

活塞压缩机整机振动分析与试验研究*

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摘 要: 为验证新设计的活塞压缩机整机运转的可靠性, 对压缩机进行有限元模态仿真分析和临界振动响应测试。首先建立活塞压缩机的三维模型, 并对其进行合理优化, 设置工作边界条件后, 完成有限元模态仿真分析, 获得压缩机在此条件下的整机临界振动响应频率理论分析结果。然后对压缩机整机进行临界振动响应测试, 获得压缩机前六阶的实时工作模态。试验结果与有限元模态分析结果对比分析表明, 二者存在一些误差, 但规律一致, 整机不会发生破坏性临界共振现象。

关 键 词: 活塞压缩机; 振动; 分析; 测试

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Analysis and Experimental Study of the Piston Compressor Vibration

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Abstract: To verify the overall operation reliability of the new designed piston compressor, finite element modal simulation and vibration response test were carried out on the compressor. First, a three-dimensional model of piston compressor was established, and then optimized. After the boundary conditions were set, a finite element modal simulation was conducted on the compressor, and the theoretical results of vibration response frequency on the compressor under this boundary condition were obtained. Afterwards, the compressor was tested for the vibration response at the critical speed, the real-time working modes of the first six steps of the compressor were obtained. The comparison between the finite element modal analysis and the empirical results demonstrates that there are some errors between them, but the results are consistent, and the destructive resonance would not occur in the new designed compressor.

Key words: piston compressor; vibration; analysis; testing

由于往复式活塞压缩机的工作特点, 其在气体压缩和真空获得领域一直占有一席之地^[1-4]。目前, 往复式活塞压缩机的发展日新月异, 高转速往复式活塞压缩机成为主流, 并且在国民经济发展中具有重要的地位。随着转速的提高, 新设计的压缩机的临界振动问题逐渐突出^[5-8]。随着计算机技术的应用, 利用仿真及模拟软件进行压缩机的模态分析, 对压缩机的临界振动状态进行评估和优化设计, 以提高压缩机运行可靠性, 逐渐成为一种可行的技术手段^[9-10]。本文以一种新设计的磁传动高速活塞压

缩机为研究对象, 为获得整机运转的可靠性, 首先进行整机模态分析^[11-16], 然后应用振动测试分析仪对压缩机进行临界振动响应测试, 通过试验获得模态分析数据^[17-21], 并与有限元模态分析数据做对比, 对压缩机工作状态下的运行可靠性进行评估^[4-6, 22]。

1 磁传动活塞压缩机结构介绍

振动分析和试验研究的产品是一种可实现二级压缩的星型磁传动活塞压缩机, 属于中小型压缩机。其组成部分主要包括机体支撑部件、旋

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