CFD modeling of a scale-bridging burner in MILD Combustion conditions

V. Rosati, V. Castro, G. Ariemma, P. Sabia, G. Sorrentino, R. Ragucci and M. de Joannon
Vincenzo.rosati@stems.cnr.it
Istituto di Scienze e Tecnologie per l'Energia e la Mobilità sostenibili - Consiglio Nazionale delle Ricerche, Napoli, Italy

Abstract
The present work search for provide deep insights into methane oxidation in a cyclonic flow field chamber that present a geometry modification respect to previous works [1] to improve the strong internal recirculation of burnt products that allows the development of a moderate or intense low-oxygen dilution (MILD) combustion regime over a wide range of operating conditions. The analysis consists in a series of steady-state Favre averaged Navier-Stokes (FANS) simulations to evaluate the thermochemical processes taking place within the reactor and to assess the suitability of existing computational fluid dynamics (CFD) models to describe the turbulence–chemistry interactions in such a scale-bridging configuration. The evaluation is performed with respect to the renormalization group (RNG) k-ε turbulence closure model, using as kinetic mechanisms GRI-Mech 3.0, as well as different turbulent combustion approaches, the flamelet generated manifold (FGM) and the partially stirred reactor (PaSR) models. The consistency of the numerical predictions is checked by direct comparison with experimental results obtained in terms of temperature profiles collected locally inside the reactor at multiple positions. The temperature field is rather uniform within the reactor, especially that predicted by PaSR whereas FGM shows higher temperature values mainly near the walls. A reasonable agreement is reached by comparison in the mid plane by PaSR method denoting a difference below the 15% and in the outlet section with a difference under the 10% respect the experimental results. PaSR predicts an early ignition zone respect to Giuntini et al. [1]. The new geometry presents an improvement to the recirculation.

Reference

[1] Lorenzo Giuntini, Lorenzo Frascino, Giovanni Battista Ariemma, Chiara Galletti, Giancarlo Sorrentino, and Raffaele Ragucci. Performance Assessment of Modeling Approaches for Moderate or Intense Low-Oxygen Dilution Combustion in a Scale-Bridging Burnen. *Energy & Fuels* 2023 *37* (13), 9500-9513.

Acknowledgement

This ENCODING project has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101072779.