ANALYSIS OF THE HEAT TRANSFER CHARACTERISTICS OF NH_3 AND H_2 COMBUSTION FOR HARD-TO-ABATE SECTORS

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Abstract

The decarbonization of Hard-To-Abate sectors represents a remarkable challenge for their intrinsic characteristics of required high-temperature and amount of energy. Therefore, combustion technologies will still play a key role for these sectors. The integration of no-carbon fuels such as ammonia and hydrogen unquestionably plays a prominent role with innovative combustion technologies, ensuring process stability, low emissions and suitable heat transfer characteristics despite the absence of CO_2. MILD combustion is able to meet all the needed requirements. With this background, the present work focuses on the heat transfer characteristics of ammonia, hydrogen and methane combustion. The influence of radiating mixture composition, reactor configuration and fuel reactivity under MILD and conventional conditions was investigated by CFD analyses. Results showed the influence of the furnace configuration in determining a non-monotonic behavior for the radiative and convective heat transfer due to the presence of a recirculation region. With respect to the radiating mixture composition, the presence of CO_2 in the combustion products plays the major role in determining higher radiative heat transfer for the pure methane case than ammonia and hydrogen, although these show higher H_2O concentrations. H_2O addition to the reactant mixture was considered as suitable solution to increase the radiative heat transfer for ammonia and hydrogen cases. In particular, volumetric %H_2O=40-50-60 in the combustion products were considered, highlighting the possibility of achieving a radiative power comparable to the reference methane one also in absence of CO_2. Finally, the fuel reactivity strongly affects the combustion process and temperature field, with spatially uniform temperatures and heat transfer for ammonia and methane, whereas hydrogen always entails most of the heat release is located in a narrow region, with the consequent formation of hot spot region.

Acknowledgments

The authors gratefully acknowledge the partial financial support of the European Union—NextGeneration EU in the framework of the “partenariato esteso initiative PE00000021 - NEST-Network 4 Energy Sustainable Transition”, Italian Ministry of University and Research Decree n.341 - March 15, 2022 - Spoke 3, CUP B53C22004060006; National Sustainable Mobility Center - MOST, CN00000023, Italian Ministry of University and Research Decree n. 1033—17/06/2022, Spoke 12, CUP B43C22000440001.