Quantification of Heat Loads for Rotating Detonation Combustor with GT Conditions

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Abstract

Rotating Detonation Combustors (RDC) offer a very high-power density compared to other engines. Although they must overcome many challenges to be integrated into a gas turbine (GT), it is certainly a promising solution for increasing cycle efficiency. Among the many challenges, cooling the RDC is one of the most predominant, due to the high heat loads generated by the combustion process. Most of the available numerical and experimental data in the literature about RDC heat loads are obtained for laboratory conditions (i.e. at atmospheric pressure). However, in order to design a cooling system for an RDC that allows for its sustainable operation and aids its integration to GT engines, a quantification of the heat loads of an RDC with GT conditions is necessary. The presence of a detonation wave/boundary layer interaction and a small annulus width leads to a very high heat transfer when compared to a conventional GT combustor.

This paper describes the numerical models and tools to estimate the heat flux and heat transfer coefficient of an RDC with GT conditions. Since the flow in most part of the RDC is supersonic, the compressible boundary relations are used to model the heat transfer. Integral boundary layer methods are employed to build a tool which uses 2D distributions of integral quantities to obtain the heat flux. The simulations are conducted using Ansys fluent utilizing a single step reaction mechanism. The heat transfer in RDC is mainly governed by the strength of detonation which is dependent on the operating conditions and many other parameters.