experimental investigation of leakage flow system for low speed turbine cascade

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Abstract

This work presents investigation of the interaction between leakage from the casing gap upstream of the rotating blade and tip clearance flow. The blade profile under consideration is design of modern high-pressure turbine for UAV. The experiment was conducted in a low speed linear cascade with secondary air system. The secondary air system with two blowers located at the inlet and outlet enables independent control of mass flow rate and tangential velocity of leakage. Pitchwise uniformity of leakage was achieved with adjustable floor. Non-dimensional boundary layer thickness(δ/τ) and non-dimensional tip clearance(τ/h) was also modified. 5-hole probe was used to investigate 3D velocity, deviation angle and total pressure loss coefficient. These were complemented by numerical calculation. Calculation results including static pressure field on blade tip and endwall were compared with experimental data for validation.

introduction

To achieve higher overall efficiency, turbine inlet temperature (TIT) of modern gas turbine keeps increase. TIT of recent gas turbine is 1800K which is higher than melting point of most metal. So, high-pressure turbine (HPT) components exposed to hot mainstream gas is cooled in various ways. In the 1st stage of HPT, about 10% of mainstream mass flow rate is used for blade and endwall film cooling and 2% of coolant leaks through gaps between blade rows. Total-to-total efficiency decreases 1% with 1% increase of mass flow rate ratio between leakage and mainstream. While there are many researches that investigated the effect of leakage from axial gap between vane and blade on aerodynamic loss, there are little research on experimental investigation of the effect of leakage from casing.

RESULTS and DISCUSSION

Leakage flow system to investigate interaction between leakage from casing and tip clearance flow was conducted. Not only the periodicity of mainstream but also that of leakage flow was achieved using static pressure taps. Using 2 blowers at inlet and outlet of leakage flow system, independent control of mass flow rate and velocity of leakage is available. Mass flow rate of leakage flow was measured with 2 flow meters located upstream and downstream of the leakage slot and velocity was measured with kiel probe located at the middle of the leakage cavity. In the further research, detail investigation of effect of leakage on mainstream flow structure and aerodynamic loss.

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| **Figure 1. SNU low speed turbine cascade with leakage flow system** |

References

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