COMPUTATIONAL INVESTIGATION OF EFFECT OF TIP CLEARANCE IN AN ANNULAR TURBINE ROTOR IMPULSE CASCADE

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Abstract

This paper describes three dimensional computational investigations of the effect of the tip clearance on the secondary and tip clearance flows in an annular turbine rotor cascade with non uniform inlet flow. In the actual turbine, the flow at inlet of the rotor is non uniform due to radial pressure gradient acting from the hub to casing. To provide non uniformity at the rotor cascade inlet, an annular nozzle cascade is provided at the upstream. The studies are carried out with the help of a commercially available CFD package. The studies have been carried out for four values of clearance, i.e. 0%, 1%, 3% and 5% of chord. Detailed comparison of the leakage flow direction, pressure gradient, and leakage vortex size, losses, location and interaction with other flow features is carried out. The results are presented in terms of static pressure coefficient distribution on the blade surfaces and total pressure loss coefficient contours in the passage. Spanwise distributions of the circumferentially averaged loss coefficient and flow angle are presented. The extent of losses in the circumferential direction is increased with the increase in the height of the tip clearance but reduced in the spanwise direction. The mass averaged loss coefficient increases rapidly from 0.24 at zero clearance to 0.42 at 1% tip clearance. As the tip clearance is further increased, the losses increase slowly (0.54 at 3% tip clearance to 0.58 at 5% tip clearance). The mass averaged flow angle decreases from 66.3° at zero clearance to 63.7° at 1% clearance to 60.1° at 3% clearance and to 57.3° at 5% clearance.

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