

Aled Edgell Assignment 2 Final

by Aled Edgell

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Assignment 2

Aled Edgell

Individual Project

PSDE5007

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1: 1st Project Proposal

This project will be carried out in the felinfach factory. In the factory we use and create powdered products, because of this there are several areas which run the risk of the powder in the air exploding. In addition to the current procedures that are in place a Fire Trace system has been implemented in the factory, not only in these areas but in most of all the panels on site.

The Fire Trace system is a fire suppressant method which requires a fire extinguisher to be fitted to the outside of the panels, and tubes linked to the fire extinguisher to be run into the panel across all the electrical devices. When a fire or a hot spot is created it will break the Fire Trace tube and the fire suppressant will be dispersed onto that area.

At the moment while most of the fire trace bottles have not been commissioned and are not in use, an engineer is regularly required to go around and inspect the bottles (that are active) to make sure they haven't been discharged, or isolated (without reason). Not only is this a very time costly activity it is also very ineffective as the bottle could discharge shortly after the inspection.

The purpose of this project is to connect each Fire Trace system to the WinCC network, this is the system that all the operators use to control the plant, which also allows other users to inspect the condition of the factory and individual items.

When the Fire Trace System is linked through the WinCC network a screen will be created which will allow all Fire Trace Systems to be inspected by looking on the screen and not required to go to each one locally. Additionally, alarms will be created so that when a bottle is discharged it will inform the operators and send an email to those who are required to be informed. In addition to monitoring the Fire Trace bottle itself the doors on the panel and the extraction fans will be monitored as the fire suppressant is less effective when the doors are open or the extraction fans are running, as it will remove the fire suppressant. In addition to the WinCC screen local pilot lamps will be used on the doors so that if an engineer is resolving an issue with the system they can easily identify what the issue could be.

The project will be completed with a combination of research at Volac and at college, while the majority of the project will be spent implementing the project at Volac. To achieve the goals of the project local inputs from a PLC will be connected to all the Fire Trace bottles and the door sensors which will be linked to the WinCC system. Any panel that doesn't have any I/O available will have Input/Output cards added to the current PLC's. However, if they don't currently have a PLC in the area one will be added and connected to the Ethernet network.

The budget for this project is £8000. While most of the cables and the I/O required are already available this will greatly reduce the amount needed to complete the project.

The 2 possible methods to complete this project are to either fit a standard terminal row fitted to a piece of Din rail to the side of the panels which will be used to connect the PLC, Fire Trace bottle and the pilot lights. The alternative method will be to create a separate panel that will have the terminals and the pilot lights fitted next to the Fire Trace bottle which will not require the use of any space in the other panels. However, it will cost more to do this and there might not be enough space to do this for some of the panels. A site survey will be carried out to determine the best course of action

Good proposal

2: Background research

For the research into the project a site survey was carried out to determine the course of action require below are the results of the panels found that require a monitoring system to be implemented.

Firetrace Ref	Location	Panel Names	Panel dims	Bottle size
1	First Aid Room	First aid room. General Ottermill sw / fuse	2.4 x 1.2 0.4 (largest <1 cubic metre)	FS1DLP1230INT
34	Blending area	Perspex covered starter panel	3.24 x 2.0 x 0.3 (largest <2 cubic Metre)	FS2DLP1230INT
36	Air compressor house	Compressor 1 Atlas Copco	0.47 x 1.95 x 1.1	FS2DLP1230INT
37	Air compressor house	Compressor 2 Atlas Copco	0.47 x 1.95 x 1.2	FS2DLP1230INT
38	Air compressor house	Compressor 3 Atlas Copco	0.47 x 1.95 x 1.3	FS2DLP1230INT
3	Area 1	Area 1 Sub Station DB2	4.0 x 2.1 x 0.9 (largest < 4 cubic metre)	FS4DLP1230INT
4	Area 1	DB32	1.2 x 1.4 x 0.25	FS1DLP1230INT
7	Area 1 Motor Store	Area 1 Motor Store	4.2 x 2.0 x 0.5 (largest 3.0 x 2.0 x 0.5)	FS4DLP1230INT
33	Area 1 NF	Mcc panel	2.44 x 2.1 x 0.6	FS4DLP1230INT
5	Area 1 NF/RO Substation	Area 1 MCC DB9 / NF MCC	3.6 x 2.0 x 0.4	FS4DLP1230INT
6	Area 1 NF/RO Substation	DB 39 / RO Polisher	1.2 x 2.0 x 0.6	FS2DLP1230INT
49	Area 2	DB86 MCC (4 sections)	3.2 x 2.1 x 0.55	FS4DLP1230INT
13	Area 2 Sub under control room	New DB 72-77	2.4 x 1.4 x 0.4 (largest <1 cubic metre)	FS1DLP1230INT
50	Area 2	Feed & Outlet Fan 1 & 2 plus incomer	3.4 x 2.6 x 0.6	FS6DLP1230INT
15	Steam Boiler House	Ottermill Dis Board	2.0 x 1.2 0.4 (largest <2 cubic metre)	FS2DLP1230INT
54	Area 2	DB87 - WPC homogeniser	0.8 x 2.1 x 0.6	FS2DLP1230INT
17	T2/T3 Sub	T2 Dis board (Sensient)	3.0 x 0.8 x 2.1 (largest <2 cubic metre)	FS2DLP1230INT
18	T2/T3 Sub	T3 Dis board (Volac)	4.0 x 0.8 x 2.1 (largest <2 cubic metre)	FS2DLP1230INT
55	Area 2	DB88 - Perm homogeniser	0.8 x 2.1 x 0.6	FS2DLP1230INT
45	Area 2 Control Room	DB 94 - CJP Panel	0.8 x 2.1 x 0.6	FS2DLP1230INT
46	Area 2 Control Room	DB 91 & 93 - SATT Panels	2.8 x 2.1 x 0.6	FS4DLP1230INT
47	Area 2 Control Room	Area 2 PLC	0.6 x 2.1 x 0.6	FS1DLP1230INT
14	Area 2 Sub under control room	Small Ottermill dis boards	4.8 x 1.2 0.4 (largest <1 cubic metre)	FS1DLP1230INT

53	Area 2 Upper Sub Station	DB79 & Stork Dryer MCC - Klockner suite	5.0 x 2.3 x 0.4 (largest <2 cubic Metre)	FS2DLP1230INT
11	Area 3 Substation 11	Offermill Sw/ fuse (multitap)	2.4 x 1.2 x 0.4 (largest <1 cubic metre)	FS1DLP1230INT
10	Area 3 Substation 11	DB63,62 & 70	4.2 x 1.9 x 0.4 (largest 1.8 x 1.9 x 0.4)	FS2DLP1230INT
12	Area 3 Substation 11	PLC panels	1.02x 2.1 x 0.4	FS2DLP1230INT
67	Attic (office)	WINCC Scada System (mesh front)	1.0 x 1.2 x 0.6	FS2DLP1230INT
8	Feeds Packing Line	Feeds Packing line BTH / DB69	2.2 x 2.0 x 0.5 (largest 1.2 x 2.0 x 0.5)	FS2DLP1230INT
9	Feeds Packing Line	DB68 BTH Bag	1.6 x 2.1 x 0.6	FS2DLP1230INT
41	Feeds Thermal Heater	Babcock Boiler 1	1.0 x 1.4 x 0.3	FS1DLP1230INT
42	Feeds Thermal Heater	Babcock Boiler 2	1.0 x 1.4 x 0.3	FS1DLP1230INT
61	Food	DB181	1.2 x 1.1 x 0.3	FS1DLP1230INT
62	Food	DB179	0.8 x 2.0 x 0.6	FS1DLP1230INT
63	Food packing Line	DB131 Boiler panel	1.2 x 0.8 x 0.25	FS1DLP1230INT
64	Food packing Line	DB183 Packing Wrapper Panel	1.0 x 1.2 x 0.45	FS1DLP1230INT
65	Food packing Line	DB184 Palletiser Panel	1.8 x 2.2 x 0.5	FS2DLP1230INT
59	Food packing Line	Food packing line panel (Dry prod Area)	1.8 x 2.1 x 0.5	FS2DLP1230INT
60	Food packing Line	DB180 LACT Mini	1.58 x 0.8 x 0.45	FS1DLP1230INT
19	Fridge Plant	Comp 1 + common control	4.2 x 2.3 x 0.6 (largest 2.0 x 2.3 x 0.6)	FS4DLP1230INT
20	Fridge Plant	Comp 2	2.0 x 2.3 x 0.6 (largest 1.2 x 2.3 x 0.6)	FS2DLP1230INT
21	Fridge Plant	Comp 3 + controls	4.0 x 2.3 x 0.6 (largest 1.2 x 2.3 x 0.6)	FS2DLP1230INT
24	Lactose MCC	Panel 7 & 8	3.6 x 2.1 x 0.5	FS4DLP1230INT
25	Lactose MCC	Panel 3,4,5 & 6	3.6 x 2.1 x 0.6	FS4DLP1230INT
26	Lactose MCC	Panel 1 & 2	3.6 x 2.1 x 0.7	FS4DLP1230INT
27	Lactose MCC	Panel 9 & 10	3.6 x 2.1 x 0.8	FS4DLP1230INT
28	Lactose MCC	Main LV Dis board + MR1 (LPG)- 2 panels	2.6 x 2.0 x 0.5 and 1.2 x 1.4 x 0.4	FS4DLP1230INT
48	Area 2	DB85 EVAP MCC	2.0 x 2.1 x 0.6	FS4DLP1230INT
29	Lactose MCC	MG disboard DB 151, 152 & 153 + Rittal PLC Enclosure	1.2 x 2.1 x 0.4	FS2DLP1230INT
58	Lactose MCC	LNG Control Panel (Prod. Area Workshop)	1.4 x 1.0 x 0.3	FS1DLP1230INT
51	Area 2	DB80 STORK EVAP	2.88 x 2.2 x 0.4	FS4DLP1230INT
52	Area 2	STORK DRIER MCC	1.6 x 2.25 x 0.6	FS4DLP1230INT

66	Main Office IT Room	Office Server (twin 42U common)	1.8 x 1.1 x 1.94	FS4DLP1230INT
43	Old reffridgeration MCC	Old refrigeration plant MCC plus DB117	2.2 x 2.1 x 0.6	FS4DLP1230INT
35	Pump House	Ring Main Water pumps (Next to DJT) 3 panels	2@0.74 x 0.3 x 0.54 & 1@0.65 x 0.15 x 0.47	FS1DLP1230INT
56	T5 Transformer	T5 Enclosure LV end	1.6 x 1.4 x 0.4	FS2DLP1230INT
57	T4 Transformer	T4 Enclosure LV end	1.6 x 1.4 x 0.5	FS2DLP1230INT
44	Pump House	Mcc4 Pump House	1.8 x 2.1 x 0.4	FS2DLP1230INT
16	Steam Boiler House	MCC3 Cooling Tower	2.0 x 2.1 x 0.4	FS2DLP1230INT
39	Steam Boiler House	Cochran boiler control panel 1	0.4 x 2.0 x 1.0	FS2DLP1230INT
40	Steam Boiler House	Cochran boiler control panel 2	0.4 x 2.0 x 1.0	FS2DLP1230INT
2	Volac ETP	ETP	3.0 x 2.1 x 0.5	FS1DLP1230INT
31	WPI Dry	DB121 + DB123	1.2 x 2.1 x 0.6 (largest 0.8 x 2.1 x 0.6)	FS1DLP1230INT
32	WPI Dry	DB122	2.4 x 2.1 x 0.5	FS4DLP1230INT
30	WPI Dry Service Area	DB120 MCC	7.0 x 2.1 x 0.6 (largest 0.8 x 2.1 x 0.6)	FS4DLP1230INT
22	WPI Wet area	DB119 Riverside MCC	4.8 x 2.0 x 0.5 open	FS4DLP1230INT
23	WPI Wet area	DB 169 MF1 MCC	3.0 x 2.0 x 0.5 open	FS4DLP1230INT
69	Feeds Dryer	Munters MDU3500 Main Demudifier		

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3: Project Specification

To comply with the standards of Volac and to successfully meet the aims set the following specification has been created which will detail how things will be carried out and what components will be used, as where possible components already kept in stores will be used to reduce the amount of new parts required to maintain the system.

Hardware specifications:

For the hardware inductive sensors supplied from IFM will be attached to each door as far away from the hinge side of the door as possible, if there are two doors that overlap the inductive sensor will be placed on the outer most door. This will ensure that the most accurate reading is taken when monitoring the doors status. To connect the Sensors to the Terminals a 5M cable also supplied by IFM will be used as this screws on to the end of the sensor and can be cut to length when wired into the terminals.

The terminals used will be 0.75mm ² terminals supplied from RS to match those that are already kept in stock, as a base 12 terminals must be fitted in a panel to allow for all the connections, with an additional 2 terminals for every door on the panel.

Pilot lamps from Schneider electric will be used which require a 24VDC supply and a 0V to operate. These will be used as local feedback so an engineer can fault find without login onto the WinCC system.

Software Requirements:

Using the TIA portal a function block will be created using the Ladder logic. This is so that a standard block can be used in all areas, and once one is confirmed working all the block should be working as intended.

The function block will require 4 inputs:

- Isolated Feedback
- Low pressure Feedback (7 bar falling)
- Discharged Feedback (5 bar Falling)
- Door status Feedback

The function block also require 3 Outputs to WinCC:

- Isolated
- Pressure Status
- Extraction/Cooling

The output for the extraction/cooling is included into the function block, however it will not be ready to use until the next phase in the project which will be taken over by another engineer. However, it has been included so that when the logic is needed it will already be ready without fear of corrupting the functioning blocks.

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4: Testing plan

To test the system is functioning correctly the following checks will be carried out:

- Once the system has been tested when it is dead to make sure it has no issues, the 24VDC will be turned on to power the circuit, the first check would be a visual one to make sure that the Pilot lights are showing correctly.
- The second test will be to check the safety aspect as the bottle will be isolated to inspect if the lamp changes state and then the WinCC screen will be inspected to make sure it has successfully changed in both areas.
- The third test will be using a simulation to test the system recognises the change in pressure of the fire extinguisher this will be reduced to 6 bar where the Low pressure alarm should be shown and once that has been confirmed working the simulation will be set to 0 bar to test the isolation feedback on both the local pilot lights and the WinCC alarm, before this test the Email recipients will be changed so that only I receive an email to make sure that it is functioning correctly, and once the Email has been received about the discharged fire extinguisher the original settings will be restored.
- The final test for the system will be to make sure the status light for the doors and the feedback is working correctly so engineers are aware the doors have been left open as this makes the fire suppressant redundant.

5: Plan for the Project

Below is the plan that will be followed to achieve the aim of the project. During the time allotted to each area the system will be implemented and tested in the method stated above.

1	Week	Objective
2	2	Create a parts list and confirm with Graham before ordering.
3	3	Work on creating the logic and the WinCC screen.
4	5	Install and test the system in the powder silo room as a test area. If successful make the WinCC screen visible.
5	7	Install the project in Area 1
6	9	Install the project in Area 2
7	11	Install the project in Area 3
8	13	Install the project in the Boiler room
9	15	Install the project in the Lactose MCC
10	17	Install the project in the WPI MCC
11	19	Install the project in the Dryer MCC
12	21	Install the project in the Evaporator MCC
13	23	Install the project in the Tank farm
14	25	Install the project in the Effluent treatment plant
15	27	Install the project in the Intake bay MCC
16		
17		

Any issues that come up will be recorded and explained how they were overcome, if the issue was so severe that it caused a delay in the Gantt chart. The time delay will be recorded and a new time schedule will be created to replace it.

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6: 1st Project Conclusion

At the current point in time, tests have been carried out using the feedback switch which was supplied by the Fire trace company to make sure they are suitable for the task required, this also provided an opportunity to find the best way that they could be implemented into the circuit.

The function block for the project has also been created and compiled into the Volac software, However it has not been added into any Areas as so it will not affect any processes until it is ready to be connected to the WinCC system. However, they will be moved into OB1 (The main block) when the hardware is in place and connected up ready for testing.

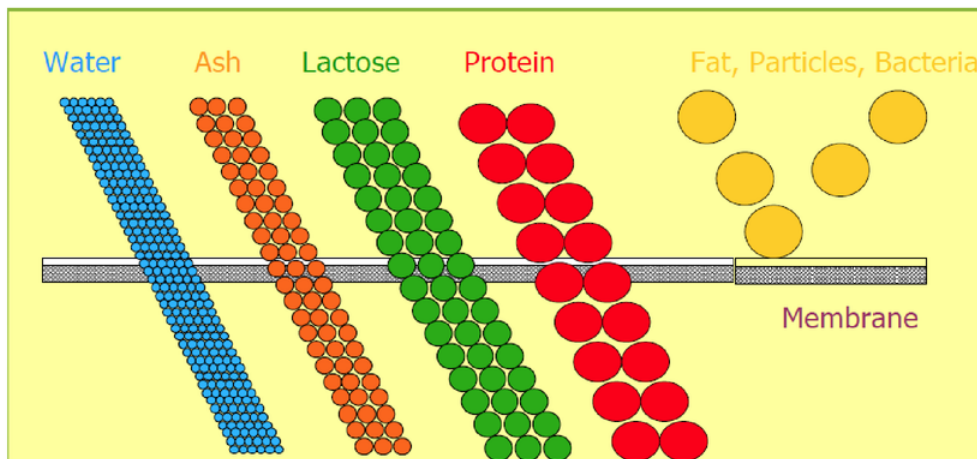
This project has been made unnecessary for me to continue with the other plan from the point of view from myself and my manager. The reason for this is rather than the option that was chosen to feed all the information back through the WinCC system the company who supplies the fire trace system 'Firetrace' have released a new product which mounts to the bottles around the factory and sends wireless feedback to boxes that they would fit on site and record and monitor the information on their servers. The advantages of this is that this system would be highly reliable, experts in the system will be available for support and send regular reports on the system as well as urgent emails if a bottle is low on pressure or if a suspected fire has been suppressed. This will also save a lot of money as the project design that had previously been agreed on had a high cost for all the parts required and the maintenance on the system would be quite extensive as it would be a safety system.

Because of this change in the project I have been assigned a new one which would be resolving the issues with the foods micro filtration plant and the pasteuriser plant regarding the solids count in the product.

*This is a
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decision
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looking at
the
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7: 2nd Project Specification

This project will be carried out in the felinfach factory. The part of the factory that this project will take place is responsible for the filtration of the product through different stages to remove parts of the raw materials going in into usable parts that will be added together in the desired quantity later. An image of how this system works is shown below. The basic purpose of the microfiltration plant is to remove the fat and other colloidal materials, this is done using semi permeable membrane. The main product out of this process is the permeate which is used in the majority of the products.



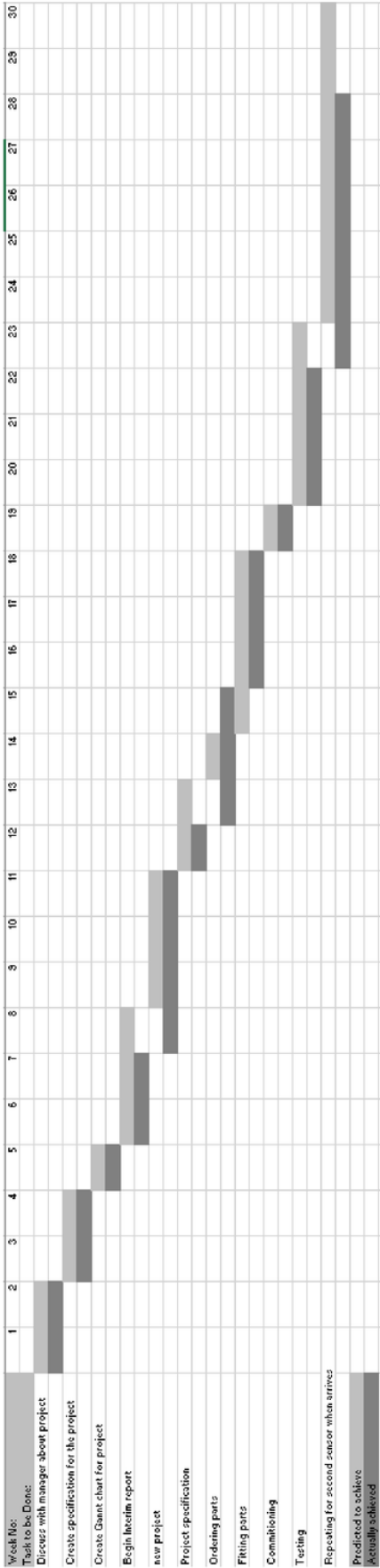
This project is needed going forward to more accurately control the solids in the products both going into the pasteuriser plant and out of the MF. The reason for this is because as the product leaves the MF the final solid amount they will have a direct effect on the powder as it goes through the dryer which will overall effect the value and standard of the powder being produced. The product is currently being manually tested using sample points located on the plant however, doing this effects the results due to outside factors, one of these would be the change in temperature which would be different from the process temperature giving inaccurate readings the other current method is using a sensor that detects the density of the product going through. However using the density meter is not highly accurate as it needs to be scaled in the program to get close to the solids value.

The aim of this project will be to fit a system that will be able to accurately measure the solids of the product going through the process and trend it on WinCC for the operators and the lab technicians to have access to record the process values and to have a comparison for carrying out further tests in the laboratory.

This project has been authorised by the engineering manager for installation in the foods process area. The total budget for this project will be £15000, with the aim that once the project is completed the solids of the product can be accurately altered to move the product into the next bandwidth of quality which is estimated to increase profit by £150 per ton produced in the dryer. However, this will not be complete profit until it has paid off for the additional instalments and control systems required for the system.

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which makes reading
this difficult.*

8: Gantt chart of time spent



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9. Three solutions

For this project three solutions could be used that would meet the requirements set in the specification, however each has its pros and cons which will be discussed below.

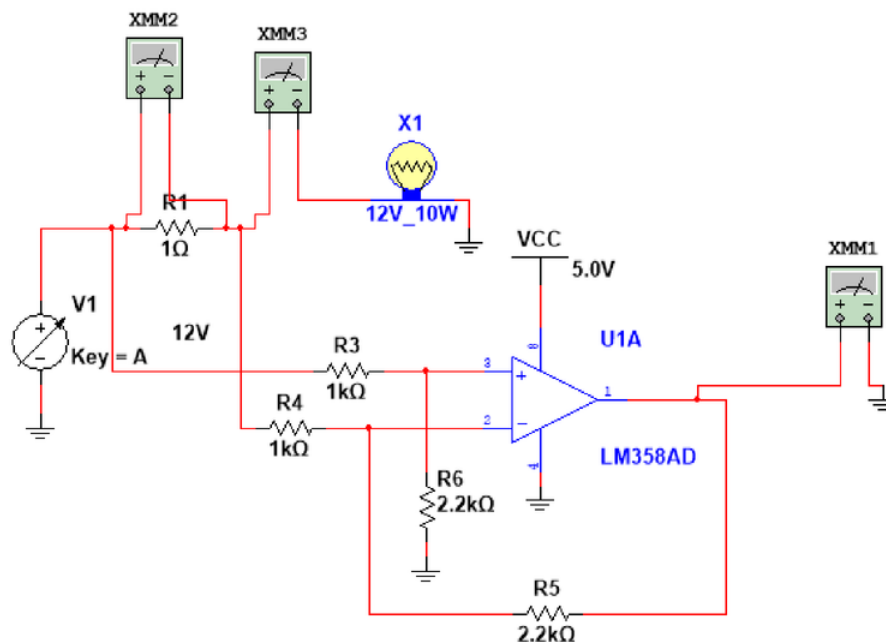
Solution 1: microprocessor system

This method demonstrates how the micro controller can be use as an alternative solution for this project.

The development and procedure is as follows:

The C program is developed using MPLAB IDE and HITECH C compiler.

The Hex program is downloaded to the PIC processor and Proteus will then Run the program.



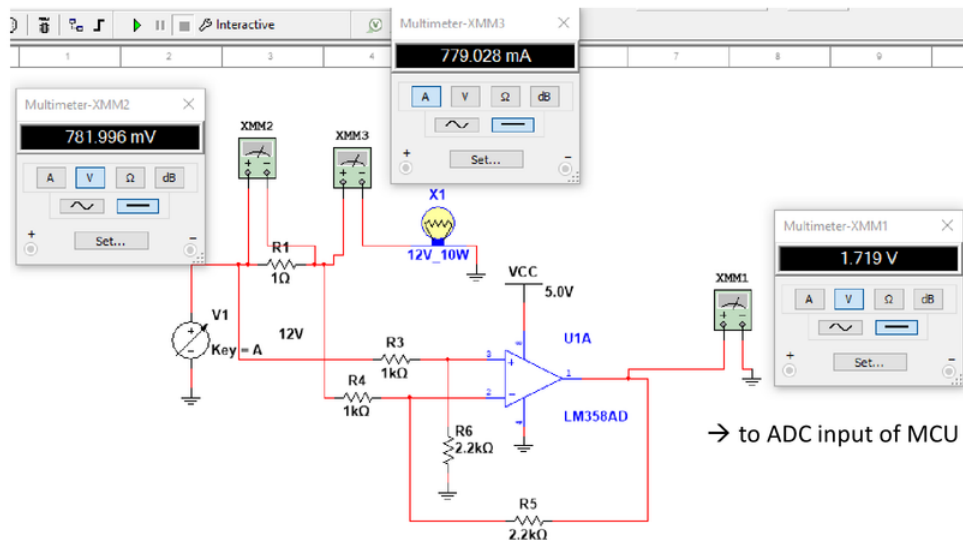
The circuit above is designed for current measurement instrument amplifier for a microprocessor system.

There must be a way of sensing electrical current flow in an external circuit that can attach to a microprocessor analogue input. The sensing circuit shouldn't interfere with the thing we are trying to measure and should be as low power but accurate as possible. The classic way to measure electrical current is to force the electrical current to pass through a known value resistor and then measure the voltage across that resistor and then using Ohm's law calculate the current.

This is a very accurate and proven method. The issues with it is that the circuit being measured is 'loaded' by the measurement or 'shunt' resistor which affects the external circuit slightly (Horowitz and Hill, 2015).

The shunt resistor needs to be a precision part which is unaffected by temperature. That makes the 'shunt' resistor expensive. The design above is a shunt resistor current measurement circuit.

The results of the circuit analysis reading the current is shown below:



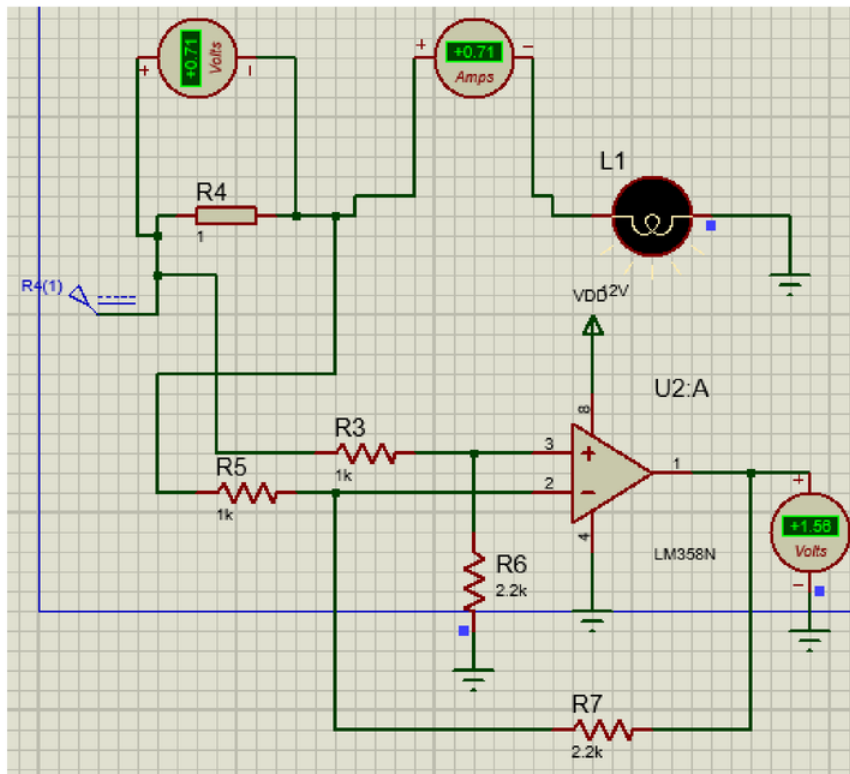
The circuit uses a 'difference amplifier' to measure the voltage developed across the shunt resistor. This voltage is then amplified and passed to an analogue to digital converter which is then in turn connected to a micro-controller and processed as required. The circuit above provides a gain of 2. The issues with the above circuit is that the resistors must be their precise stated value and must not differ with temperature. Any slight fluctuation in the supply voltage to the op amp or noise at the ground terminal will cause the measurement to be incorrect.

Most difference amplifiers these days are made with precision resistors. They can be bought as a single part with the circuit implemented within the silicon. The resistors are typically trimmed during manufacturing so that $R2/R1 = R4/R3$. The differential gain of the device can be calculated easily:

$$A_v (\text{Gain}) = R2/R1$$

The reference voltage (V_{ref}) is added to the output voltage (V_o).

The same circuit developed using Proteus CAD system.

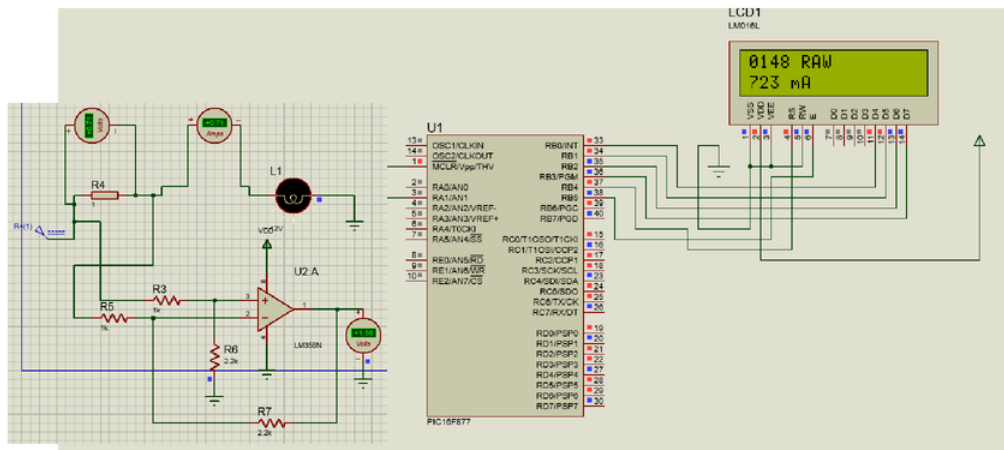


The circuit designed using Proteus CAD system performed in exactly the same way as in Multisim and can now be connected and tested on a microprocessor system using an ADC (Analogue to Digital Converter) input.

The differential amplifier has been set up with a gain of 2 and this can be converted using the math functions in the C program of the PIC controller.

Once the circuit design has been tested for a linear output it can be connected to the input of the PIC microprocessor.

The diagram below demonstrates this connection and operation:



Current measurement using differential amplifier instrumentation and PIC micro controller.

The circuit shows the measurement of the current and the output of the differential amplifier. The diff output is twice the current because of the amplifier gain.

This gain is compensated for in the C program by dividing the output analogue value by 2 after the ADC has finished the conversion.

The LCD displays the RAW value from the ADC 10 bit value on line 0 and the calculated current in milliamps on line 2.

This was tested using various supply voltages:

Supply voltage	Raw value and current
12V	0160 RAW 782 mA
10V	0133 RAW 658 mA
6V	0080 RAW 391 mA

The table shows the results of the current in the series circuit with different supply voltages applied and common loads (lamp).

The circuit can be used to measure any values of current using the same principles.

The C program with code comments is given below:

```
#include <pic.h>
#include "lcd.h"

void Display_LCD_Value(int line, int value);
void Display_LCD_Voltage(int line, int value, float max);
void Delay(int t);

void main(void)
{
    int value=0, low_byte=0, high_byte=0;

    TRISA = 0b11111111;           //port A all inputs
    TRISB = 0b00000000;           //port B all outputs
    TRISC = 0b00000000;
    TRISD = 0b00000000;
    TRISE = 0b11111111;

    ADCON0 = 0b10001001;           //select RA1 as analogue input, Fosc/32
    ADCON1 = 0b10000100;           //select RA0, RA1, RA3 as analogue, rest are digital
    LCD_Startup();

    while(1)
    {
        ADCON0 = ADCON0 | 0b00000100;           //set GODONE bit to 1;
        GO_DONE = 1;
        while(GO_DONE == 1);                       //check the GODONE bit is still 1
        Delay(100);

        //wait for ADC to settle
        low_byte = ADRESL;
        high_byte = ADRESH;
        value = low_byte + 256*high_byte;           //calculate analogue value

        value = value / 2;
        Display_LCD_Value(0,value);                 //send to display
        Display_LCD_Voltage(1,value, 5.00);

    }
}

void Display_LCD_Value(int line, int value)
{
    char string[9]={0,0,0,0,0,0,0,0,0};
    int units=0, tens=0, hunds =0, thous=0, temp=0;

    thous = value / 1000;
    temp = value % 1000;
    hunds = temp / 100;
    temp = temp % 100;
```

```

    tens    = temp / 10;
    units   = temp % 10;

    string[0] = (char)thous + 48;
    string[1] = (char)hunds + 48;
    string[2] = (char)tens  + 48;
    string[3] = (char)units + 48;
    string[4] = ' ';
    string[5] = 'R';
    string[6] = 'A';
    string[7] = 'W';
    string[8] = 0;

    DisplayString(line,string);

}

void Display_LCD_Voltage(int line, int value, float max) //value is the raw number value
{
    char string[8]={0,0,0,0,0,0,0,0}; //max is the max volts for the pot
    int units=0, tenths=0, hundths =0, temp=0;
    float voltage;

    //mult by 1000 for the 3 decimal places created
    voltage = max * 1000 * (float)value /1023;

    units   = (int)(voltage / 100);
    temp    = (int)(voltage - (float)units*100); //sort out the decimal values
    tenths  = temp / 10;
    hundths = temp % 10;

    string[0] = (char)units + 48;
    string[1] = (char)tenths + 48;
    string[2] = (char)hundths + 48;
    string[3] = ' ';
    string[4] = 'm';
    string[5] = 'A';
    string[6] = 0;

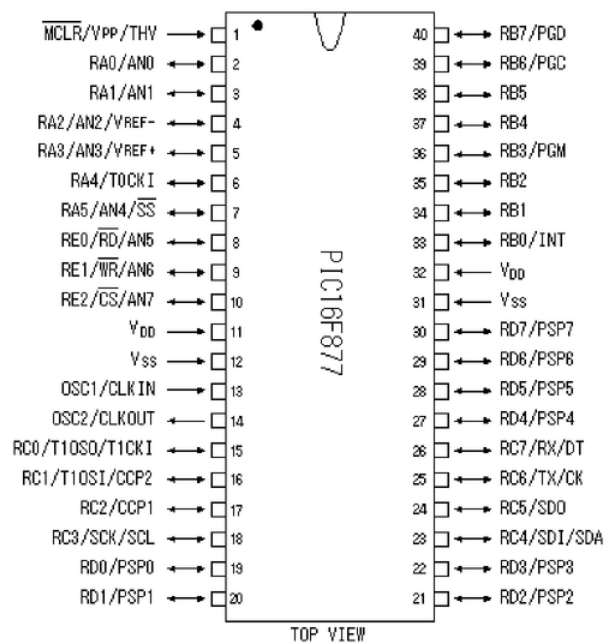
    DisplayString(line,string);

}

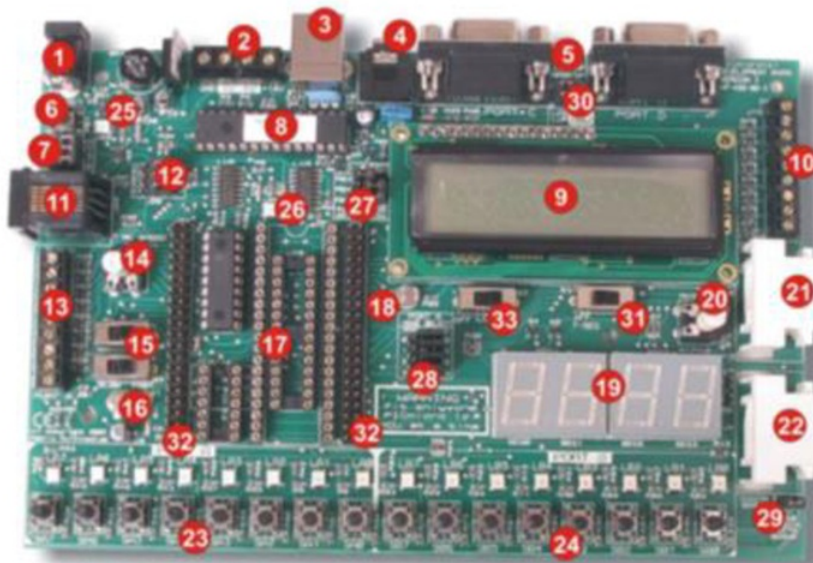
void Delay(int t)
{
    int i;
    for(i=0;i<t;i++);
}

```

The PIC controller used for this system is the PIC16F877:



This system architecture which is designed and implemented using Proteus is a copy of the HP488 development board. This means that the same system will work when connected practically to the development board.



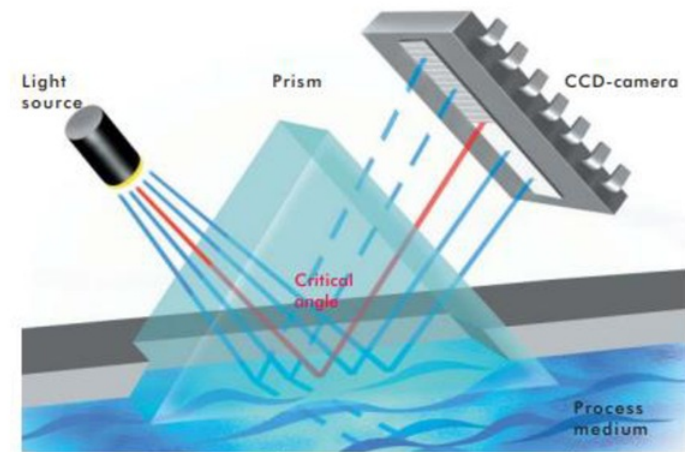
- | | |
|---|-----------------------------------|
| 1. Power supply connector | 29. Digital sensor selector |
| 2. 5V outputs for E-blocks connection | 30. LCD display LVP mode selector |
| 3. USB connector | 31. 7-segment display enable |
| 4. Single bit audio output | 32. Expansion bus |
| 5. E-blocks connectors for ports C and D | 33. LCD enable |
| 6. Reset switch | |
| 7. Power selector link block—USB or Power connector | |
| 8. USB interface chip | |
| 9. 2 line 16 character alphanumeric display | |
| 10. Screw terminal connectors for port B | |
| 11. In Circuit Debug socket | |
| 12. ICD/USB programming selection | |
| 13. Screw terminal connectors for port A | |
| 14. RC speed potentiometer | |
| 15. Oscillator mode selection switches | |
| 16. Removable crystal | |
| 17. Sockets for programming 8, 14, 18, 28 and 40 pin PICmicro devices | |
| 18. On-board light sensor | |
| 19. Quad 7-segment displays | |
| 20. Analogue input potentiometer | |
| 21. External analogue sensor input | |
| 22. External digital sensor input | |
| 23. Port A switches and LEDs | |
| 24. Port B switches and LEDs | |
| 25. Power indicator | |
| 26. Programming indicator | |
| 27. LVP pin selector | |
| 28. Port A analogue/ digital selector | |

Option 2:

The second option would be to fit a density meter to stage 6 of the microfiltration plant and at the beginning of the pasteuriser which would allow the constant measurement of the product and when linked to the WinCC screen in feature if required could be linked to the control logic to keep the product at a constant value. The advantage of this is even though instrumentation will be required it is still a fairly cheap option. However the only disadvantage of this would be that the sensors kept in stock measure density which will the values will be close to that of the solid will not fully meet the specification as it will not be accurate enough to depend on fully with automatic control.

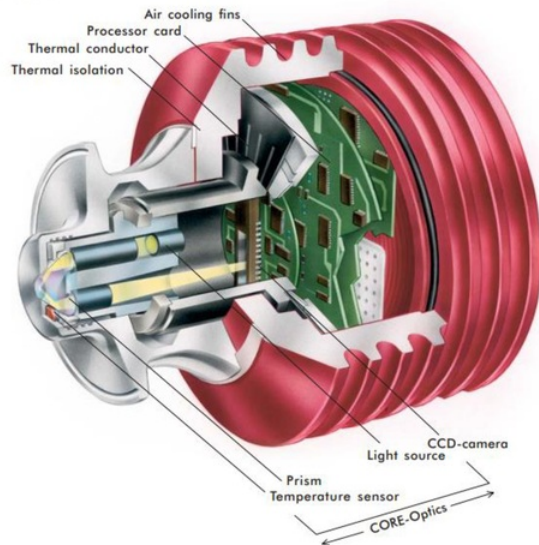
Option 3:

The final option of this project will be to fit a specialised probe that will be designed able to read the solid count of the product at a highly accurate rate. As with option 2 the advantage of this system would be that it would be possible to link to WinCC and produce highly accurate results that would be suitable for automatic control as it is measuring the solids not the density and calculating the solids from that reading as would be the issue with option 2. While the specialized probe will be the best option for control and accurate measurements it is by far the most expensive option of the three. The optimal specialized instrument for this task is a refractometer which uses a yellow light source which reflects off of the product in the pipe to a CCD-camera which measure how much light has returned through the prism created. The more solids in the product the more light is reflected. For example during a CIP (general cleaning of pipes with chemicals and water) the light will fully penetrate the water as it has no solids so the light returned through the prism will be 0. This sensor as mentioned before measures the solids in the product. Below is an image from the manual describing how the refractometer works.

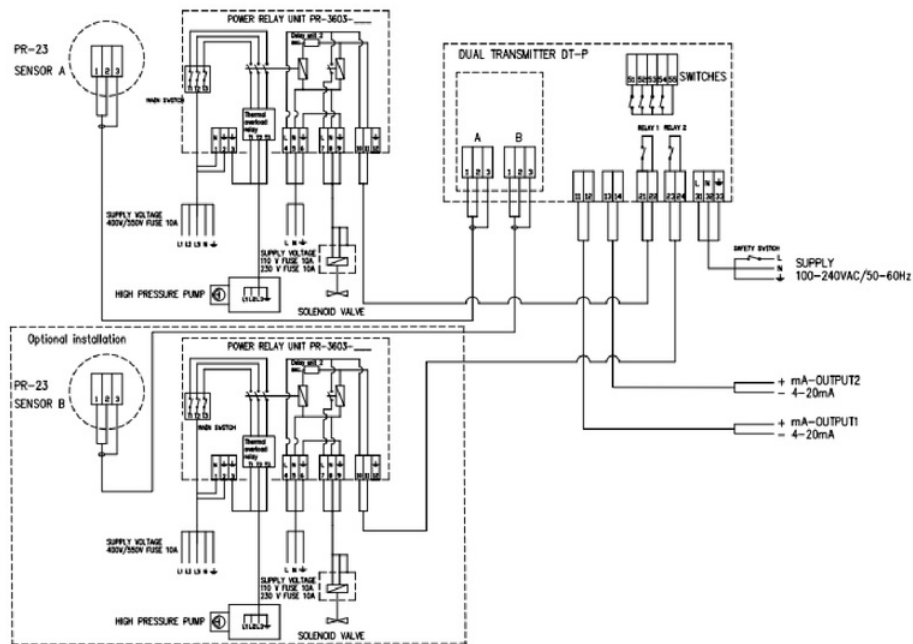


The internal design of the refractometer can be seen below, in addition to the prism that the product will flow past to measure the solids in the product it has a temperature sensor fitted as well. This gives the added advantage of measuring the process temperature while the product is going through the prism. This is important as the process temperature affects the reading for the solid content. This is why the current method of using laboratory machines is no longer as efficient as needed because of the change in temperature, as well as other factors such as the time delay which will cause massive inaccurate calibration of the system.

DESIGN



Inside the head of the refractometer there are 3 cables that must be wired in which are: Positive, neutral and earth, as this sensor measures the solid in Brix if we need to convert it into a 4-20mA a panel supplied by K-patents would be required to carry out that function.



Very good discussion of solutions

10: Final solution and implementation

As the other 2 solutions have issues preventing them to meet the standards required in the specification. The first being a sample valve that would be regularly tested in the laboratory and the second a density meter which isn't accurate enough to control the solids in the product. Therefore a third solution has been decided upon which will include fitting new instruments into the process lines to accurately measure the product solids.

The final solution that was chosen was to fit refractometers to both the MF and the pasteuriser plant, the reason why these sensors were fitted was because they were designed just for the measurement of solids in the product and are highly accurate which was the main point that was required as stated in the specification. The company that will be supplying the refractometers are Flowcon Ltd they will be supplying 2 refractometers one for the start of the process on the pasteuriser plant and the other on the end of the MF plant on stage 6. Below is an image of the refractometers that were fitted.

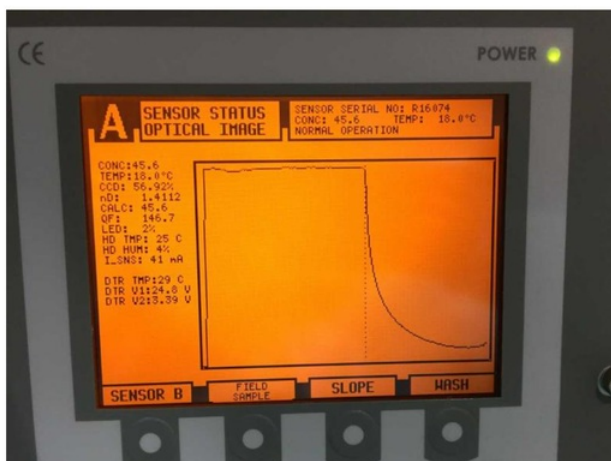


As these sensors read the solids of the product in Brix a panel was supplied by K-Patents that receives the inputs from at most 2 sensors and displays their value on the screen. This panel is built and programmed by the company and has a built in scaling function that scales both sensors brix input and converts them to a 4-20mA output that will be connected to the local PLC Which was located on the side of the MF. After wiring up the refractometer as specified in the manual an engineer from K-Patents came down to inspect both the fitting of the refractometer and the wiring

to make sure it was to the slandered specified by them, once this was confirmed the sensor was commissioned and the panel was set up Below is an image of the panel supplied for scaling the Refractometers.



As can be seen from the display of the panel the first refractometer is receiving a value from the refractometer displaying the total solids in the product and the process temperature In addition to displaying the readings from the refractometers and scaling the output to the PLC they also show the condition of the instruments and indicate if they need changing or cleaning as they have a test function, this screen can be seen below.

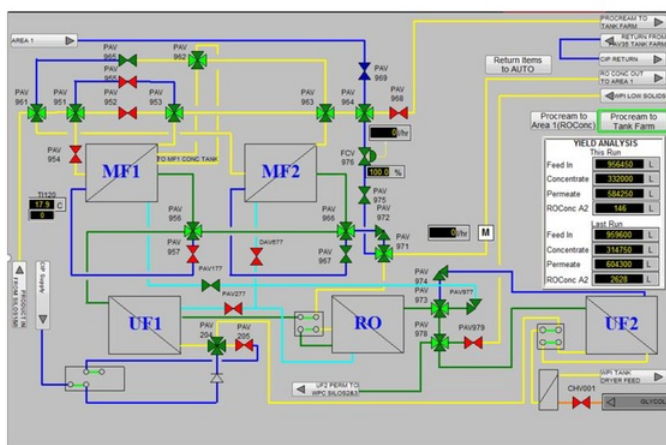


As can be seen from the test run once the first refractometer was fitted the start of the graph has a brick wall response which means it is in its optimal condition, as this starts to get more used if product starts to build up on the sensor the graph will start to have a distinguished curve in it, if this happens the sensor needs to be cleaned. However, this could be due to damage to the lens however it is unlikely as it is a liquid based product and the lens has a sapphire cover on it to prevent it from scratches and damage. Below is an image of how the refractometer function as described from the manual supplied with the instrument.

[Good analysis here](#)

To test the refractometer a CIP was run through the line which is the process in which we wash the plant. During this as the water and chemicals have no solids in them the sensor should be showing a value of 0 brix. Once this was don't and foods production were back on product samples were taken every half hour over the course of 6 hours and tested in the laboratory to make sure it was showing the correct value as measured by the lab results. As well as conducting samples using the sample taps the panel connected to the refractometer had a 'field sample' function which record not only the finished values but the raw values used for the calculation an the scaling used as commissioned in the K-Patents factory when built. Once the panel completes its cycle of taking samples it stored the information and that was used by the K-Patents technicians to calculate any changes needed for the engineer to make due to any unforeseen process issues.

After the testing of the local display and the refractometer, the output from the refractometer panel was connected to the local I/O panel to trend it on WinCC the program used to link the input into the PLC analogue input card to the WinCC However the display will not be visible to the operators until the next WinCC Server update which has been postponed until the November shutdown.



Since the first refractometer was fitted on the MF plant and trended on WinCC the second one has been fitted onto the pasteuriser plant waiting for the engineer from K-Patents to sign off on the fitting and wiring. Once this is done the same testing procedure will be carried out on the second refractometer and it will then be scaled to winCC As the project stands where it is nearing completion £13000 of the £15000 budget has been spent. The delay between fitting the 2 refractometers was due to them having to be made once ordered. Until the Engineer return on May 17th to commission the second sensor the display for WinCC will not be able to be made du to restrictions with tagging.

The laboratory has continued to take regular samples from the MF plant however, no only on a daily basis as it was before, with the hope to make that unnecessary in the future as the refractometer continues to prove its accuracy.

The solution chosen to fit the refractometer has met the standards set in the specification with no major issues, if the second refractometer requires calibration as it will still be covered by Flowcon once signed off, the panel will enter a calibration mode and take 15 samples over the course of production and save them to the calibration screen. These results will be then emailed to Flowcon where their specialized lab technicians will calculate the values that must be inputted into the panel's calibration to correct any offset.

This part should have included the program of the PLC which handled the analogue input from the

11: 2nd Project Conclusion

At the current point in time, tests have been carried out using the monitoring feature on the panel and using the test results from the lab to periodically check its accuracy for the first few months. While the first refractometer has been fitted and is connected to WinCC pending the update, the second recently arrived on site and has been fitted by whitland engineering in the pasteuriser input pipe to measure the solids going into the process to determine the increase in the solids ratio.

At current we are waiting for the engineer from K-Patents to commission the second refractometer so that it can be wired to a 4-20mA input on the local PLC and displayed on WinCC on the pasteuriser screen. If following the gantt cahrt the second refractometers WinCC information can be uploaded on the November shutdown with the first one.

At current the first one has had no issues found and soon the monitoring from the lab will stop once they are happy it is completely reliable. Future development for this project will be linking the inputs from the panel to move control valves to automatically control the solids in the product which will be a much more efficient way to run the plant and reduce operator error.

*This is
reasonable,
but should
focus just on
what has
been
achieved so
far.*

11: References

Manual for the refractometer from flowcon kpatents:

http://www.kpatents.com/assets/files/downloads/pr-23_manual.pdf

Sensor description from kpatents:

<http://cms.pm/uploads/files/flowcon.seesites.biz -- 85101105.pdf>

P. Horowitz, W. Hill (2015). The Art of Electronics: 3rd Edition, ISBN: 13: 978-0521809269

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Aled Edgell Assignment 2 Final

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

49/100

PAGE 1

PAGE 2

PAGE 3

Text Comment. Good proposal

PAGE 4

PAGE 5

PAGE 6

Text Comment. It is obvious from here that there are many sites which will escalate the cost. This is definitely a question mark for management.

PAGE 7

Text Comment. Good spec. All areas have been identified

PAGE 8

PAGE 9

Text Comment. Plan looks feasible.

PAGE 10

Text Comment. This is a company decision and looking at the number of sites to monitor, there was always a risk that this could be shelved due to uncontrolled costings.

Text Comment. *****This is the start of the new project*****

PAGE 11

Text Comment. Grammar is poor which makes reading this difficult.

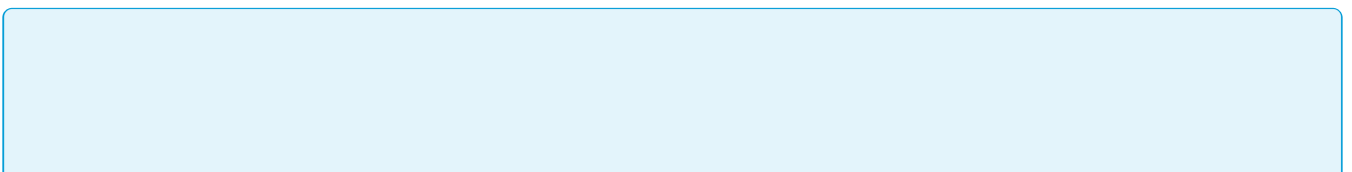
Text Comment. Good use of Gant chart

Text Comment. Very good discussion of solutions

Text Comment. Good analysis here

Text Comment. This part should have included the program of the PLC which handled the analogue input from the refractometer.

Text Comment. This is reasonable, but should focus just on what has been achieved so far.



RESEARCH-INFORMED LITERATURE



There is evidence of background research, but overall the research is limited. There are not enough references included in the report. Introduction and research - 5/10 references - 4/10

9/20

KNOWLEDGE AND UNDERSTANDING



Specification is good. It is noted that there is a second spec for the contingency project due to the feasibility factor of the initial project. - 6.5/10 There are alternative solutions considered and one solution is tested. - 6.5/10

13/20

ANALYSIS



Testing of alternative solution and chosen solution is evident. An improvement would be a more in depth analysis through testing of the reflectometer with PLC input. - 6/10 Conclusion should have more focus on the test results. It would have been good to view some test results read by the PLC. Possibly a table of results to comment on.- 4/10

10/20

PRACTICAL APPLICATION AND DEP.



The project has been implemented in a test scenario and the results evaluated. Two solution have been

12/20

tested and evaluated. - 3/5 Final solution has been implemented and tested. This should have been tested with the PLC and results discussed.- 6.5/10
Quality of work is good, but the grammar in report was poor in parts.- 2.5/5

SKILLS FOR PROFESSIONAL PRAC.



Report was good despite some poor grammar in parts. Technical content is explained fairly well.-
5/10

5/20