HYDROGEN SAFETY

ANDY AVENELL

HEAD OF SALES SUPPORT

crowcon

DETECTING GAS. **SAVING LIVES.**

CROWCON AT A GLANCE

Established in 1970

Over 500,000 portable and fixed Crowcon devices are in use around the world

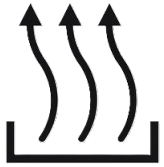
Leading experts in Process and Infrastructure Safety

Pioneered over 10 technology and industry firsts

HYDROGEN SAFETY

Combustible between 4-80% volume concentration in air.

Lighter than air gas (0.07 relative density)



Significantly lower flame radiant heat compared to hydrocarbons

No Smoke

- Early detection is essential to prevent potential ignition
- The properties of the gas necessitate specific detection techniques

POTENTIAL RISKS ASSOCIATED WITH HYDROGEN

Fire/Explosion

Invisible flame

Low ignition energy

Flammability 4-80% Vol.

Asphyxiation

Pressurized

Confined Spaces

Properties

Lighter than air

Colourless

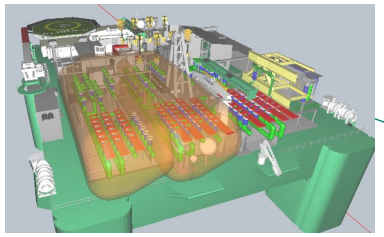
Odourless

Tasteless

Frostbite

Liquified

ASSESSING RISK



Fire & Gas Mapping

DSEAR

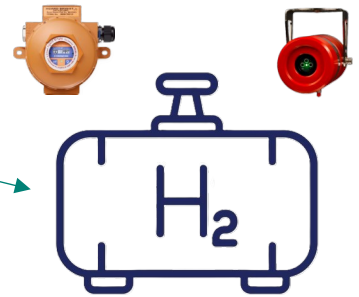
Targets

IEC ISO

Standards Requirements

Consult an expert

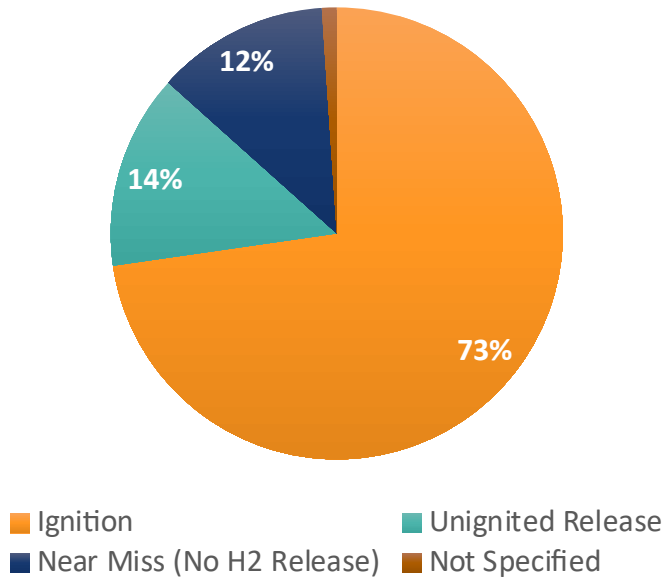
Risk Assessment



System Requirements

INCIDENT STATISTICS

CONSEQUENCE OF RE-PORTED INCIDENTS



HYDROGEN INCIDENT AND ACCIDENT DATABASE 2.1

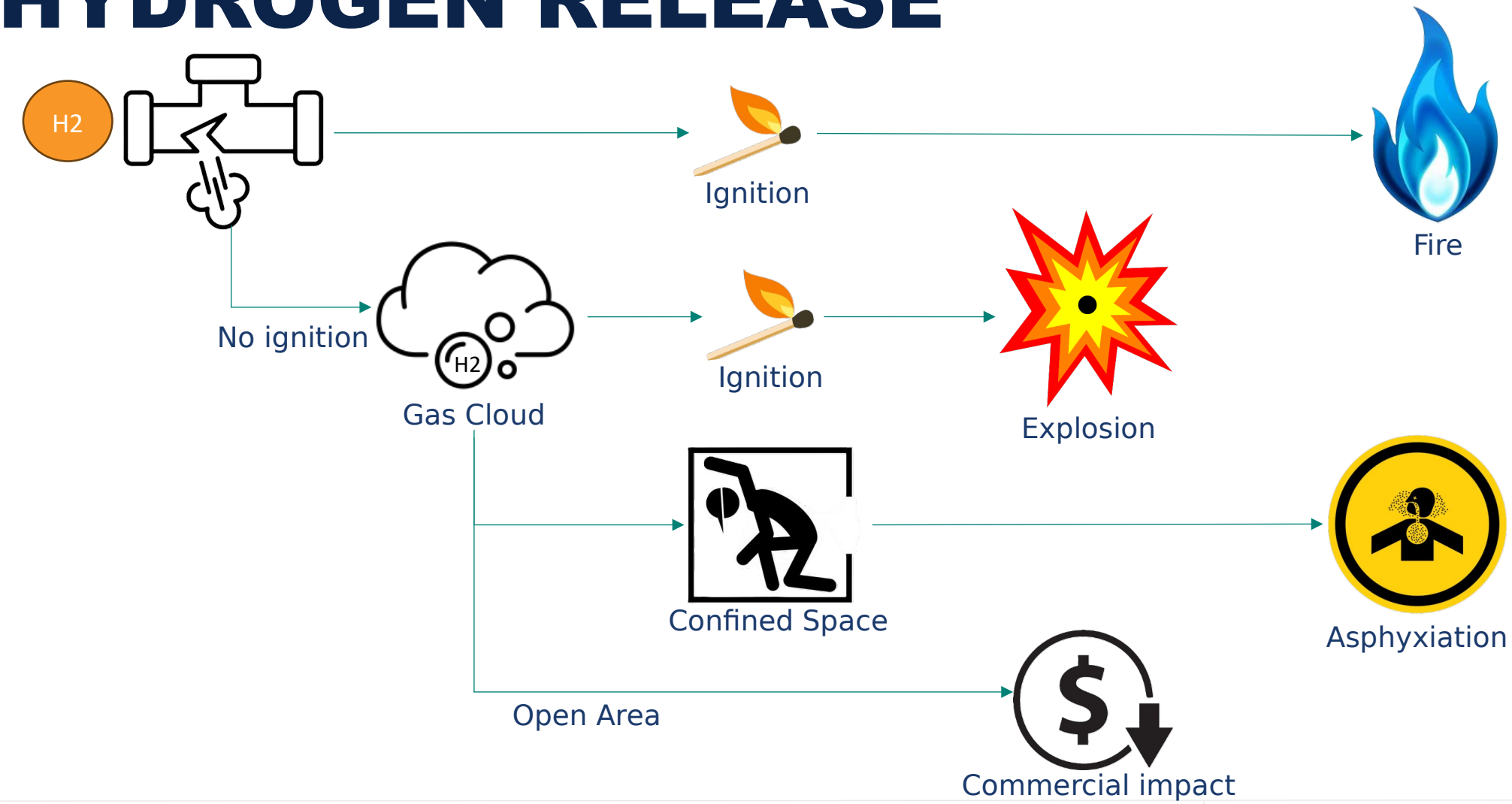
Reported causes:

- Valve malfunction & leaking connections are the leading causes of hydrogen incidents

Root cause: About 50% of incidents could have been avoided if:

- Staff were trained and educated about hydrogen safety
- Incidents were reported and correction measures taken
- Better system designs and material selection were adopted

HYDROGEN RELEASE



DETECTING HYDROGEN

Portable Gas Detector

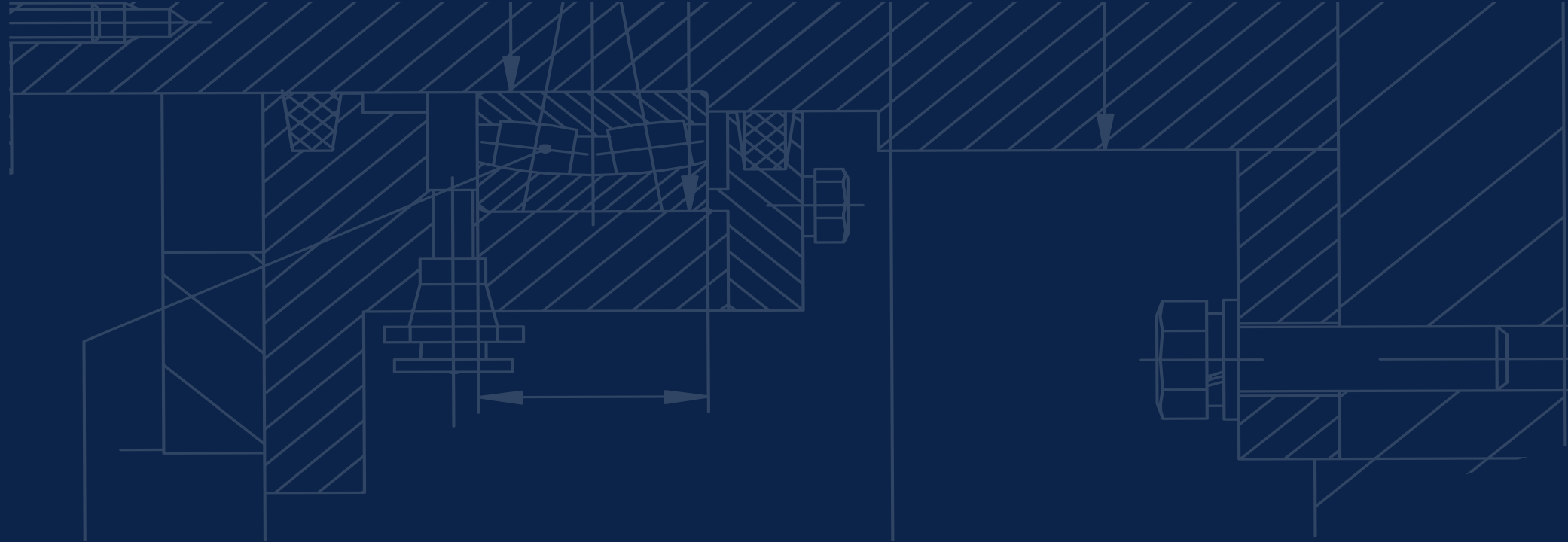
Fixed Gas Detector

Flame Detector

Acoustic Leak Detector

Gas Sampling System

Personal Protectio	Asset & Personnel Protection		
Detects hydrogen gas	Detects hydrogen flame	Detects gas leaks from pressurized sources	Measures hydrogen & oxygen concentration in electrolyser process lines



HYDROGEN GAS SENSOR TECHNOLOGIES

GAS SENSOR TECHNOLOGIES

Sensor Technology	Advantages	Limitations
Catalytic Bead or Pellistor	Relatively low cost Detects many flammable gases including hydrogen	Requires Oxygen to function Cannot detect very low or very high concentrations Exposure to high gas concentrations could kill the sensor **Easily poisoned by Silicone, Lead and other compounds** **Does not fail safe** Requires 6-monthly calibration Life-span typically 3-5 years
Electrochemical	Can detect very low ppm-level concentrations	Limited operating temperature range Cross sensitivity to other gases like Carbon Monoxide Requires 6-monthly calibration Life-span typically 2-3 years
Metal Oxide Semiconductor (MOS)	Lowest cost Long sensor life span	Cross sensitivity to other gases and environmental changes May go to sleep if not regularly exposed to gas Frequent calibration required
Micro-Electro-Mechanical Systems (MEMS)	Detects hydrogen and other gases **Does not require calibration for at least 5 years** **Long life span >10 years**	Requires oxygen to function Higher cost than a pellistor
Thermal Conductivity	Does not require oxygen to function Can detect very high concentrations	Less sensitive to low concentrations Can only be used where there is a defined binary gas mixture
Non-Dispersive Infrared (NDIR)	**Cannot detect hydrogen**	

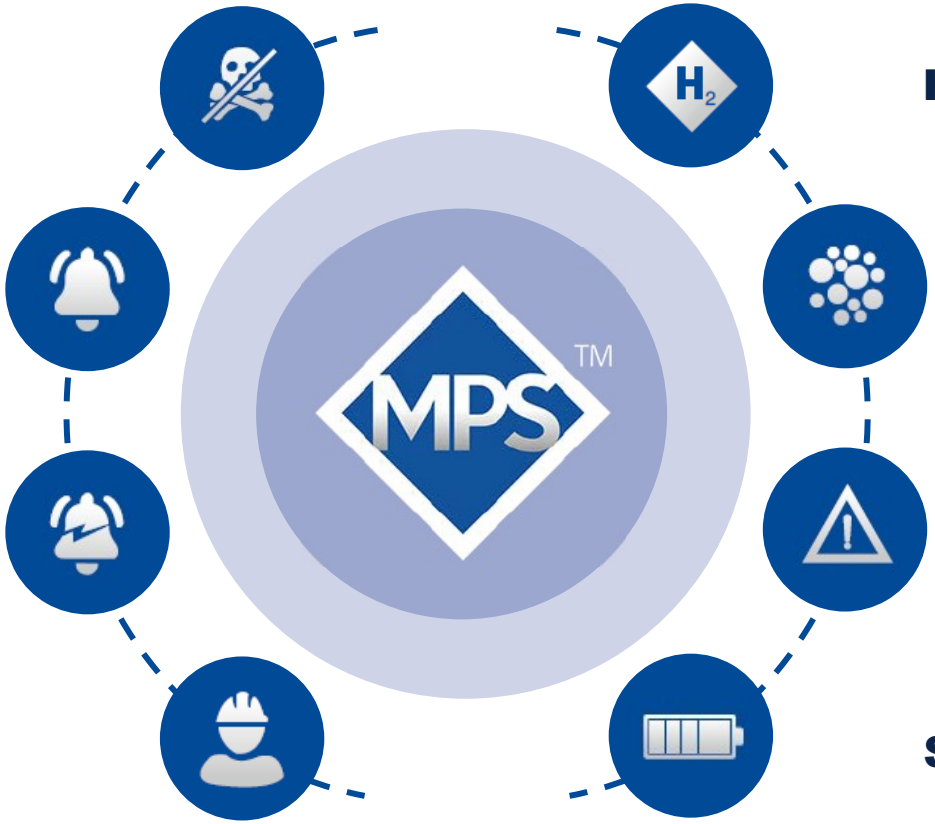
MOLECULAR PROPERTY SPECTROMETER™ (MPS)

No Sensor Poisoning

Lower False Alarms

Reduced Masked Alarms

Minimal On-Going Maintenance



Hydrogen (H_2) Detection

Multi-gas protection (True - LEL)

Zero calibration for 5 years

Sensor Life >10 years

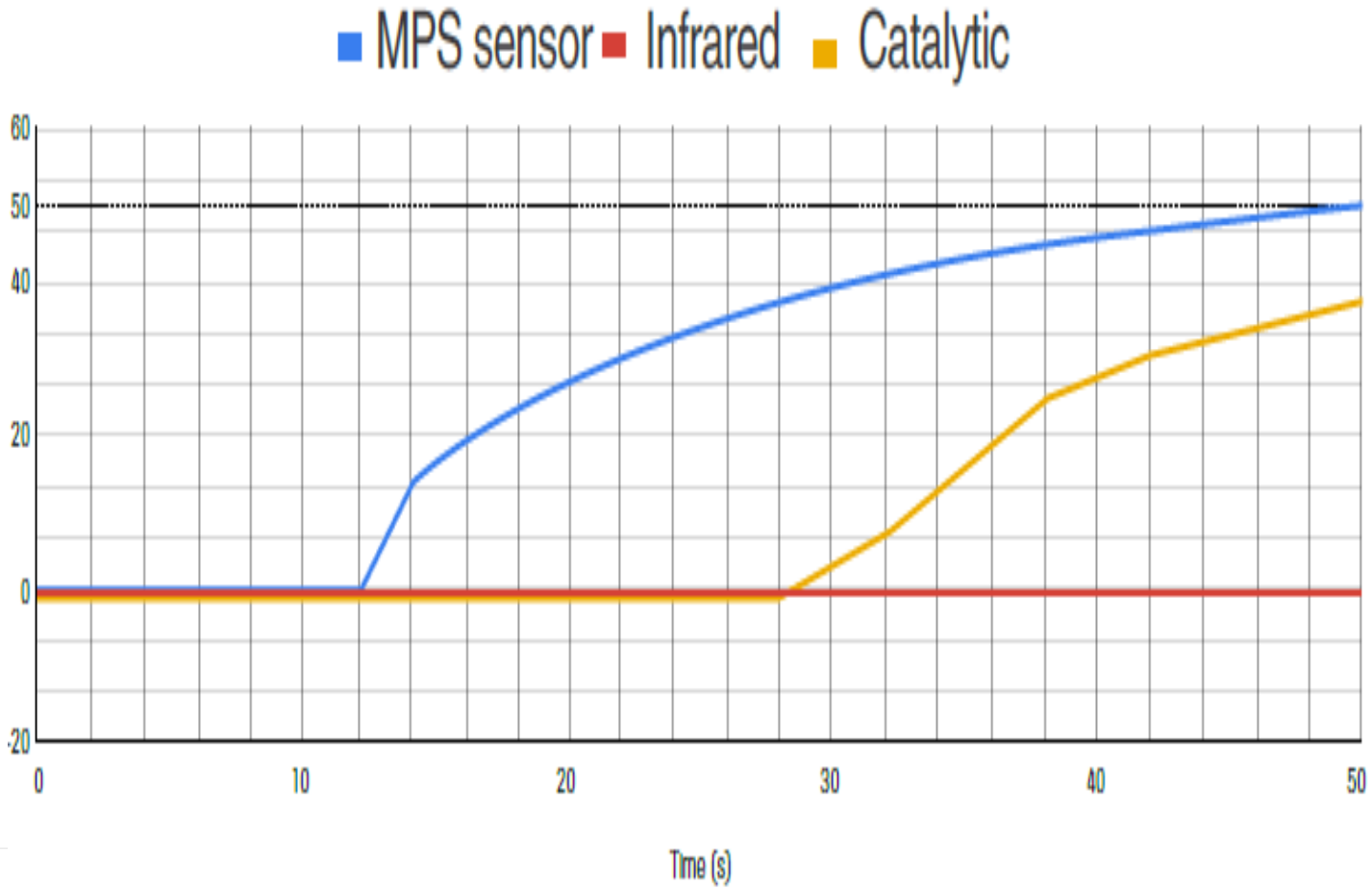
SENSOR DETECTION COMPARISON

H_2 Response Test

Only MPS reaches true LEL value within one minute

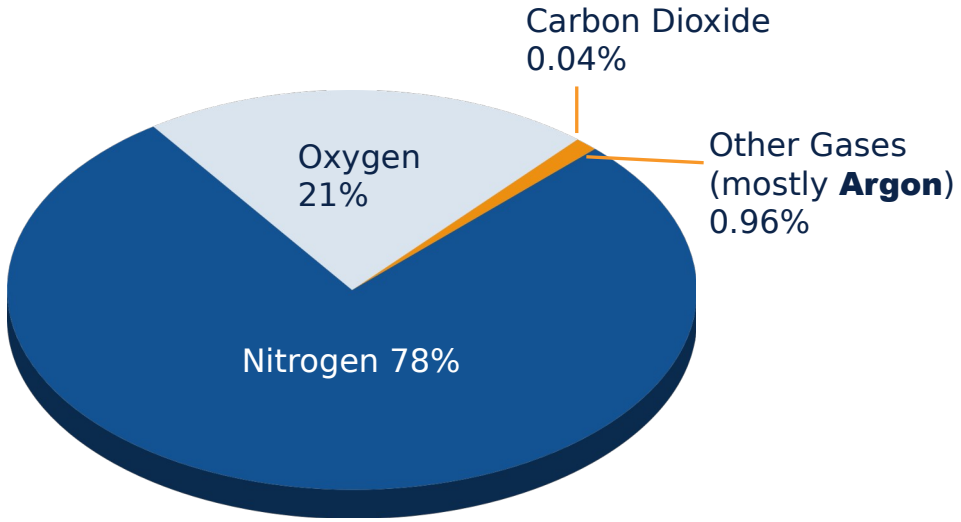
MPS has a 57% faster response than a Pellistor

Infrared doesn’t respond to Hydrogen



HOW DOES MPS WORK?

The composition of the atmosphere is not just O_2 and N_2

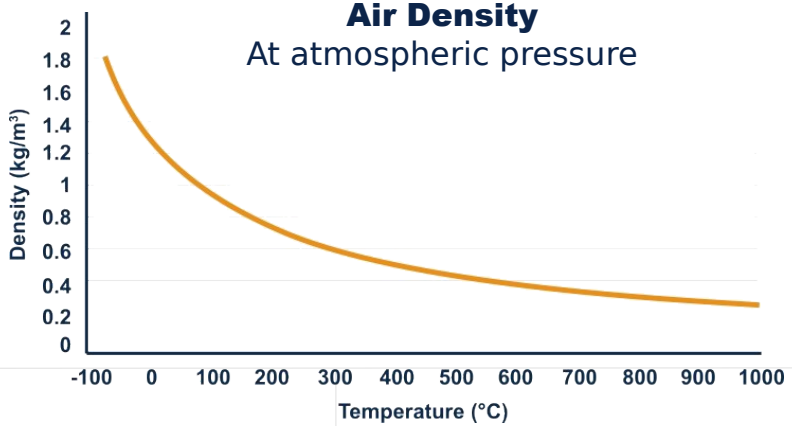


The dry composition of the atmosphere is mostly nitrogen and oxygen. It also contains fractional amounts of argon and carbon dioxide and trace amounts of other gases, such as helium, neon, methane, krypton and hydrogen.

Measurements of the thermodynamic properties of the air/gas mixture are consistent and linear

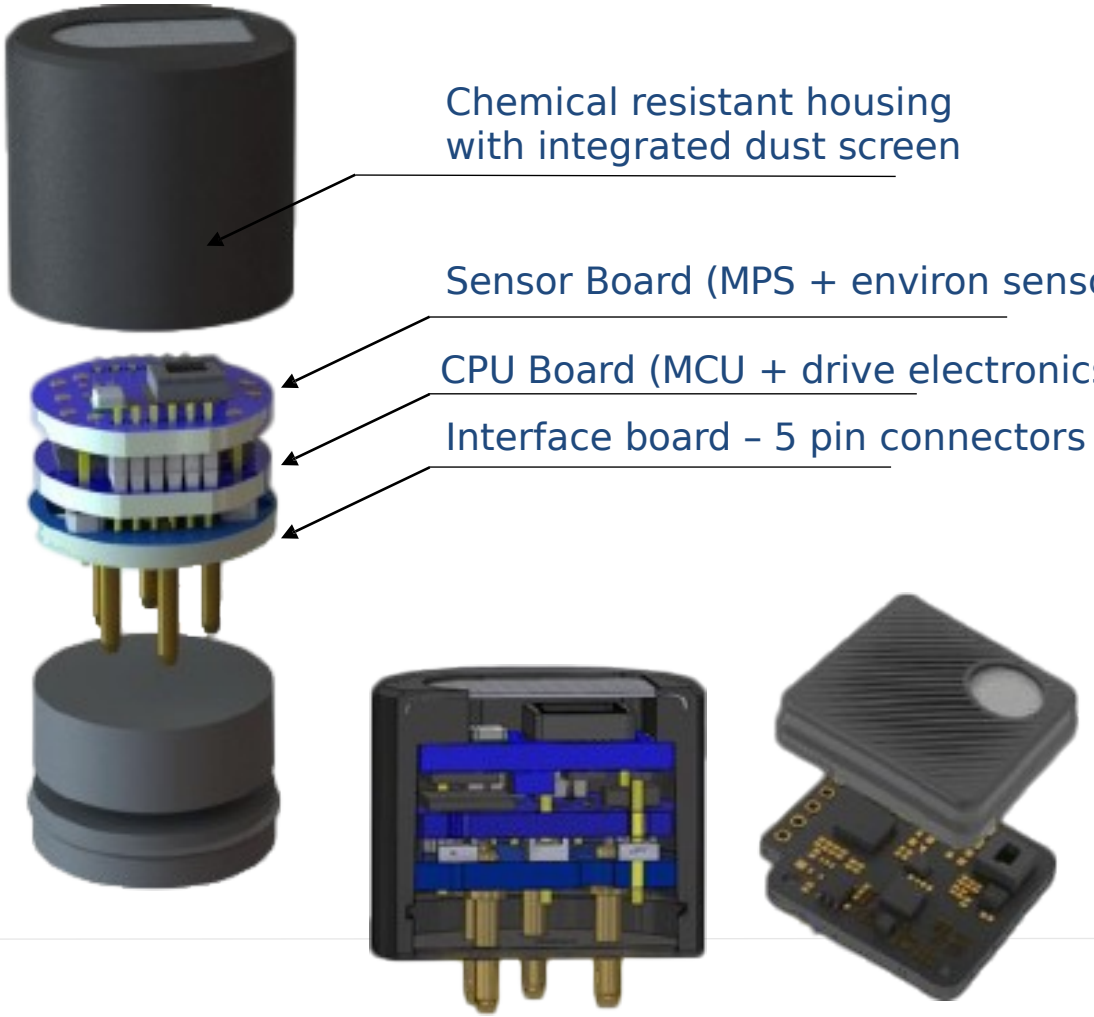
The sensor uses this curve as a base-line and measures the thermodynamic properties of the air/gas mix every two seconds by heating the membrane to 900˚C and taking measurement at five points on the temperature scale.

Results are then compared to data stored in the processor to identify the gas class and concentration.

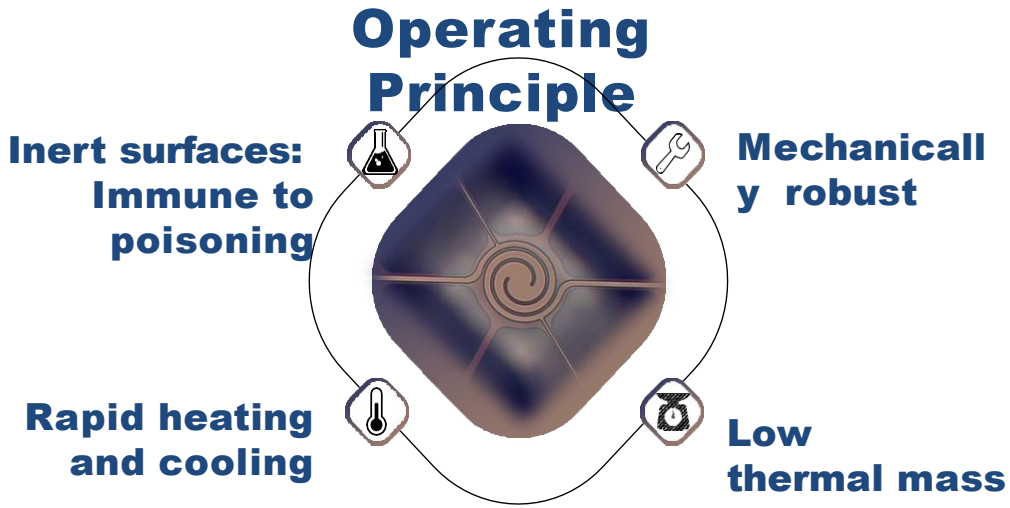


MORE THAN A SENSOR

MPS smart sensor module



Operating Principle

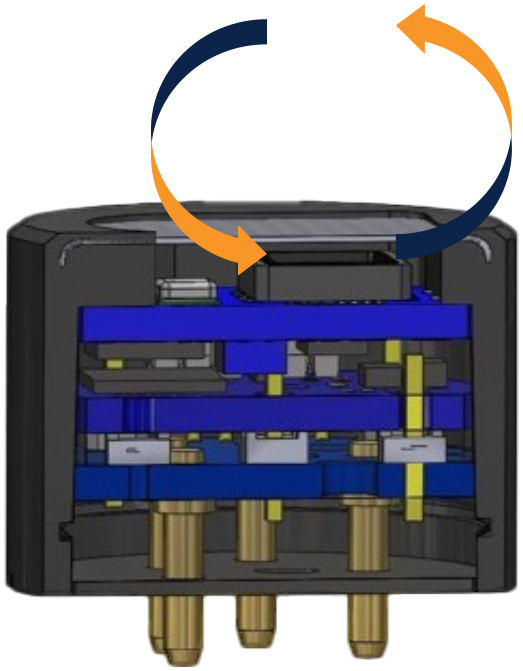


- Transducer is a MEMS (micro electromechanical system) membrane with an embedded Joule heater and resistance thermometer.
- The MEMS transducer is mounted on a PCB within a rugged enclosure open to ambient air.
- Measurements of the thermodynamic properties of the air/gas mixture
- Sensor data is processed by patent-pending algorithms to report accurate concentration and classify the flammable gas

Software Enables MPS Versatility to Accurately Target Specific Applications

MORE THAN A SENSOR

MPS smart sensor module

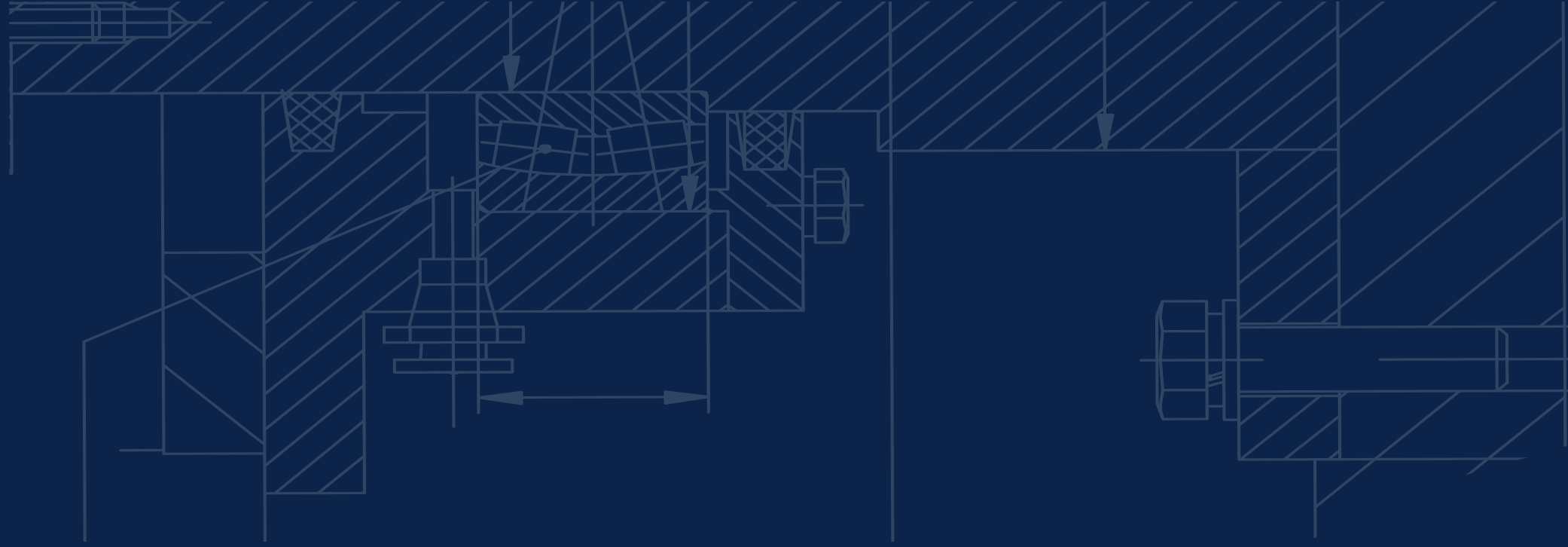


STEP-BY-STEP How does the MPS sensor detect gas, and how does the environmental sensor help establish a baseline measurement?

1. Gas rapidly defuses through the sensor's mesh screen and into the sensor chamber, entering the MEMS sensor module.
2. The joule heater rapidly heats the hot plate.
3. Real-time environmental conditions (temperature, pressure, and humidity) are measured by the integrated environmental sensor.
4. The energy required to heat the sample is precisely measured using a resistance thermometer.
5. The gas level, corrected for gas category and environmental conditions, is calculated and output to the gas detector.

In short:

- The MPS take advantage of thermodynamic properties of the air/gas mixture
- The system measures the energy to heat the sensor module
- With environmental data this allows us to calculate the gas level and classification



HYDROGEN APPLICATIONS

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Green Hydrogen Production

Hydrogen Filling Stations

Hydrogen Storage

Hydrogen Transportation

- # QUESTIONS?

crowcon

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STAY CONNECTED

Talk to us!

andy.avenell@crowcon.com

www.crowcon.com