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Entitled

EXPERIMENTAL STUDY OF CENTRAL AND SIDE JET WITH AND WITHOUT CHEVRON NOZZLE EXIT ON GAS TURBINE LEADING EDGE JET IMPINGEMENT COOLING

by

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Abstract

This thesis presents a comprehensive investigation into the application of jet impingement cooling on turbines blade leading edge. Gas turbines are extensively utilized in power generation and aerospace industries, where efficient cooling techniques are crucial to enhance the performance and lifespan of turbine blades. The leading edge of a turbine blade is particularly vulnerable to high-temperature exposure and thermal stresses, making it an essential area for effective cooling strategies. Jet impingement cooling is one of the most effective cooling techniques mostly used in the leading edge of rotating and stationary blades. This study aims to explore the performance of jet impingement cooling by examining how various parameters affect its efficiency. The effects of Reynolds numbers and Rotation number on the overall heat transfer performance are studied. The experimental study is performed on central and side jets targeting a cylindrical surface. Reynolds number ranges from 5000 to 11000, and rotating speed is between 0 and rpm=200. Two jet designs (chevron/normal) are considered. A high-speed camera with liquid crystal sheets are used for temperature mapping and analysis. Results show that side jets cases have a higher average Nusselt number compared to central jets. side non-chevron configuration provided the best overall heat transfer performance. Chevron jets produced a higher Average Nusselt number for central jets. However, for side jets non-chevron design produced better results. For central jets, Increasing the rpm slightly has increased the average Nusselt number. For side jets, Increasing the rpm significantly has increased the average Nusselt number. At low rpm, average Nusselt number has dramatically increased by increasing Reynolds numbers. For high rpm, the average Nusselt number has a slight increase for central jets configuration. Yet, for side jet configurations the average Nusselt number decreases slightly by increasing Reynolds number. At low rpm, all configurations produced similar Average Nusselt numbers for the same Reynolds number. Experimental results help us understand the effects of different parameters and configurations on jet impingement cooling. The aim is to optimize the heat removal process to obtain the best thermal efficiency of the gas turbine. Results are used to understand how combining chevron designed jets with side and central configurations affect the overall heat transfer performance and the overall average Nusselt number.