



INSTRUMENTS

Gas Detection For Life



RIKEN KEIKI

Partners in Gas Detection



ORR[®] Protection

Mission Critical Fire Protection Experts[®]




Gas Detection Solutions for Lithium-ion Battery Production

Providing safe work environments and stable production

World Leader in Gas Detection & Sensor Technology



NMP monitoring for Drying Processes



Combustible and Toxic gas monitoring for Electrode Filling Processes



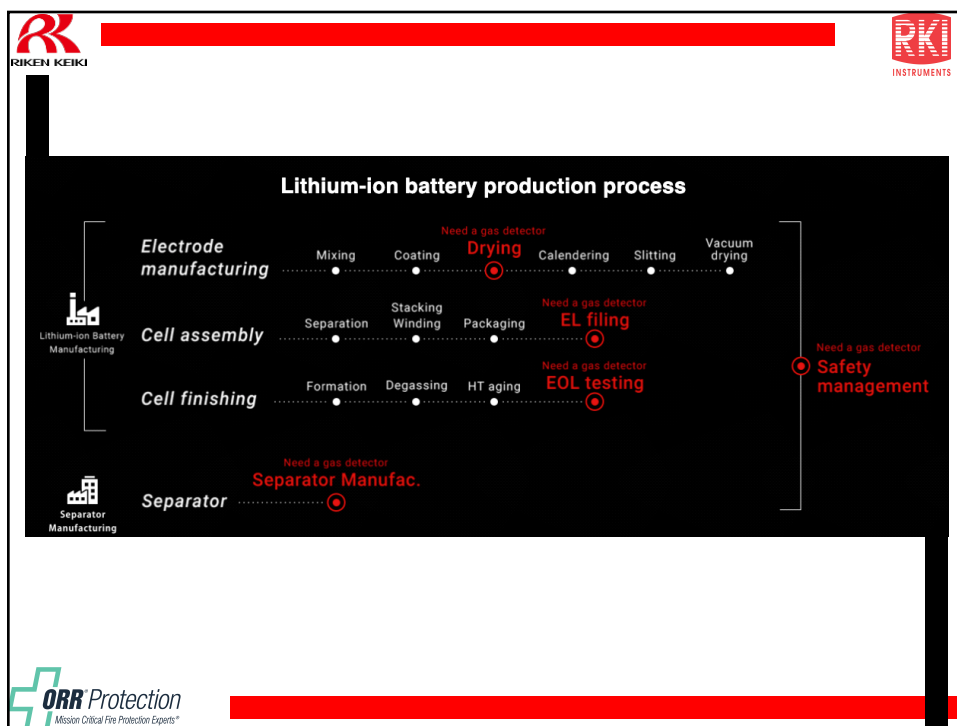
Monitoring Solutions for Testing Processes



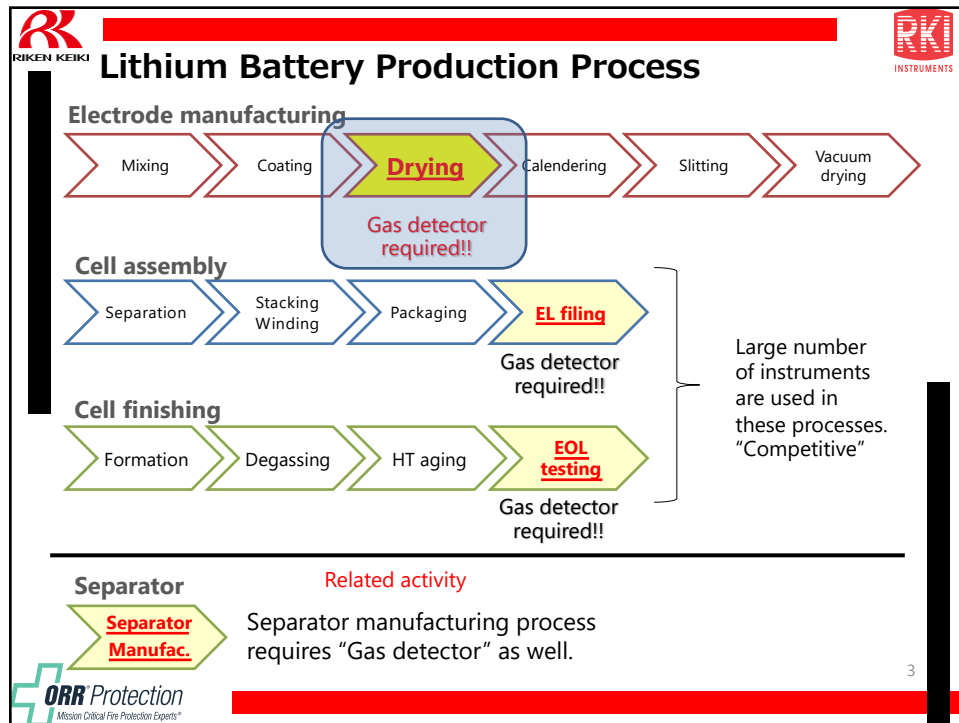
Oxygen Deficiency Monitoring


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Coating & Drying Process

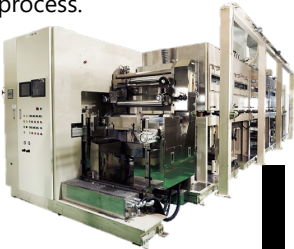
NMP is present all the time at the coating and drying process.


Necessity of gas detection

- 1) To confirm the concentration is not decreasing
- 2) To confirm it will not exceed the explosion limit.

For 32GWh factory ...


- around **8 lines**
- around **18 sets of gas detectors** per line






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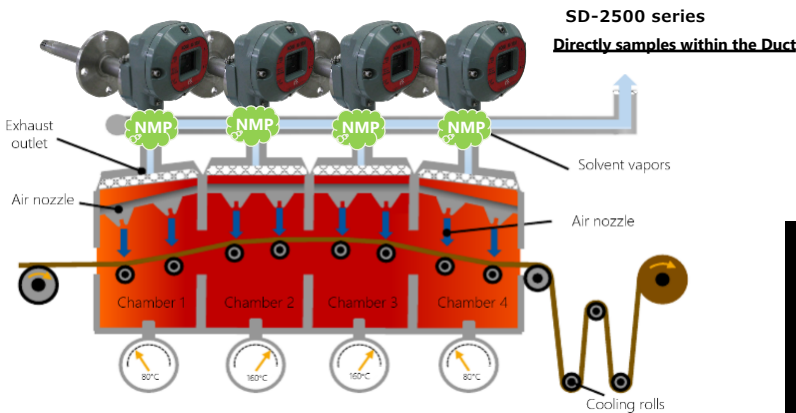
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Coating and drying process mainly uses NMP.

It generates explosive NMP in this drying process




SD-2500 series
Directly samples within the Duct


NMP volatilizes only at high temperatures.
Therefore, it is necessary to insert a detector directly into the exhaust duct and detect it at high temperature.



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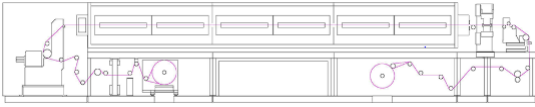
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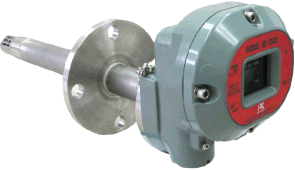



Coater- Dryer

Responsible for the manufacturing process of electrode plates (positive and negative electrode materials), which is a key battery manufacturing process.




Suggest instrument:
1) SD-2500






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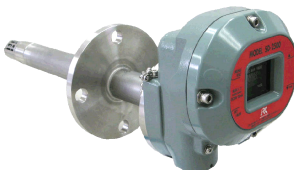
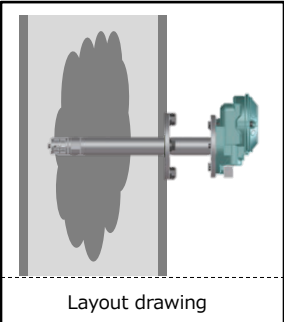


Product advantage

Directly detecting inside the DUCT

Accurate detection is possible because there is no risk of condensation (liquefaction)


Model: SD-2500

Layout drawing



Advantages

- 1. No risk of liquefaction**
⇒ avoid solvent adsorption on piping and sensors.
- 2. Duct insert diffusion method**
⇒ no dead time.
- 3. No suction pump required**
⇒ low running cost




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In-furnace direct feed type recommended

RIKEN KEIKI
- SD-2500 : 0- +160°C
- SD-2600 : 0- **+200°C**




UL/ATEX approval

GASTRON
- GTD-2000: -20- +60°C




ATEX approval

CROWCON
Xgard : -40- +150°C



ATEX approval

New COSMOS ELECTRIC
- KD-12HT : 0- +160°C




Non ATEX approval



Riken Keiki Advantages

- 1) Has **UL/ATEX**
- 2) Has **wide temperature range**
- 3) Has **long insert part**

RIKEN KEIKI is an explosion-proof product that can be used in the highest temperature environment and has the longest insert ! !


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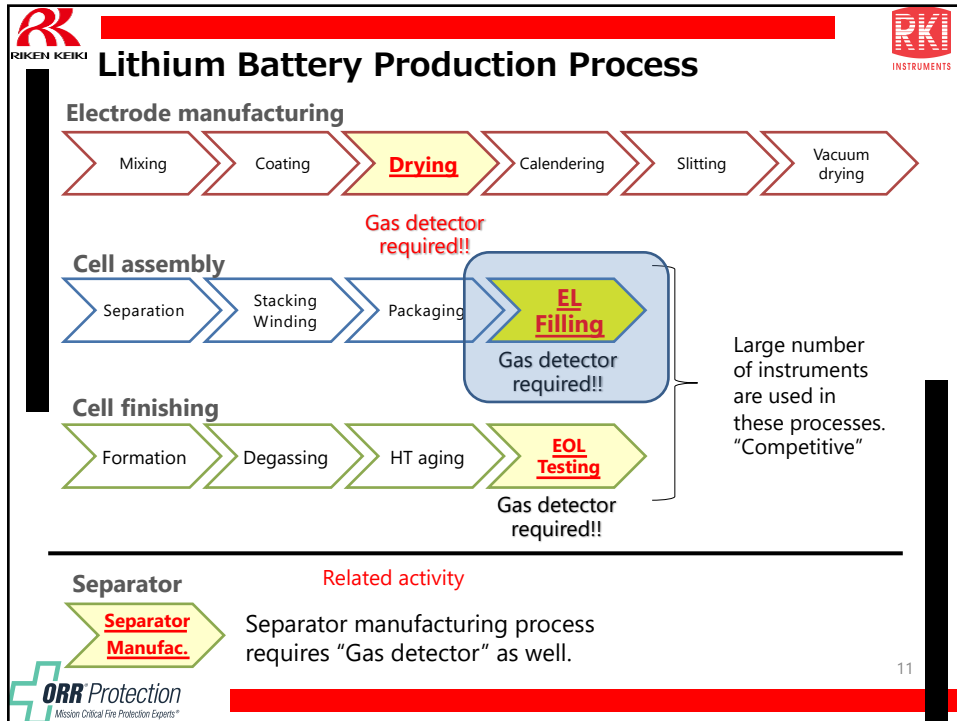
Competitive Advantages

Combustible Gas Monitoring Comparison

| Company | RIKEN KEIKI (SD-2600) | Company A | Company B | Company C |
|-----------------------------------|--------------------------|---------------|----------------|---------------|
| Insertion depth | ✓ 250mm | 250mm | Not Available | 250mm |
| Operating temperature (Sensor) | ✓ 0°C ~ +200°C | -20°C ~ +80°C | -40°C ~ +150°C | 0°C ~ +160°C |
| ATEX / IECEx/ UL | ✓ Acquired | Acquired | Acquired | Not Available |



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Cell assembly

Electrolyte filling process


A variety of solvents are mixed in electrolytes, such as DMC, EMC, and DEC. These have the potential to explode if vaporized, so gas detectors are required.


Electrolyte Filling Process Gas Monitors

| SD-D58 (HW - Sensor) | SD-1GP | SD-1RI | M2A | SD-10X |
|-----------------------|-----------------------|---------------------------------------|-----------------------|-----------------------|
| Concentration display | Concentration display | Concentration display | Concentration display | Concentration display |
| Pump suction Type | Diffusion Type | Diffusion Type | Diffusion Type | Diffusion Type |
| Ex-proof | Ex-proof | Non-Dispersive Infrared Method Sensor | Ex-proof | Ex-proof |

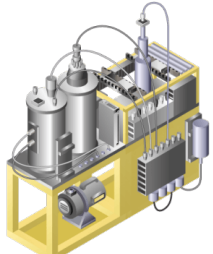
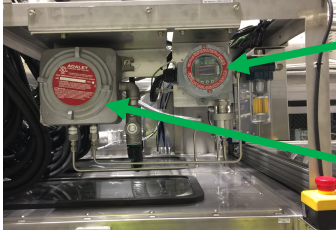
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The electrolyte contains DMC (dimethyl carbonate) and when it is vaporized, it becomes an explosive atmosphere. Also, to prevent oxygen deficiency during inspections, oxygen meter is installed.


+



M2A – DMC

Model 1017F

For 1 unit of electrolyte injection system ...
DMC detector : 1unit + OX-5001 : 1unit + O2 detector : 1unit is used


For a 32GWh factory ...


- around **24 lines**
- around **20 sets of gas detector** per line



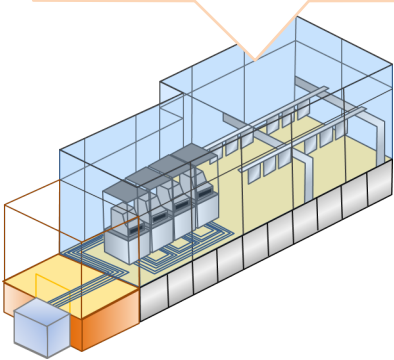
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When DMC(dimethyl carbonate) contained in the electrolyte is vaporized, it becomes an explosive gas.



We have prepared detectors that can handle each gas type.


Use : Explosion prevention /
Leakage detection (DMC)

Model : SD-D58 (DMC) /
SD- 1 RI (diffusion type) /
M2A

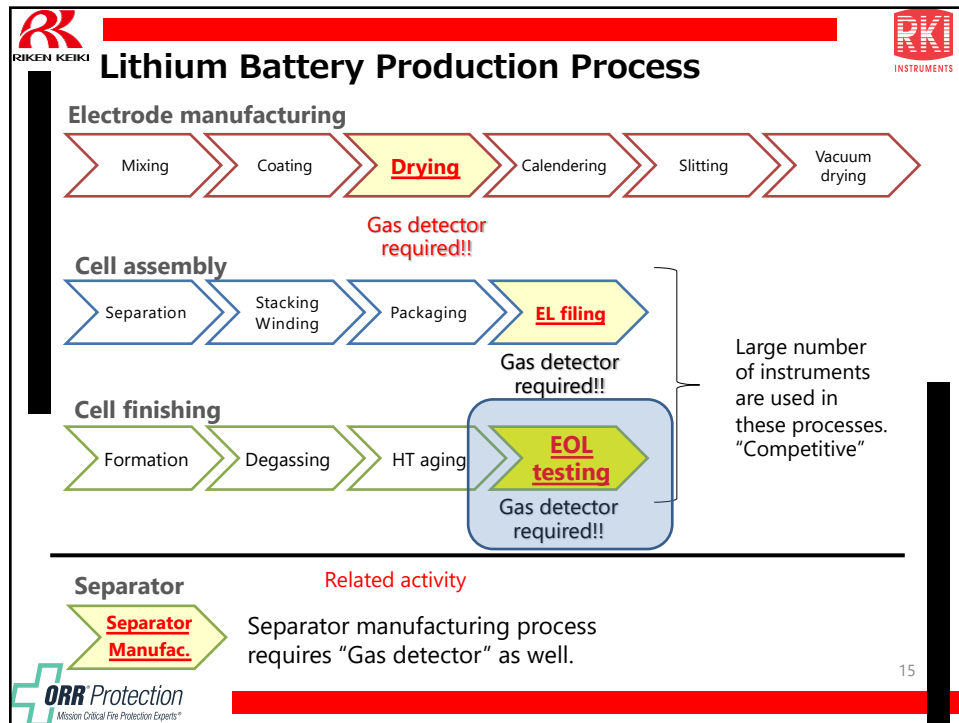
Use : Oxygen deficiency prevention
Model : SD-1 OX (diffusion type)

【Electrolyte injection device (image)】

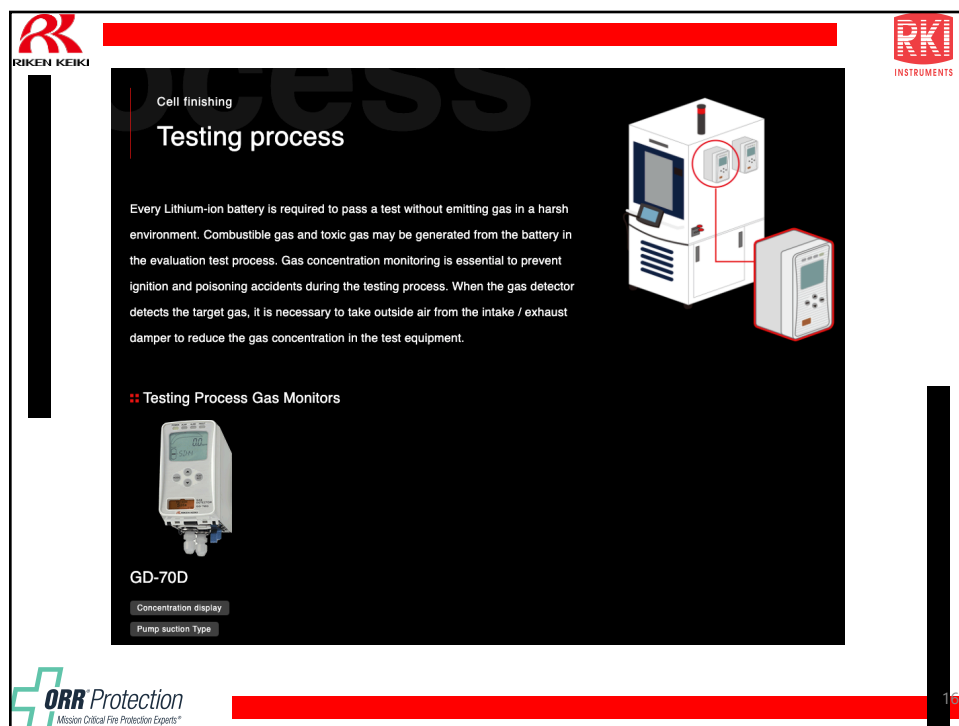


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■ Test process

Depending on the Type of battery (encapsulated electrolyte), H₂(hydrogen), CO(carbon monoxide), H₂S(hydrogen sulfide) occurs !!

Use : Explosion prevention / Poisoning prevention (H₂/CO/H₂S/HF etc)
Model : GD-70D

Gas: CO, H₂, H₂S, HF, CH₄, O₂
Typically 1 or 2 gas monitors per test equipment.

"Test equipment (image)"

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Lithium Battery Production Process

Electrode manufacturing

Mixing → Coating → **Drying** → Calendering → Slitting → Vacuum drying

Cell assembly

Separation → Stacking Winding → Packaging → **EL filing**

Cell finishing

Formation → Degassing → HT aging → **EOL testing**

Separator

Separator Manufac.

Gas detector required!!

Gas detector required!!

Gas detector required!!

Gas detector required!!

Related activity



Separator manufacturing process requires "Gas detector" as well.

Large number of instruments are used in these processes. "Competitive"

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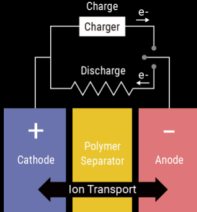
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Separator

Separator production process

Dichloromethane (DCM) and other solvents are used for cleaning purposes in the production process of separators for lithium-ion batteries. For measuring low-concentration solvent gas and combustible gas, RIKEN KEIKI's gas detectors are ideal solutions for separator processes.




Separator Production Gas Monitors




FI-900

Concentration display
Need external sampling unit
Ex-proof




SD-1GP

Concentration display
Diffusion Type
Ex-proof




SD-1RI

Concentration display
Diffusion Type
Non-Dispersive Infrared Method Sensor
Ex-proof





SD-1GH

Concentration display
Diffusion Type
Ex-proof



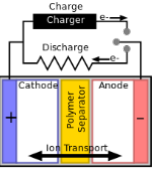
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Separator

We have installation experience in Japan with ASAHI KASEI (Celgard, LLC) the No.1 separator company. Have an individual instrument that no other competitor has which was accepted by the separator company.


-> Dichloromethane is inspected while separator is manufactured.




Use : Explosion prevention /
Poisoning prevention

Model : FI-800 + RS-330
SD-1GH + Beacon Controller
GH-5001 + GD-A80V


Gas: Dichloromethane, Propane




FI-800



RM-5000





GD-A80V



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Major Accident Cases


Created by quoting and processing from the workplace safety site
(Ministry of Health, Labor and Welfare :
http://anzeninfo.mhlw.go.jp/anzen/sai/saigai_index.html)



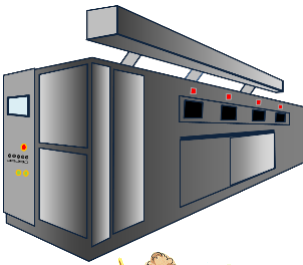
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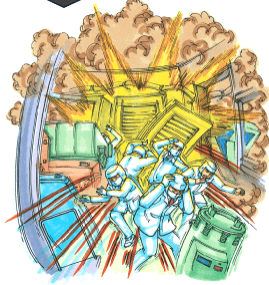
Explosion of drying equipment while heat drying chemicals




Drying equipment cause of damage
 During the drying operation, the odor of ethanol as a solution was strongly felt and the exhaust device was confirmed. An explosion occurred after the switch was turned on because the exhaust system was not operating.

Injured : 6 people







- Thorough training of workers needed
- Establishment of safety management system
- +
- Installation of detector to detect leakage of flammable gas




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Product Information



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Coating & Drying Processes Flame-proof Furnace Safety Monitor Model : SD-2500 / SD-2600 / GD-2400




Features

- Detection of high boiling point solvents
- Detection of N-methyl-2-pyrrolidone(NMP) vaporized in the drying furnace
- Catch the exact concentration in the center of the exhaust duct by direct insertion in the furnace




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Electrolyte Filling Process Flame-proof Suction Type Gas Detector Model : SD-D58 | GD-D58 | M2A



SD-D58
(With concentration indicator)




GD-D58
(Without concentration indicator)



M2A
(With gas display)

Features


- Suitable for use as an explosion proof product even in hydrogen atmospheres
- Equipped with automatic flow rate abnormality
- Integrated assemblies of replacement parts to simplify maintenance




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Testing Process Smart Transmitter / Gas Detector Model : GD-70D



Features



- A universal design that does not depend on the sensor technology. The main unit is shared.
- Reduced power consumption - up to 20% of conventional (Potentiostatic Electrolysis Method)
- Compliant with GADMS and other systems
- No internal tubing (Main unit) / No Coil (Pump unit)
- Front access, no tools required for easy replacement of sensor & pump



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Personal Safety | Confined Space | VOC Detection Portable Gas Monitors


Model : GX-3R | GX-3R Pro | GX-6000




GX-3R
- Smallest confined space monitor



GX-3R Pro
- Smallest 5 gas monitor
- Bluetooth alarm notifications



GX-6000
- 6 gas sample draw with smart sensors
- 4 PID sensor options
- 5 operating modes


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SUCCESSES







a brand of  **FREUDENBERG**


CELGARD

AsahiKASEI



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Panasonic Energy of North America



Tesla Gigafactory



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Li-Ion Manufacturing Shipments

| Equipment | Model | Gases | Ranges | Units |
|-------------------------|---------------|----------------|-----------|-------|
| Liquid injection device | M2A (IR Type) | DMC | 0-100%LEL | 200 |
| Liquid injection device | OX-5001-1017 | O2 | 0-25VOL% | 200 |
| GNC Device | M2A (IR Type) | DMC | 0-100%LEL | 200 |
| GNC Device | OX-5001-1017 | O2 | 0-25VOL% | 200 |
| Encapsulation device | GP-6001-1017 | Xylene, Hexane | 0-100%LEL | 10 |
| Coater machine | GP-5001-A2400 | NMP | 0-100%LEL | 126 |



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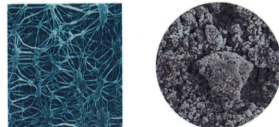
Gas sensor deterioration factors

In principle, the gas sensor detects gas by a chemical quantitative reaction.
Contact with substances that are chemically harmful to the sensor
Due to changes in the properties of sensor constituent materials due to long-term use
Its sensitivity is gradual, but it deteriorates.

Sensitivity confirmation by regular inspection and regular replacement as preventive maintenance are required

Deterioration factors of constant potential electrolytic sensor

- Working electrode [Reduction of surface area]
 - ⇒ Impurity mixed (surface oxidation / dissolution)
 - ⇒ Long-term contact with reaction gas (surface oxidation)
- Gas permeable membrane [Reduction of transmittance]
 - ⇒ Adhesion of fine particles, oil mist, etc. (clogging)
 - ⇒ Organic solvent vapor contact (decreased water repellency)
 - ⇒ Pressure load (decreased water repellency)
- Electrolyte [Reduction of liquid volume]
 - ⇒ Dry air contact (electrode exposure)




Gas permeable membrane

Deterioration factors of constant potential modulus sensor

- Working electrode [Reduction of surface area]
 - ⇒ Impurity mixed (surface oxidation / dissolution)
 - ⇒ Long-term contact with reaction gas (surface oxidation)
- Gas permeable membrane [Reduction of transmittance]
 - ⇒ Adhesion of fine particles, oil mist, etc. (clogging)
 - ⇒ Organic solvent vapor contact (decreased water repellency)
 - ⇒ Pressure load (decreased water repellency)
- Electrolyte [Reduction of liquid volume]
 - ⇒ Dry air contact (electrode exposure)


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Need for maintenance

----- Specificity of gas detector equipment -----

- The usage environment is complicated and diverse →
There is a "difference" in the operating status (due to the environment)
- Normally, it is in a standby state (it never operates) →
There is almost no opportunity to check the operation
- The detection target is gas →
There is no operation inspection method other than gas introduction



To operate correctly in case of emergency


Maintenance of functions and performance is extremely important


Maintaining durability in continuous operation.

➡

Regular inspection and maintenance

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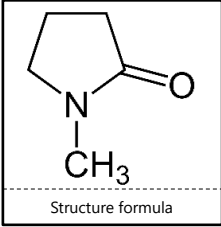


N-Methyl-2-pyrrolidinone(NMP) Physical properties


Chemical formula : C₅H₉NO
Molecular weight : 99.13
Lower explosion limit : 0.9 vol%
Flash point : 95 °C
- > Exceeding this may produce air and explosive gas mixtures

Boiling point : 204 °C
Vapor pressure : 66 Pa(25 °C) -> 7 %LEL
3200Pa(=3.2kPa)->350 %LEL(3.15 vol%)

Classification : Corresponds to third petroleum





Structure formula



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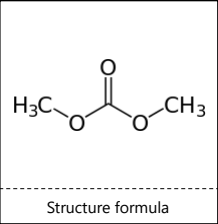


Dimethyl carbonate(DMC) Physical properties


Chemical formula : C₃H₆O₃
Molecular weight : 90.08
Lower explosion limit : 4.2 vol%
Flash point : 18 °C
- > Exceeding this may produce air and explosive gas mixtures

Boiling point : 90.2 °C
Vapor pressure : 7.4 kPa(25 °C) -> 173 %LEL(7.3 vol%)

Classification : Corresponds to first petroleum



Structure formula



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