Abstract

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VALIDATION OF CFD MODELLING APPLIED TO THE C3X TURBINE VANE INCLUDING STRESS ANALYSIS

Film cooling is an essential technology for the development of high performance gas turbine engines. A well-designed film cooling strategy allows higher turbine inlet temperatures, thus improving the engine thermodynamic efficiency. The present study focused on the improvement efficiency by enhancing of film cooling for gas turbine vanes using computational techniques. A demonstration of this technique using a commercial CFD solver ANSYS ® is presented for simulations of film cooling for C3X turbine vane which had been experimentally studied by previous studies to evaluate the heat transfer coefficient and film cooling effectiveness [?] in different operating condition and cooling configurations. This study is divided to four stages. Firstly, prediction of pressure distribution (blade loading) including sensitivity analysis and model validation. Secondly, validations of the heat transfer coefficient distribution using different operating conditions. Thirdly, evaluation of local heat transfer coefficient and film cooling effectiveness using different values of temperature ratios and blowing Ratio percentage .Finally, prediction of the influence of film cooling on the overall cycle efficiency and the amount of consumed fuel during the combustion process. Film cooling was found to limit heat transfer between the flue gases and the vane walls thus reducing wall temperature downstream of injection. In general, an increase in blowing ratio was shown to increase film cooling effectiveness reaching 11.39 % enhancement at 0.2 temperature ratio and 0.61 blowing ratio percentage. Finally, the overall thermodynamic efficiency had been calculated after increasing the gas turbine inlet temperature reaching 1.6 % increase. An economical study had been performed showing the amount of fuel saved per MW of output power.