High Vacuum system incorporating pump down control and automated pressure measurement/process logging feature.

B.Sc. (Honours) in Instrument Engineering

Department of Physical Sciences

Student Name: Ben Hitchman
Supervisor: Dr Donagh O'Mahony

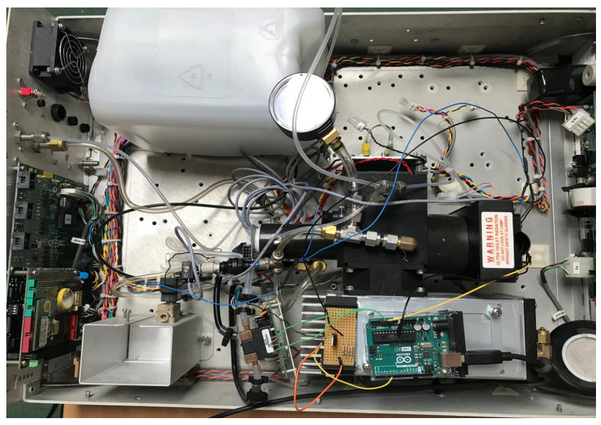
Introduction To Project

Abstract

Vacuum systems are used throughout industry for a variety of applications. Extensive research has been carried out into the world of vacuum systems which has resulted in industrial systems being able to reach vacuum levels as low as Ultra-High Vacuum. This project uses an old Teledyne NOx analyser as a vacuum system. The system pressure and flow rates can be monitored graphically in real time and saved for further analysis. The system automatically allows the bleeding of gas into the chamber via a solenoid valve while keeping the system at a vacuum level.

Vacuum System

An old Teledyne NOx Analyser was used for this system.



Project Aims

The aim of this project was to design a system with a user-friendly HMI to:

- Control the bleeding of gas into the vacuum chamber,
- Incorporate a process logging feature
- Display process data live on the HMI

Set Up and Design

Programming

The programming software for used for this project was predominantly Visual Basic.

However, Arduino was code was also used. Both the Arduino code and the Visual Basic code communicate with each other.

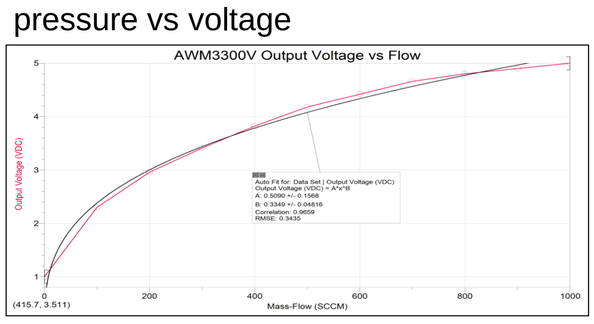
The Arduino code reads in the output voltages from the sensors on the system and outputs a signal for the solenoid control.

The Visual Basic code was used to display the process data , save the data to an excel and created a user-friendly HMI.

Determining Sensor Equations

Flow Sensor: Determined using associated data sheet.

Pressure Sensors: Determined by slowly dropping the pressure by 10KPa and reading the associated voltage outputs to produce a linear graph of pressure vs voltage

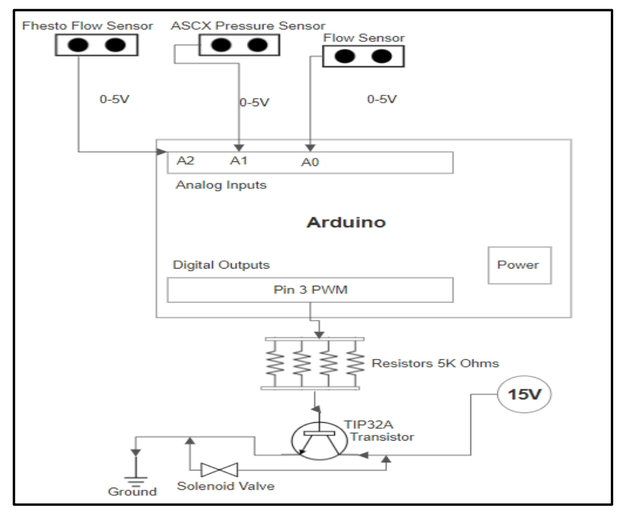


Saving Process data

Vacuum systems are becoming increasingly popular in the medical device, pharma and biopharma industries. These are highly regulated industries that must comply with good manufacturing practices (GMP). GMP plants are required to keep records of all process data.

This project incorporates this feature of saving process data by saving it to Arrays in the Visual Basic environment before being exported to an excel file.

Sensor Set Up



Key Achievements

HMI

Visual Basic used to create the HMI.

Theoretical Pump down Curve

A pump down curve was generated based on the pump down equation. The Theoretical pump down time for the system was 0.378 seconds. This pump down time was very fast as expected due to the theoretical pressure values decreasing at constant intervals

System Pump down Curve

Pump down time for the system was 2.4 seconds.

Solenoid Control

When the system reaches a setpoint pressure the solenoid valve pulses at one second intervals to allow gas into the system chamber while maintaining the vacuum level within the system. Circuitry for the solenoid control had to be configured in the following way to prevent voltage kick back to the Arduino.

Acknowledgments

Dr Donagh O'Mahony Department of Physical Sciences, Munster Technological University.

Dr Anthony Grant, Department of Physical Sciences, Munster Technological University.

Dr Josh Reynolds, Department of Physical Sciences, Munster Technological University.

Mr Stephen Collins, , Department of Physical Sciences, Munster Technological University.