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NUMERICAL INVESTIGATION OF A LEAN PREMIXED BURNER FIRED WITH PURE H2 AND CH4

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Hydrogen using as energy carrier in a gas turbine is an interesting option for power generation and could increase the value of some petrochemical waste. Hydrogen can give several advantages respect to conventional fuels, including methane, since its pollutant impact is limited to NOx emissions. Control of NOx emissions in gas turbines supplied by natural gas is effectively achieved by lean premixed combustion technology, but its application to hydrogen fuelled units is still not a reliable practice [1]. In this context, the characterization of hydrogen lean premixed combustion by experimental and modelling analysis has a special interest for the development of hydrogen low NOx combustors. Computed Fluid Dynamics (CFD) is a powerful and mature tool to perform 3-D investigations in order to make exhaustive the information coming from the experimental analysis [2,3].

This paper describes the use of numerical investigation to support the experimental activities on a double annular counter rotating swirler (DACRS) [4] premixer fuelled with hydrogen and methane. The unit was characterized on an atmospheric test rig focusing primarily on the NOx emissions.

A commercial code was used to define a 3D RANS procedure trough the previous experience [3,5–8] and a influence analysis of numerical models as the turbulence, the chemical kinetic and NO post processor parameters. Finally the procedure was validated by comparison with some test results and the results are comparable with the data from Leonard at al [4].

The numerical investigation has made it possible to integrate the data from the experimental activity, highlighting the combustor regions where NOx were mainly produced and showing how the position of dilution holes is important for the NOx production.

In addition, the numerical procedure was used to analyse some relevant aspects of an actual gas turbine combustion chamber (e.g. the effects of the operative pressure and the combustion chamber cooling on the NOx emissions), that the test rig wasn't able to take into account.

A combustion chamber cooling of 9% respect the thermal input reduces the NOx emission of 60% respect the adiabatic case and a cooling of 18% shows a reduction of 80%.

For these reasons, the defined numerical procedure revealed as a valuable tool for the investigation of hydrogen burners, suggesting guidelines for their improvement aimed to NOx abatement.

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