Large Eddy Simulations of hydrogen combustion in a reverse flow micro gas turbine burner

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Abstract
Hydrogen is gaining more and more interest in future power generation and heating systems. The current need for decarbonization of the energy sector puts hydrogen forward as a suitable energy carrier.
This research aims to perform numerical simulations of the combustion process of hydrogen and hydrogen-derived fuels in innovative micro-Gas Turbines (mGT) combustors using three-dimensional Large Eddy Simulations (LES) to predict combustion efficiencies and pollutant emissions. The study analyzes the performances of a reverse flow mGT combustor designed for domestic fuel-flexible applications to minimize pollutant emissions. The LES simulations were performed using the YALES2 research code developed at French lab CORIA. Given the challenges in simulating this combustor type, a two-step modeling approach was used. Firstly, the fuel mixing problem in a non-reacting flow was solved before moving on to the multi-species reacting flow between air and hydrogen. The study includes a comprehensive model for simulating multi-species reacting flow, which requires further experimental data validation. The preliminary simulations indicate that the model accurately captures the flame structure, providing confidence in the accuracy of the approach. The results of this study will have a positive impact on the development of advanced and decarbonized energy conversion systems. Having reliable computational models for the combustion of hydrogen and its derivatives is a crucial step toward achieving this goal.