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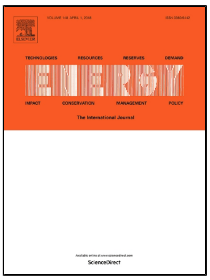

An optimal design approach for the annular involute-profile cross wavy primary surface recuperator in microturbine and an application case study

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An optimal design approach for the annular involute-profile cross wavy primary surface recuperator in microturbine and an application case study

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Abstract

In this work, a computational model of heat transfer and pressure drop is established for the design optimization of the annular involute-profile cross wavy primary surface (CWPS) recuperator in microturbine. The genetic algorithm method is employed to solve the optimization problem of annular CWPS recuperator with multiple design variables. Thus, an optimal design approach for this kind of recuperator is formulated. The validity of the computational model is checked by comparing the calculation results with the experimental data of C30 and C65 prototype recuperators (Capstone Turbine Corporation). With the total relative pressure loss as the optimization target, the developed method is applied to the optimal design of the recuperator in a 300kW power-level microturbine. In comparison with the original design, the optimal design results in a significant reduction of the pressure loss in the case that all constraints are satisfied, which indicates the formulated optimal design approach is effective for the annular CWPS recuperator. By replacing the optimization target, the optimal design approach presented in this work can be also applied to the single-objective optimization for other targets (compactness, heat transfer area, weight, volume, effectiveness, etc.) and even the multi-objective optimization according to the particular requirements of different microturbines.

Keywords: Cross wavy primary surface; Recuperator; Microturbine; Optimization design; Genetic algorithm

1. Introduction

A concept of primary surface recuperator (PSR) is first presented by Parsons [1] to improve the cycle efficiency of gas turbine and reduce the fuel consumption. In view of the features of micro gas turbine, recuperator must meet such requirements as high effectiveness, low pressure losses, light weight, minimum volume, low cost and high reliability. In early stage, due to poor manufacturing technology, PSR had not been widely used in the energy conversion and utilization units. However, with the breakthrough of low-cost manufacturing techniques, the application of PSR in micro gas turbines has been greatly promoted due to the increasingly pressure from the energy saving and emission reduction. The typical applications of PSR include C30, C65 and C200 (Capstone Turbine Corporation) [2] and VT100 (Rekuperator Svenska AB, RSAB) [3]. Recently, Xiao et al. [4] presented an overall review on recuperators

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