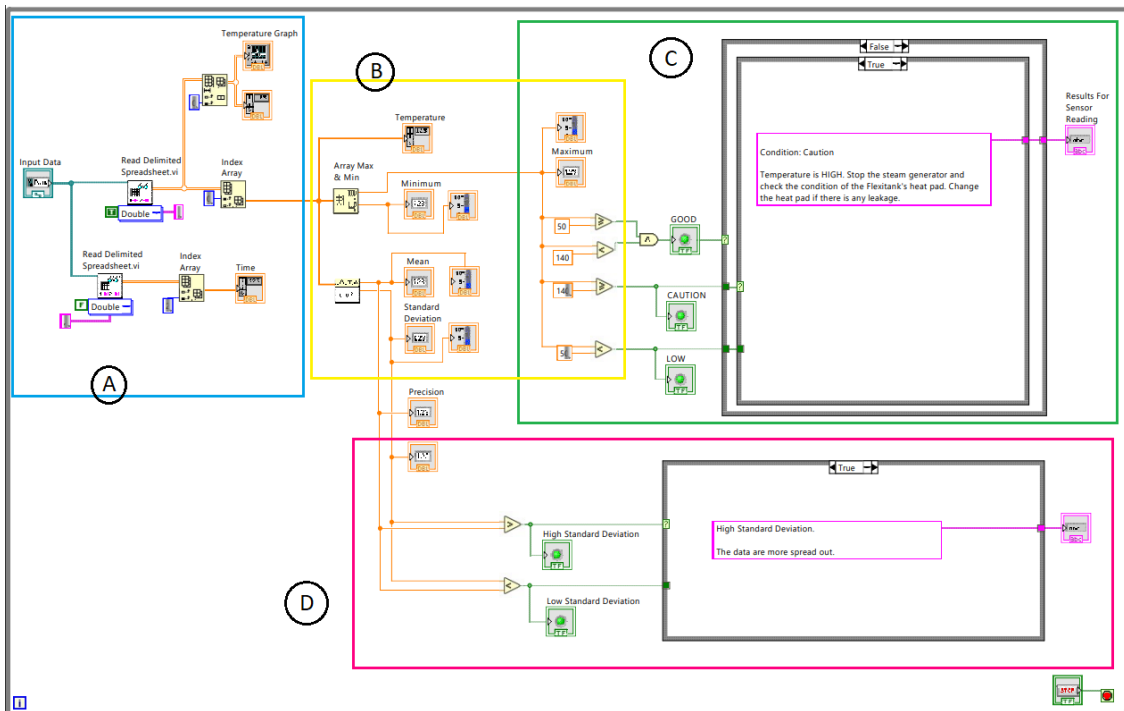
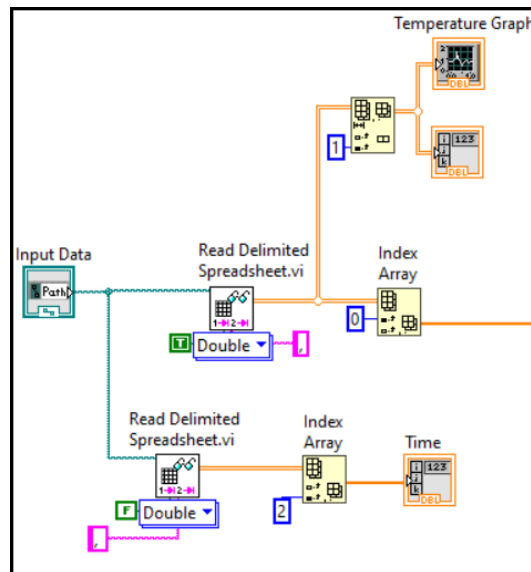
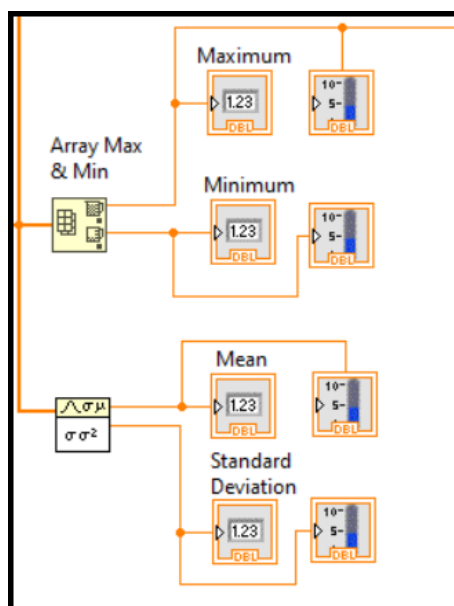


Figure 2: LabVIEW block diagram



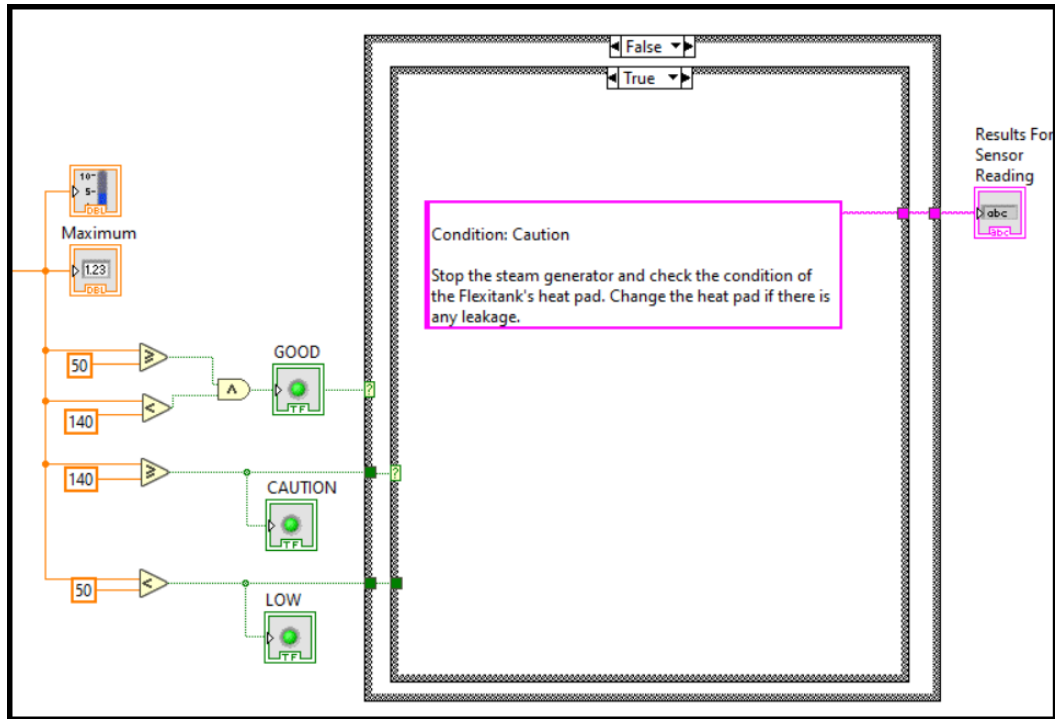
**Figure 3: Section A of the LabVIEW block diagram**

The first section is the file path, where the user can insert the data file into the system to be analysed and plot the graph. The path file name was connected to read the delimited spreadsheet to read the spreadsheet data from the CSV file. To plot the data, the temperature graph needs to be connected from the reading delimited spreadsheet vi and index array.



**Figure 4: Section B of the LabVIEW block diagram**

The second section is where the system calculates the minimum, maximum, mean, and standard deviation values and display them. The maximum and minimum values can be calculated using the array of minimum and maximum connected to the index array of the input data. The values will be displayed as numerical values and a scale. This will help the user to identify and observe the values easily and clearly, which will help when a huge data is inserted into the system



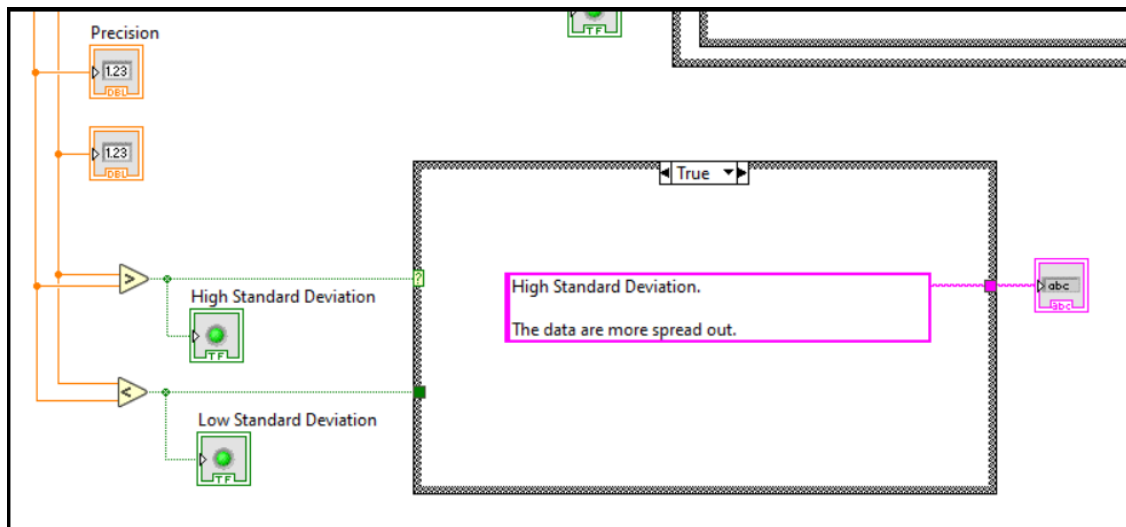
**Figure 5: Section C of the LabVIEW block diagram**

The third section determines whether the maximum values of the input data exceed the set value allowed in the heating pad. The data analysis result has three conditions: ‘Low’, ‘Good’, and ‘Caution’. If the maximum temperature is less than 50 °C (< 50 °C), the LOW button will light up. Meanwhile, if the temperature is same or higher than 50 °C and less than 140 °C ( $\geq 50 \text{ °C}$  and  $< 140 \text{ °C}$ ), the ‘Good’ condition will be triggered. Lastly, the ‘Caution’ condition will be triggered if the temperature value is higher than 140 °C ( $>140 \text{ °C}$ ).

The description of the conditions is shown below.

**Table 1: Thermocouple Sensor Analysis**

No.	Condition	Details	Dialogue Box Display
1	Low	Max < 50°C	Condition: LOW  Please check the condition of the temperature sensor if there is an error. Make sure the steam properly flows into the tube. Please check if there is any leakage.
2	Good	140°C < Max < 50°C	Condition: Good  The temperature in the heating pad is in a normal state.
3	Caution	Max > 140°C	Condition: Caution  Temperature is HIGH. Stop the steam generator and check whether there’s any damage or leakage on the heating pad. Maximum temperature = 150 degrees Celsius.



**Figure 6: Section D of the block diagram**

Lastly, the fourth section is where the system determines the precision value based on mean and standard deviation values. Standard deviation and variances block was used to directly calculate the standard division and mean values of the temperature data obtained from the file. The standard deviation measures how dispersed the temperature data is in relation to the mean. Meanwhile, precision measures how close the measured values (temperature data) are close to each other. Therefore, we can see that the data spread of the temperature is clustered around the average value or more spread out. When the standard deviation value is lower than the mean, it means that the data are more clustered around the mean value. This shows that the data are normally distributed. Meanwhile, it is possible to have a higher standard deviation value than the mean value. This occurs when the data is not normally distributed.

### 2.3 Equations

Mean equation,

$$\text{Mean} = \frac{\text{Sum of data}}{\text{Number of data}} \quad \text{Eq. 1}$$

Standard deviation equation,

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N - 1}} \quad \text{Eq. 2}$$

where,

$\sigma$  = standard deviation

$x_i$  = data value

$\mu$  = mean

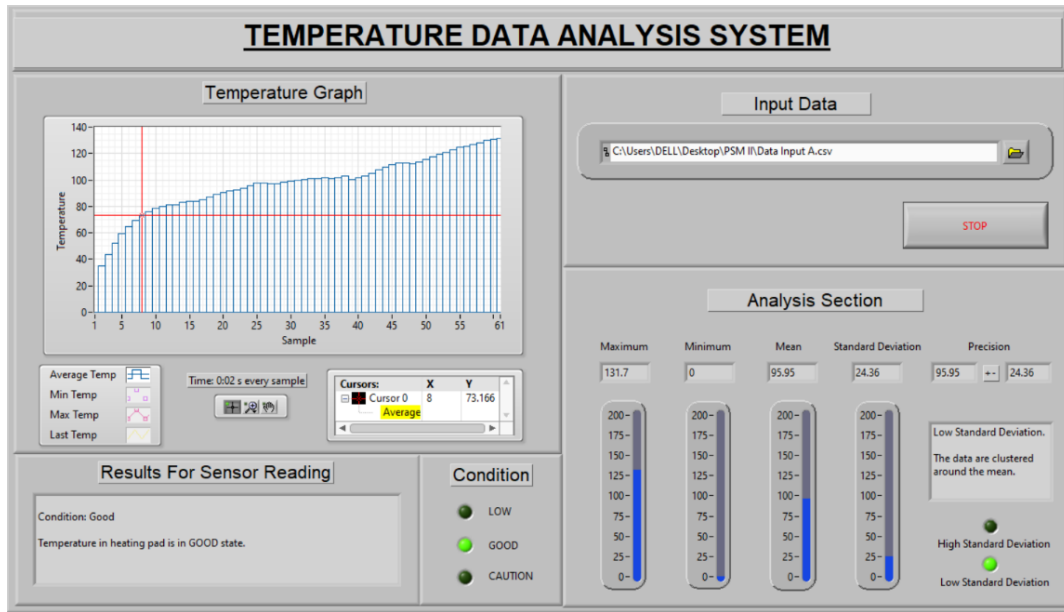
$N$  = number of data

Precision equation,

$$\text{Precision} = \text{Mean} \pm \text{Standard deviation} \quad \text{Eq. 3}$$

## 3. Graphical User Interface Result

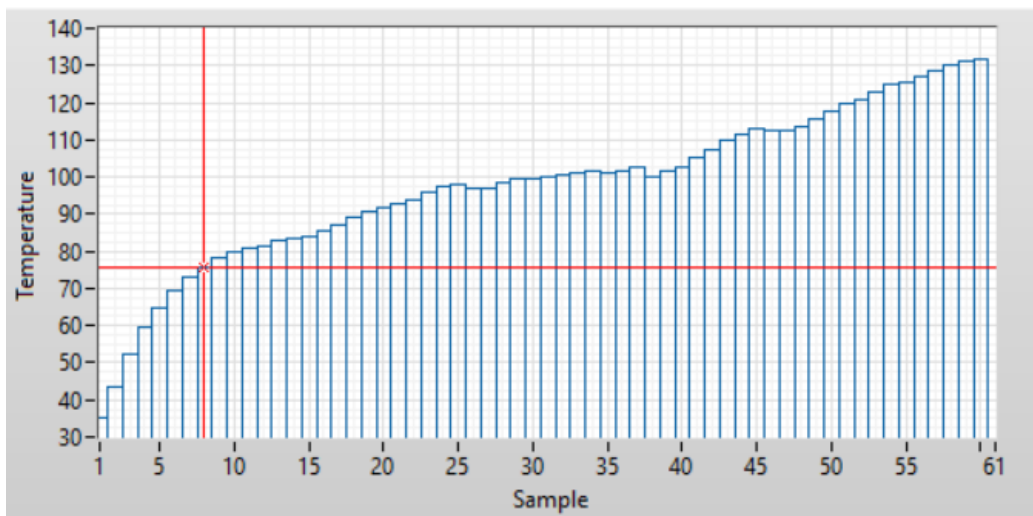
### 3.1 Result



**Figure 7: Temperature data analysis GUI system**

Figure 7 shows the overall Graphical User Interface (GUI) for the Thermocouple sensor after inserted the raw data of Point A into the Temperature Data Analysis System.

3.2 Graph of the data temperature at Point A



**Figure 8: Graph of the data temperature at Point A**

The GUI system shows the trend of the temperature data using plotted graph. For example, we can see the increase in the data trend as the steam flows into the tube. Based on the graph, we can see that the temperature data rapidly increase from the 1<sup>st</sup> sample (Time: 0:00 s) at 34.953 °C to the 10<sup>th</sup> sample (Time: 0:18 s) at 79.765 °C, before a steady increase until the 24<sup>th</sup> sample (Time: 0:46 s) at 97.625 °C. There is a decrease of 0.783 °C from the 25<sup>th</sup> sample (Time: 0:48 s) at 97.84 °C to the 26<sup>th</sup> sample (Time: 0:50 s) at 97.057 °C and a decrease of 2.623 °C from 37<sup>th</sup> sample (Time: 1:12 s) at 102.808 °C to the 38<sup>th</sup> sample (Time: 1:14 s) at 100.185 °C. Then, the temperature steadily increases from the 47<sup>th</sup> sample (Time: 1:32 s) at 112.266 °C until the 60<sup>th</sup> sample (Time: 1:58 s) at 131.708 °C, which is the highest temperature value recorded from input A in 2 minutes.

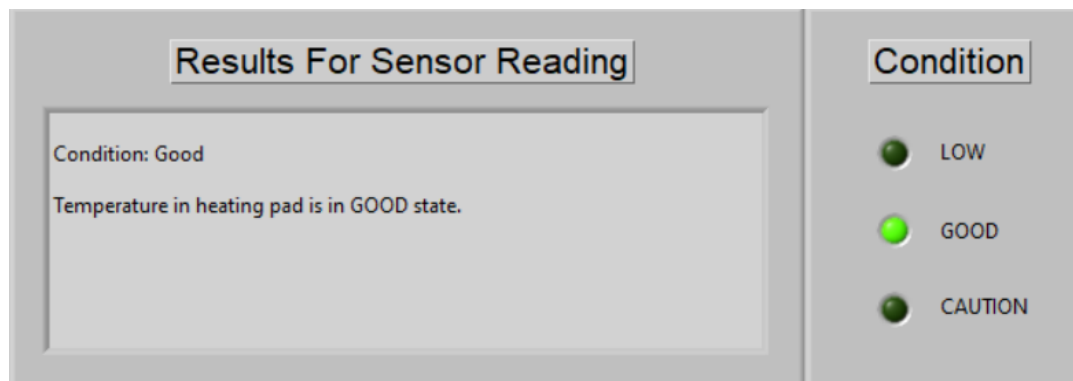
### 3.3 Temperature Data Reading Analysis

**Table 2: Thermocouple Sensor Analysis**

No.	Item	Temperature (°C)
1	Minimum	34.95
2	Maximum	131.7
3	Mean	97.74
4	Standard deviation	21.09
5	Precision	97.54 ± 21.09

The GUI system directly calculated and displayed the values of minimum, maximum, mean, standard deviation, and the precision of the data. Mean is the average value of the data, in this case, it calculates the average data temperature. The standard deviation measures how dispersed the temperature data is in relation to the mean. Meanwhile, precision measures how close the measured values (temperature data) are close to each other. Therefore, we can see that the data spread of the temperature is clustered around the average value as the standard deviation value (21.09 °C) is smaller than the mean (97.54 °C). This shows that the temperature data are normally distributed.

### 3.4 Sensor reading condition analysis



**Figure 9: Sensor reading condition**

As we already know, the use of the heat pad is to evenly reheat the cargo before unloading. It has been proven that the high temperature of the steam is causing leakage and damage towards the heating pad of the flexitank in some conditions. The maximum temperature of heat input of the heating pad is approximately 150 °C. There are three conditions of the data analysis result for the GUI system: 'Low', 'Good', and 'Caution'. Based on the result, the maximum value of temperature is 131.7 °C in the 60<sup>th</sup> sample (Time: 1:58 s). Thus, the data reading is in a 'Good' state, (140 °C > 131.7 °C > 50 °C). This shows that the degree of damage or leakage that occurs on the heating pad is low.

## 4. Conclusion

The Graphical User Interface (GUI) Temperature Data Analysis System is purposely developed to help the user to observe and analyse the data easily. This can help the user to observe the trend of the temperature data by observing the increase and decrease of the temperature data in the plotted graph as the steam continuously flowed into the heating pad tube. This study analysed the input data obtained from the heating pad. However, due to the leakage on the tube of the heating pad, the steam did not flow to all the input points. Thus, we only can analyse the data only at point A. By analysing the input data at input Point A, we observed whether the maximum values of the input data exceed the required temperature allowed to flow into the heat pads. This helps the user understand how precise the temperature data is in relation to the average value and helps indicate the condition of the readings. In



this study, the maximum did not exceed the set value of 150 °C, thus we determine that the probability of the leakage and damage occurring on the tube is low. Based on the precision value, we can determine that the input data from point A is normally distributed and stable as the data is clustered around the average value.

At the end of this study, we hope that the data obtained from this study can be used as a reference for future uses and that this analysis system can help as a basic implementation of the more advanced analysis system for flexitank. For example, by implementing a real-time analysis system and building the warning system to warn the user if the temperature went above the maximum temperature allowed in the flexitank.

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