Calibration of the Oscillatory Environmental Water Flow Tunnel

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Abstract

Our main goal for our research project was to calibrate the oscillatory environmental water flow tunnel. We constructed a net of sensors to measure pressure and used the pressure reading to calculate the expected flow rate inside the tunnel. Using this data, we could determine whether or not the flow tunnel was working properly.

Background Information

ΔVelocity (of fluid): $\sqrt{\frac{-2(\triangle P)}{\rho}}$

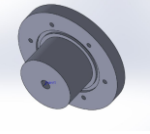
Volumetric Flow Rate: $m = \rho A v$

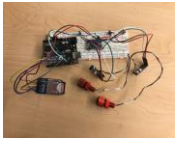
The volumetric flow rate in a pipe or tunnel is dependent on the density of the fluid, the cross-sectional area of the pipe and the velocity that the fluid is traveling.

We can find the velocity using the equation above involving the pressure inside the pipe and the density of the fluid. Then, we can insert that value into the second equation and get the volumetric flow rate.

Sensor Design

Components:
1 Arduino
2 Blue Robotics Bar02 Pressure sensors
1 Adafruit I²C multiplexer
1 I²C Level Converter
1 SD Card Reader



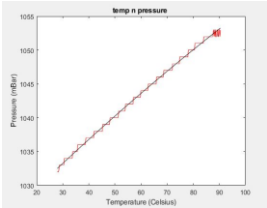


For this circuit, we are using a multiplexer that allows us to run two Bar-02 sensors to measure both pressure and temperature. The level converter steps down the 5V voltage given out by the Arduino to a more manageable 3.3V, considering we found the pressure sensors to malfunction at 5V. We store the pressure data points, outputted by the Arduino program, in the SD card which we use to calibrate the system and measure the pressure accurately. From this point, the pressure values we collect are used to calculate the expected flow rate inside the tunnel.

Data and Calibration

Data Collection:
- submersed pressure sensor into water and gradually increased temperature of boiler
- took values from SD card and created graph in MATLAB
- created line of best fit as calibration curve
- each plateau is where we turned the temperature to the next setting on the boiler's dial.

The program that runs the flow tunnel asks for a volumetric flow rate as an input. We can take this given flow rate and the equations we found to determine what the flow rate in the tunnel would be based on our pressure reading. Then, we can conclude how accurate the flow tunnel system is based on the difference between what the computer system says and what we calculate as the volumetric flow rate.



Conclusion

Throughout the entirety of the project, we were able to identify the correct sensors and other materials needed in the pressure sensor, design the circuitry necessary to measure pressure, and temperature, and successfully gather accurate data from a "demo" setup with the boiler. We also were able to design the structure to mount the sensors in the flow tunnel. Despite not being able to be bring the sensor to the actual flow tunnel, we were able to set-up the foundation for the project. Expect a continuing in this project later in the future.

Future Work

- continuing with the idea behind the project and and being able to gather data from the tunnel
- expanding number of sensors
- making two sensors work together
- integrating new porthole housing design
- making project clear so that it can be easily altered for other researchers

References

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