RingIR Optical Cavity for Vapor Phase Monitoring

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Background

RingIR has made an IR spectroscopy system that can take a molecular fingerprint of the gases present in a sample of air. This has many applications such as mining safety, vapor leak detection, dust analysis, and air quality monitoring. An additional application, security, is where our team is focusing efforts. Specifically, the spectroscopy system needs to detect explosives molecules in the air. The challenge is that before molecules can be detected, they must make it into the IR cavity. Unfortunately the molecules tend to stick to the sides of the tube, making sensing inaccurate. Our team was tasked with fixing this problem.

Objective

Our experiments show that the Coanda Nozzle is not viable for reducing the adsorption of explosives molecules in the IR spectrometer pathway.

Requirements

The Coanda Nozzle (pictured below) utilizes the coanda effect to focus flow in a concentrated stream in the center of the pipe.

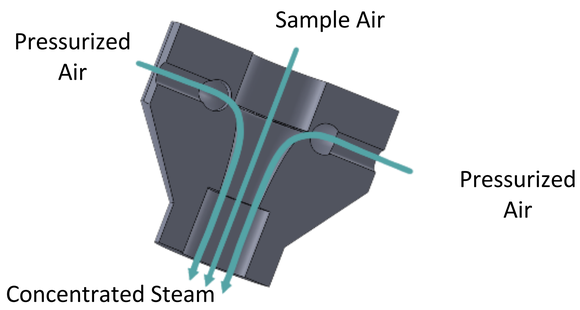

Figure 1: Simplified flow path in the Coanda Nozzle

The design must be:

- Inexpensive
- Inert
- Rugged
- Electrostatically dissipative

Simulations

Fluid simulations were run in COMSOL to theoretically model the effectiveness of the Coanda Nozzle design.

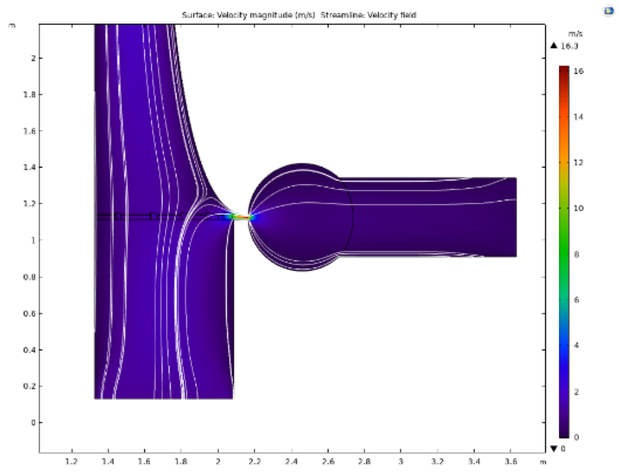

Figure 2: COMSOL fluid simulation of Coanda Nozzle.

Simulations show that a laminar flow is being created in the nozzle, where most of the flow is being routed towards the middle of the pipe. Furthermore, velocities of the simulation (0-16 m/s) are of reasonable values. This simulation demonstrates that the design for the Coanda Nozzle is performing its desired purpose.

Testing

Baseline testing (without the Coanda Nozzle) and Coanda Nozzle testing (with the Coanda Nozzle) were performed to measure the concentration differences of ethanol at two ends of a pipe. Comparing the two tests was critical in determining whether the Coanda Nozzle reduces adsorption along a pathway.

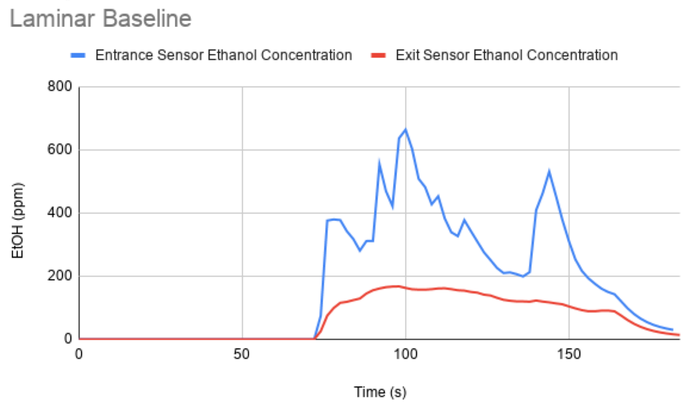

Figure 3: Laminar Baseline test plotting adsorption vs time.

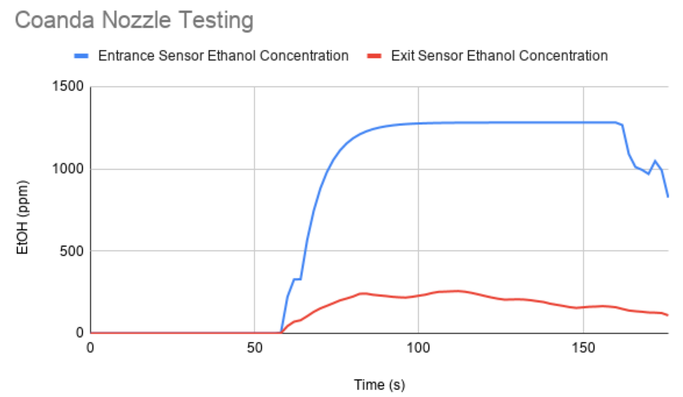

Figure 4: Coanda Nozzle test plotting adsorption vs time.

Analysis of Results

These results show that the Coanda Nozzle does not reduce ethanol concentration along a pipe compared to the baseline test. This suggests that the Coanda Nozzle is not effective in reducing adsorption of molecules in a pathway and is not viable for this application.

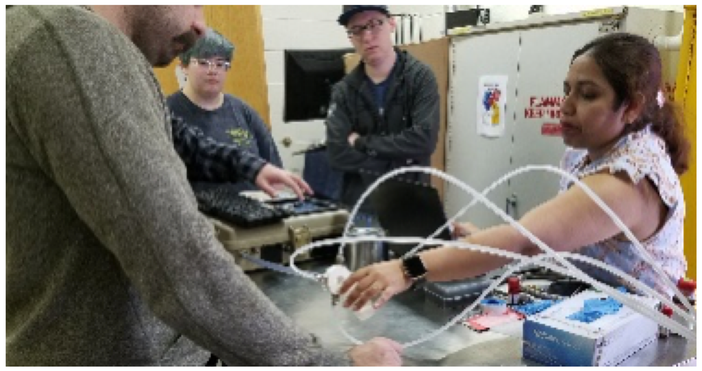

Figure 5: RingIR engineers and NMT team testing nozzle.

The nozzle was tested by RingIR engineers at Socorro. Results showed no adsorption reduction by the Coanda Nozzle. This could be caused by a variety of factors, but is likely due to an imperfect integration of the nozzle to their IR spectrometer. In the future, RingIR plans to work to better integrate the nozzle with their IR spectroscopy system.