Monitoring and Control of a Process Heating Rig

B.Sc. (Honours) Instrument Engineering

Department of Physical Sciences

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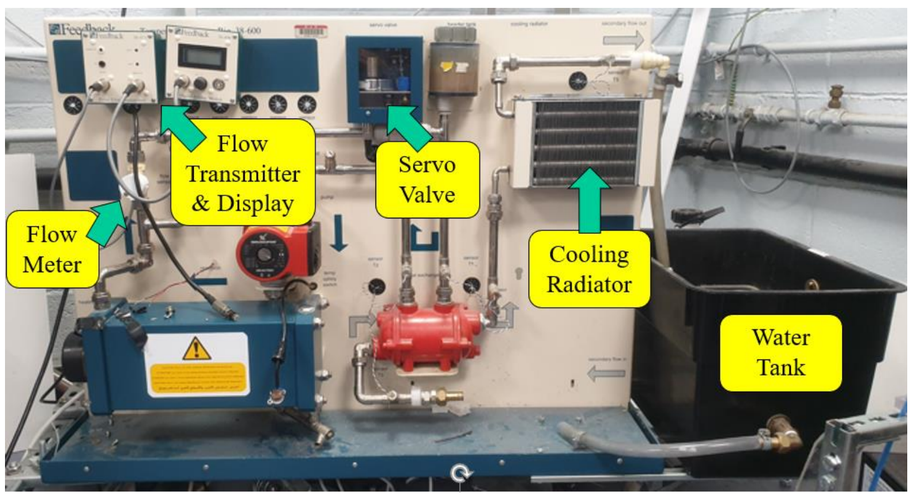
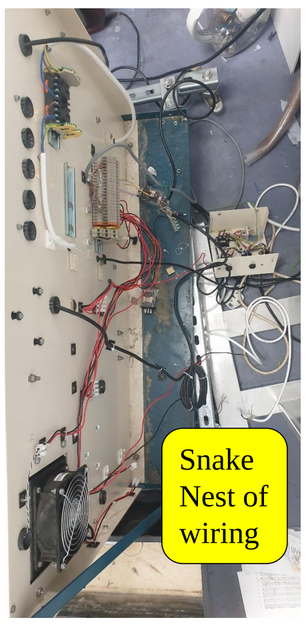
Background & Skid Problems

Initial Skid Problems

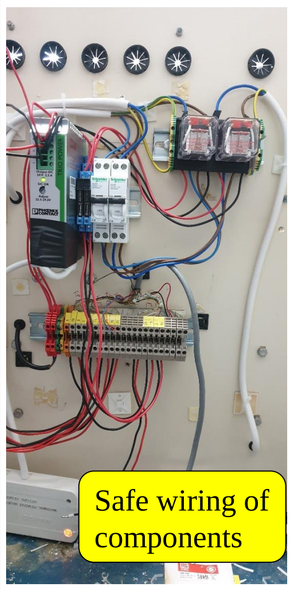
- Current cooling radiator not efficient leading to inadequate control over system.
- Flow transmitter, Digital Display & turbine meter all obsolete.
- Servo Valve obsolete.
- Snakes nest of wiring behind the Rig.

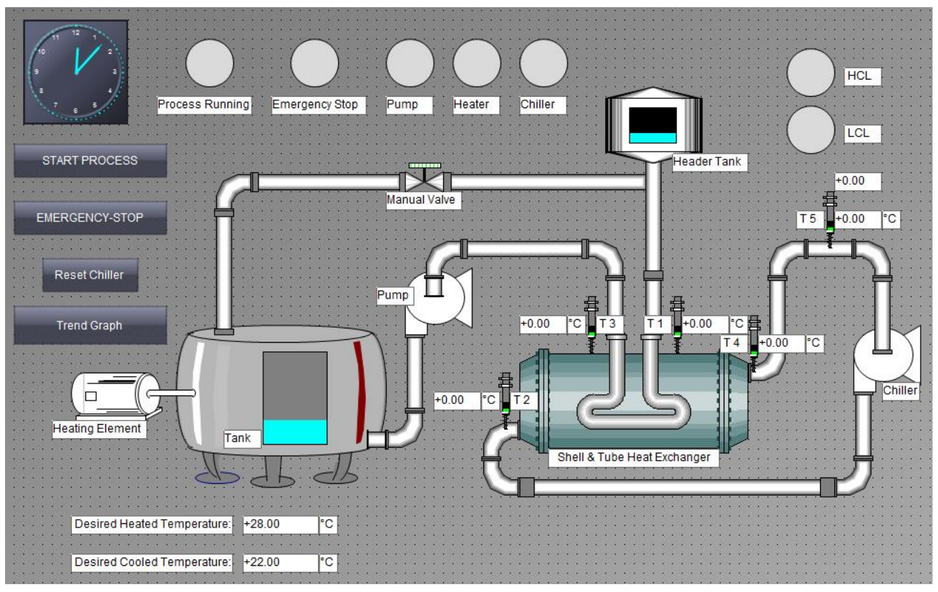




Proposed Solution

- Create an automated heating and cooling model to implement on the Rig.
- Wire all controllable Rig components were up safely to an S7-300 PLC.
- The improved Rig will use a chiller in replace of the cooling radiator/water tank for more effective cooling performance.
- The "In-Line" RTD's will monitor the temperature changes in the system.

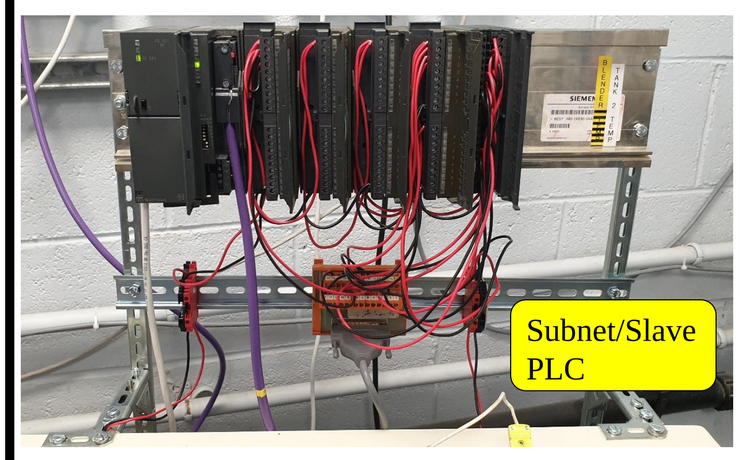




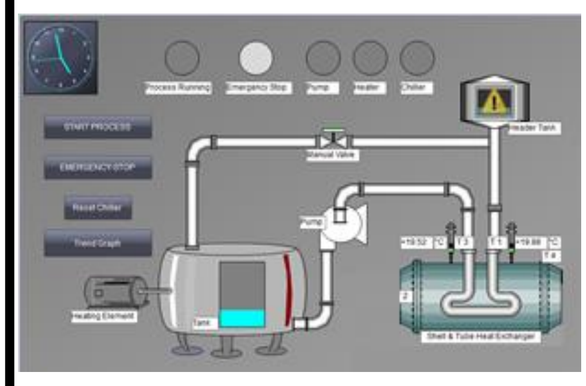
Model Creation

Wiring & fitting

- Set-up Subnet PLC & wire all remote I/0 safely to the Slave PLC.
- Resistance Temperature Detectors (RTD's) were used to read & transmit the temperature values to the PLC.
- Heating loop = Measures Temp reading before and after the Heat Exchanger
- Cooling loop = Measures Temp reading before and after Heat Exchanger

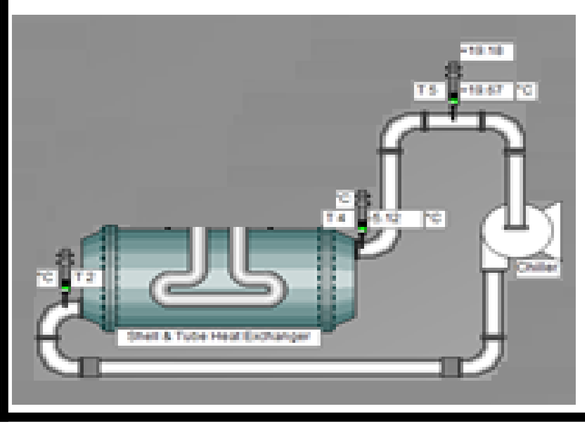


SCADA Design Process



Heating Loop Sequence:

- Select/change Heated Temp Set-Point (HCL)
- Pump On
- Heater on
- RTD1 > 30°C
- Heater Off

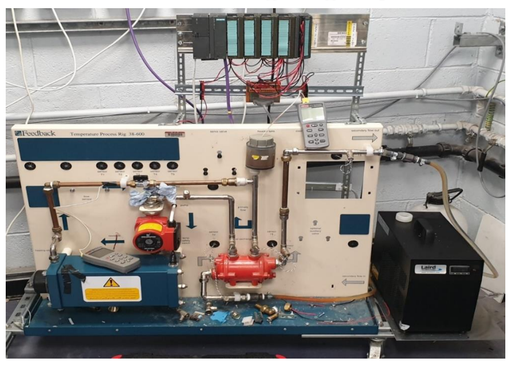


Cooling Loop Sequence:

- Select/change Cooling Temp Set-Point (LCL)
- Chiller On
- RTD1 < 20°C
- Chiller Off
- Process complete/Batch ready

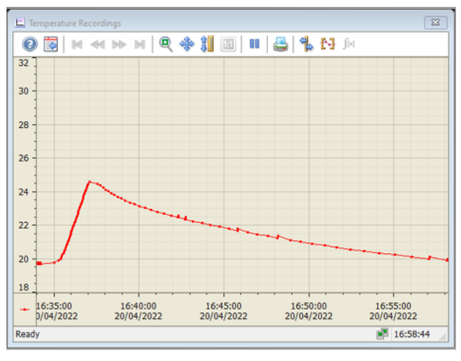
Results

Upgraded & fully Automated Heat Exchanging System



- The automated process carries out its full cycle once the Process is started needing no local control or input necessary.
- The Setpoint of HCL & LCL can be changed at any time during the process.

Data Collection



- The Trend graph on SCADA monitors & records the process cycle. The fluid is initially at ambient temperature. It is heated up to a selected temperature (25°C). Once the heating setpoint is met, the chiller cools the fluid down to the selected cooling setpoint (20°C).

Success/Challenges

Success:

- The automated model created controls the entire process remotely. This means the operator can input his batch requirements, click the start button at a work station and manipulate the process remotely without being next to the rig.

Challenges:

- Getting PLC to read the RTD's signal & scale to degrees Celsius took allot of experimental means necessary.
- Lead time on critical components meant that full functionality of the rig was delayed.

Conclusion/Improvements

- The design model I created is a well automated solution to monitor and control the process heating rig.
- This project has given me the skills and self capabilities to be able to work independently on a project with set goals to successfully fulfil.
- If more time allowed and parts come in time, the implementation of a turbine meter and proportional solenoid valve would allow for PID control over the rig. Where by the control of fluid velocity would directly influence the heating/cooling rate of the process.

References

1. Lairdthermal.com. 2022. [online] Available at: <https://www.lairdthermal.com/sites/default/files/ckfinder/files/resources/Manuals/MRC-Chillers/MRC-150-300/MRC150-300-User-Manual-rev12.pdf> [Accessed 25 April 2022].
2. Lairdthermal.com. 2022. [online] Available at: <https://www.lairdthermal.com/sites/default/files/ckfinder/files/resources/Manuals/MRC-Chillers/MRC-150-300/MRC150-300-User-Manual-rev12.pdf> [Accessed 25 April 2022].