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NOx Emission Evaluation with CFD of Low NOx Emission Burner for Hydrogen Aircraft

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To prevent global warming, various policies for reducing greenhouse gas emissions have adopted all over the world. In the aviation industry, R&D is underway with the aim of reducing CO2 emissions to virtually 0 by 2050, such as introduction of SAF, electrification of propulsion systems, and hydrogen combustion technology.

Kawasaki Heavy Industries (KHI) is developing core technologies which are necessary to realize hydrogen aircraft, such as hydrogen combustors, hydrogen fuel supply systems, and liquefied hydrogen tanks with the support of New Energy and Industrial Technology Development Organization (NEDO) Green Innovation Fund in Japan. KHI is planning to conduct demonstration tests of a system that integrates these core technologies in 2030.

In order to operate the hydrogen-fueled combustor in a commercial aircraft engine, it is necessary to adapt NOx emission regulation determined by ICAO. In the present study, Micro Mix (MMX) combustion technology is applied[1] to reduce NOx emission. This combustion technology reduces NOx emission due to generation of small flames caused by rapid mixture of hydrogen and air.

Typically, NOx emission characteristics is experimentally evaluated by combustion tests. However, conducting combustion tests at actual combustor inlet condition of aeroengines requires a lot of time and cost. Numerical approach is a potential candidate for improvement efficiency of design process. On the other hand, prediction accuracy of NOx emission depends on turbulence model and combustion model because complex interaction between turbulent flow and chemical reaction defines the combustor aerothermal performance.

In this paper, the NOx emission of MMX burner for aeroengines has been evaluated numerically by RANS simulation as well as Large Eddy simulations (LES). In addition, Flamelet Generated Manifolds(FGM) and Eddy dissipation concept(EDC) model were applied to understand the effect of combustion model for the NOx emission. The results were compared to NOx emission measured by combustion test [2]. As a result, predicted NOx emission showed reasonable agreement with measured one.

References

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