多口分子泵中检口位置对氦质谱检漏仪性能的影响研究

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摘 要:在氦质谱检漏技术中,多口复合分子泵通过接入不同的抽气口可以适应不同的检漏需求,这拓宽了传统分子泵的应用范围。抽气口的位置影响分子泵的抽气能力,而分子泵的抽气能力决定检漏仪的性能,本文基于分子泵抽气基本理论,建立了多口复合分子泵计算模型,在分子泵牵引级选取不同位置设置中检阀的抽气口,并结合质谱仪实际使用情况对抽气特性进行研究,分析了中检口位置对氦质谱检漏仪性能的影响,得到了不同检漏工况下的最优开口位置,为检漏用多口复合分子泵结构优化设计提供了理论依据。结果表明,在牵引级选择高度为 15~20mm 处设立中检阀,既可以获得较优的检测性能又可以保证质谱室的许可压力,以及较宽的工作压力范围。

关 键 词:多口复合分子泵;中检阀;开口位置;牵引级;氦质谱检漏

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Influence of the Position of Molecular Pump Medium Detection Port on the Performance of Helium Mass Spectrometer Leak Detector

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Abstract: In the helium mass spectrometry leak detection technology, the multi-port composite molecular pump can meet different leak detection requirements by connecting to different air extraction ports, which broadens the application scope of traditional molecular pump. The location of the gas extraction port affects the pumping capacity of the molecular pump, which determines the performance of the leak detector. Based on the basic theory of molecular pump pumping, the calculation model of multi-port compound molecular pump is established. The pumping ports of medium check valve are set at different positions in the drag stage of molecular pump. The pumping characteristics are studied by combining with the actual use of mass spectrometer, and the influence of medium check position on helium leakage is analyzed. The optimal opening position under different leak detection conditions is obtained, which provides a theoretical basis for the structural optimization design of multi port composite molecular pump for leak detection. The results show that, when the medium detection port is set at the height between 15mm and 20mm, it can not only obtain better detection performance, but also ensure the allowable pressure of mass spectrometry chamber, and has a wide working pressure range.

Key words: multi-port compound molecular pump; medium detection valve; port position; drag stage; helium mass spectrometry leak detection

氦质谱检漏技术是一种以氦气作为示漏气体,专门用于真空检漏的质谱分析技术,广泛应用在航天、电力、石油、环保等领域[1-4]。氦质谱检漏仪在真空检漏技术中使用范围最广,性能最好,灵敏度最高[5-7]。分子泵作为氦质谱检漏技术中获得高真空的重要设备,是氦质谱检漏仪的关键部件,其抽气性能直接影响检漏仪检测性能的好坏[8]。多口式复合分子泵在氦质谱检漏仪中可满足粗检、中检、精检等不同的需求[9],扩展了氦质谱检漏仪的使用范围,同时提高了检测灵敏度

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