INDIVIDUAL ASSIGNMENT

TECHNOLOGY PARK MALAYSIA

EE038-2-2ESA

ENGINEERING SOFTWARE AND APPLICATIONS

LABVIEW

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Introduction

This report is about design and simulating a factory that processes milk using LabVIEW. The program is designed with proper graphical user interface (GUI) and also have proper functions that simulate the real milk processing process.

There are several processes that need to be done while processing the milk to make it safe for human consumption. However, the program designed in this assignment will only cover 4 processed which are separation, standardization, pasteurization and homogenization. All the conditions needed to run each processed is also simulated in the program designed to make the program more realistic.

By applying the functionalities in LabVIEW, the program designed has the capabilities to get several inputs from the user to make the program have more user interaction. Firstly, the program will need the user to input the amount of raw milk that is going to be supplied into the process. Then all the amount of thing that is processed out from the raw milk will also be recorded and displayed to the user. Then all the situation and the conditions that is needed to be maintained during the milk processing are also can be monitored by the user such as pressure, speed and temperature. On top of that, crude oil is used to heat the milk during the process and the program is also capable to track the market price of crude oil and record it. Lastly after all the, process had been completed, the user can choose to export the record of the process into excel file. In addition, the user can straight start the new batch of milk processing without needing to restart the program.

Assumptions

There are several assumptions that is done while simulating the conditions for milk processing. Firstly, the milk will have to go through separating process to separate the fat component from the milk which is the cream. In this process, the milk will be placed in a centrifuge and the speed has to be maintained between 6000 to 10000 rpm (Milky Day, n.d.). The reason of doing so is because skim milk and the cream has different density. Thus, by spinning them under high speed will make them separated. The program designed will also simulate the speed between 6000 to 10000 rpm and anything lower than 6200 rpm will be consider as low speed and indication will be given to the user. According to research by FrieslandCampina Institute in 2015, there is roughly 4.4 grams of fat or cream for every 100 grams of raw milk. This makes up of 4.4% of the raw milk is the fat content. Hence, the program will also follow the ratio to separate the raw milk into skim milk and cream.

Then the milk will go through standardization process where some of the cream separated will be added back into the skim milk to increase the fat content in the skim milk to make the milk creamier and tastier. In this case, it is assumed that for every 4.4 grams of cream, 0.4 grams of fat will be added back with the skim milk. In this case, the total amount of milk that will go through the following process is 96% of the raw milk input to the system.

Then the milk will go through homogenization process where the milk will be heated to 72 degrees Celsius for 15 seconds to kill all the bacteria (Britannica, 2022). Then after that the milk will be cooled to 20 degrees Celsius to prevent the growth of bacteria (Alberta Health Services, 2021).

After that the milk will undergo homogenization process to break down the fat globules in the milk to reduce the chance of the milk to coagulate (Dairy Processing, n.d.). This also help to make the milk produced smoother. The milk will be heated to 55 to 80 degrees Celsius and the pressure between 10 to 25 Mega Pascal will be applied onto the milk during the process. These conditions are simulated in the program.

Lastly the milk will be packaged.

This program also assumes that the excel file the records the milk production records are existed.

Flow Chart

Initialization

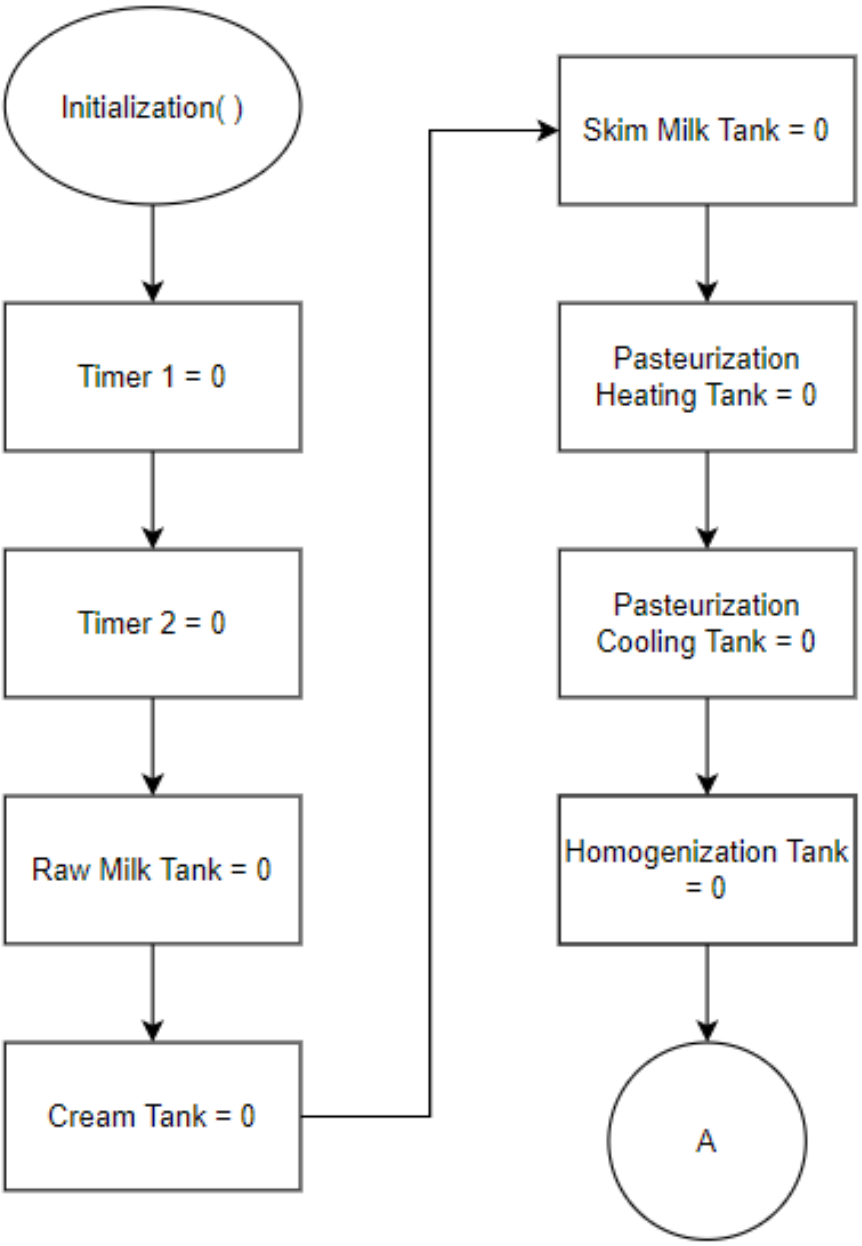


Figure 1: Flow Chart Initialization 1

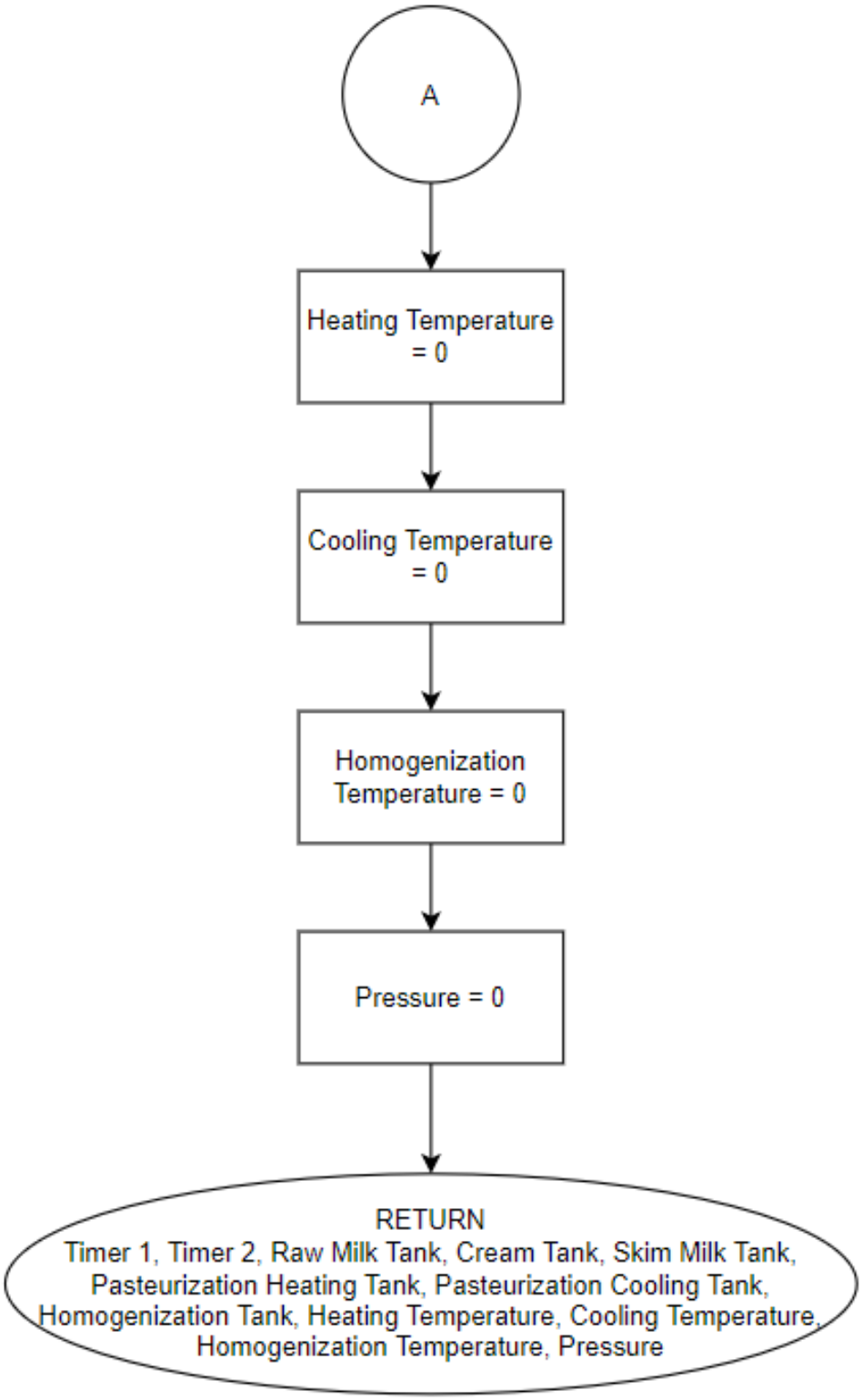


Figure 2: Flow Chart Initialization 2

Separation

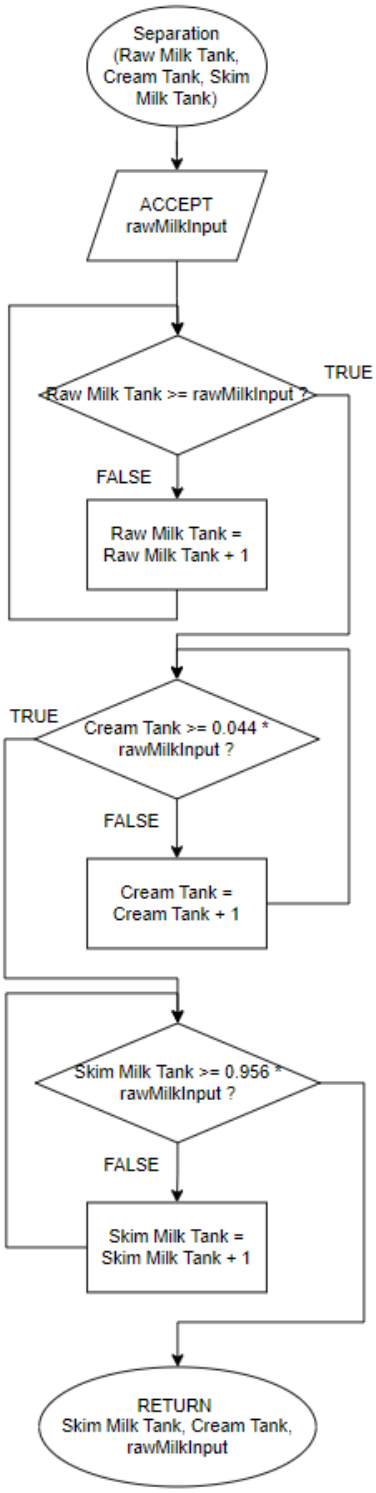


Figure 3: Flow Chart Separation 1

Standardization

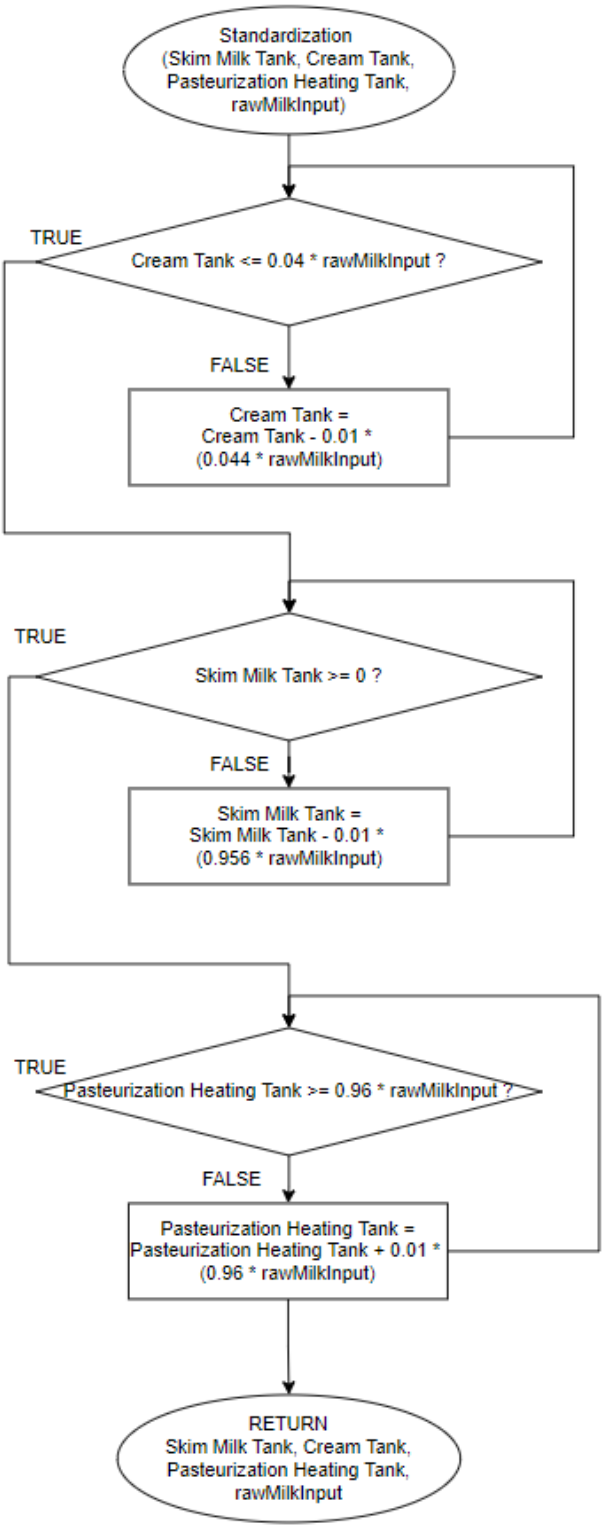


Figure 4: Flow Chart Standardization 1

Pasteurization

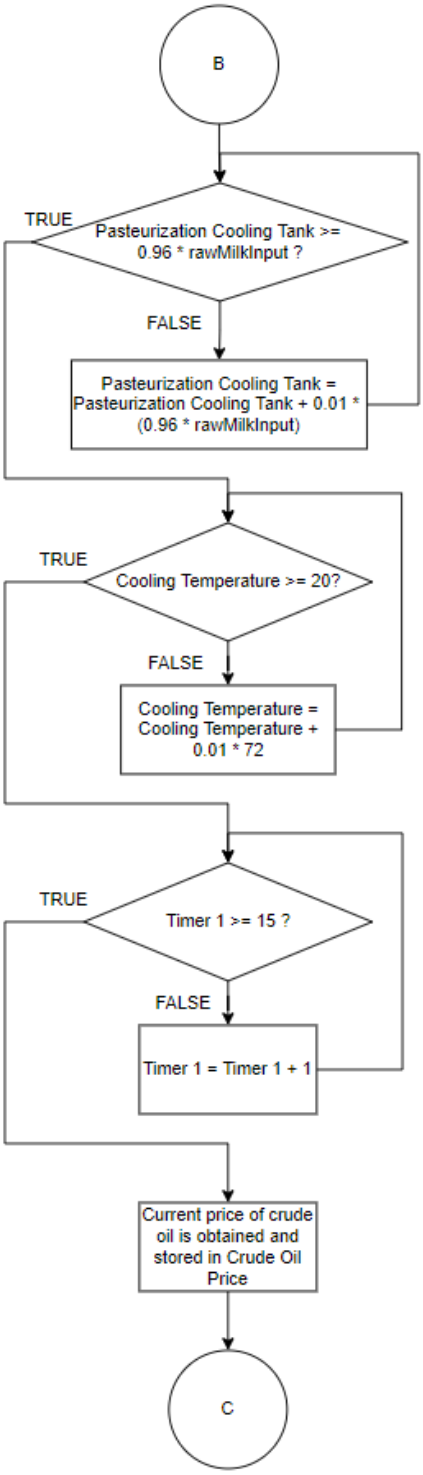


Figure 5: Flow Chart Pasteurization 1

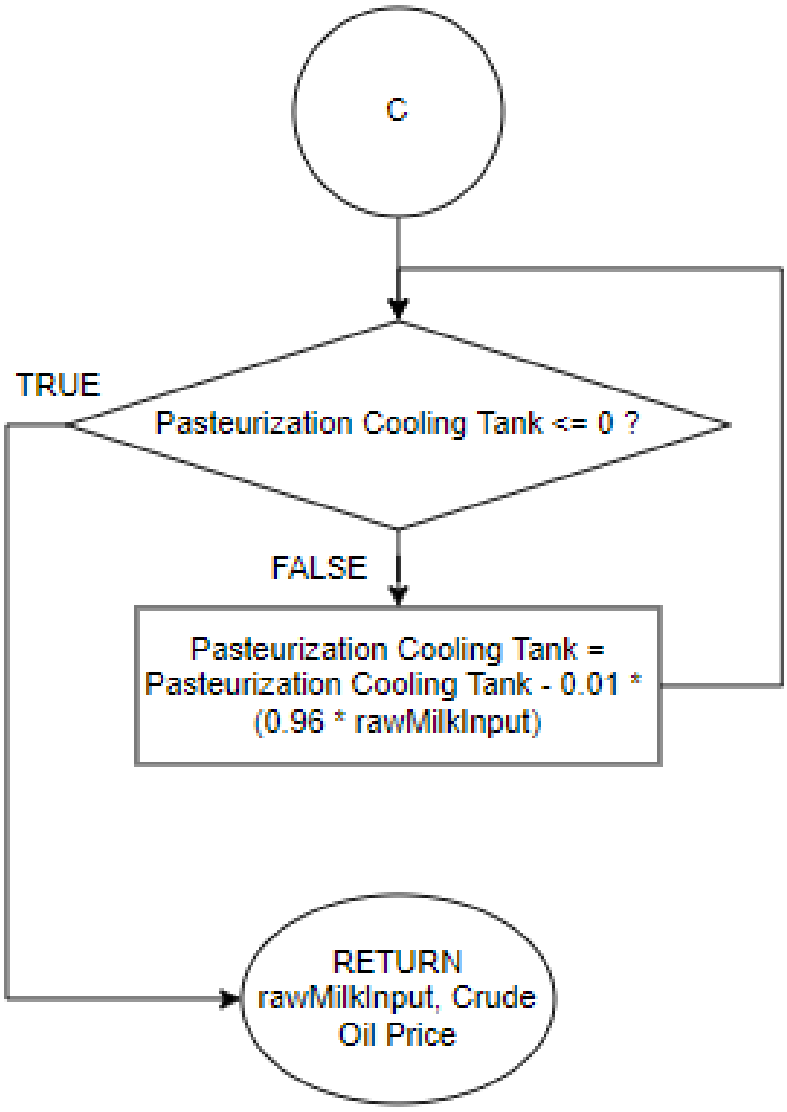


Figure 6: Flow Chart Pasteurization 2

Homogenization

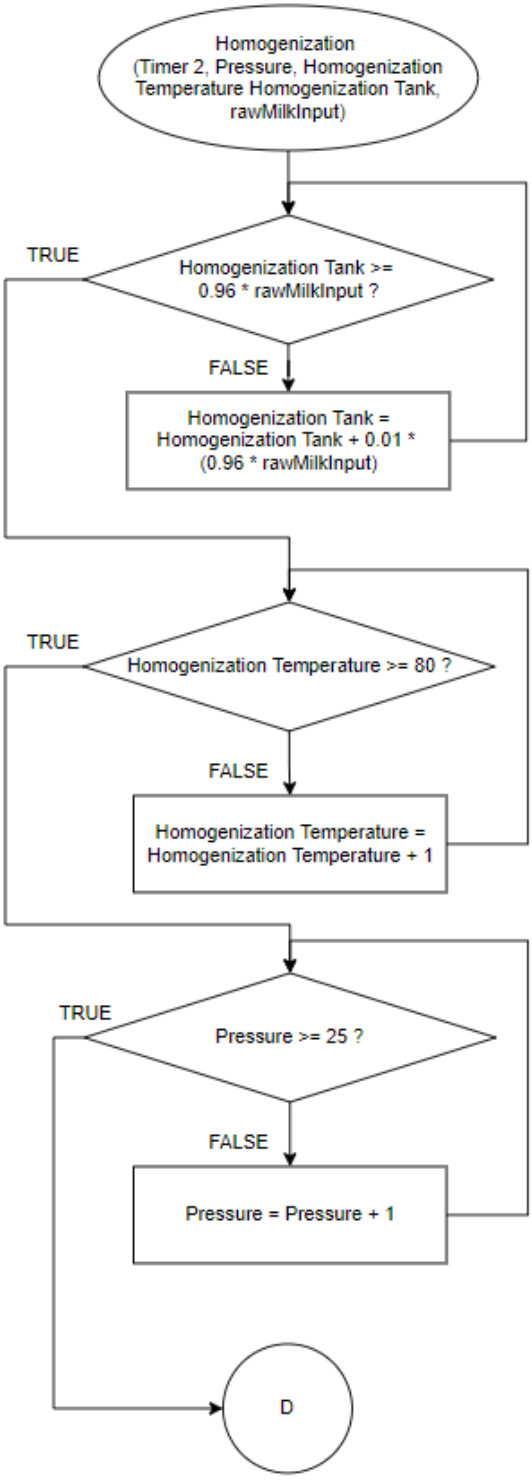


Figure 7: Flow Chart Homogenization 1

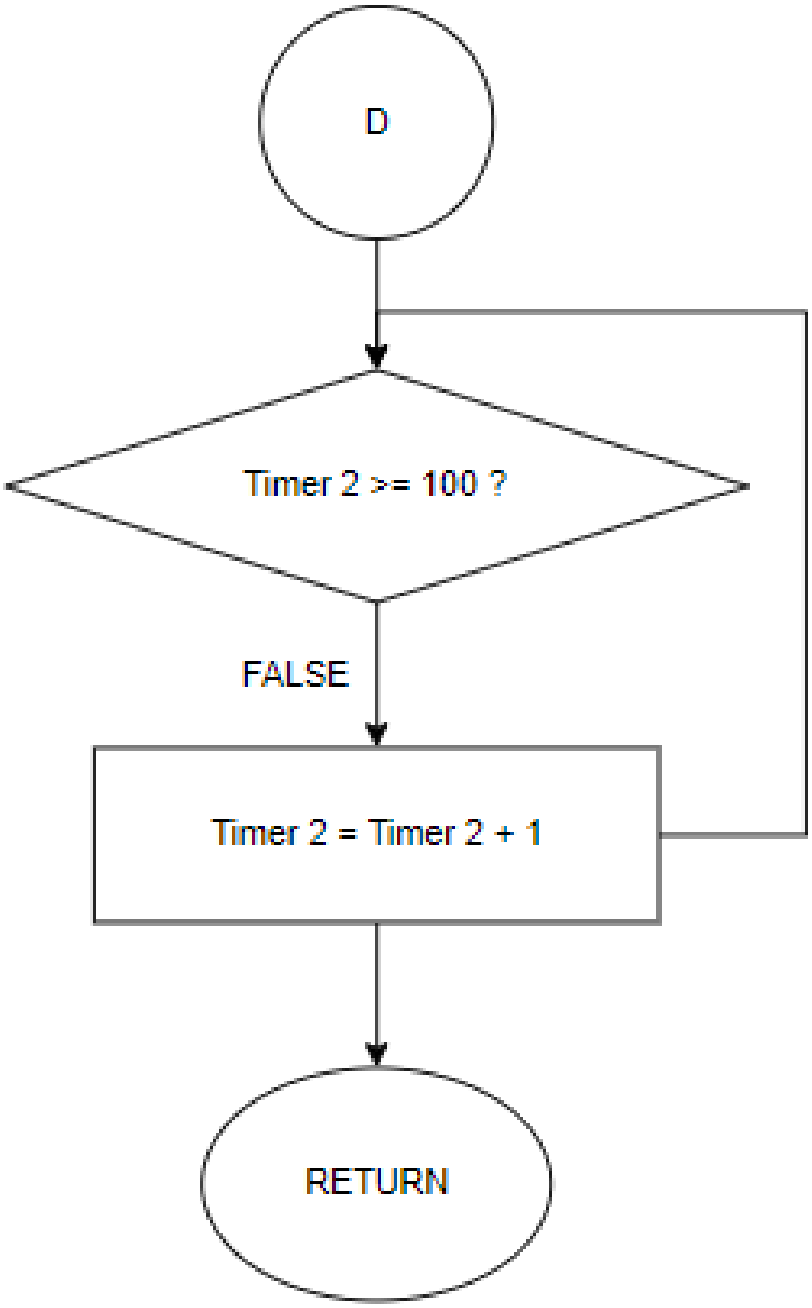


Figure 8: Flow Chart Homogenization 2

Main Flow

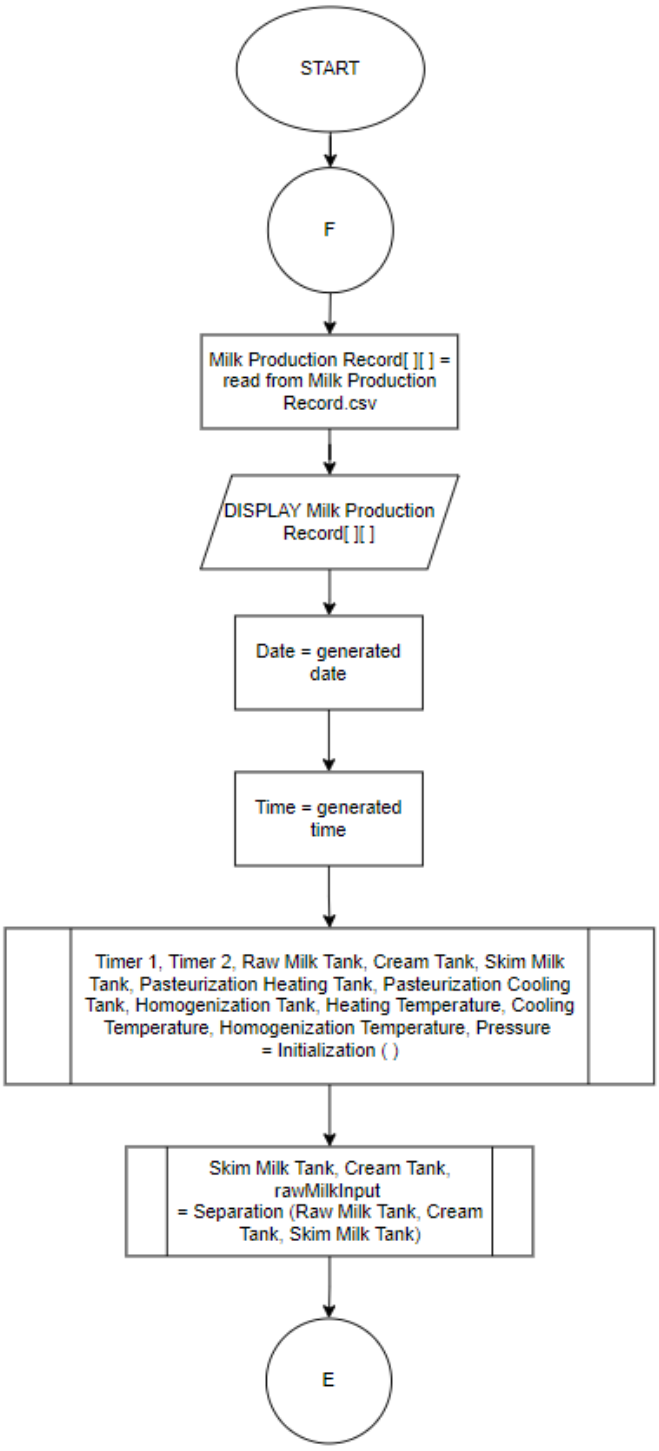


Figure 9: Flow Chart Main Flow 1

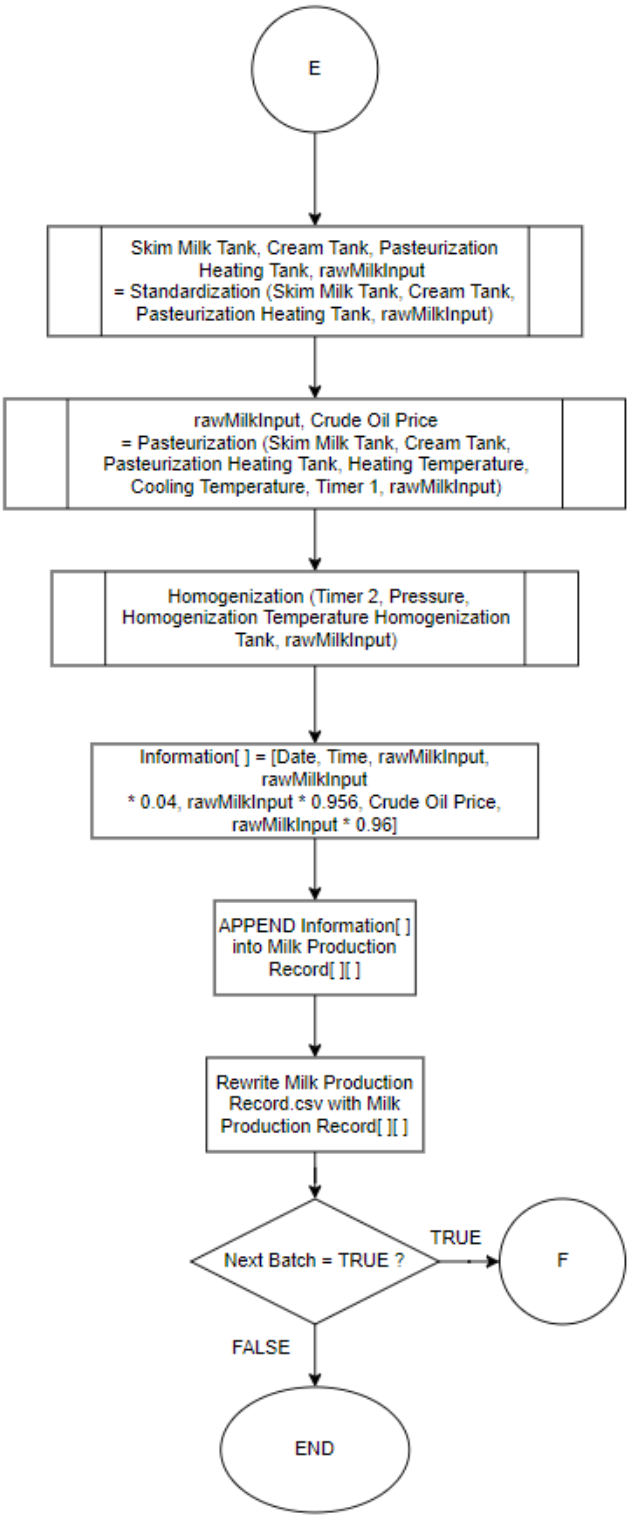


Figure 10: Flow Chart Main Flow 2

Discussion

Graphical User Interface

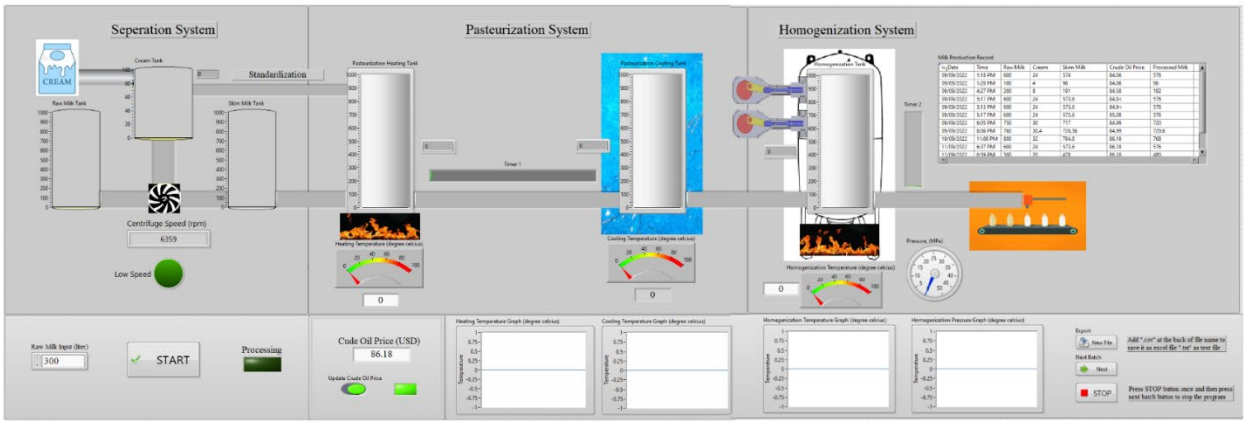


Figure 11: Graphical User Interface

Figure above shows the whole graphical user interface design of the program. As you can see, they are separated into 3 major parts which are separation system, pasteurization system and homogenization system. While standardization process occurs between the separation system and pasteurization system where some of the cream obtained is added back to the pasteurization tank with the skim milk to increase the fat content of the produced milk.

The top panel of the GUI consists of 6 tanks which are raw milk tank, cream tank, skim milk tank, pasteurization heating tank, pasteurization cooling tank and homogenization tank. The milk is transferred between these tanks through pipes which are represented using progress bars. While there are also some meters to monitor the conditions of the process which includes the speed of the centrifuge, pasteurization heating temperature, pasteurization cooling temperature, homogenization temperature and pressure. On top of that the heating cooling temperature, homogenization temperature and pressure are also plotted on graph over time to see their change over time clearly. After homogenization tank, there will also be gif that indicates the milk are packaged into small bottles. Besides there is also a table to record all the milk production which includes the date, time, volume of raw milk, cream, skim milk, crude oil price during the process, and also the volume of produced milk.

At the bottom panel is where most of control of the program located and also the graph mentioned recently. There is an input site for the user to indicate the program how much of raw

milk to be supplied into the system. To start the program the user will have to press the start button and then the processing led will light up to indicate that the process of processing milk had start and the user is not allowed to change the input anymore. Then next section at the bottom panel will consists of the cluster of things related to updating the crude oil price. The user can also use the button in the cluster to control if he wanted to update the crude oil price. Then the continuing section will consist of the graph of pasteurization heating and cooling temperature, homogenization temperature and pressure. The graphs are provided for the user to have a clearer view on the situation that is going on during the milk processing over time. Lastly the last section will consist of 3 buttons. The first button is for the user to export a new file of the milk production record incase he need a new file or other reference. While the second one is where the user will press when the user had completed 1 loop of the whole process and want to run the next loop. While the last button is where the user can press when the user wants to stop the program.

Initialization & Reading from File

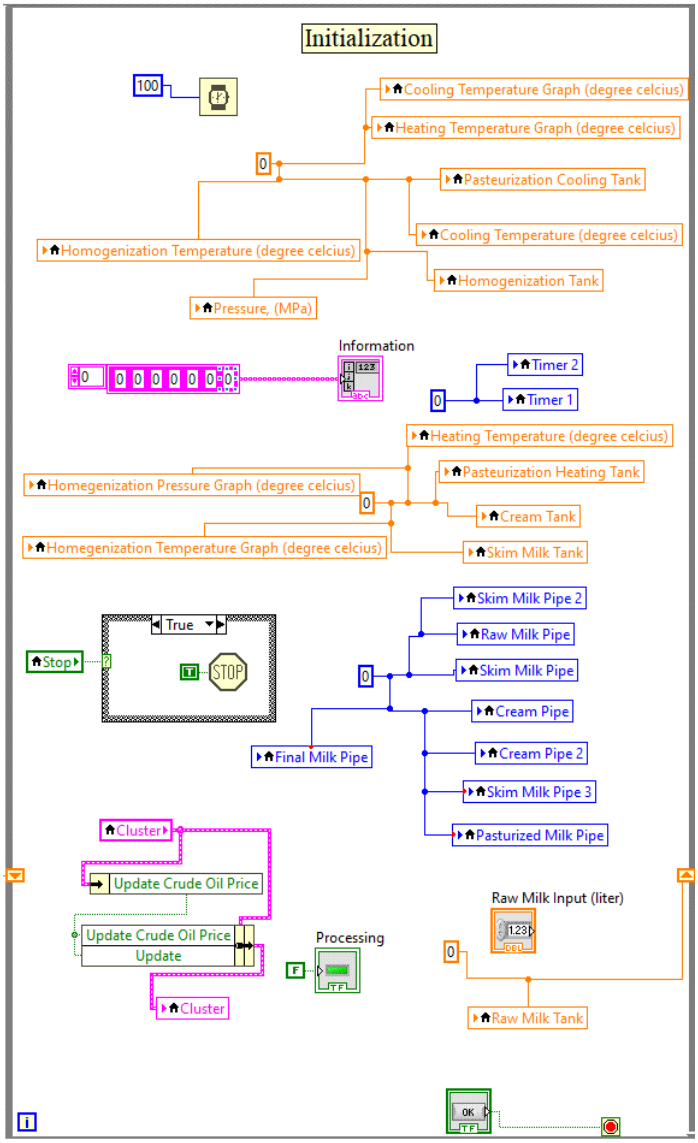


Figure 12: Initialization Code

Figure above shows the code of initialization before running any process. This is where all the pipes, tanks and arrays were cleared to be empty so that it won't interferes with the input that is given and produced wrong results. Besides that, the array that is going to be used to store the information of the milk production is also cleared so that the new information does not interferes with the old one. This process is placed in a while loop and it will only exit the while loop when the user press the start button after he had gave input of how much raw milk input is given into the system.

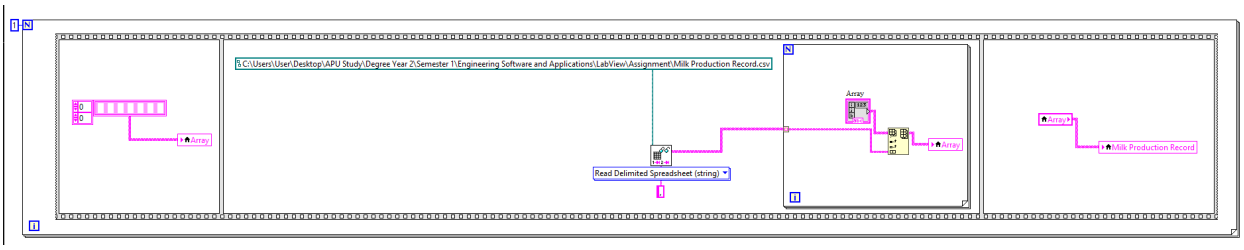


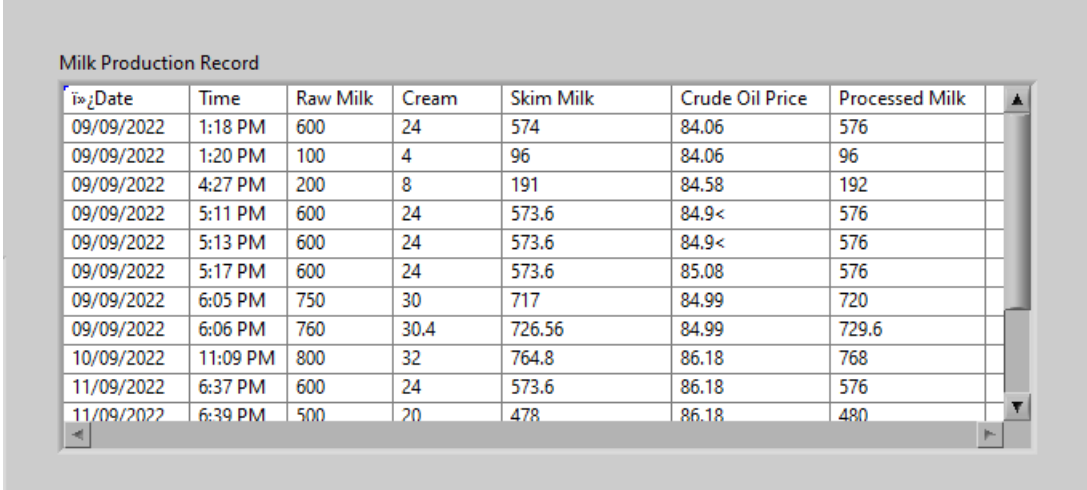
Figure 13: Reading from File Code

At the same time of initializing the tanks, array and pipes, the program will also read the previous record of milk production from the excel file named as Milk Production Record.csv file. The reason of using the file type of csv is because it will be easier to red string from csv file type comparing to other excel file type. In csv file, the content in the cells were separated by commas ",". Hence it is essential to put the delimiter as "," to make the program be able to read the file accurately. After reading the file, the records are stored in an 3D array and is displayed in the form of table for the user.

Date	Time	Raw Milk	Cream	Skim Milk	Crude Oil F	Processed Milk
09/09/2022	1:18 PM	600	24	574	84.06	576
09/09/2022	1:20 PM	100	4	96	84.06	96
09/09/2022	4:27 PM	200	8	191	84.58	192
09/09/2022	5:11 PM	600	24	573.6	84.9<	576
09/09/2022	5:13 PM	600	24	573.6	84.9<	576
09/09/2022	5:17 PM	600	24	573.6	85.08	576
09/09/2022	6:05 PM	750	30	717	84.99	720
09/09/2022	6:06 PM	760	30.4	726.56	84.99	729.6
10/09/2022	11:09 PM	800	32	764.8	86.18	768
11/09/2022	6:37 PM	600	24	573.6	86.18	576
11/09/2022	6:39 PM	500	20	478	86.18	480
11/09/2022	6:41 PM	300	12	286.8	86.18	288
12/09/2022	10:24 AM	200	8	191.2	85.45	192
12/09/2022	10:59 PM	100	4	95.6	88.67	96
12/09/2022	11:01 PM	150	6	143.4	88.67	144

Figure 14: Excel File

Figure above shows the content of the excel file.



ï»¿Date	Time	Raw Milk	Cream	Skim Milk	Crude Oil Price	Processed Milk
09/09/2022	1:18 PM	600	24	574	84.06	576
09/09/2022	1:20 PM	100	4	96	84.06	96
09/09/2022	4:27 PM	200	8	191	84.58	192
09/09/2022	5:11 PM	600	24	573.6	84.9<	576
09/09/2022	5:13 PM	600	24	573.6	84.9<	576
09/09/2022	5:17 PM	600	24	573.6	85.08	576
09/09/2022	6:05 PM	750	30	717	84.99	720
09/09/2022	6:06 PM	760	30.4	726.56	84.99	729.6
10/09/2022	11:09 PM	800	32	764.8	86.18	768
11/09/2022	6:37 PM	600	24	573.6	86.18	576
11/09/2022	6:39 PM	500	20	478	86.18	480

Figure 15: Milk Production Record Table

Figure above shows the table that is used to display the record in the excel file.

Filling up Raw Milk Tank

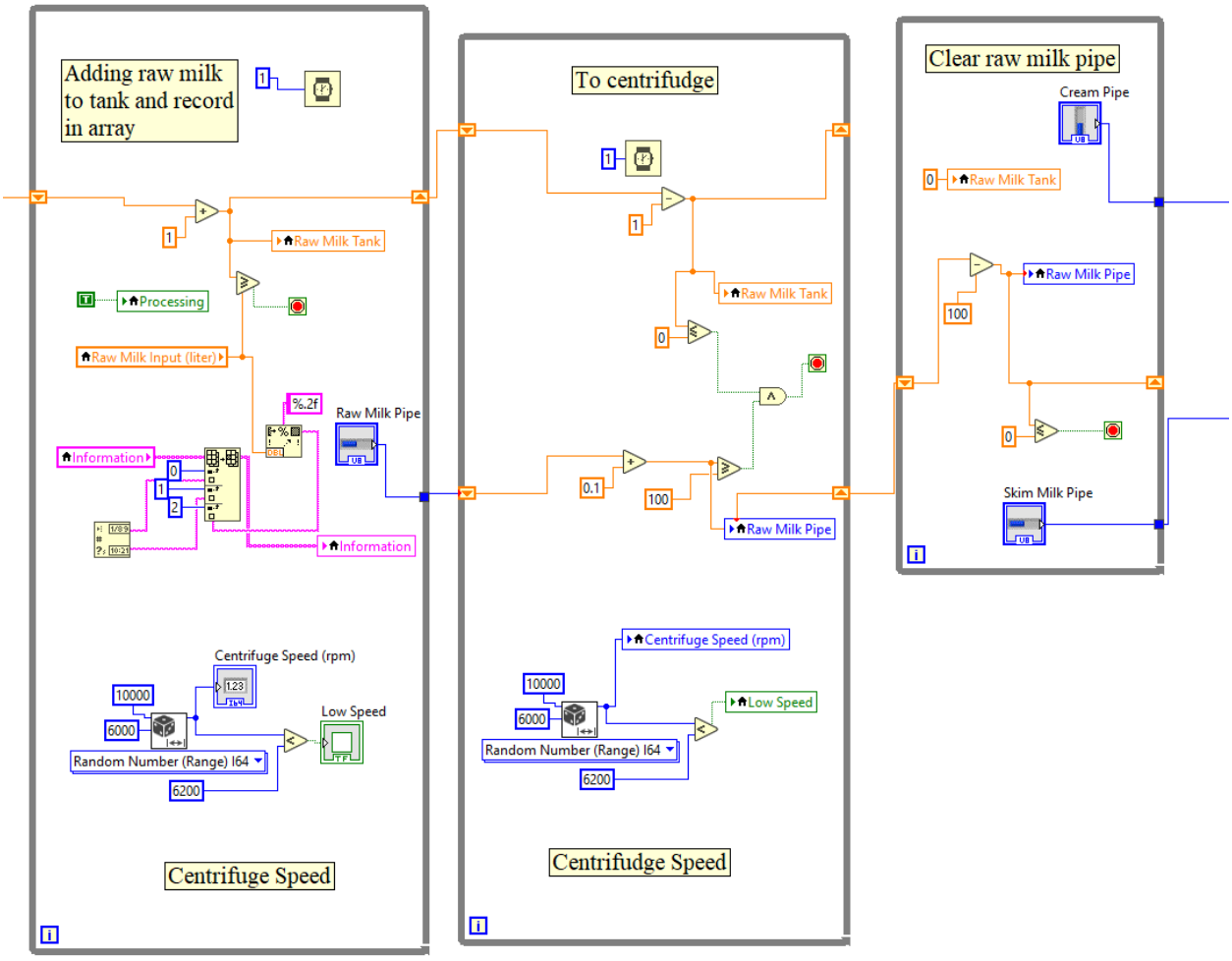


Figure 16: Filling Up Raw Milk Tank Code Example

Figure above is the code of filling up the raw milk into its tank. The process is done using while loop until the tank is filled up until the desired level. At the same time, the program will also generate the current date and time when the process is running and store them into the information array. The processing led light is also lighted up to indicate the user that the process had started. On the other hand, the centrifuge speed is also generated using the random number block and given its upper and lower boundary. And when the speed generated is lower than 6200 it will light up the low-speed light to indicate the user. On top of that, the transfer of the milk through pipes are also represented by progress bars to make it more realistic. All the while loops in this whole program are connected using shift registers to ensure that the loops don't run together and only runs in sequence.

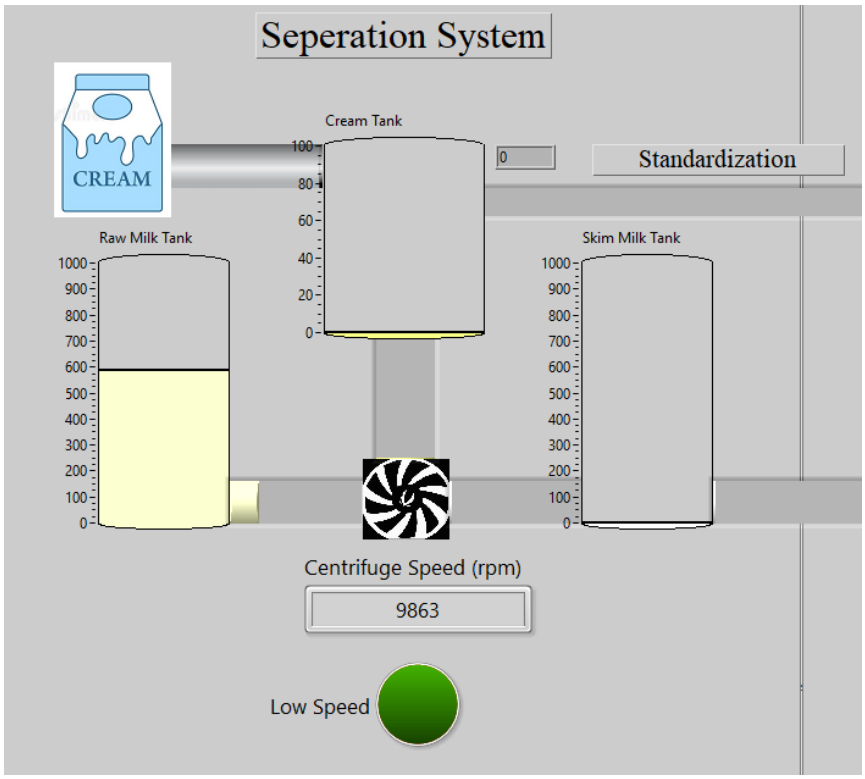


Figure 17: Raw Milk Tank

Figure above shows the raw milk tank that is filled up.

Separation

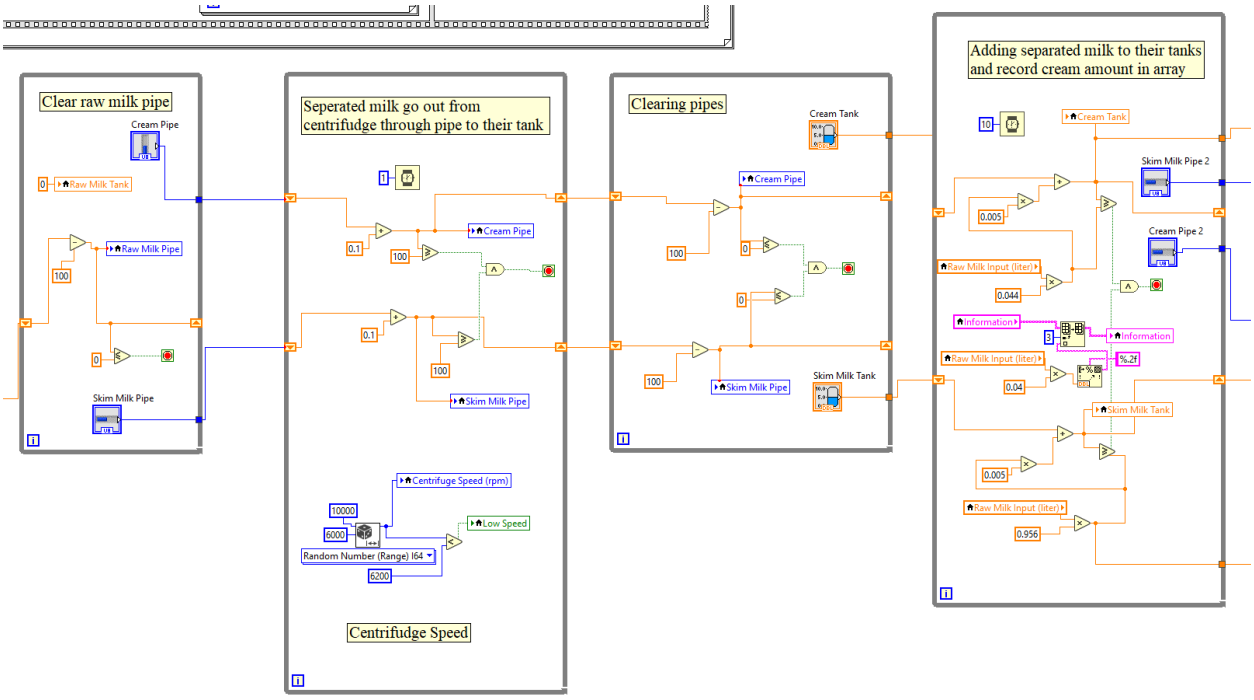


Figure 18: Separation Code Example

The figure above shows an example of codes for the separation system. The separation process is basically dividing the raw milk into 2 portions which are cream and skim milk. Hence, math operations are used to calculate each of the portion and they are also filled up to their own tank using while loop. While adding them into their own tank, the information of how much volume of them is also recorded in the information array.

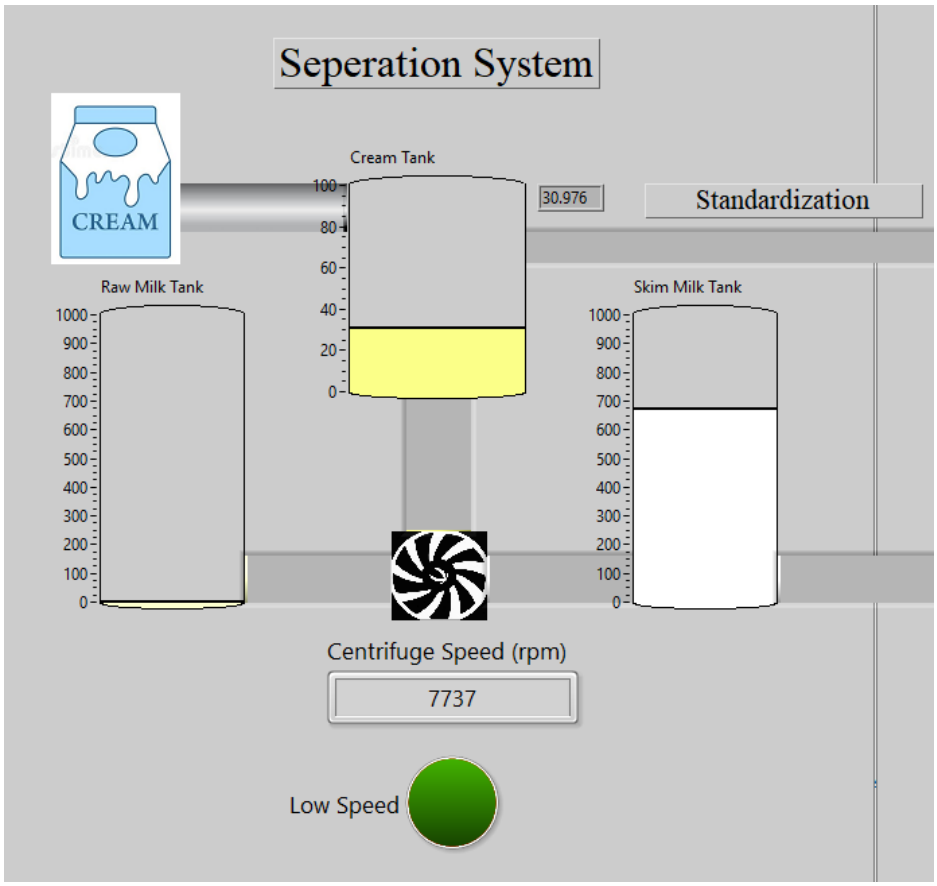


Figure 19: Cream Tank Skim Milk Tank and Centrifuge

Diagram above shows the cream tank and skim milk tank that is filling up. Besides that, the centrifuge is also represented by a gif and the speed is also displayed.

Standardization and Getting Crude Oil Price

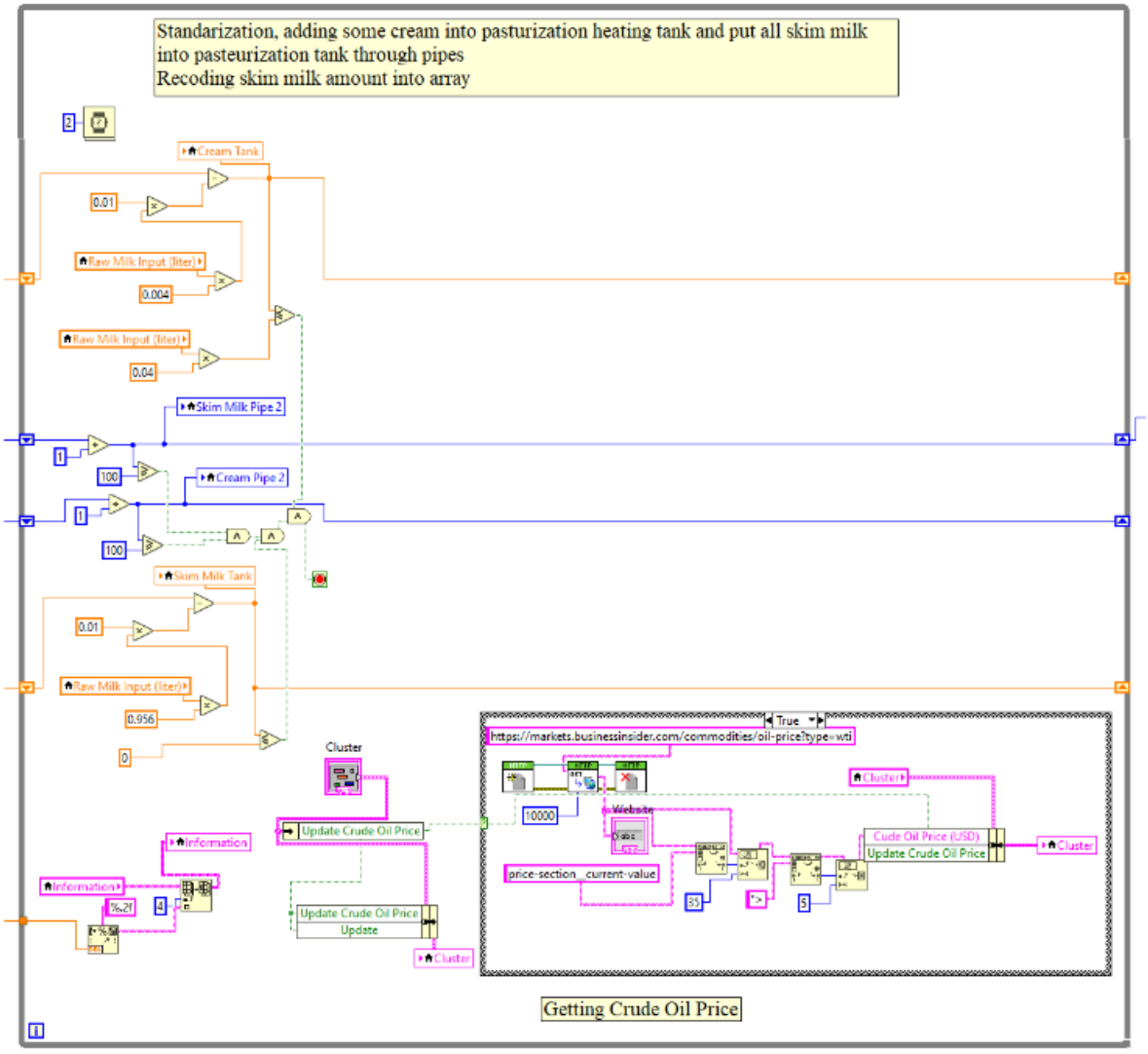


Figure 20: Standardization and Getting Crude Oil Price Code Example

Figure above shows an example of code of standardization process and also getting the current price of crude oil. A small portion of cream that is separated in the separation process is added back to the pasteurization tank with all the skim milk to increase the fat content of the produced milk. The process is also done using math operation blocks. At the same time the current crude oil price is also obtained from the Internet. All the controls of obtaining the current crude oil price are placed in a cluster to make them easier to be managed. The cluster consists of a button and a Boolean indicator and also a string indicator. The button is for the user to choose whether he want the crude oil price to be update or not while the Boolean indicator is used to tell

the user the current condition of price updating. If the user chooses to not update the current price the Boolean indicator will tell the user false and vice versa. Case structure is also used in this section to control the program whether to update the price or not.

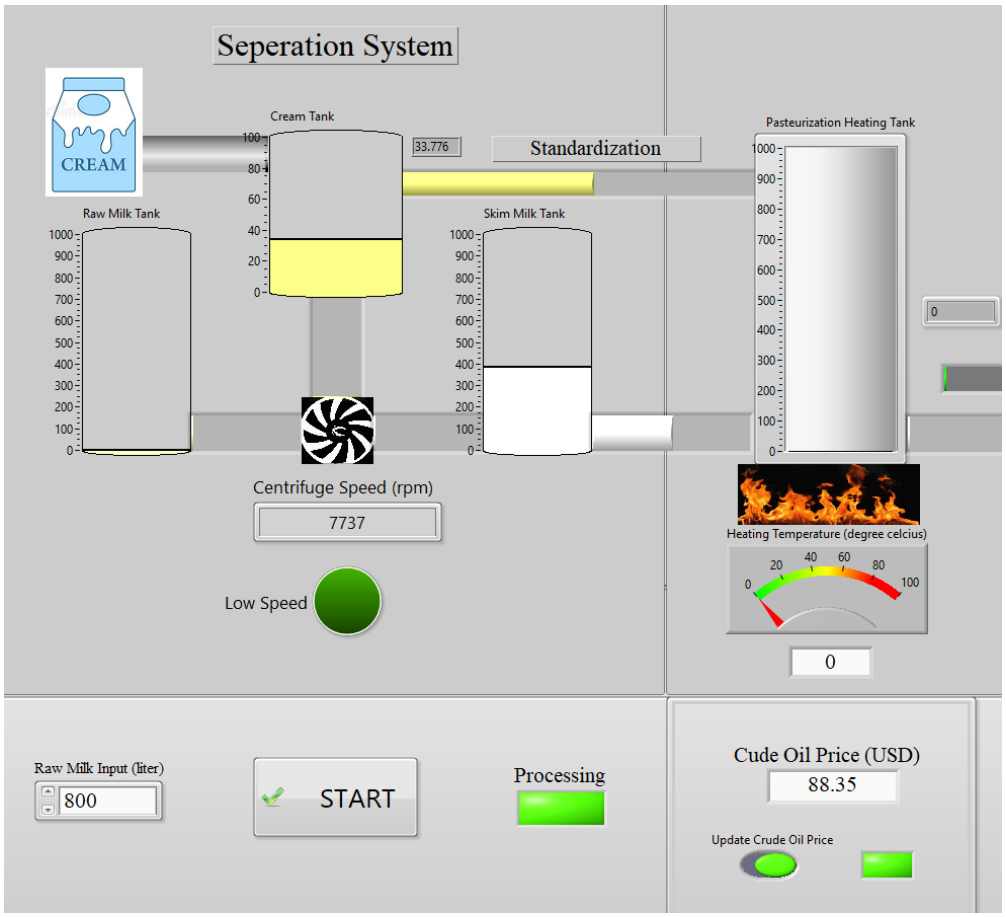


Figure 21: Standardization

Figure above shows the process of standardization where some of the cream is added back into the pasteurization heating tank and also all the skim milk. Besides, the crude oil price is also updating in the cluster.

Pasteurization

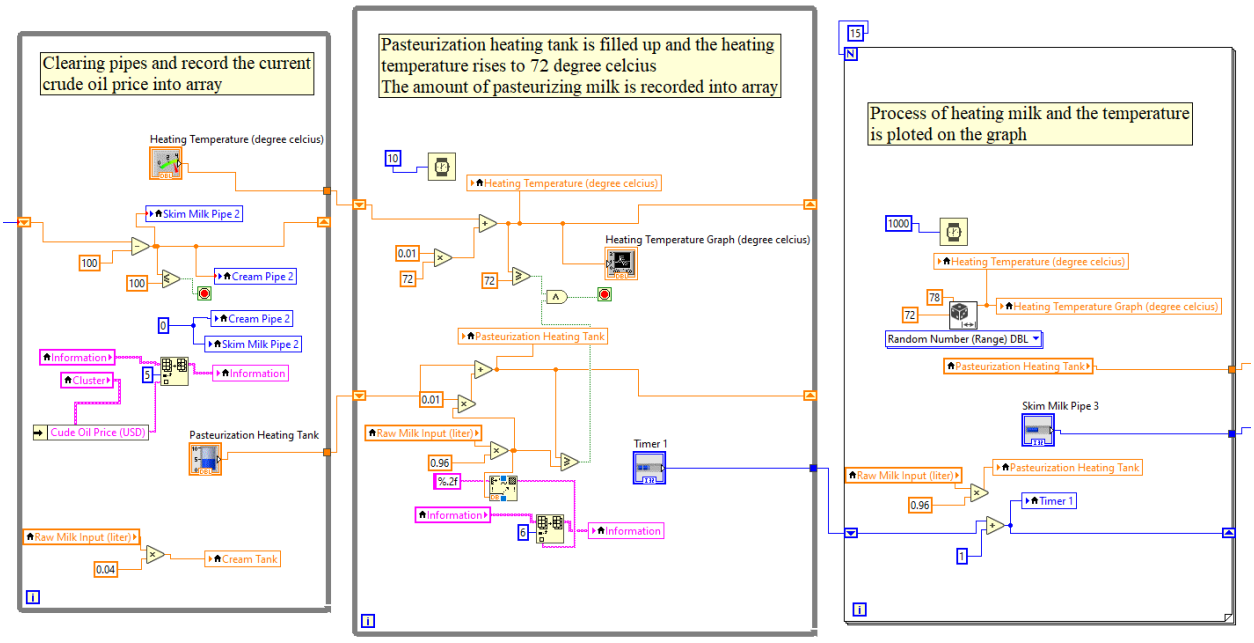


Figure 22: Pasteurization Code Example (Heating)

Figure above is the example of code of pasteurization heating section. Firstly, the current crude oil price that is obtained will be recorded into the information array. After that the pipes that filled up the pasteurization heating tank is cleared and the heating process will begin and the pasteurization heating tank will also be fille up. The temperature will increase until 72 degrees Celsius. At the same time, the volume of the milk that is going to be produced after adding some cream is also recorded into the information array. After that the program will go into a for loop with 15 loops to simulate that the milk is heated for 15 seconds. In the process the heating temperature will be random number between 72 to 78 degrees Celsius. And the temperature will be shown by a meter and plotted on a graph to let the user has a clearer view. There is also a timer that is represented by a progress bar to let the user monitor the progress of heating.

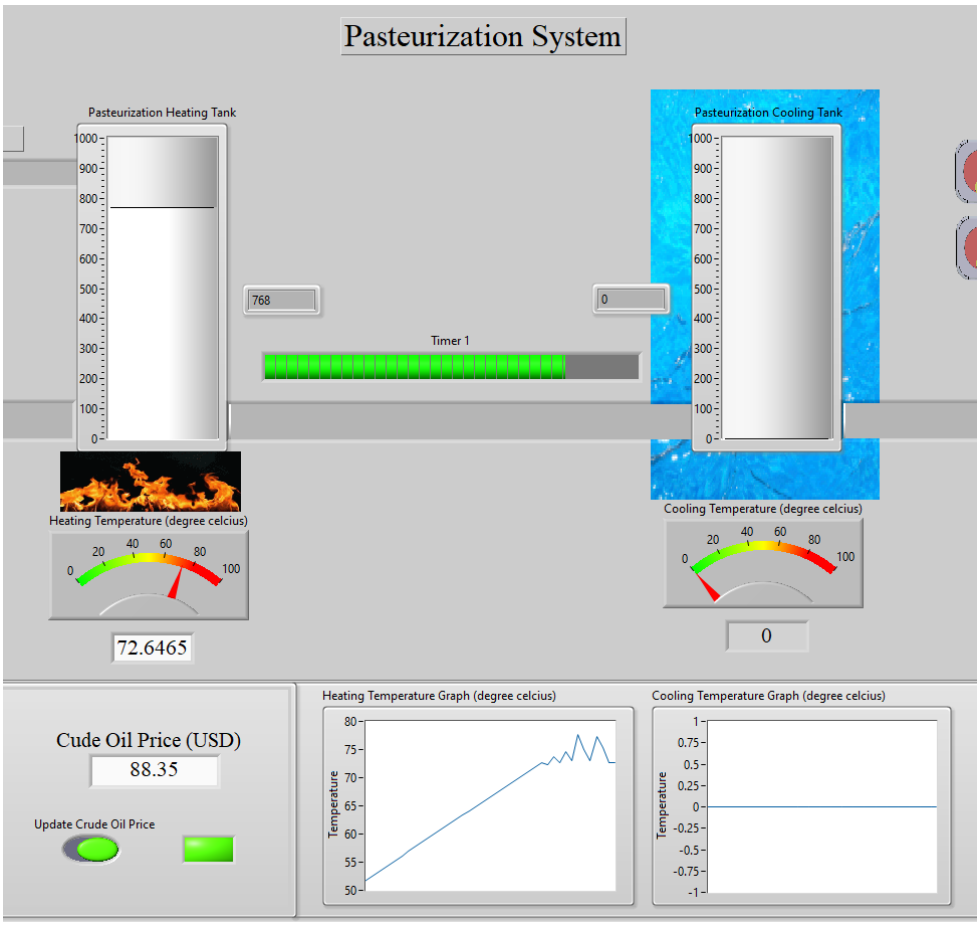


Figure 23: Pasteurization Heating Tank

Figure above shows the process of heating. The change in temperature is displayed in the meter and the change over time is also plotted on a graph. The timer is also used to display the heating progress.

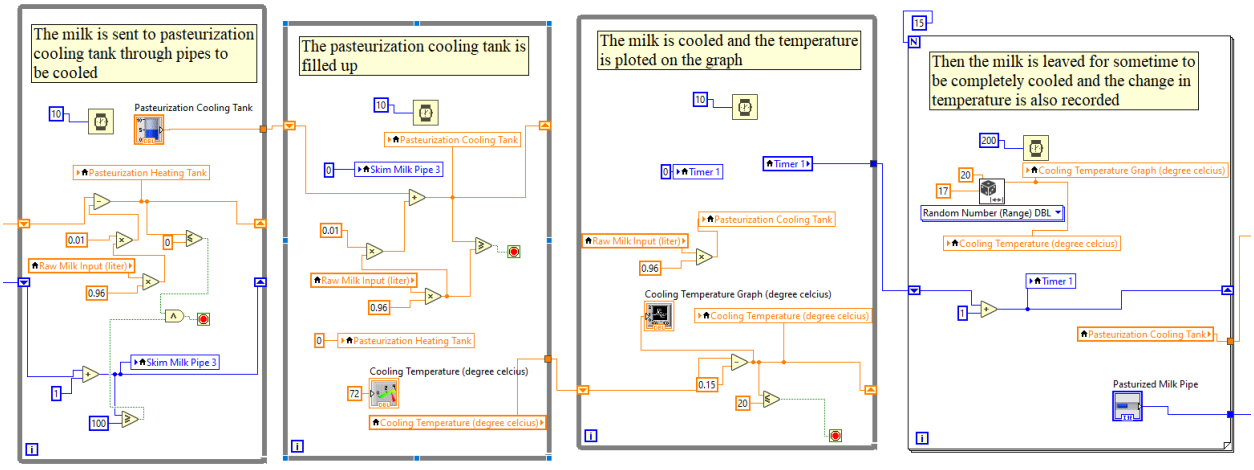


Figure 24: Pasteurization Code Example (Cooling)

After finish heating, the program will continue to the cooling process. The process is similar to what is done in the heating process just that the temperature is reduced gradually until 20 degrees Celsius and also random number between 17 to 20 degrees Celsius will also be generated. The change in temperature while cooling will also be shown on a meter and plotted on graph to let the user be able to monitor easier.

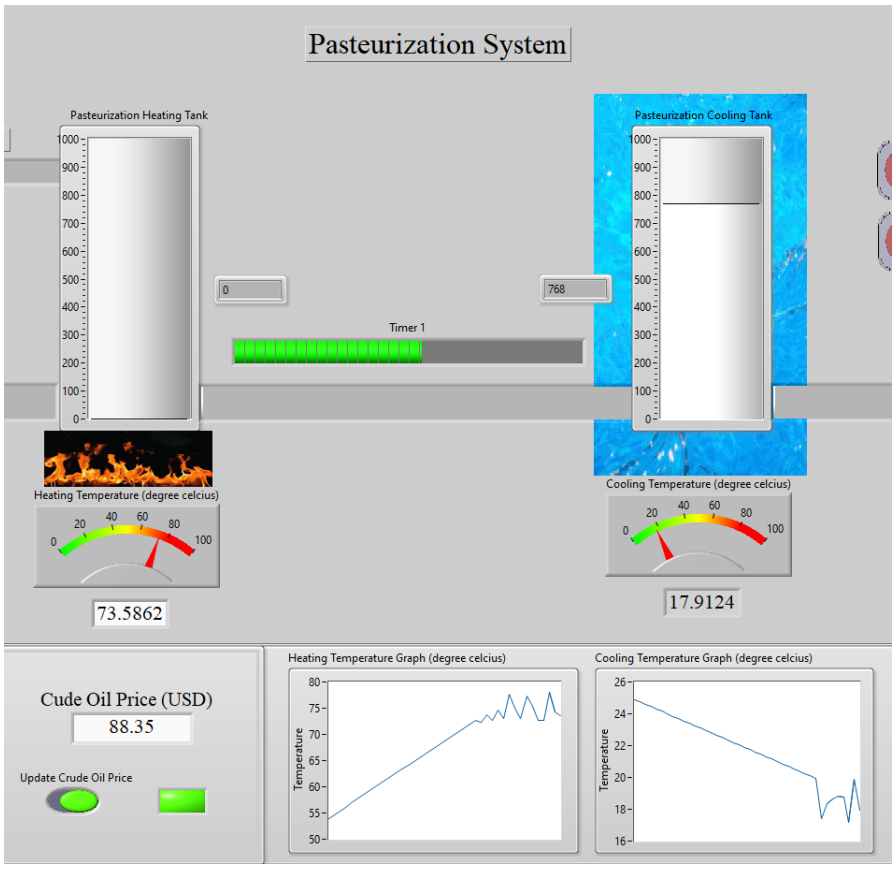


Figure 25: Pasteurization Cooling Tank

Diagram above shows the cooling process where the temperature is also displayed through meter and the change over time is also displayed on the graph. The timer is also used to indicate the progress.

Homogenization

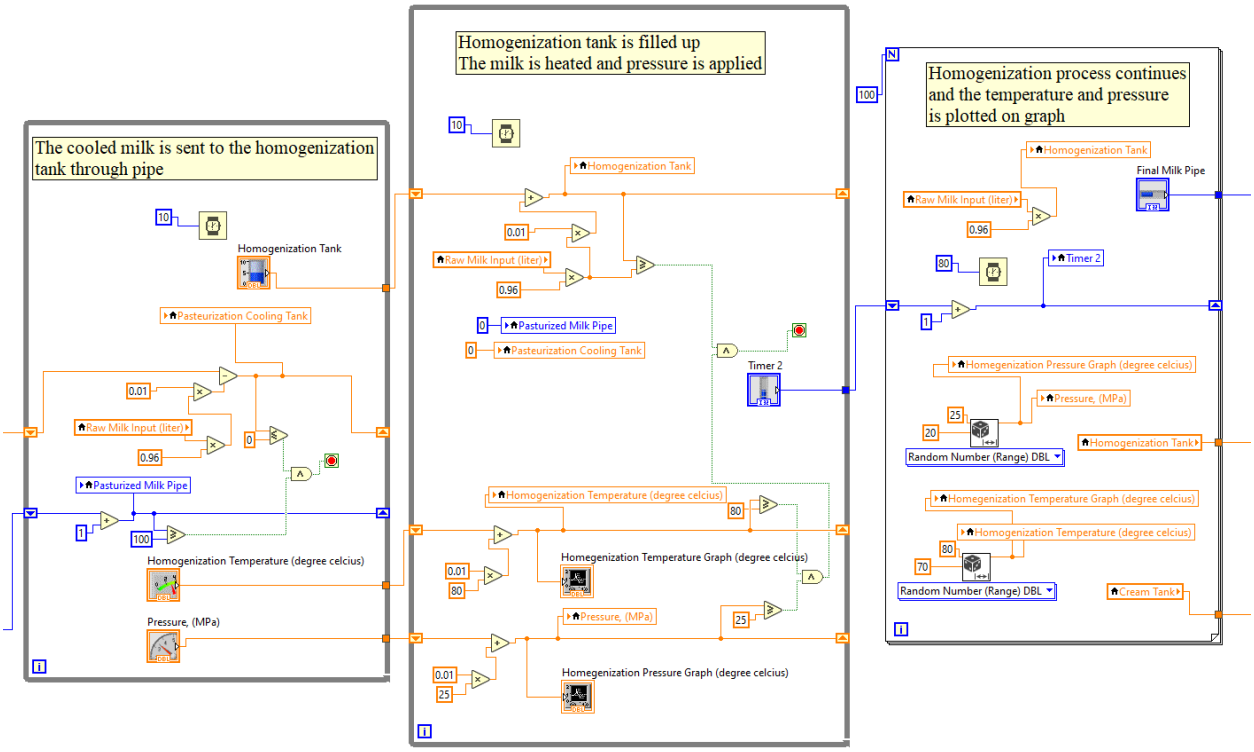


Figure 26: Homogenization Code Example

After cooling, homogenization process will take place. Firstly, the homogenization tank will be filled up from the pasteurization cooling tank through pipes. After it is filled, the temperature and pressure will be increased to simulate the homogenization process. The value of pressure and temperature is also shown to the user using gauge and meter while the change over time is also plotted on graph to make the process easier to be monitored.

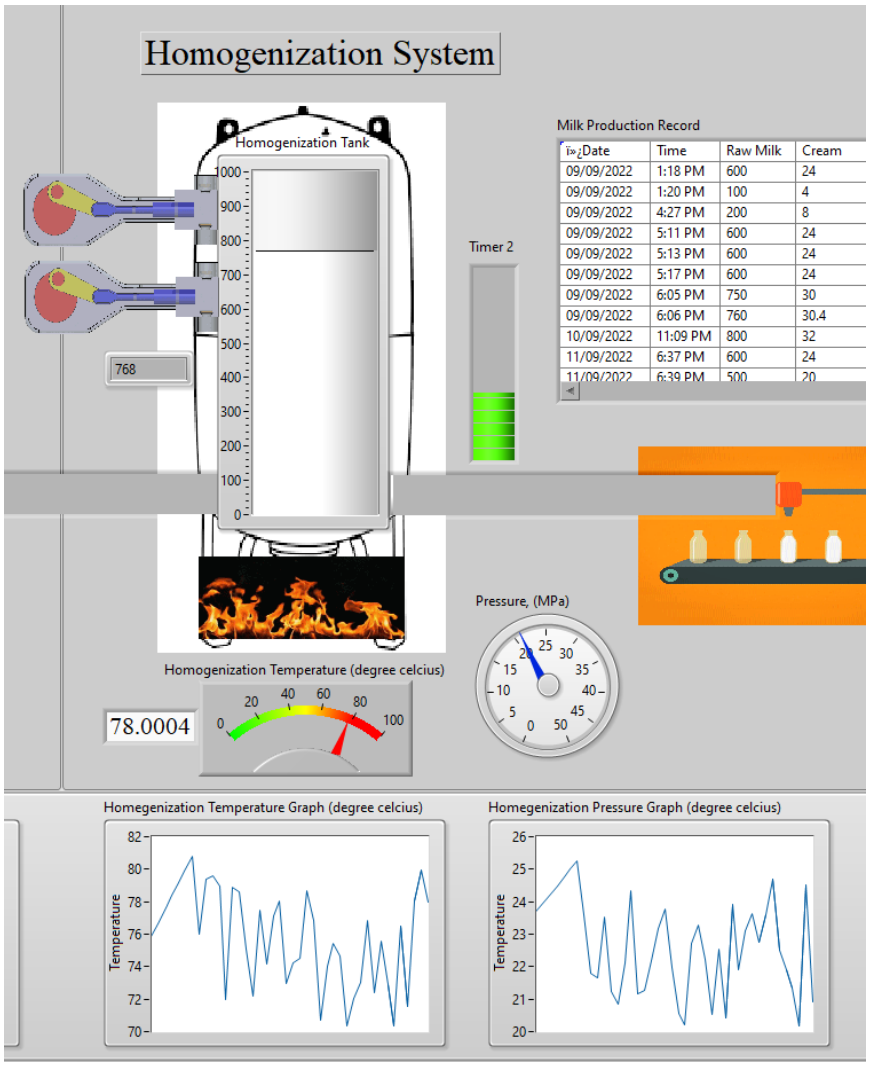


Figure 27: Homogenization Tank

Diagram above shows the homogenization process where the temperature and pressure are also displayed through meter and gauge. The change over time is also plotted on graph. There is also a timer to show the progress.

Writing to File

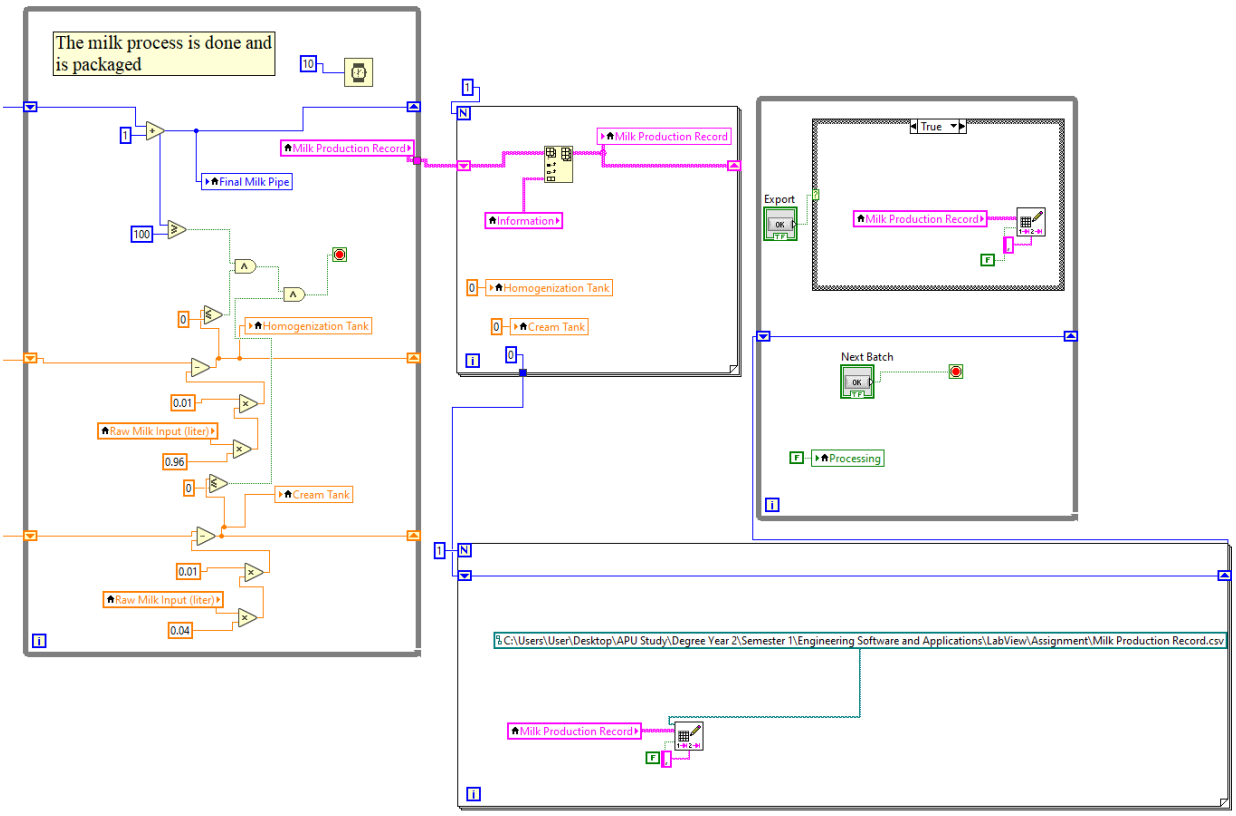


Figure 28: Writing to File Code Example

Lastly after the milk finishes its processing the milk will go out of the homogenization tank and go to packaging which is represented using a gif. At the same time, the extra cream that is not used in standardization that is left in the cream tank will also be packaged into cream. After that all the information that is stored in the information array is appended into the 3D array that stores the previous record. Then the new 3D array that stores the new record is used to rewrite the old excel file to update it. Besides that, the user also has the choice to export a brand-new file by pressing the export new file button for other reference purpose. If not, the user can press the next batch button to start the process all over again with new input of raw milk. To stop the program, the user will have to press the next batch button and then press the stop button.

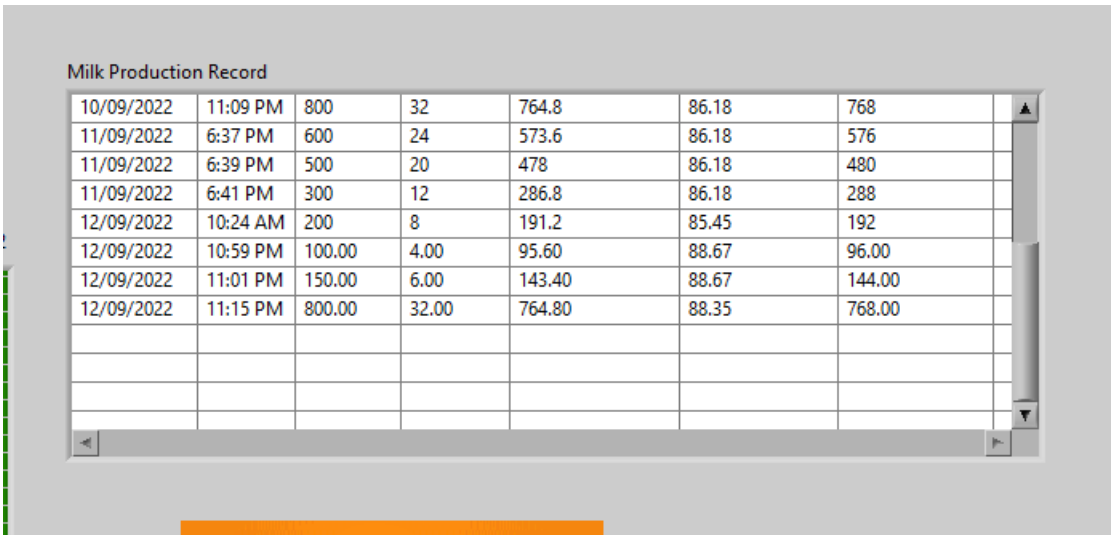


Figure 29: Milk Production Record Table Update

Diagram above shows the update in the table that displays the milk production record.

Date	Time	Raw Milk	Cream	Skim Milk	Crude Oil F	Processed Mil
09/09/2022	1:18 PM	600	24	574	84.06	576
09/09/2022	1:20 PM	100	4	96	84.06	96
09/09/2022	4:27 PM	200	8	191	84.58	192
09/09/2022	5:11 PM	600	24	573.6	84.9<	576
09/09/2022	5:13 PM	600	24	573.6	84.9<	576
09/09/2022	5:17 PM	600	24	573.6	85.08	576
09/09/2022	6:05 PM	750	30	717	84.99	720
09/09/2022	6:06 PM	760	30.4	726.56	84.99	729.6
10/09/2022	11:09 PM	800	32	764.8	86.18	768
11/09/2022	6:37 PM	600	24	573.6	86.18	576
11/09/2022	6:39 PM	500	20	478	86.18	480
11/09/2022	6:41 PM	300	12	286.8	86.18	288
12/09/2022	10:24 AM	200	8	191.2	85.45	192
12/09/2022	10:59 PM	100	4	95.6	88.67	96
12/09/2022	11:01 PM	150	6	143.4	88.67	144
12/09/2022	11:15 PM	800	32	764.8	88.35	768

Figure 30: Milk Production Record File Update

Figure above shows the update in the excel file.

Overall Appraisal

The flow of the whole program is very understandable and clear for the user. All of the parameters and conditions for each process which are separation, pasteurization and homogenization are all displayed through meters and gauge. Their change over time is also plotted on the graph to let the user has a clearer view and easier to monitor.

During the time of designing the program several difficulties were faced. Firstly, it is found out that there is no way to control the flow of the loops without using the flat sequence where all of the loops will run at the same time which results in disasters. After doing some research, it is found out that adding shift registers to the loops is the best way to control the sequence of the loops. By connecting the loops with each other through shift registers can help in controlling the flow. Besides that, shift registers also help to update the variables when it is going into the next loop which is also very crucial for the program.

Furthermore, difficulty is also faced while trying to create a control for the user to end the program because if want to create a control for the user to be able to stop the program whenever that they want. The control will have to be placed in all of the loops in the program which is less effective. Hence after doing some research, it is found that application control function can perfectly solve this problem where only 1 is needed. However, the user still is not able to stop the program anytime that they want but only at the start of the program in the initialization loop.

In addition, the crude oil price that is obtained from the website is not that accurate because the website that is used which is Markets Insider does not update the price that frequently. Hence the change crude oil price in the program will be slower. This can be solved by using other professional trading website such as Trading View as the source of the price update information.

Conclusion

In a nutshell, all of the objectives of this assignments are achieved. The whole flow of the program is represented in flow chart clearly. Arrays and clusters are also widely utilized in the program designed. On top of that loops are also one of the most significant components that is also utilized widely in the program. In addition, shift registers are also applied to control the sequence of the loops. On the other hand, the program is also able to read information from excel file and display it to the user. After completing the milk production process, the program is also capable to write to the excel file to update the file with new record and also able to create new file of the record.

However, there is still some limitations for the program created. Firstly, the location of the file that is read and written in this program is fixed. If there is no file that is located at the particular location, the program will have errors because there is no file for it to read and write. To solve this problem, a dynamic file path can be designed where the program can ask for the location of the file from the user.

Furthermore, the program designed is more on a simulation on the production of milk where most of the conditions and the parameters of the processes were assumptions based on the research done. The user is not able to manipulate the conditions. To improve this, the program can be designed to have upper or lower boundary for each process to make sure that the conditions and parameters are suitable for the process and also allows the user to have some control over it.

In addition, the program also has the limitation of displaying the maximum of 1000 liter of milk. To overcome this problem, the tanks with larger scale can be used.

To conclude, after completing this assignment understandings on LabVIEW had been improved. The program is created by utilizing many types of function blocks in LabVIEW. The capability of creating a robust logic to design a system that can run without any error is also improved. As a cherry on top, the conditions and parameters that is significant during the production of milk is also learned during the process.

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