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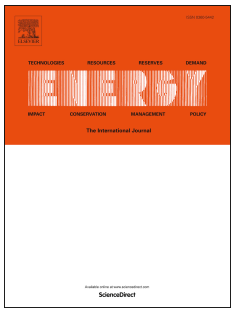

Multi-objective optimization of hot steam injection variables to control wetness parameters of steam flow within nozzles

Mohadeseh Sadat Mirhoseini, Masoud Boroomand

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Multi-objective optimization of hot steam injection variables to control wetness parameters of steam flow within nozzles

Mohadeseh Sadat Mirhoseini, Masoud Boroomand*

Department of Aerospace Engineering, Amirkabir University of Technology, Tehran, Iran

ABSTRACT

The formation of liquid droplets in the low pressure steam turbines has devastating impacts on the turbine adiabatic efficiency and also causes the mechanical damage of blades due to the occurrence of severe erosion phenomenon. Previous investigations have shown that the injection of steam can decrease liquid mass fraction as well as the size of the averaged radius of droplets. To exploit the maximum potentials of this method, the optimization of injection variables is necessary. In the present study, the numerical solution of wet steam flow by the injection of hot steam within convergent-divergent nozzles together with a multi-objective genetic algorithm method are used to evaluate the appropriate injection parameters. It is concluded that to reduce liquid droplet size by 66% and liquid mass fraction by 13%, an injection steam flow rate of 4% of the main stream flow rate with a temperature 1.8 times of inlet steam temperature is required. Such a reduction of liquid droplet size has an enormous effect on lowering the erosion damages of blades. Furthermore, the injection drives the liquid droplets away from the solid boundaries, which is also expected to reduce the possible mechanical damages to the blades and the casings of turbine.

Keywords: Wet Steam; Multi-Objective Optimization; Laval Nozzle; Hot Steam Injection; Condensation

1. Introduction

Steam turbines play a major role in power and energy industry; therefore, any development in their efficiency and performance saves costs of power generation. In order to meet this target, loss has to be reduced. One of the sources of loss in steam turbines is the formation of two-phase flow in the last stages of low-pressure steam turbines, which also causes mechanical damage to the blades of the last rows. Any improvement in the last stages of low pressure steam turbine causes a significant increment in the entire cycle efficiency[1].

* Corresponding author. Tel: +98 (21) 64543280
E-mail address: boromand@aut.ac.ir (M. Boroomand)