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Impact of Different Fuel Inlet Diameters onto the NOx Emissions in a Hydrogen Combustor

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Abstract : The Advisory Council for Aeronautics Research in Europe (ACARE) is creating awareness for the overall reduction of NOx emissions by 80% in its vision 2020. Hence this promotes the researchers to work on novel technologies, one such technology is the use of alternative fuels. Among these fuels hydrogen is of interest due to its one and only significant pollutant NOx. The influence of NOx formation due to hydrogen combustion depends on various parameters such as air pressure, inlet air temperature, air to fuel jet momentum ratio etc. Appropriately, this research is motivated to investigate the impact of the air to fuel jet momentum ratio onto the NOx formation in a hydrogen combustion chamber for aircraft engines. The air to jet fuel momentum is defined as the ratio of impulse/momentum of air with respect to the momentum of fuel. The experiments were performed in an existing combustion chamber that has been previously tested for methane. Premix of the reactants has not been considered due to the high reactivity of the hydrogen and high risk of a flashback. In order to create a less rich zone of reaction at the burner and to decrease the emissions, a forced internal recirculation flow has been achieved by integrating a plate similar to honeycomb structure, suitable to the geometry of the liner. The liner has been provided with an external cooling system to avoid the increase of local temperatures and in turn the reaction rate of the NOx formation. The injected air has been preheated to aim at so called flameless combustion. The air to fuel jet momentum ratio has been inspected by changing the area of fuel inlets and keeping the number of fuel inlets constant in order to alter the fuel jet momentum, thus maintaining the homogeneity of the flow. Within this analysis, promising results for a flameless combustion have been achieved. For a constant number of fuel inlets, it was seen that the reduction of the fuel inlet diameter resulted in decrease of air to fuel jet momentum ratio in turn lowering the NOx emissions.

Keywords : combustion chamber, hydrogen, jet momentum, NOx emission
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