Monitoring and Control of a Miniature Natural Gas Installation

B.Sc. (Honours) in Instrument Engineering

Department of Physical Sciences

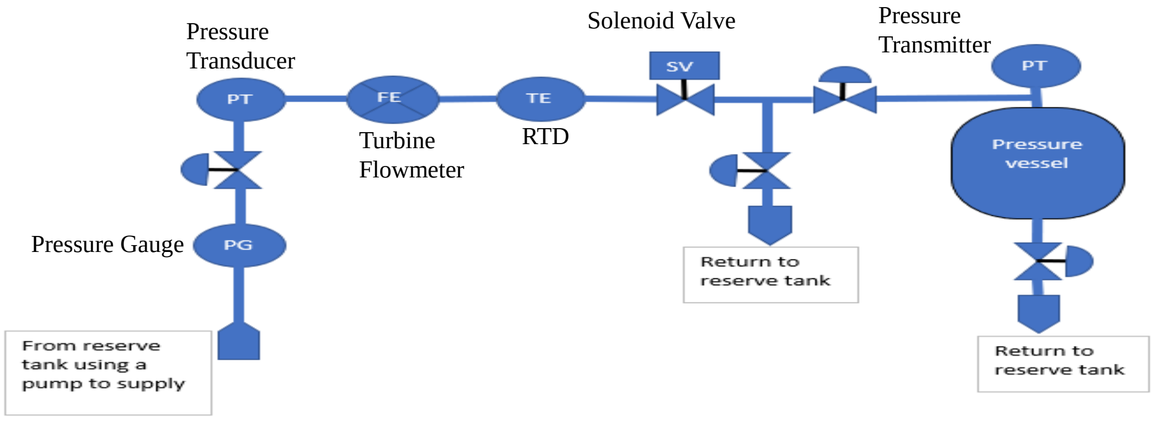
Student Name: Eoin Buckley

Supervisor: Aidan O'Connell

Project Overview

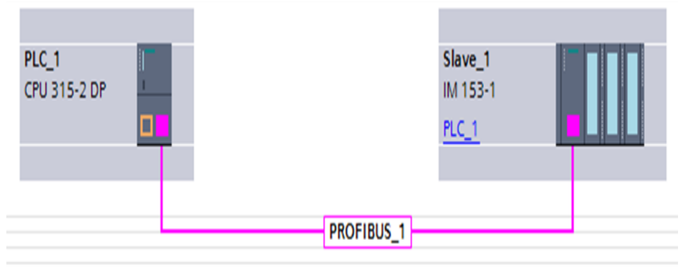
Project Requirements

- Evaluate and Implement the appropriate instrumentation, actuators and control requirements for the rig construction
- Select and implement the optimal signal processing and communication protocol for the control system
- Apply appropriate control strategies for flow and pressure control
- Evaluate various monitoring and control functionality options to utilise control system stability



PLC Master/Slave Configuration

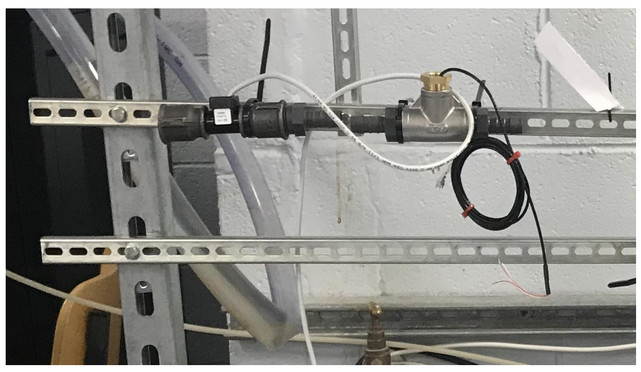
- Slave PLC subnet was physically wired with the signals that were being linked to the master PLC
- Profibus cable used to provide communication between the rig instruments and the Tia Portal network code
- Logic in the network ladder was addressed to the appropriate analog and digital I/O slots on the subnet PLC on the rig
- Device configuration table was labelled with appropriate abbreviations to clearly identify memory locations for each element of the logic code



Construction

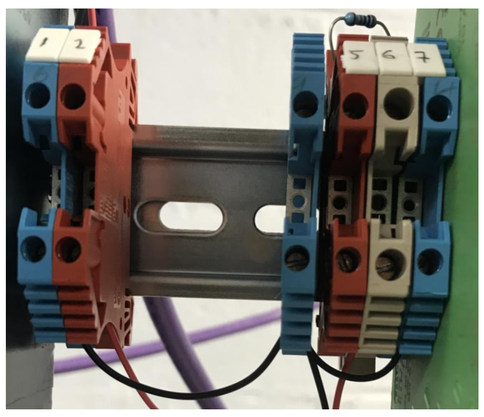
Rig Construction

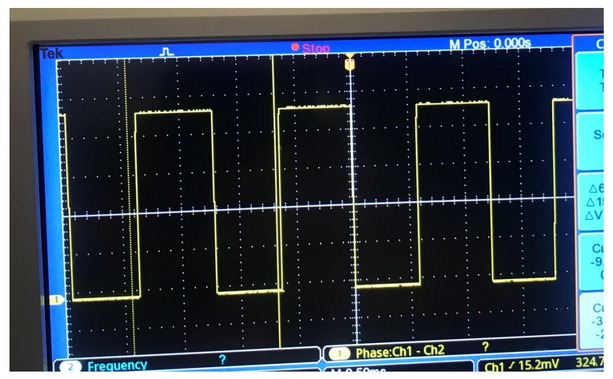
- Diagram sketch used as a blueprint for instrument positioning, with scope to alter when problems arouse
- Construction involved structure measurements, flow-path consideration, subnet and terminal block positioning, leak elimination, wiring and commissioning
- Installing the PLC subnet and wiring each instrument into the appropriate analog and digital I/O's that were needed



Instrument Wiring and Commissioning

- Daisy chaining wire block connectors from the PSU to distribute power to each instrument (24V DC supply)
- Multi-meter used to test each individual instrument to ensure that they had access to power
- Use of an oscilloscope to set the range value of the pulses coming from the turbine flowmeter into the 0-10V converter for correct signal processing
- Dip switches on converter adjusted to deal with signals needed (mA - V)

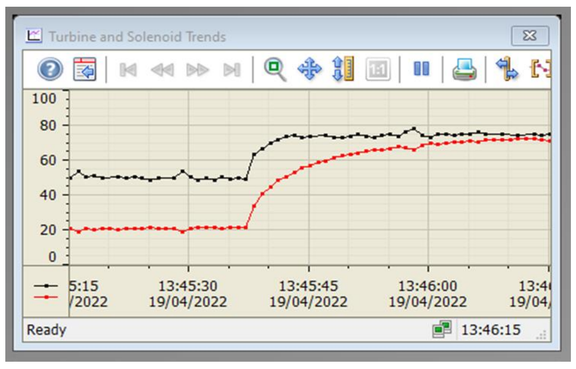




Challenges and Successes

PID Control

- Adjusting the proportional gain, integral time and derivative time to achieve a stable response from the system output graphs
- Graphics used to eliminate system errors and increase system efficiency



Gas Calculation

- Converting from normal flow to standard flow
- Taking account of temperature and pressure compensation
- Z compression factor set to 1, based on the guidance from IGEM handbook
- Pressure increase, V_b increases
- Temperature increase, V_b decreases

$$V_b = V_m \times \frac{P}{P_b} \times \frac{T_b}{T} \times \frac{Z_b}{Z}$$

Successes & Challenges

- Constructing an entire control system from the bare Unistrut to a Master/Slave PLC control system
- Knowledge of wiring techniques, PLC subnet addressing, PLC configuration ,various Instrument operations and creating a WinCC SCADA interface
- Equipment lead time due to delivery
- Time Constraints of the project as a whole, trying to cohere with the project plan
- Understanding the operation of the instruments being used in the control system

Results

- Rig construct
- Signalling conversion
- Functioning Tia Portal logic network
- An operating control system with PID control implemented
- Scada interface
- Gas calculation understanding
- Used as a training tool in the future for students

References

IGEM/GM/5 Edition 3 Communication 1730 'Electronic gas volume conversion systems' Pages 34-41

Instrument Engineers' Handbook, Volume One: Process Measurement and Analysis 4th Edition, Kindle Edition