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轴流压气机叶顶喷气控制实验研究

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Experimental Investigation of Control with Tip Air Injection in Axial Flow Compressor

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摘要

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摘要

叶顶喷气已被证实能够有效拓宽轴流压气机的稳定工作范围。基于此,针对轴流压气机流动失稳控制,以叶顶喷气作为控制手段,采用比例电磁阀实现喷气量的实时可调,充分利用从微喷气到大喷气的扩稳能力。通过设计相应的DSP(Digital Signal Processing)控制器,实现信号采集、算法分析、控制信号输出的功能。并结合提出的互相关分析检测前失速先兆信号的方法,成功地实现了从动态信号检测到叶顶喷气的反馈控制。实验结果表明:基于比例电磁阀和DSP控制器的叶顶喷气控制,不仅在扩稳效果和传统的定常喷气相当,而且能够节省大量的喷气能量,具有良好的应用前景。

关键词: 压气机 叶顶喷气 比例电磁阀 DSP控制器 互相关分析

Abstract:

Tip air injection is proven to be able to enhance effectively the stall margin in axial flow compressors. It is here selected as a control method, and a proportional electromagnetic valve is adopted to realize the real-time adjustment of injected mass flow, which can take full advantage of the stability enhancement ability from micro injection to macro injection. A corresponding DSP (Digital Signal Processing) controller is designed to realize signal acquisition, algorithm analysis and output of the control signal. In the DSP controller, a cross-correlation analysis is performed to detect the pre-stall inception signal. Experiments are performed in a single-rotor axial flow compressor. The experimental results demonstrate that the control with tip air injection based on the proportional electromagnetic valve and DSP controller not only achieves the same stability enhancement as the steady tip air injection, but also saves a considerable quantity of injected energy. This method has a good application prospect.

Keywords: compressor tip air injection proportional electromagnetic valve DSP controller cross-correlation analysis

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