

Vacuum Technology for Mass Spectrometry

Broad portfolio of reliable, high quality vacuum solutions for critical Mass Spectrometry challenges

Introduction

Mass spectrometry can trace its origins to the turn of the 20th century when the first discovery of positive ion streams formed from residual gases were found in CRTs. New ionization techniques continued to develop well into the 1990s. Still operating on many of the original principles, today's instruments are more robust, predominantly software controlled, data intensive and highly complex. The complexity arises not only from requirements for greater automation and smaller footprint, but also from instrument sensitivity requirements. Companies strive to accomplish more with fewer resources and less laboratory space.

The heart of any mass spectrometer is its analyzer. Within the analyzer's high vacuum region, ions generated from samples are guided on a specific pathway by an electrostatic or electromagnetic field. Ions of various mass, kinetic energy, and charge are moved differently depending on the strength of the field. Mass spectrometers range from the simple quadrupoles to the highly advanced hybridized instruments (with multiple mass spectrometric and fragmentation methods) but operationally, they all share one thing in common—a vacuum system operating at one or more finely controlled pressure regimes. A sub-optimal vacuum can produce product path deviations for the analyte ions, creating undesirable ion-molecular reactions and background interference, leading to loss of sensitivity. Used in fields as critical as neonatal screening, to analyzing the pesticide content in foods, to drug development for some of the deadliest diseases, today's mass spectrometers need to be capable of detecting and quantifying compounds over a large dynamic range of concentrations to very low limits.

MKS Vacuum products solve key challenges in Mass Spectrometry with solutions in:

solutions in:

- Custom Vacuum Machining
- Pressure & Vacuum Measurement
- Flow Measurement & Control
- Vacuum Isolation Valves
- Advanced Data Analytics

New Challenges in Mass Spectrometry



Mass spectrometers have improved rapidly in performance and can differentiate between molecules that weigh 356.0005 amu from those that weigh 356.0006 amu. These highly sensitive instruments are routinely used for high throughput analyses, generating terabytes

of data. Resolving power, robustness and accuracy has also migrated to other laboratory areas such as clinical

chemistry bringing new design and analysis requirements. Some of the key challenges today include:

- Ultra High Vacuum (UHV) standards for chamber design and assembly
- Extremely reliable pressure & vacuum measurement and stable gas flow and control
- Informatics: data mining, visualization, predictive analysis—intensive automated data analysis

Vacuum Technology for Mass Spectrometry

MKS Solutions



One of the most critical areas in a mass spectrometer is the vacuum chamber where the fundamental mass to charge separation takes place. The vacuum chamber must be free of any scratches or aberrations, ultra-clean and properly vacuum sealed. MKS Custom Vacuum Solutions offers state-of-the-art

machining, welding, finishing and cleaning, as well as sub-assembly, assembly and system testing of components, to UHV standards. MKS provides expert engineering, custom subcontract manufacturing and focused project management ensuring reliable, high quality vacuum solutions.

It is critical to maintain vacuum levels within the chamber during analysis. Any deviations in that level or leaks could lead to a significantly reduced sensitivity, suboptimal performance and inaccurate data. MKS is the global leader in pressure, vacuum measurement and control. Customers turn to MKS Granville-Phillips® Vacuum Gauge solutions

for reliable, precise vacuum measurement across a wide vacuum range, from 10^{-11} Torr to 1,000 Torr, for the most demanding mass spectrometry applications. MicroPirani™, Micro-Ion® and hot and cold cathode gauges offer high quality, increased reliability and superior lifetime performance.



A number of mass spectrometry techniques involve controlled amounts of gases flowing into the instrument. In order to maintain instrument resolution and sensitivity, the flow needs to be precise, stable and repeatable across the full range of flow rates. MKS Flow Solutions offer a number of products to regulate gas flow. MKS' proprietary control algorithms provide fast and repeatable response to set point throughout the device control range. Current mass flow controllers (MFCs) feature multi-gas, multi-range capability, remote access for real-time monitoring and elastomer and metal seal options. In addition, MKS MFCs are clean-room manufactured to eliminate contamination of analyte samples during analysis.

For ultraclean vacuum environment requirements, MKS is a leader in high reliability, precision stainless steel vacuum isolation and pressure control valves. The UHV valve features metal Con-Flat flanges to limit outgassing and permeation for all vacuum to atmosphere seals and is assembled in a Class 100 clean room. The MKS family of vacuum isolation valves includes bellows and ball valves, manual, pneumatic and electro-pneumatic actuated valves in heated or unheated angle and inline configurations, safety shut off valves and soft start valves.



Newer mass spectrometers are very data intensive due to stringent regulatory requirements and increasing number of analyses per day. This generates huge amounts of data and processing that can still be very manual and time consuming. Therefore automation of the data analysis process, visualization,

interpretation and ability to perform predictive analyses becomes critical. MKS Data Analytics Solutions provides innovative, advanced analytics software enabling easy and rapid analysis of large and complex datasets. The MKS Umetrics Suite is a complete package that includes sophisticated software for design of experiments (MODDE®) and multivariate data analysis (SIMCA®). The Suite also includes real-time process monitoring software that enables early fault detection and quality prediction.

MKS is a leading global provider of vacuum technology products for analytical instrumentation manufacturing, medical equipment manufacturing, research laboratories, semiconductor and other advanced manufacturing applications. We are committed to helping our customers solve their most complex problems.