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NUMERICAL MODELLING OF SLOT FILM COOLING USING A WALL FUNCTION

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ABSTRACT

CFD modeling of gas turbine film cooling remains a challenge for the computational arena due to the lack of robust accurate turbulence model or numerical technique to solve this highly complex problem. Modeling the exact behavior of the coolant jet is computationally expensive due to the complexity of the jet mainstream interaction, such as vortex generation, and separation. This paper, validation progress is presented using experimental data executed by the second author [GT2011-46491] and Thurman et-al [GT2011-46498] for blowing ratios of 1.0 and 2.0, and density ratio of 1.0. A wall function approach is chosen for a robust computation, and aiming for CPU time reduction. The in-house CFD code EOS is used to solve the RANS equations. A simple flow over flat plate validation problem was executed using experimental data of Klebanoff and El-Tahry as a code validation evidence. The computational results of the flow field were in agreement with the experimental measurements, with a slight over estimation of the thermal field due to over prediction of dissipation, resulting in less diffusion and mixing between the coolant jet and the mainstream. The wall function approach is shown to have great potentials for a robust accurate solution. The use of the continuous slot injection is known to be the best film cooling technique when compared to the other conventional circular coolant tubes, with the critical drawback of lowering the mechanical integrity of the blade. One way to overcome this problem is the use of discrete slots, which will optimize for better film cooling effectiveness, while maintaining the structural strength of the blade. Rectangular slots showed an increase in film cooling effectiveness for the same mass flow rate of coolant and blowing ratio when compared to the standard circular hole, which is due to the minor counter