NUMERICAL BASELINE ANALYSIS OF THE T100 MICRO GAS-TURBINE (MGT) COMBUSTOR

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Abstract
In the last decades, micro Gas Turbines (mGTs) have gained interest in distributed power generation, over other technologies, due to their characteristics. The low emissions and noise level, their compact sizes, the fuel flexibility and in general, their high-efficiency combustion became key factors for their affirmation in the energy production horizon. mGTs are small-scale gas turbines that operate on a regenerated Brayton cycle characterized by a power output below 500 kW and are used in various applications, such as Combined Heat and Power (CHP) and cogeneration systems. Despite their technological potential, the harsh operating conditions lead to the necessity for the development of high-performance components. The mGT combustion chamber is exposed to high temperatures and pressures, which can cause thermal stresses and material degradation, and the use of different fuels can affect the mGT durability. From this point of view, the necessity for a careful analysis of these aspects became significant.
A numerical study of the methane-powered Ansaldo T100 mGT tubular, single-can, reverse-flow combustion chamber was defined. Starting from a kinematic analysis of the flame in Cantera, 3D CFD RANS simulations were run to evaluate both the adiabatic and non-adiabatic case through a complete conjugate heat transfer (CHT) analysis: the latest were carried out using the commercial Navier-Stokes solver ANSYS Fluent. Moreover, a CFD run of the full domain, considering the distribution air volute at the combustor inlet, was performed to better discretize and evaluate the air split between the dilution holes and the combustor inlet. The turbulent combustion is modelled using the Flamelet Generated Manifolds (FGM) formulation using both the standard Zimont's Turbulent Flame Closure (TFC) and an Extended Turbulent Flame Closure (ETFC) model to introduce the stretch and heat loss effects on the flame. The ETFC uses a look-up table for the laminar flame speed defined in a pre-processing step where the heat loss was applied on both the fresh gas and burned mixture through an enthalpy-based parameter. The preliminary analysis brought showed non-uniform temperature distributions, which affect the flame symmetry and NOx emissions.