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Analysing the Losses in Wet Steam Flow through a Turbine's Last Stage

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Extended Abstract

This study is dedicated to a comprehensive exploration of the losses encountered within steam turbine blades, with a specific focus on analysing the ultimate stage of the 13K215 steam turbine [1,2]. The primary objective is to employ advanced predictive Computational Fluid Dynamics (CFD) models to intricately simulate the complex conditions of wet steam flow through the steam turbine blades, encompassing the actual geometry of the final stage in a 200MW steam turbine. Our fundamental aim is to establish novel, applicable relationships that allow for the precise quantification and characterization of losses across the 2D blade geometry and the more intricate 3D geometry of the final stage.

Employing the ANSYS CFX software, this study engages in numerical simulations of steady-state compressible two-phase flow, distinctly considering the governing equations for the continuous phase (steam) and dispersed phase (tiny liquid droplets). To accurately model the condensation phenomenon, we incorporate the classical nucleation theory along with the Kantrowitz correction factor [3,4], coupled with the Gyarmathy droplet growth model [3,4], enabling us to predict both the number and diameter of the tiny liquid droplets formed during the phase transition within the steam.

Verification and validation of our numerical results for the 2D blade geometry were performed using the valuable experimental data obtained from the well-equipped laboratory of the SUT [5,6], demonstrating a strong concurrence between the simulations and experimental findings. Furthermore, this study delves into the outcomes derived from the simulation of wet steam flow through the actual 3D geometry of the last stage of the steam turbine, an area that remains largely unexplored due to the inherent complexities involved in modelling and analysing three-dimensional flows.

Steam turbines serve as fundamental components within power production systems, emphasizing the critical role they play. It is imperative to grasp the extent of losses occurring in steam turbine blades and the underlying factors influencing them, as this knowledge is pivotal for enhancing efficiency and optimizing performance. In addressing this crucial issue, our research takes a significant stride by calculating losses within the real three-dimensional geometries of turbine blades—an issue that has been relatively underrepresented in recent studies [7-9]. By conducting loss calculations based on real blade geometry, we aim to yield more dependable and precise results. In bridging this research gap, our study not only fills a critical void but also strives to contribute more reliable insights into the losses incurred within steam turbine blades.

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