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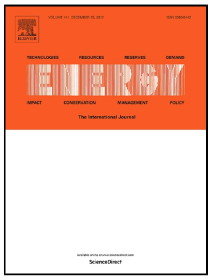

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Design optimization workflow and performance analysis for contoured end-walls of axial turbines

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ABSTRACT

Advances in computer based optimization techniques can be used to enhance the efficiency of energy conversions processes, such as by reducing the aerodynamic loss in thermal power plant turbomachines. One viable approach for reducing this flow energy loss is by end-wall contouring. This paper implements a design optimization workflow for the casing geometry of a 1.5 stage axial flow turbine, towards mitigating secondary flow. Two different parametric casing surface definitions are used in the optimization process. The first method is a new nonaxisymmetric casing design using a novel surface definition, the second method is an established diffusion design technique. The designs are tested on a three-dimensional axial turbine RANS model. Computer-based optimization of the surface topology is demonstrated towards automating the design process. This is implemented using Alstom Process and Optimization Workbench (APOW) software. Kriging is used to accelerate the optimization process. The optimization and its sensitivity analysis give confidence that a good predictive ability is obtained by the Kriging surrogate model used in the prototype design process tested in this work. A flow analysis confirms the positive impact of the optimized casing groove design on the efficiency compared to the diffusion design and compared to the benchmark axisymmetric design.

Keywords: Flow control, Design optimization, CFD, Contoured casing, Axial turbine, Kriging.