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TBCC进气道涡轮通道扩张段设计及涡轮模态特性

Design of turbo diffuser for TBCC inlet based on characteristics of turbo mode

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中文关键词： 组合发动机 内并联布局 进气道 涡轮通道扩张段 涡轮模态 TBCC 风洞试验

英文关键词:combined engine over/under type inlet turbo diffuser turbo mode TBCC wind tunnel test

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中文摘要：

采用拓展中心线、不同的流通截面面积变化规律和倒圆半径变化规律对内并联型TBCC（turbine based combined cycle engine）进气道涡轮通道扩张段进行了设计.通过数值模拟的手段，对涡轮通道扩张段设计参数的影响规律和涡轮模态下涡轮通道扩张段的气动特性进行了研究，并利用高速风洞试验结果对数值模拟方法进行了验证.研究结果表明：中心线控制点纵坐标在1.50~2.25、涡轮通道扩张段出口等直段长度与出口直径比值在0.3~0.7的范围内取值时，涡轮通道扩张段可获得较高的出口总压恢复系数和较小的出口总压畸变指数；采用前急后缓的流通截面面积和倒圆半径变化规律能使涡轮通道扩张段获得较小的出口总压畸变指数；随着飞行马赫数的增加，进气道和涡轮通道扩张段的流量系数先不断减小，在飞行马赫数为0.9附近达到最小，之后又逐渐增加，涡轮通道扩张段出口总压恢复系数不断升高，在飞行马赫数为0.7附近达到最大，之后又逐渐降低；涡轮模态下，涡轮通道扩张段出口总压畸变指数均小于0.5，能很好地满足涡轮发动机对进口流场的要求.

英文摘要：

Turbo diffuser for over/under type TBCC (turbine based combined cycle engine) inlet was designed with extended center line under different flow section area variation laws and blend radius variation laws. The influence of design parameters on the turbo diffuser and its aerodynamic characteristics in turbo mode were investigated by numerical simulation. High speed wind tunnel experiments were carried out to validate the numerical simulation method. Results indicate that turbo diffuser obtains high total pressure recovery coefficient and low total pressure distortion index at outlet when the ordinate of center line control point is within 1.50-2.25 and the ratio of constant area section length of turbo diffuser to exit radius is within 0.3-0.7. Both the flow section area and blend radius variation laws in a "first quick,then slow" manner contribute to a low total pressure distortion index at outlet of turbo diffuser. With the increase of flight Mach number, mass flow coefficients of both inlet and turbo diffuser firstly decrease until reaching its lowest point at flight Mach number of 0.9, then increase subsequently. Total pressure recovery coefficient at outlet of turbo diffuser firstly increase then decrease and the peak comes around at flight Mach number of 0.7. The total pressure distortion index at outlet of turbo diffuser is less than 0.5 for turbo mode and it satisfies the requirements of turbo engine for the flow quality at the entrance section.

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