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关于压气机过渡段设计方法的探讨

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Exploration About Compressor Intermediate Duct Design

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摘要

为改善压气机过渡段内的流动损失,提高设计过程的快速性和结果的准确性。首先,发展了结合气动评估与优化算法的带支板压气机过渡段的设计方法,并编制了相应程序。针对算法各自的特点将不同的气动评估方法运用到优化方法的不同阶段,求解子午平面的二维方法用于解空间的全局寻优,精确求解三维雷诺平均Navier-Stokes (RANS)方程的方法用于进行局部寻优,这使得设计流程变得快速而不失准确性,并建立了方便进行流通面积控制的过渡段参数化方法。其次,针对一算例开展了设计工作,并分析了损失来源,结果表明过渡段的设计如果不考虑支板的影响将对结果产生重大偏差;对于进出口面积相同的过渡段设计,沿流动方向先增大后减小的面积变化有助于减小过渡段支板后半段的局部快速扩压作用与凹壁面减速作用相互叠加引起的高损失区域,避免大的流动分离;过渡段流通面积扩张度有一个最佳值,其值受支板翼型、进出口面积比等因素共同影响。最后,将本文设计方法得到的过渡段规律同前人所做类似工作得到的结论进行对比,吻合较好,说明本文发展的设计方法是可行的。

关键词： S弯过渡段 支板 设计优化 遗传算法 神经网络

Abstract:

To improve the flow losses of compressor intermediate duct and ensure rapidity of the design process and accuracy of the results, first, an optimization algorithm combined with different aerodynamic evaluation methods is proposed for the design of compressor annular strutted intermediate duct. The fast two-dimensional evaluation method is used for global optimization, and the three-dimensional viscous evaluation method by solving Reynolds averaged Navier-Stokes (RANS) equation is used for local optimization. This combination is effective and efficient for the design process, and a parameterization method beneficial to flow area control is formulated. Second, a sample is designed and loss analysis is performed. It is proved that the duct design result will suffer great deviation if the strut effect is ignored. And a flow area raise in the middle of the duct has a positive effect on reducing the total loss. This raise of area reduces the strong pressure gradient and reaccelerates the flow at the rear of the duct. The best rate of area raise exists which is affected by the profile of the strut and the ratio of the inlet to outlet area. Good agreement with similar design approaches is achieved, and it proves that the design method used in this text is valid.

Keywords: S-shape annular duct strut design optimization genetic algorithm neural network

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