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亚声速轴流压气机转子轴对称机匣造型优化的数值研究

Numerical investigation on subsonic axial-flow compressor rotor with implementation of axisymmetric casing contouring optimization

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中文关键词： 亚声速轴流压气机转子 轴对称造型优化 泄漏涡 流动损失 稳定裕度

英文关键词:subsonic axial-flow compressor rotor axisymmetric contouring optimization leakage vortex flow loss stability margin

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作者	单位
高翔	西北工业大学 动力与能源学院, 西安 710072
楚武利	西北工业大学 动力与能源学院, 西安 710072;先进航空发动机协同创新中心, 北京 100191

中文摘要:

以西北工业大学某亚声速轴流压气机孤立转子为研究对象，提出了较为可靠的数值模拟方法，进而采用NUMECA软件包中DESIGN/3D软件块，在峰值效率工况下对该转子机匣进行了轴对称造型优化，最终得到优化转子.优化转子在叶片前缘将叶顶间隙泄漏涡推离叶片吸力面，虽然该结果导致前30%轴向弦长间隙泄漏涡涡量及流动损失有一定程度增大，但是在后70%轴向弦长，优化转子间隙泄漏涡的涡量与流动损失比原始转子有了很大程度降低，从而使得全局损失降低，峰值点效率提高，出口绝对总压增加.优化转子的峰值点效率提升约为0.36%，大流量点效率增加更多，但是近失速点会更早地形成叶顶低速区从而诱发失速，使得优化转子比原始转子稳定裕度略有降低.

英文摘要:

For the study object of a subsonic axial-flow compressor rotor of Northwestern Polytechnical University, a reliable numerical simulation method was presented, and then axisymmetric contouring optimization for the casing under the condition of peak efficiency was conducted with the module DESIGN/3D in software package NUMECA, and the optimal rotor was obtained finally. The optimal rotor pushed the tip clearance leakage vortex away from the suction side at the leading edge of the blade. Although this led to an increase of the magnitude of leakage vortex and flow loss at the first 30% axial chord, the magnitude of leakage vortex and flow loss were greatly reduced at the last 70% axial chord of the blade, thus reducing the total loss, and increasing the peak efficiency and absolute total pressure at the outlet. The efficiency of the optimal rotor increases about 0.36% under the peak efficiency condition, which increases more under large mass flow rate condition, but under the near stall condition, the optimal rotor forms low velocity zone earlier at the blade tip area, leading to an earlier stall and making the stability margin of the optimal rotor smaller.

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