Particulate Emissions

Removal of Sulfur from Natural Gas to Reduce PM2.5 Emission from a Micro Turbine Engine

OVERVIEW

In 1997, the EPA promulgated new air quality standards for particulate matter with an aerodynamic diameter less than 2.5 µm (PM2.5). PM2.5 is responsible for many negative environmental and human effects, including but not limited to, reduced air quality and visibility as well as increased morbidity and mortality in humans.
Due to increasing environmental consciousness and growing energy needs, it is necessary to pursue cost effective environmentally friendly solutions for energy generation. As gas turbine cogeneration plants become increasingly popular for meeting gaps in energy needs, it is essential to design systems to meet EPA emissions regulations for PM2.5.

A contributing factor to the PM2.5 emissions of turbine generation plants is the mercaptan odorant added to natural gas for safety. Sulfur-containing particulate is predominately formed when SO2 is converted to particulate. The mechanisms by which this occurs are largely unproven; though it is understood that power plants which burn fossil fuels greatly contribute to this process by emitting SO2 (Gillani et al. 2003). By reducing or eliminating sulfur compounds present in the fuel, SO2 can be nearly eliminated in gas turbine exhaust thereby curtailing the addition of sulfate particulate to the atmosphere.

GOALS

The goal of this project is to determine the effect of removal of mercaptans from natural gas fuel on the emission of PM2.5 from a Capstone C60 micro turbine generator.

COMPLETED WORK

Initially, an extensive literature review was necessary to determine the current technology available for sampling PM2.5 and current technology pertaining to the odorization and deodorization of natural gas.
It was determined that, for the purposes of this study, the most effective method to remove sulfur compounds from natural gas is to construct a sulfur scrubbing rig using specially treated activated carbon. Reintroduction of sulfur compounds into the gas at variable concentrations will be accomplished using a 1% methyl mercaptan/methane blend with injection into the gas stream by means of a jewel orifice.
Sampling of the exhaust gases exiting the turbine will be accomplished using a Horiba MDLT-1300T constant volume sampling system. The particulate matter captured on the quartz fiber filter will be analyzed using a Horiba MEXA-1370PM super low mass particulate analyzer. The total sample mass returned by the MEXA-1370PM will be used to determine particulate mass concentrations in the exhaust gases.
A TSI DustTrak Model 8531 aerosol particulate monitor will be used to monitor the size distribution of the particles exiting the exhaust stack of the micro turbine generator to ensure that removing the odorant from the fuel has no negative effects on the number concentration or size distribution of particles.
A basic experimental setup was then generated incorporating the chosen equipment and is given below in Figure 1.

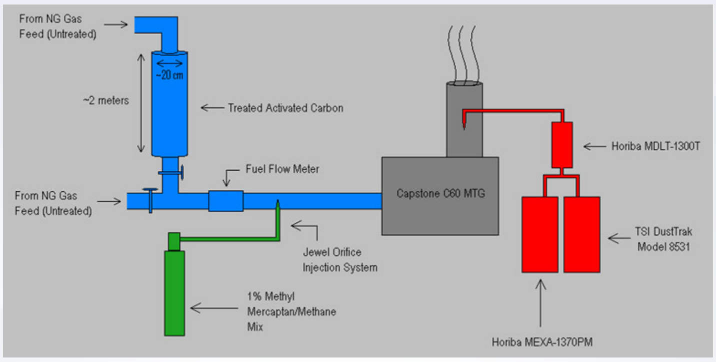

Figure 1: Schematic of proposed experimental setup

Future Work

Future work will include the construction of the required systems including the sampling system and the mercaptan addition and removal systems. At this point, the systems will be rigorously tested to verify proper operation.
The first phases of testing will include a baseline particulate emissions test to establish the characteristic emission of PM2.5 from the test engine. Following the baseline testing, primary testing will be completed. Primary testing will consist of varying the fuel mercaptan concentration to ascertain its effect on particulate emissions.
In the final stage of the project, the collected data will be analyzed and papers related to the findings will be published.

PERSONNEL

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