Magnetic Sector Mass Spectrometer for Use in Hazardous Environment

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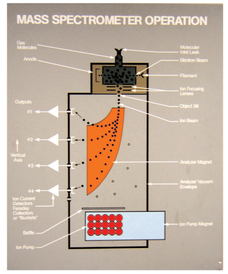
Magnetic Sector MS

Why Use Magnetic Sector MS for Monitoring Air in Rugged Environment?

- Superior stability—less susceptible to instrument drift
- High sensitivity—high transmission efficiency
- Ruggedness
- Field-proven performance



Single Focusing, Fixed Collector MS

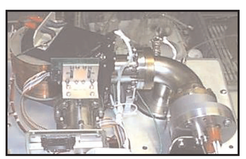
Popular Configurations

- Single focusing
  - Fixed magnet, multiple collectors
  - Magnetic or voltage scan
- Double focusing
  - Scanning
  - Focal plane detector

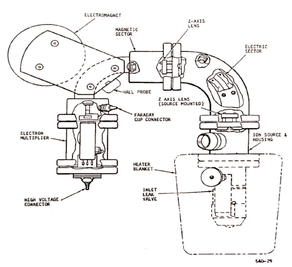
Single Focusing, Magnetic Scan MS

Design Considerations for Field MS

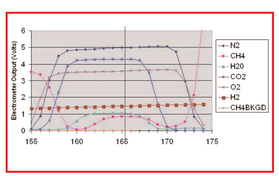
- Environmental compatibility—pressure, temperature, humidity variations
- Shock and vibration isolation
- Long-life ion source
- Rugged, compact vacuum pump with adequate gas load



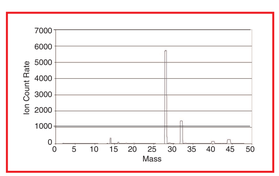
Double Focusing, Magnetic Scan



Flat-top Peak: When scanning across a mass peak, if the beam width is narrower than the detector slit width, the top of the peak is flat. If the drift of the instrument is within the flat portion of the peak, the peak amplitude remains unchanged. This is one of the key features for maintaining long-term stability.



Single Focusing, Magnetic Scan

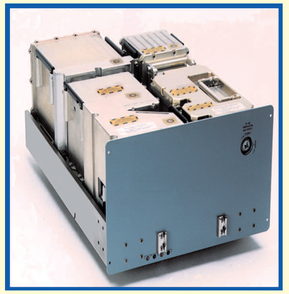


Double Focusing, Magnetic Scan

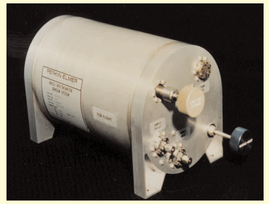
Space Applications

Summary

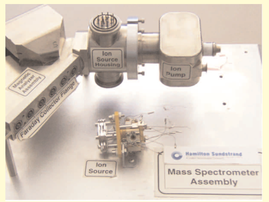
- Single focusing, fixed-collector analyzer flown on Skylab for measuring respiratory gases, ISS for measuring major gases inside the cabin
- Double-focusing analyzer was used for the Viking GC/MS analyzer for measuring organics, if present
- Currently, we are developing the air monitor for the Crew Exploration Vehicle



International Space Station Major Constituent Analyzer

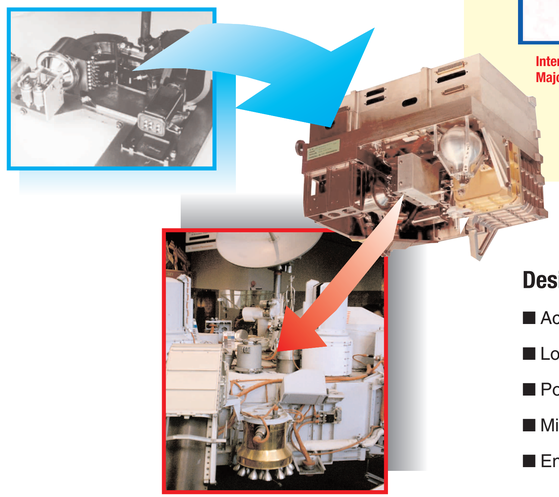


Skylab Metabolic Analyzer



MS Analyzer

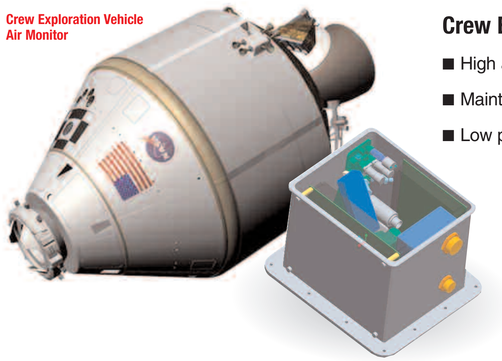
Mars Viking Lander GC/MS



Design Considerations for Space Applications

- Accuracy
- Lon-term stability
- Power, size, weight
- Microgravity compatibility
- Environmental compatibility
- Vacuum compatibility
- Reliability, safety
- Human factors
- Consumables
- Crew involvement

Crew Exploration Vehicle Air Monitor



Crew Exploration Vehicle Air Monitor Criteria

- High accuracy for cabin atmosphere control
- Maintain stability for the mission duration
- Low power, size, weight
  - Compatible with pressure change
  - High Technology Readiness Level (TRL)
  - A single focusing, multiple collector, senor class MS is the optimum solution

Submarine/Industrial Process

Submarine Atmospheric Monitoring

- Submarine atmosphere monitoring deployed in U.S. and allied submarine fleets world-wide to measure and monitor the air quality onboard
- Monitor life gases, refrigerants, aliphatic and aromatic hydrocarbons, and trace contaminants

CAMS–Central Atmospheric Monitoring System

Attributes of Submarine MS

- Highly accurate and stable
- Modular design for ease of maintenance
- Fully automated 24/7 operation
- Ruggedized design for submarine environment
- Dual-filament and long-life ion pump last for 2-3 years without maintenance action

Industrial Process Monitoring

- Used for petrochemical, chemical, steel processing, and pharmaceutical industries to monitor effluents to improve efficiency

Attributes of Industrial Process MS

- Highly accurate and stable
- Automated 24/7 operation
- Highly reliable
- Compatible with process environments