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机匣造型设计对涡轮叶尖泄漏流损失的影响

Effect of contoured casing design on tip-leakage loss in a turbine

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中文关键词: 涡轮 机匣造型 轴对称机匣处理 叶尖泄漏流 叶尖泄漏流损失控制

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中文摘要:

针对带叶尖间隙的T106高负荷低压涡轮叶栅,基于耦合了Langtry-Menter转捩模型的Menter's SST (shear stress transport)两方程模型,数值研究了涡轮叶片全机匣造型和部分机匣造型对叶尖泄漏损失的影响.计算结果表明:机匣造型设计的引入重新组织了叶尖区域内的涡系结构及损失成分,且这一改变明显受到机匣造型圆弧高度的影响;叶尖间隙内靠近压力面分离泡的展向尺度增大,分离泡形成的堵塞效应降低了叶尖泄漏流动能;而部分机匣造型处理可以缓解叶片通道内因局部扩张而引起的横向流动,使得出口展向损失减小区域进一步扩大,从而造成叶栅出口损失的明显下降;相对原始机匣,最大降幅可达6.1%.间隙敏感性分析表明,两种机匣造型在一定的间隙范围内能够有效降低叶尖泄漏流损失,而且部分机匣造型具有更宽的有效间隙范围和更大损失减小量.

英文摘要:

Based on Menter's SST (shear stress transport) turbulence model coupled with Langtry-Menter transition model, the effects of fully contoured casing and partial contoured casing on the tip-leakage loss was numerically investigated in the highly-loaded low-pressure turbine cascade T106 with tip clearance. The results show that: the contoured casing design changes the vortex structures and loss components in tip region, and such effect is obviously impacted by the height of contoured casing arc. The increase of the spanwise size of the pressure side/tip junction separation bubble leads to stronger blocking effect, thus reducing the kinetic energy of the tip-leakage flow. Partial contoured casing could reduce the additional cross flow near the endwall caused by the local divergence of blade passage, and lead to larger spanwise loss reduction area at outlet. Therefore the cascade outlet loss is reduced essentially, and the maximum is up to 6.1% compared with original casing. The tip-gap size sensitivity analysis shows that both kinds of contoured casings can effectively reduce the tip-leakage loss in a certain. Moreover, the partial contoured casing achieves broader effective tip-gap size and lower loss.

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