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Computational and Experimental Investigation of Swirling and Bluff-Body Stabilized Ammonia/Hydrogen Flames

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Abstract

The penetration of renewable energy sources in the share of energy consumption has greatly increased in the last few decades. However, fossil fuels still account for the majority of energy use in the world and it is likely that combustion remains a key technology in the nearby future, but alternative fuels leading to reduced emissions are expected to play an increasingly more important role. Among these, hydrogen is a clean fuel as far as CO or CO2 are concerned, with wide flammability limits and very high flame speed, but is not freely available, its transport and storage is difficult, raises safety concerns and tends to emit more NOx than natural gas, whose adiabatic flame temperature is lower. On the other hand, ammonia has a high energy density, it is easier to store than hydrogen and has lower safety risks, but has a low flame speed, narrow flammability limits and tends also to emit significant amounts of NOx. Hence, mixtures of hydrogen and ammonia have been investigated in the last few years. Hydrogen and ammonia can be burnt without emission of carbon dioxide, which has been widely recognized as one of the main responsibles for global warming. In this lecture, an experimental and computational investigation of the combustion of ammonia/ hydrogen mixtures in a swirl and bluff-body stabilized burner is described. Lean, stoichiometric and rich flames are considered for a constant thermal input. The measured flammability limits are discussed, and the flue gas emissions are investigated for different equivalence ratios. The results of simulations carried out using CFD or a chemical reactor network are presented to support the discussion of the experimentally observed trends.