Application of Sweep to Low Pressure Turbine Cascade Blade for Tip Flow Containment

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Abstract:

A numerical investigation on a low-speed linear cascade has been done to study the impact of sweep applied at the tip of a turbine rotor blade on tip leakage flow. Two forward and two backward swept blade tip modifications have been applied to the T106 profile to create new blade cascade configurations. The aim of applying sweep to the blade?s tip is an attempt to reduce tip losses. This can be achieved by reducing the leakage mass flow rate or by altering the leakage flow to reduce the leakage vortex strength, which is the main contributor to tip losses. A detailed comparison of the tip region including blade loading, mass flow, turbulent kinetic energy, pressure gradients, and
velocity vectors, has been conducted to gain insight into the flow structures within the tip gap. A similar detailed comparison has been conducted for the main passage to determine leakage vortex formation, location, size, turbulent kinetic energy and interaction with secondary flow. Forward sweep was observed to reduce mass flow rate, however, an increase to the tip gap vortex size and strength was also observed; which raised the turbulent kinetic energy introduced into the leakage flow, thereby increasing the size and strength of the leakage vortex and increasing pressure loss. Backward sweep, contrarily, increased mass flow but reduced the tip gap vortex, thus decreasing the turbulent kinetic energy introduced. Therefore the leakage vortex size and strength was reduced, ensuring a reduction in pressure loss.

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