The Effect of Hydrogen Enriched Methane on Combustion Chamber Coatings: Temperature Analysis

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Introduction

Nonrenewable fuels lead to large amounts of carbon emissions. By infusing hydrogen content into the fuel, it becomes more environmentally friendly. The research at this lab was involved in the practicalities of hydrogen-enriched methane. Specifically, how much hydrogen can be added to the fuel before moisture damage of the combustion chamber becomes a problem.

A picture of the combustor in the lab. The fuel lines connected to tanks sitting around the room. Fuels included hydrogen, methane, and propane, among others.

Site Information:

University of Maryland Combustion Laboratory (UMCL)

Address: 2181 Martin Hall, University of Maryland, College Park, Maryland, 20742

Principal Investigator: Dr. Ashwani Gupta

Mission: UMCL is devoted to cutting edge research in the fields of combustion, renewable energy, and alternative fuels. Our goal is to innovate technologies for cleaner and efficient combustion of fuels for power generation and propulsion to promote sustainability.

Goal of my site: to research the possibility of hydrogen-enriched methane as a fuel alternative, which would be more sustainable than current fuels.

Activities:

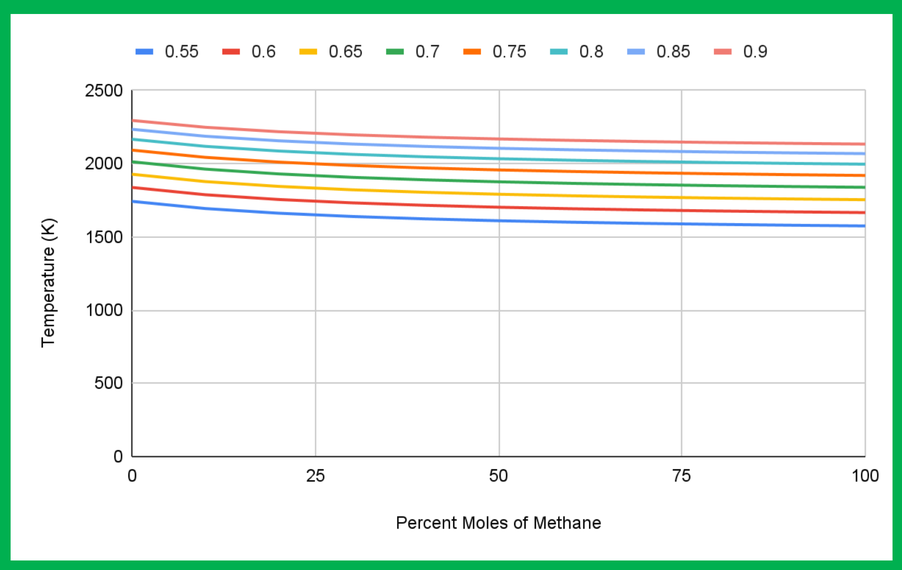
I learned how to use software to perform temperature calculations for combustion in different conditions. Relevant factors included equivalence ratio, air flow, and percent methane in the fuel. After gathering combustion temperature data for a range of values of these variables, I compiled it all, created graphs, and put together a final report to describe my findings.

Equations used:

Normal Methane Combustion: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Combustion with Hydrogen: $xCH_4 + yH_2 + z(O_2 + 3.76N_2) \rightarrow aCO_2 + bH_2O + cN_2$

Results:



Combustion temperature graph based on percent moles of methane for various equivalence ratios. Calculations were done using https://cearun.grc.nasa.gov/.

Discussion:

After performing temperature calculations, a couple trends could be seen. First off, it was clear that as the fuel gained methane content (and lost Hydrogen), the combustion temperature decreased. Additionally, as the equivalence ratio increased, so did the combustion temperatures.

Future Work:

The next step is to choose specific data points on the graph above to test in the combustor. Temperature can be written as a function of percent moles of methane and equivalence ratio: T(M,EQ). The combustor itself has limitations on temperature thresholds, so only a couple data points could actually work for an experiment.

Acknowledgments:

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