

大型风洞用离心真空泵气动设计

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摘 要:某大型风洞试验气体温度高、流量大,对真空排气设备要求高,传统风洞用真空排气设备无法满足要求,为达到减小规模、降低成本的目的,首次将大排量、高转速离心真空泵应用于风洞试验设备。本文根据风洞试验排气要求,对离心真空泵的气动结构进行了设计。利用三维数值模拟软件对离心真空泵内部流动情况进行了模拟分析,为了充分考虑离心真空泵内部流动的非对称性,对离心真空泵转子的气体流动特性进行了全通道模拟分析。结果表明,设计出的离心泵流量、极限真空度等各项指标均达到设计要求,并在试验台测试和风洞实测中得到性能验证,较好的完成风洞试验的真空排气保障工作,离心真空泵的设计和运用取得圆满成功。

关 键 词:风洞;排气设备;离心真空泵;气动结构;内部流动

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Pneumatic Design of Centrifugal Vacuum Pump for Large Wind Tunnel

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Abstract: Someone large wind tunnel test with high gas temperature and large flow requires for better vacuum exhaust equipment, and the traditional wind tunnel exhaust equipment cannot meet the requirements. To achieve the purpose of reducing the scale and cost, the first large displacement, high speed centrifugal vacuum pump was applied to the wind tunnel test equipment. In this paper, the pneumatic structure of centrifugal vacuum pump is designed according to the exhaust requirement of wind tunnel test. Using three-dimensional numerical simulation software to simulate the internal flow of centrifugal pump, in order to give full consideration to the asymmetry of the internal flow of centrifugal pump, the flow characteristics of rotor of the centrifugal pump the whole channel simulation analysis. The results show that the design of centrifugal pump flow, the ultimate vacuum and other indexes meet the design requirements, which is verified in actual work and better complete the wind tunnel test for vacuum exhaust security work.

Key words: wind tunnel; exhaust equipment; centrifugal vacuum pump; pneumatic structure; internal flow

某高超声速高温风洞是开展吸气式高超声速飞行器等高超声速武器研制的关键地面设备^[1-2]。类似风洞排气方式主要有真空抽吸排气和引射排气两种。美国 NASA 兰利研究中心的 8 英尺高温风洞采用的是高压空气引射排气,中国空气动力研究与发展中心某风洞^[3]采用的是水环真空泵真空抽吸排气。

某大型风洞试验气流为大流量、高温、高速

气流,对排气系统抽气能力需求巨大。如何减少设备规模、降低建设成本、提升排气能力是一个亟需解决的关键问题,其中真空排气设备的设计尤为关键。

真空排气设备需达到的技术指标如下:

1)工作压力范围:17kPa~0.1MPa;

2)极限真空度:15kPa;

3)气体温度:≤304K;

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