Fuel Composition Sensors For Smart Combustion

MOTIVATION

As Americans realize their dependency on foreign oil is unsustainable the next abundant fuel source that could meet environmental regulations is natural gas. Problems arise when trying to standardize the composition mixture of the fuel. For the most part, natural gas is composed of 90-98% methane, CH_4, with ethane and propane as the next main contributors. Carbon dioxide and nitrogen take up the remaining few percentages [1]. The ratio of the three main components of natural gas can vary drastically by region, with no supply being the same as the others. This fuel variability can damage or degrade the performance of some burners that were never designed to handle these types of conditions. As a result, sensors that can identify the nature of the fuel composition would be very useful for ensuring safety of operation as well as facilitate "smart" operation of the burner to optimize performance.

GOAL

In this senior design project we propose to develop an inexpensive sensor array that can measure the composition of natural gas in a manner sufficient to be applied in fuel flexible burner control systems.

SENSOR ARRAY

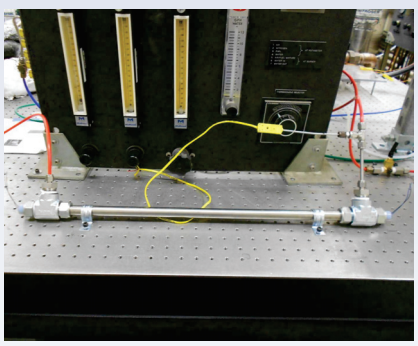

Figure 1: Speed of sound sensor setup

Figure 2: Piezoelectric Transducer [2]

Speed of Sound Sensors:

Using piezoelectric transducers and ideal gas equations, one can find the density of an unknown substance. This is effective for binary gases, but can become difficult in analyzing multi-gas mixtures.

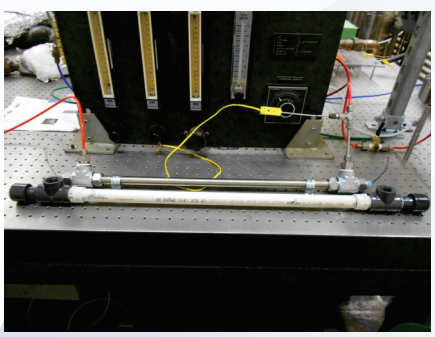

Figure 3: Alternative plastic sensor housing

FUEL MIXING STATION

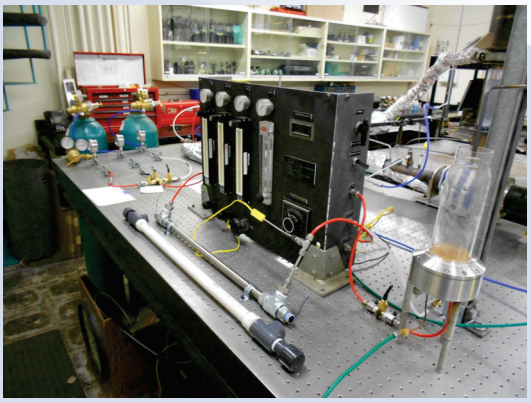

Figure 4: Experimental setup for mixing fuel

The mixing station will offer precise control of gas composition by using sonic orifices to regulate the flow splits. Instead of simply releasing the gases into the environment, the fuel will be burned using a flat flame burner after passing through the sensor array. This burner can also be integrated with emission sensors to gather pollution data.

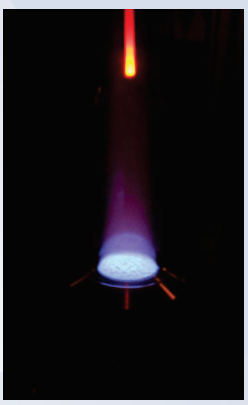

Figure 5: Flat flame burner (left), running at 100% CH_4 at stoichiometric (right)

Progress

1. Built mixing station
2. Created two sensor mount structures
3. Taken preliminary emissions data

Future Work

1. Build supporting circuitry for sensors
2. Develop data acquisition method
3. Run experiments and analyze data

REFERENCES

[1] Liss, W. E., Thrasher, W. H., Steinmetz, G. F., Chowdiah, P., and Attari, A., 1992, "Variability of Natural Gas Composition in Select Major Metropolitan Areas of the United States," GRI-92/0123, Mar

[2] Airmar Technology; www.airmartechnology.com

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Date: 2/22/2012