A Comparative Study of Natural Gas and Biogas Combustion in A Swirling Flow Gas Turbine Combustor

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Abstract

In this study, non-premixed combustion of a traditional fuel-natural gas, and an alternative fuel-biogas, is simulated in a swirling flow industrial gas turbine combustor geometry which includes the combustor liner and the outside casing in order to replicate the flow and combustion in a real gas turbine combustor. The 3D combustion simulations are validated and the results for combustion of both gases are analyzed to compare and evaluate the viability of biogas as an alternative fuel for use in industrial gas turbine combustors. The combustion performance is evaluated based on multiple combustion performance optimization parameters, namely, the combustion efficiency, pattern factor, and pollutant emissions (CO and NO). The effects of two design parameters: swirl number and fuel injector diameter on the combustion performance optimization parameters are examined. The results have been analyzed to identify the best case for each combustion performance optimization parameter and a suitable trade-off case for both gases is proposed. Additionally, the comparison of the combustion performances of both gases revealed that despite possessing much lower methane and hence lower heating value (LHV), a combination of swirl number and fuel injector diameter for biogas of a specific composition results in a combustion performance comparable to natural gas along with lower NO emission, although at the expense of higher CO emission. Therefore, biogas can potentially be utilized as an alternative fuel in industrial gas turbine combustors, and methods for reducing CO emission can be devised.

Keywords

Author Keywords: Biogas and natural gas combustion; alternative fuel; combustion performance; swirl number; fuel injector; gas-turbine emissions

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