ALTERNATIVE FUELS

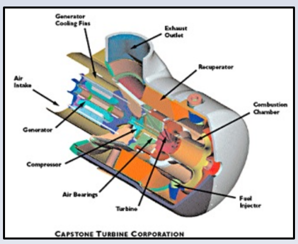
LandFill and Digester

OVERVIEW

Microturbine generators (MTGs) have already shown flexibility in operation on alternative fuels. The nature of this distributed generation platform also allows for deployment near sites of renewable fuel production such as landfills and waste water treatment plants. The combustible mixtures produced at these sites can be utilized by a MTG for the generation of electricity and the potential for waste heat recovery.

The gases released from these sites typically contain methane diluted with carbon dioxide and nitrogen. Due to the presence of diluents, these mixtures contain a lower volumetric energy content than pure natural gas and are commonly termed medium-BTU fuels.

Since MTGs are optimized on pure natural gas, the variation in fuel composition experienced from site to site can be problematic. If these units are to meet the increasingly stringent emissions requirements, the systematic effect of fuel composition on engine performance must be understood. A Capstone C60, 60 kW MTG was selected for this test in order to leverage previous baseline base line work.



Capstone Microturbine generator

GOALS

Characterize MTG performance on fuel mixtures representative of landfill and anaerobic digester gas compositions.

OBJECTIVES

Develop a strategy to reduce emissions to 10 ppmv for both CO and NOX over a 50-100% load range.

RESULTS

The MTG was characterized over a 50-100% load range using fuel CO2 levels as high as 45%. Emissions results from this test are shown in Figures 1 and 2. The stratification revealed in both figures indicates that the diluent effect is likely thermal in nature. Higher levels of diluent result in lower combustion temperatures and produce expected trends in emission formation. These figures indicate that NO remains well below the target range of 10 ppm for all conditions and that the main focus of emissions reduction must be placed on CO.

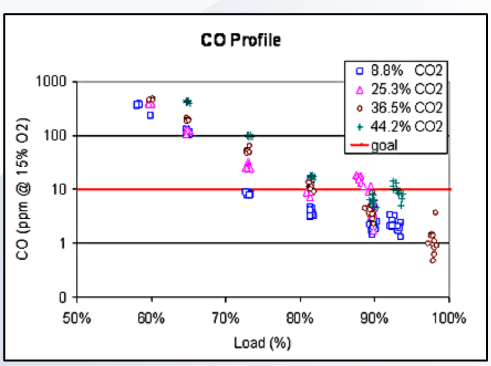


Figure 1: CO vs. power demand

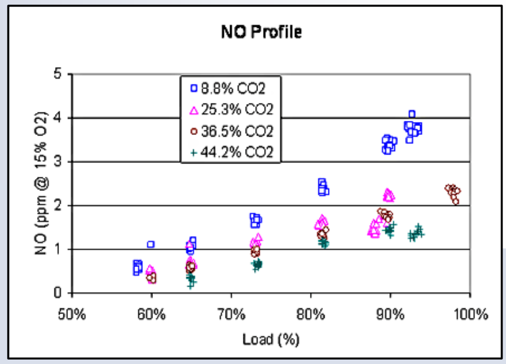


Figure 2: NO vs. power demand

The emission strategy chosen was an increase in the primary zone equivalence ratio that would recover some of the lost temperature due to the presence of diluent. This was achieved by using a modified injector designed to reduce the total amount of air entering the combustion zone. A design of experiments investigation was conducted on these new injectors in order to determine the effects of fuel concentration and load on emissions output. A numerical correlation was generated and found to follow experimental values as seen in Figure 3. Figure 4 shows the improvement in CO emissions was significant at lower load demands but unchanged at higher demands.

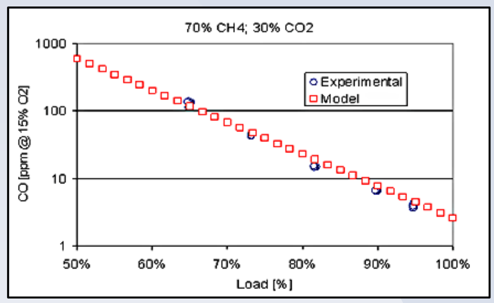


Figure 3: Model and experimental data comparison

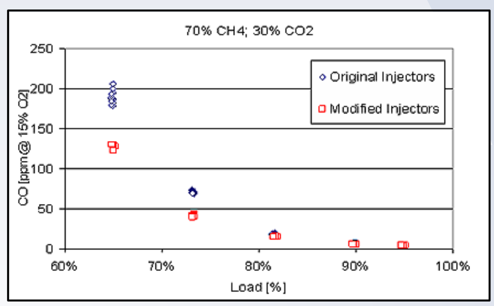


Figure 4: Injector comparison

RECENT PUBLICATIONS/PAPERS

INVESTIGATION OF POLLUTANT EMISSIONS FROM A GAS TURBINE COMBUSTOR OPERATED ON DILUTED NATURAL GAS, paper #1708, presented at the 4th Joint Meetings of the US Sections of the Combustion Institute, March 22, 2005.(M.W. Effinger, J.L. Mauzey, and V.G. McDonell)

CHARACTERIZATION AND REDUCTION OF POLLUTANT EMISSIONS FROM A LANDFILL AND DIGESTER GAS FIRED MICROTURBINE, GT2005-68250. Presented at ASME Turbo Expo 2005: Power for Land, Sea and Air, June 6-9, 2005 (M.W. Effinger, J.L. Mauzey, and V.G. McDonell)

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