3rd World Conference on Mechanical Engineering

Vienna, Austria 21 - 23 June

Optimizing aerothermal performance: Comparative analysis of cooled and uncooled NGVs gas turbines operating at Two different hole inclinations and slot presence

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Abstract

In the demanding operating environment of gas turbines, particularly in the first stage where temperatures reach extreme levels, turbine vanes are subject to intense thermal stress. Film cooling is a critical technique, forming a protective layer that reduces exposure to the intense temperature generated during combustion. An ANSYS CFX numerical simulation was run to study flow behavior through leaned NGV turbine. The key objective was to carry out a comparative study investigating the effect of the presence of the cooling system, one utilizing cooling holes with two distinct inclination angles 25 and 30 degree, at the same mass flow rates (MFR) of 0.5 and the other incorporating slot, ensuring that both cooling methods were positioned alike for a close comparison. In addition, the study investigated the influence of different mass flow rates (MFR) of 0.5, 1, 1.5 and 2 for the case of 30 degrees. The study highlights a significant reduction in hub temperature from 1704.0845 K (30-degree hole) to 1627.85 K (slots only), reflecting considerable effectiveness of the different cooling methods. Pointing to the mass flow rate's importance in optimizing cooling performance.

Keywords: Aerodynamic; Blade; CFD; Computational Study; leaned Vane.