YOUNG IN ACE

ACE 1100 IMR-MS

Ion Molecule Reaction Mass Spectrometer

I Analysis of

Air Pollutant

Water Pollutant

Indoor air quality

AMCs on Semicon process

ACE 1100 IMR-MS

Advances in technology are bringing convenience to life, but are also causing increased exposure to more diverse and harmful chemicals.
Young In Ace is a technology leading manufacturer of quadrupole mass spectrometers, providing various mass spectrometry solutions that customers need, starting with the ACE 1100 IMR-MS.

I Analysis of

- Air and Water Pollutant
- Odor-causing substances
- Indoor air quality and automotive interior materials
- Work environment safety
- Semiconductor process contaminants
- Petrochemical
- Pharmaceuticals and food
- Rapid diagnostics

ACE 1100 IMR-MS

According to a report by the World Health Organization (WHO), air pollution causes up to 6.5 million deaths per year worldwide. In particular, it is known that children or people with weak immunity are more sensitive to exposure to various air pollutants and have a relatively large impact on their health. The main culprits of these air pollutants are fine dust and Volatile Organic Compounds (VOCs).

Exposure to fine dust affects various organs such as the respiratory system and cardiovascular system. Concerns about such health damage are raised as a major social issue, but countermeasures are insufficient.

Major factors affecting the concentration of fine dust in the atmosphere include emissions from industrial area, generation by reaction, and inflow from outside. As it turns out that the effect of generation by reaction is as big as emissions and inflows, the need to establish countermeasures to prevent them is increasing.

The concentration of VOCs in the atmosphere is increasing due to various causes such as emission of pollutants from industrial area and vehicles. VOCs emitted from industrial facilities can cause air quality degradation in neighboring residential areas and adversely affect the health of local residents, and are also known to be precursors to fine dust and ozone generation.

VOCs have harmful effects on the human body in the atmosphere, destroy the ozone layer in the stratosphere, directly cause global warming, and pose a threat to both health and the environment, so much effort is needed to solve this problem.

Currently, the management of VOCs and fine dust generating industrial area is simply performed through the inspection method by manpower. However, the number of industrial areas under the jurisdiction of the monitoring agency is much higher than the number of inspection personnel, making it difficult to manage.

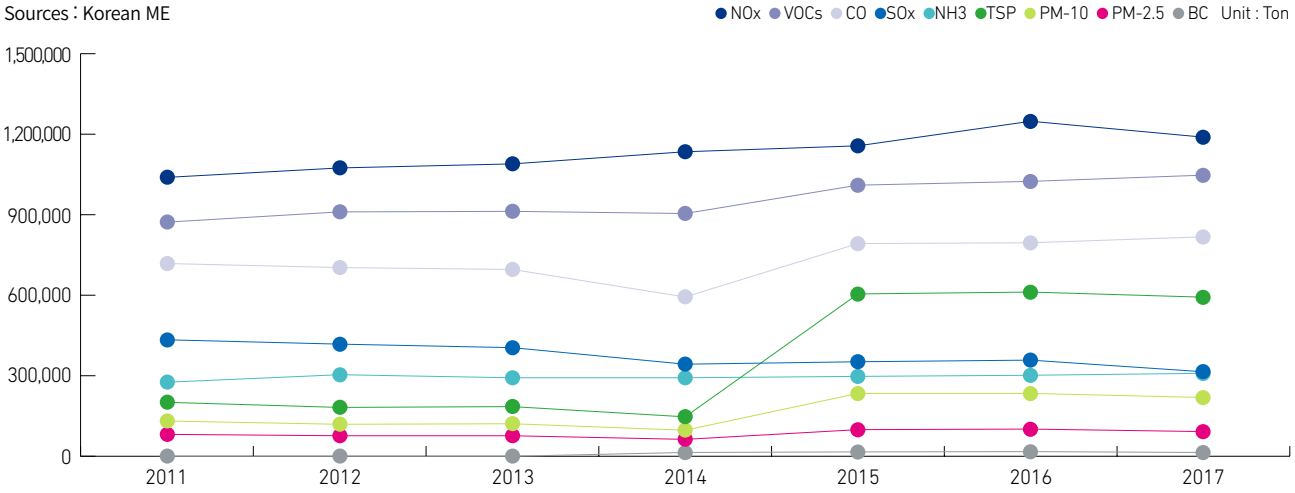
Problems of pollutant emission sources

- Occupational safety in hazardous environment
- Sample variation, contamination during Transport after sampling
- Requires analysis by test equipment of institutions
- Slow response in a event of a pollution accident

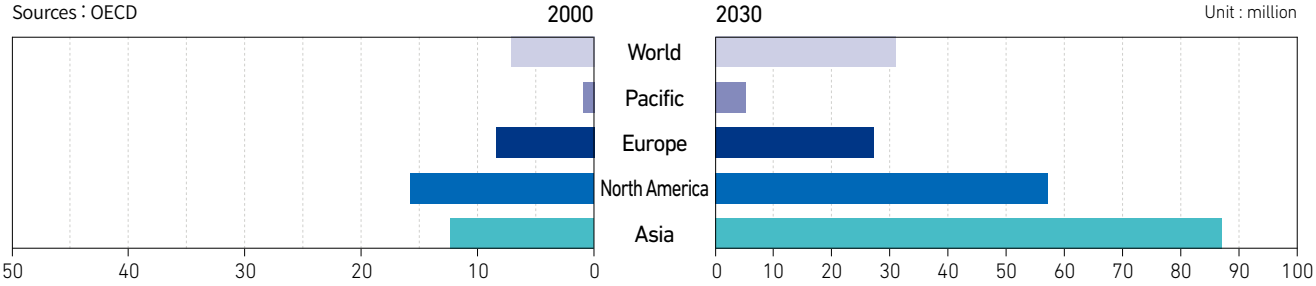
ACE 1100 IMR-MS Solutions

- On-site management with real-time monitoring
- Instant analysis on the spot with Mobile Lab
- Easy operation even for non-experts
- Quickly check results on-site without preprocessing

2011 - 2017 Air pollutant emissions



Premature deaths from urban ozone pollution exposure



Name of VOCs	Molecular formula
Acetaldehyde	C_2H_4O
Acetylene	C_2H_2
Acetylene Dichloride	$C_2H_2Cl_2$
Acrolein	C_3H_4O
Acrylonitrile	C_3H_3N
Benzene	C_6H_6
1,3-Butadiene	C_4H_6
Butane	C_4H_{10}
1-Butene, 2-Butene	$C_4H_8[CH_3CH_2CHCH_2)]$, $C_4H_8[CH_3(CH)_2CH_3]$
Carbon Tetrachloride	CCl_4
Chloroform	$CHCl_3$
Cyclohexane	C_6H_{12}
1,2-Dichloroethane	$C_2H_4Cl_2$
Diethylamine	$C_4H_{11}N$
Dimethylamine	C_2H_7N
Ethylene	C_2H_4
Formaldehyde	CH_2O

Name of VOCs	Molecular formula
n-Hexane	C_6H_{14}
Isopropyl Alcohol	C_3H_8O
Methanol	CH_4O
Methyl Ethyl Ketone	C_4H_8O
Methylene Chloride	CH_2Cl_2
Methyl Tertiary Butyl Ether	$C_5H_{12}O$
Propylene	C_3H_6
Propylene Oxide	C_3H_6O
1,1,1-Trichloroethane	$C_2H_3Cl_3$
Trichloroethylene	C_2HCl_3
Acetic Acid	$C_2H_4O_2$
Ethylbenzene	C_8H_{10}
Nitrobenzene	$C_6H_5NO_2$
Toluene	C_7H_8
Tetrachloroethylene	C_2Cl_4
Xylene	C_8H_{10}
Styrene	C_8H_8

ACE 1100 IMR-MS

Odors are unpleasant smells that stimulate the human sense of smell. They occur in various places such as sewage treatment plants, livestock facilities, and industrial areas, and each has a unique odor.

Because people's sense of smell is different for each individual, it is not easy to objectively evaluate odors. Odors are known to act as an aesthetic environmental pollutant that causes allergic reactions, respiratory disorders, and mental stress.

Volatile Organic Compounds(VOCs) are substances that cause odor in residential and urban areas. VOCs emitted from industrial facilities and livestock facilities deteriorate the air quality of neighboring areas and adversely affect local residents, so their management is becoming very important.

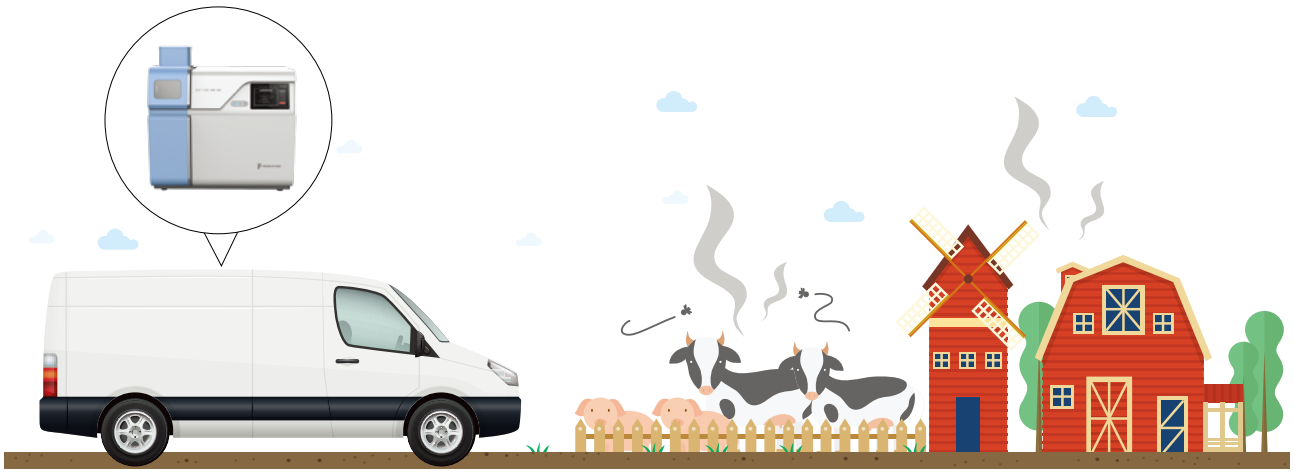
In the case of odors from most odor emission facilities, they are related to harmful air pollutants, and it is difficult to solve them with general air pollution management methods due to the nature of odors.

Unlike general air pollutants, odors have different degrees of damage according to seasonal changes. Management of numerous odorous substances from various types of pollutants emission facilities exposed to the air is also difficult.

Currently, a method using the human sense of smell is being used as an analysis method for managing odor emission sources. There is a risk that odor inspectors will inhale harmful gas, and problems such as different measurement values for the same concentration and low reliability of values for complex odors may occur, so more effective management methods are needed.

Problems of odorous substance emission sources

- Different results for each inspector through the sense of smell
- Variation of emissions depending on weather and time
- Emission of odorous substances from various types of pollutants
- Difficult to identify the main cause of odor due to various pollutants emission

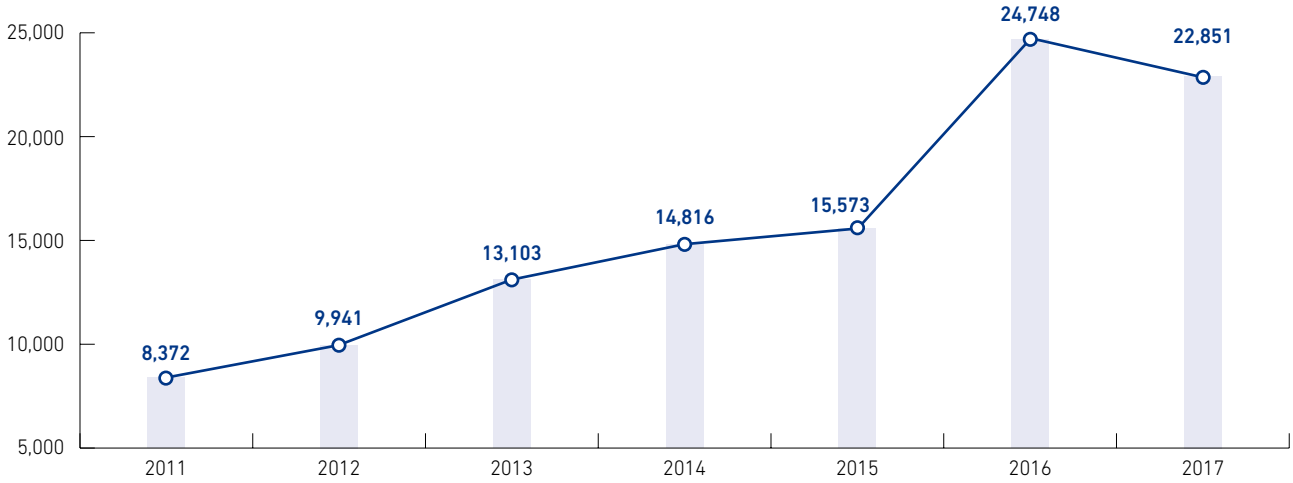


ACE 1100 IMR-MS Solutions

- Clear results with a simple mass spectrum
- On-site, real-time analysis with fast result processing
- Management according to region with Mobile Lab
- Identification of main-ordor causing substances with software

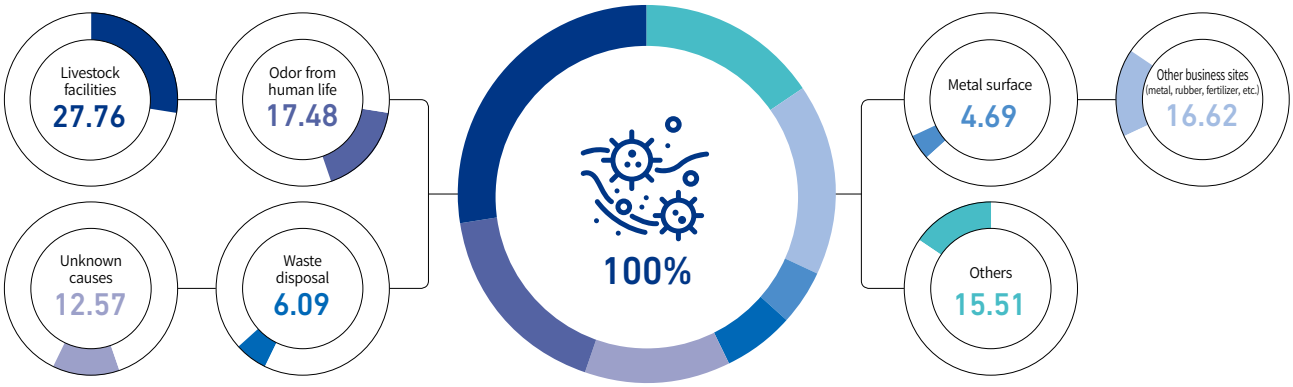
Number of odor complaints by year

Source : Korean ME



Percentage of odor complaints by major site in 2016

Source : Korean NIER



Name of Odor substance	Molecular formula
Ammonia	NH_3
Methyl mercaptan	CH_4S
Hydrogen sulfide	H_2S
Dimethyl sulfide	C_2H_6S
Dimethyl disulfide	$C_2H_6S_2$
Trimethyl Amine	C_3H_9N
Acetaldehyde	C_2H_4O
Styrene	C_8H_8
Propionaldehyde	C_3H_6O
Butyraldehyde	C_4H_8O
n-Valeraldehyde	$C_5H_{10}O$ $[CH_3(CH_2)_3CHO]$

Name of Odor substance	Molecular formula
i-Valeraldehyde	$C_5H_{10}O$ $[(CH_3)_2CHCH_2CHO]$
Toluene	C_7H_8
Xylene	C_8H_{10}
Methylethylketone	C_4H_8O
Methyl isobutyl Ketone	$C_6H_{12}O$
Butyl acetate	$C_6H_{12}O_2$
Propionic acid	$C_3H_6O_2$
Butyric acid	$C_4H_8O_2$
n-Valeric acid	$C_5H_{10}O_2$ $[CH_3(CH_2)_3COOH]$
i-Valeric acid	$C_5H_{10}O_2$ $[(CH_3)_2CHCH_2CO_2H]$
i-Butyl alcohol	$C_4H_{10}O$

ACE 1100 IMR-MS Mobile Lab

ACE 1100 IMR-MS can be mounted on a vehicle and used as a Mobile Lab.
By measuring the sample at the site, more accurate results can be obtained,
and by real-time and on-line monitoring at the place where analysis is required,
damage can be minimized and risks at the site can be controlled.

4G

Immediate monitoring in various places where on-site analysis and monitoring are required

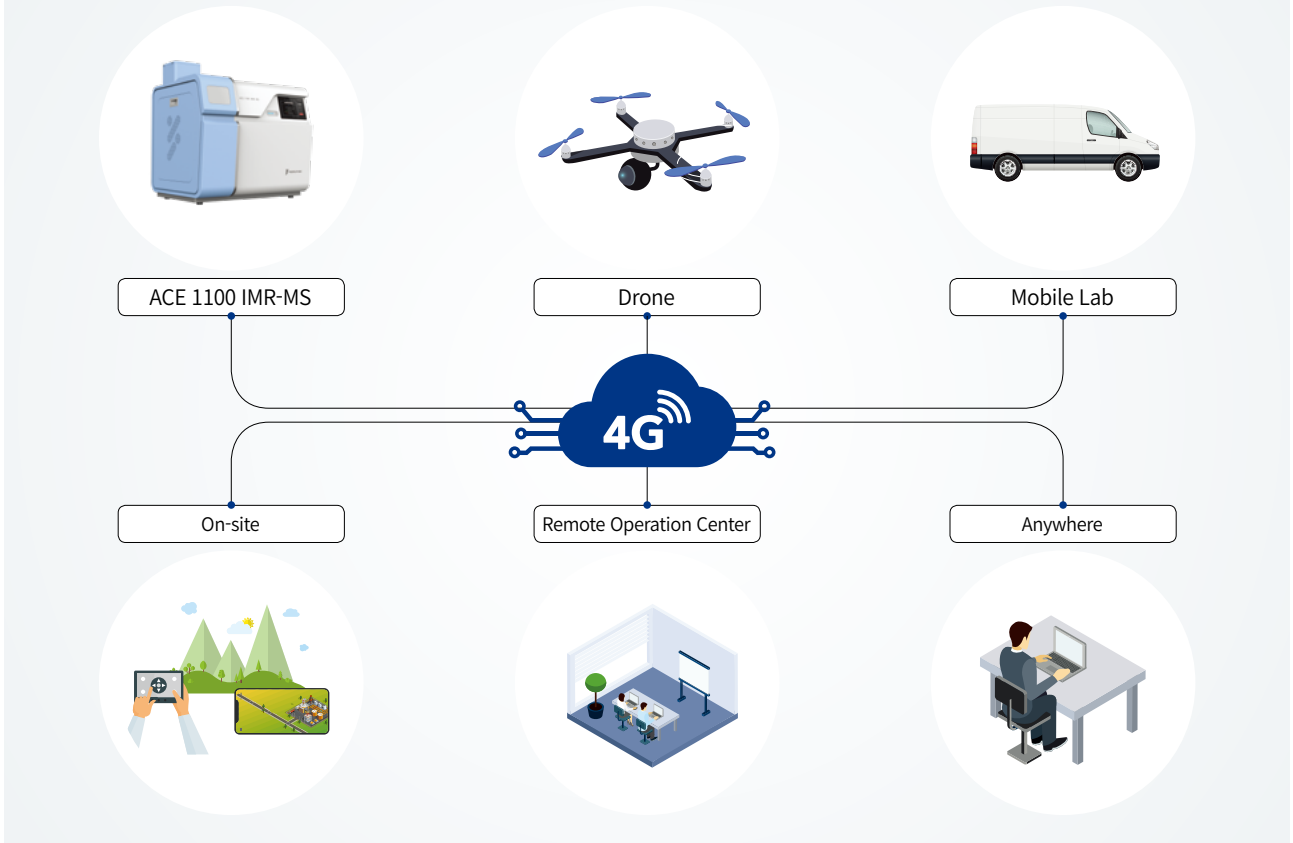
Real-time analysis and measurement of odor substances, hazardous air substances, fine dust, etc. while moving or stationary

Real-time mapping of pollution levels by pollutants using data visualization and statistical processing software for integrated management of analysis data

Mobile Lab

ACE 1100 IMR-MS is mounted on a vehicle and analyze rapidly on the current spot, working as a Mobile Lab. It enables to minimize pollution and control the site through real-time analysis for quick response to dangerous situations.

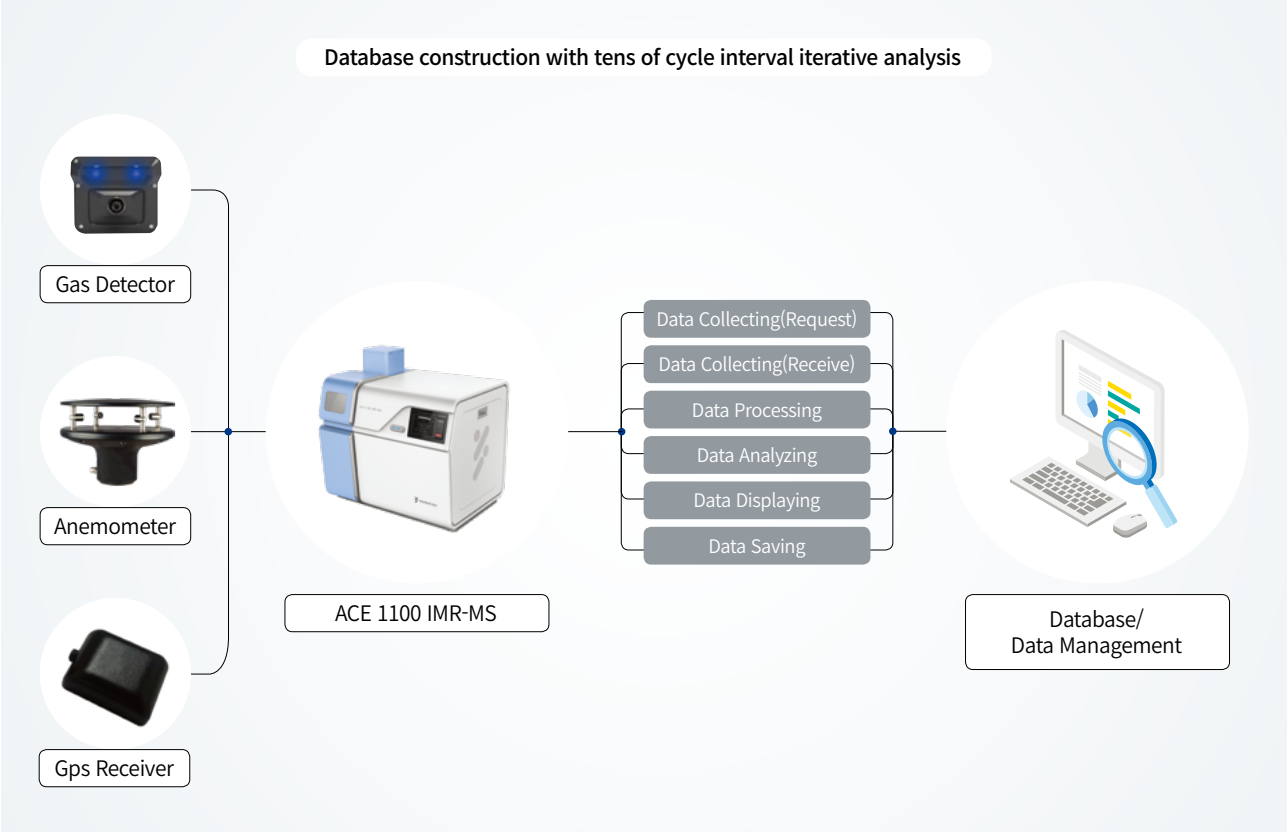
- On-site analysis where analysis is required, and immediate monitoring where monitoring is required
- Real-time measurement and analysis of odor substances, hazardous air substances, fine dust, etc. while moving or stationary
- Real-time mapping of pollution levels by pollutants using data visualization and statistical processing software for integrated management of data



ACECube-MS

Mobile Lab software

ACECube-MS, a mobile analysis laboratory software, is a mobile exploration and real-time monitoring solution with various analytical devices to analyze air, water and soil samples, analyze the diffusion path of pollutants, and verify the effectiveness of pollution control.

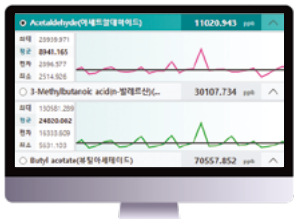


Map-based monitoring

- Display the location and the measurement value changed in color symbols on the map
- Grid, Line, Circle can be selected as desired symbols

Real-time alarm check

- Alarm history can be checked according to the value set in real-time



Reporting analysis variable

- Display measurement statistics and history by device and variable in numerical and chart form

Analysis results report

- Automatically log analysis result data
- Save as PDF file

ACE 1100 IMR-MS

Application

- Air and Water Pollutant
- Odor-causing substances
- Indoor air quality and automotive interior materials
- Work environment safety
- Semiconductor process contaminants
- Petrochemical
- Pharmaceuticals and food
- Rapid diagnostics

Features

FAST analysis
Direct analysis, save time without sample preparation and separation procedures

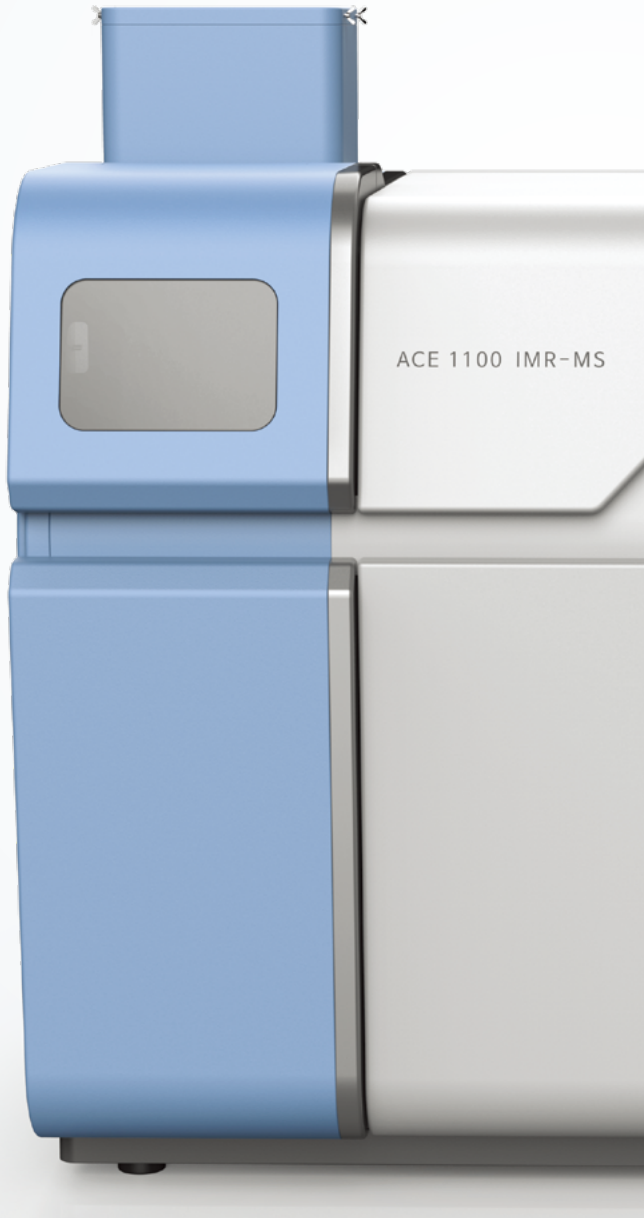
REAL-TIME analysis
Immediately getting a result with real-time analysis within tens of seconds

ACCURATE results
Clear interpretation of results with simple mass spectrum
Ionize the parent molecule itself using chemical ionization

ON-LINE monitoring
Continues result acquisition(24hrs/7days)

MOBILE LAB
Mounted in vehicle for Mobile Lab
Immediate analysis on-site

EASE OF USE
Easy data processing with software
Expert and beginner can operate easily



Software

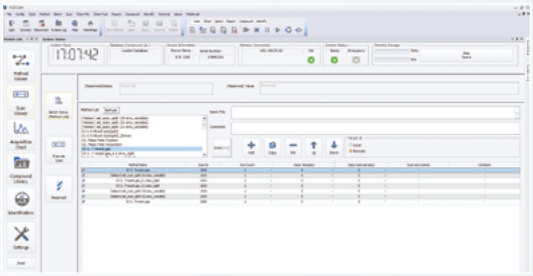
ACE 1100 IMR-MS has built-in software developed by Young In Ace, making it easy for users to operate the equipment. From the operation of the equipment to the data processing of the analysis results, it can be used according to the options customized by the user.

Built-in SW

Operation setting for ACE 1100 IMR-MS
Monitoring Analysis Results
System Control

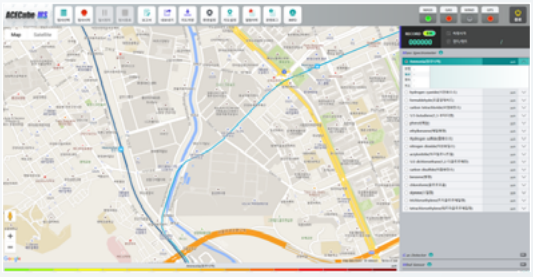
ACECube

Analysis method setup, qualitative/quantitative analysis
Analytes library
Analysis data processing



ACECube-MS

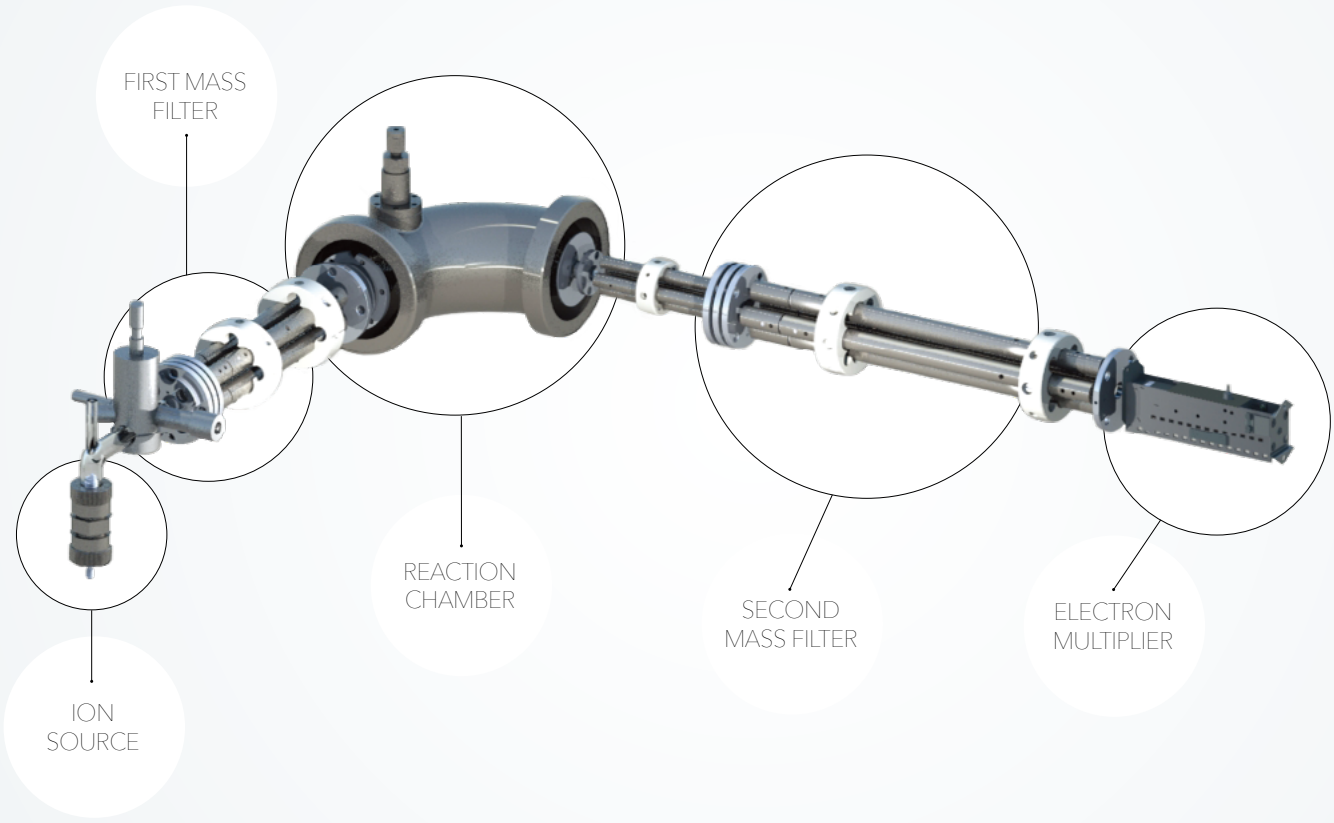
On-site real-time monitoring
Analyzing data according to GPS while driving
Running with equipment, interlocking devices



ACE 1100 IMR-MS

ACE 1100 Ion Molecule Reaction Mass Spectrometer(IMR-MS) is an optimized mass spectrometer for qualitative and quantitative analysis of Volatile Organic Compounds(VOCs). GC-MS and LC-MS use Chromatography systems for separation of analysis compounds and need the interface between mass spectrometer and Chromatography system. In contrast with GC-MS & LC-MS, IMR-MS loads sample directly into the mass spectrometer and immediately can get analysis results in real-time. It can be used not only in the laboratory but also on-site analysis is required, the place where the on-line monitoring is necessary.

Configuration



Ion Source
Normal water and air pass through microwave plasma to produce Reagent ions

First Mass filter
Selects Reagent ion, transfer to the Reaction chamber
On Scan mode, transfer Reagent ion by orderly

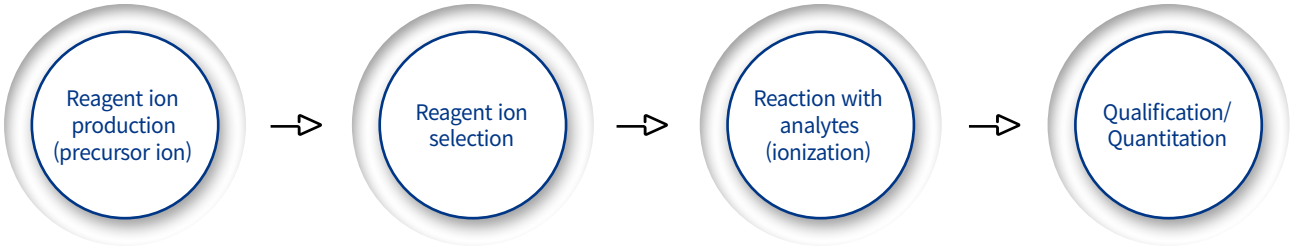
Reaction Chamber
Reagent ion and Analyte react to ionize analyte molecules

Second Mass filter
Separates the ions which are produced during passing the Reaction chamber according to their mass-to-charge ratio

Electron Multiplier
Detects by amplifying signals from passed ions

Principle of Analysis

ACE 1100 IMR-MS uses a soft chemical ionization method and it ionizes the sample molecule itself or minimizes the fragmentation of the target molecule. This ionization method assists achieve a simple and accurate mass spectrum.



① Reagent ion(Precursor ion) production using microwave plasma

② Selective transfer technology of Reagent ions using mass filter

③ Direct sample loading technology(Patent registration number:10-2132977)

④ Quantitative control technology for ionization reaction between sample and Reagent ion(ionization of sample molecules, chemical ionization)

⑤ Separation technology by mass of sample molecules using the second mass filter. Precisely control the mass value, RF and DC value therefore only molecular ions selected according to their mass-to-charge ratio pass through the mass filter and reach the detector(Electron multiplier)

⑥ Result acquisition

⑦ Built-in software controls each part of the system and operates data processing for sample analysis results.

Chemical Ionization Mechanism

Proton transfer: Proton affinity of the analyte(sample molecule) > Proton affinity of the Reagent ion

$M + H^+ \rightarrow MH^+$ $(CH_3)_2CO + H_3O^+ \rightarrow (CH_3)_2COH^+ + H_2O$

Electron transfer: Ionization energy of the analyte(sample molecule) > Ionization energy of the Reagent ion

$M \rightarrow M^+ + e$ $O_2^+ + C_6H_6 \rightarrow C_6H_6^+ + O_2$

Dissociative Electron transfer: If the ionization potential of the analyte(sample molecule) is lower than 12.07 eV and 9.26 eV, the Reagent ions O_2^+ and NO^+ cause the electron transfer mechanism

$AB \rightarrow A^+ + B + e^-$ $O_2^+ + n\text{-}C_4H_{10} \rightarrow C_3H_7^+ + O_2 + CH_3$

Hydride abstraction: Abstraction of hydrides by O_2^+ and NO^+

$NO^+ + CH_3CHO \rightarrow CH_3CO^+ + NOH$

Association: Reagent ions combine with molecules to form ions in the presence of third substances such as carrier gas

$A^+ + M \rightarrow AM^+$ $NO^+ + CH_3OH + He \rightarrow NO.\ CH_3OH^+ + He$

ACE 1100 IMR-MS

Ion Molecule Reaction Mass Spectrometer

- FAST
- ON-LINE monitoring
- REAL-TIME
- MOBILE LAB
- ACCURATE
- EASE OF USE

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