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跨声串列转子及前后排叶片匹配特性分析

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Analysis of Transonic Tandem Rotor and Matching Characteristic of Forward and Aft Blades

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摘要 在叶尖折合切线速度为381 m/s的条件下,利用跨声串列转子技术实现了总压比为2.25、负荷系数高达0.55的风扇转子设计。基于数值模拟结果,分析了串列转子前后排叶片独特的匹配特性,及其与常规压气机匹配特性不同的原因;并进一步推导验证了前后排叶片气动参数之间的解析关系,为利用常规压气机设计体系进行跨声串列转子设计提供数学物理模型。研究结果表明:在跨声串列转子工况从堵点向近失速点移动的过程中,前排叶片的工作特性与常规转子一样,而后排叶片的总温升、总压比则不断下降,该变化规律存在解析关系,并可以利用数学物理模型进行准确预测后排叶片的整体性能。

关键词: 跨声串列转子 前后排叶片 匹配特性 气动设计 高负荷风扇

Abstract: With transonic tandem rotor technology, fan stage design is accomplished to produce total pressure ratio of 2.25 and responding loading coefficient of 0.55 at corrected tip speed of 381m/s. Based on the simulation results, the distinctive matching characteristic between forward blades (FB) and aft blades (AB) is analyzed, as well as the reason for its difference from conventional multistage compressor. Analytic correlation of aerodynamic parameter between the FB and AB is deduced and testified further, which provides a mathematic and physical model to elementary design for tandem rotor in conventional compressor design system. The result indicates that while the operating point is moving from choking to near stall condition, the characteristic of FB is identical with conventional rotor, whereas the total temperature rise and total pressure ratio of AB are declining in certain analytic rules. The model in this paper is competent to predict the characteristic of AB.

Keywords: transonic tandem rotor forward and aft blades matching characteristic aerodynamic design highly loaded fan

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