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Design of Low-Emission Catalytically Stabilized Combustion Chamber Concept

Authors : Annapurna Basavaraju, Andreas Marn, Franz Heitmeir

Abstract : The Advisory Council for Aeronautics Research in Europe (ACARE) is cognizant for the overall reduction of NOx emissions by 80% in its vision 2020. Moreover small turbo engines have higher fuel specific emissions compared to large engines due to their limited combustion chamber size. In order to fulfill these requirements, novel combustion concepts are essential. This motivates to carry out the research on the current state of art, catalytic stabilized combustion chamber using hydrogen in small jet engines which are designed and investigated both numerically and experimentally during this project. Catalytic combustion concepts can also be adopted for low caloric fuels and are therefore not constrained to only hydrogen. However, hydrogen has high heating value and has the major advantage of producing only the nitrogen oxides as pollutants during the combustion, thus eliminating the interest on other emissions such as Carbon monoxides etc. In the present work, the combustion chamber is designed based on the 'Rich catalytic Lean burn' concept. The experiments are conducted for the characteristic operating range of an existing engine. This engine has been tested successfully at Institute of Thermal Turbomachinery and Machine Dynamics (ITTM), Technical University Graz. One of the facts that the efficient combustion is a result of proper mixing of fuel-air mixture, considerable significance is given to the selection of appropriate mixer. This led to the design of three diverse configurations of mixers and is investigated experimentally and numerically. Subsequently the best mixer would be equipped in the main combustion chamber and used throughout the experimentation. Furthermore, temperatures and pressures would be recorded at various locations inside the combustion chamber and the exhaust emissions will also be analyzed. The instrumented combustion chamber would be inspected at the engine relevant inlet conditions for nine different sets of catalysts at the Hot Flow Test Facility (HFTF) of the institute.

Keywords : catalytic combustion, gas turbine, hydrogen, mixer, NOx emissions
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