



Mound Technical Solutions, Inc.

965 Capstone Dr. POB 203 Miamisburg, OH 45343 USA
937.865.3715

www.moundtech.com

Features unique to MoundTech Mass Spectrometer System not available from alternate sources:

- 1) Designed specifically for fuel cell analysis (analytical capability, sample system design, and software are all specifically developed for fuel cell gas composition analysis)
- 2) Complete integration with MT571 Fuel Cell Test Systems means that MS data is time integrated and correlated with operating conditions and test unit performance.
- 3) Mass Spectrometer analytical data is automatically converted to gas composition analysis via our integrated software. There is no need for GC standardization, ion current interpretation, or any computation; since the MoundTech Gas Analysis Software performs the actual gas composition analysis that is not available on other systems.

The unit can measure the ion current of each of the 100 masses from 1-100 and always provides this information according to the list of masses you ask it to measure. (See attached Spectrum Guide regarding the first 50 masses.) From this Guide, one can see the Ions at a given amu come from a single gas species or in some cases from multiple gas species. However, a single mass does not always tell you what actual species caused its appearance in the spectrum. But if you measure enough ions and know the various fragments formed from gas species, one can analyze for the species present. In the case of ions of interest for Fuel Cell related work, we find that the ion currents of 22 unique masses produce an analytical result. Analyzing the other 78 out of 100 amu mass range is not further diagnostic; however, the ion currents are provided if selected. The unique feature of our unit is the software algorithm that analyzes the data and presents the actual species which is of interest to the user.

An example would be the measurement of mass 16. One would traditionally need to analyze the entire spectrum and process through complex calculations to determine whether that mass 16 represented methane, ammonia, oxygen, carbon dioxide, carbon monoxide, water, or alcohol. The MoundTech software automatically processes the data and provides and determines the accurate species allocation and does this all instantaneously in real-time.

A majority of mass spectrometers are used in situations, such as semiconductor manufacturing, where only a few select ion current peaks are of interest and there is no need to process the data to produce composition by species. Our unit is specifically targeted for the fuel cell industry where specific gas species determination is required. Realizing that fuel cell research requires enough expertise in its simplest form, and in the absence of this capability in the market, MoundTech has incorporated this unique and valuable analytical tool into our system. It produces accurate and meaningful results in real time and relieves the operator of significant interpretation and computations.

- 4) Sample system (included) automates the sampling of eight (8) different points of pressures ranging from 1 to 3 atmospheres. Sample point selection is automated for operator-free testing via our test recipe software. Sample system requires no external support (electrical power or air for pneumatic valves); the sample system is completely supported by the 24 VDC power from the self contained system.
- 5) This bench-top system is completely transportable for use in various locations and with the MT571 testers or stand-alone. Dimensions are: Width: 13" (330 mm), Depth: 15" (381 mm), Height: 20" (508 mm), Weight: ~60 lbs (27 kg). The only additional external support equipment required is a PC with MoundTech Analytical System Software and one (1) USB port for interface. Analytical System is power requirement is 120 VAC / 5A.
- 6) Sample system is designed specifically to preserve the sample taken from the test unit and provide fast and accurate analysis without perturbing the test operation (proportion of sample is small, lines and sample inlet are thermally controlled, sampling does not require process to pause, and no pressure perturbations are created).
- 7) Mass Spectrometer sensor is long-life closed ion source quadrupole with 0-100 AMU mass range, dual mode operation (FC or EM ion detection), sensitivity of 1-10 ppm dependent upon species, and capability of batch or continuous 24/7 operation. Calibration reference standard option is available.
- 8) Pump Station is fully automated providing comprehensive user control and information regarding performance. System is fully self-protecting with interlocks ensuring that the mass spectrometer sensor is protected from insufficient vacuum situations.
- 9) Comprehensive support of the MoundTech Analytical System is provided including:
 - Ohio based technical support:
 - Hardware support of Mass Spectrometer, Sample System, and Pump Station
 - Software support of Interface, Automated Control, and Data Acquisition/Analysis Modules
 - Expert Technical Support of Mass Spectrometer application, operation, and data analysis
 - Custom design of sample capillary size to accommodate intended applications
 - Installation
 - Training



TECHNICAL NOTE

General RGA Spectrum Interpretation Guide

AMU	ION(S)	SOURCE(S)
1	H	Hydrogen, Water, Acids, HY
2	H ₂	Hydrogen
	D	Deuterium
3	HD	Hydrogen – Deuterium
	He	³ Helium
4	He	Helium
6	C	DI Carbon
7	N	DI Nitrogen
8	O	DI Oxygen
10	Ne	DI Neon
11	Ne	DI ²² Neon
12	C	Carbon dioxide or monoxide, HY, HL
13	CH	Methane, HY
14	CH ₂	Methane, HY
	N	Nitrogen, Ammonia
15	CH ₃	Methane, HY
	NH	Ammonia
16	CH ₄	Methane, HY
	NH ₂	Ammonia
	O	Oxygen, Carbon dioxide or monoxide, Water, Alcohol
17	NH ₃	Ammonia
	OH	Water, Alcohol
18	H ₂ O	Water
	Ar	DI ³⁶ Argon

AMU	ION(S)	SOURCE(S)
19	F	Fluorine, Hydrofluoric acid, HL, Silicon tetrafluoride, PFK, PFTBA
20	HF	Hydrofluoric acid
	Ar	DI Argon
	Ne	Neon
22	Ne	²² Neon
	CO ₂	DI Carbon dioxide
24	C ₂	HL, HY
25	C ₂ H	HY
	CF ₂	HL, DI CF ₂
26	C ₂ H ₂	HY
	CN	Hydrogen cyanide
27	C ₂ H ₃	HY
	HCN	Hydrogen cyanide
28	C ₂ H ₄	HY
	CO	Carbon dioxide or monoxide
	N ₂	Nitrogen, Air
	Si	Silicon, Silicon tetrafluoride
29	C ₂ H ₂	HY
	COH	Alcohol
	N ₂	¹⁵ Nitrogen + ¹⁴ Nitrogen
30	C ₂ H ₆	HY
	COH ₂	Alcohol
	N ₂	¹⁵ Nitrogen ₂
	NO	Nitrogen oxides

DI = Doubly ionized
 HY = Hydrocarbon fragment
 HL = Halocarbon fragment
 PFK = Perfluorokerosene
 PFTBA = Perfluorotributylamine

NOTES:
 1) 5, 9, 21, and 23 AMU do not have commonly found ions.
 2) All are seen as positive ions.
 3) Minor isotopes identified by superscripted atomic weight.

AMU	ION(S)	SOURCE(S)
31	CH ₃ O	Alcohol
	CF	HL, PFK, PFTBA
	P	Phosphorus
32	CH ₃ OH	Alcohol
	CHF	HL
	O ₂	Oxygen
	S	Sulfur
33	SH	Hydrogen sulfide
	S	³³ Sulfur
	CH ₂ F	HL
34	H ₂ S	Hydrogen sulfide
	SH	Hydrogen ³³ sulfide
	S	³⁴ Sulfur
	CH ₃ F	HL
35	H ₂ S	Hydrogen ³³ sulfide
	C1	Chlorine, Hydrochloric acid, HL, Chlorobenzene, Carbon, tetrachloride
	OF	HL
36	H ₂ S	Hydrogen ³⁴ sulfide
	HC1	Hydrochloric acid
	C ₃	HY
	Ar	³⁶ Argon
37	C1	³⁷ Chlorine, HL, Hydrochloric acid Chlorobenzene, Carbon tetrachloride
	C ₃ H	HY
38	HC1	Hydrogen ³⁷ chloride
	C ₃ H ₂	HY
	F ₂	HL, Fluorine

NOTES:

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AMU	ION(S)	SOURCE(S)
39	C ₃ H ₃	HY
40	C ₃ H ₄	HY
	Ar	Argon
41	C ₃ H ₅	HY
	C ₂ HO	Alcohol
42	C ₃ H ₆	HY
	C ₂ H ₂ O	Alcohol
43	C ₃ H ₇	HY
	C ₂ H ₃ O	Alcohol, Acetone, Methyl Ethyl Ketone
44	C ₃ H ₈	HY
	CO ₂	Carbon dioxide
	N ₂ O	Nitrous oxide
	CS	Carbon disulfide
45	C ₂ H ₅ O	Alcohol
46	C ₂ H ₅ OH	Alcohol
	NO ₂	Nitrogen dioxide
47	CC1	Carbon tetrachloride, HL
	SiF	Silicon tetrafluoride
48	CHC1	HL
	SO	Sulfur dioxide
49	CH ₂ C1	HL, Chlorobenzene
	CC1	Carbon tetrachloride, HL
50	CHC1	HL, Chlorobenzene
	CF ₂	HL, PFK, PFTBA
	C ₄ H ₂	HY
	SO ₂	Sulfur dioxide

DI = Doubly ionized
HY = Hydrocarbon fragment
HL = Halocarbon fragment
PFK = Perfluorokerosene
PFTBA = Perfluorotributylamine



GLOBAL HEADQUARTERS:

Two Technology Place, East Syracuse, NY 13057 USA
Tel: +1.315.434.1100 Fax: +1.315.437.3803 E-mail: reachus@inficon.com

UNITED STATES FRANCE GERMANY LIECHTENSTEIN SWITZERLAND UNITED KINGDOM CHINA JAPAN KOREA SINGAPORE TAIWAN

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MoundTech Analytical Software Real-Time Gas Composition

MoundTech Mass Spectrometer Analytical Software Module Features:

- Species vs. Time Data
- Data provided as Mole % and Partial Pressure
- No Need to Interpret Data — Software Provides Real-Time Composition Analysis
- Species Update Every 2 Sec

Species Reported:

2- H ₂	Major Fuel Component
4-He	Inert Tracer for Leak Detection
15-CH ₄	Methane Byproduct of some Reformers
18-H ₂ O	Humidified Gas & Reaction Product
28-N ₂	Nitrogen Diluent when Air is Oxidizer
28-CO	Carbon Monoxide - Undesired Reaction Product
29/30-H ₂ CO	Formaldehyde - Undesired Reaction Product
31-CH ₃ OH	Methanol/Ethanol – Fuel (Un-Reformed)
32-O ₂	Oxidizer; Consumption Measure
34-H ₂ S	Sulfur Impurity
39-C ₃ H ₃	Aromatic Hydrocarbon Fragment
40-Ar	Inert (Air); Diagnostic for Flows
43-C ₃ H ₇	Alkane Hydrocarbon Fragment
44-CO ₂	Complete Oxidation of Carbon in Fuel or Reformate Product
64-SO ₂	Oxidized Sulfur Impurity

Additional species may be added by customer through our Species Matrix Editor

Non-gas species can be volatilized for measurement and analysis