CFD of an ultra mini regenerator

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Abstract:

The paper presents a preliminary CFD anlysis of the combustion chamber of an ultra-mini turbogas (5 kW nameplate power) with the aim of increasing combustion efficiency through air preheating. The proposed design in intended to achieve such preheating by placing a compact regenerator around the combustor's wall.

The preheater consists thus in a channel of rectangular cross-section that spirals around the combustion chamber: object of our study is to optimize the number of swirls.

Compressed air enters the regenerator at 370K, and its temperature increase is function of the number of swirls. The combustion process is described in a previous paper by our research group and is not studied here: at design conditions (without preheating) the calculated residence time was $0,012$ s and the exhaust gas temperature 1283 K.

The chamber is made of a super alloy (INCONEL 617): the chamber wall thickness is a compromise between weight and durability under extreme thermo-mechanical stress. Goal of this project is to optimize the preheater geometry in order to reach a higher efficiency for the same air inlet and peak combustion temperatures.

We begin our study by analyzing a preliminary geometry based on empirical data and good engineering judgment: then we create a model which is iteratively refined by a series of a CFD simulation.

Keywords:

Ultra-mini regenerator, Combustor, Turbogas, Brayton cycle efficiency.