Sensors Converge

Innovative MEMS-Based Thermal Conductivity Sensors for Hydrogen Detection

Federico Pasquini, Director, Sales and Marketing, N.E.T. s.r.l,

June 21, 2023 | Santa Clara, CA

#SensorsConverge

Agenda

1. THE HYDROGEN ECONOMY IS UPON US
2. APPLICATIONS AND DETECTION SCENARIOS
3. HYDROGEN SAFETY CONCERNS
4. COMMON HYDROGEN DETECTION TECHNOLOGIES
5. THERMAL CONDUCTIVITY SENSORS
6. NET KATHAROMETER GAS TECHNOLOGY
7. NET MAK (MEMS ANALOGUE KATHAROMETER)
8. CONCLUSIONS

n.e.t. innovative gas sensing

Federico Pasquini | Director, Sales&Marketing
email | federico.pasquini@nenvitech.com
www.nenvitech.com

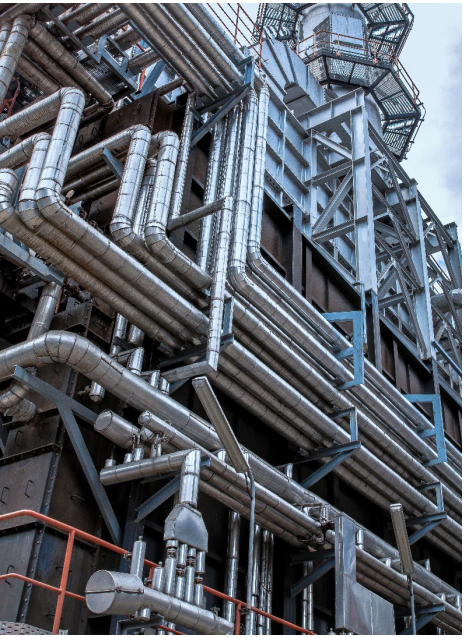
twenty years of advanced solutions for gas detection 20 YEARS ANNIVERSARY

THE HYDROGEN ECONOMY IS UPON US

- A global sustainability effort is undergoing to significantly increase use of hydrogen between here and 2050.
- More and more, in the upcoming future, hydrogen will be used to decarbonize entire economic sectors.
- Hydrogen is highly energetic and extremely environment friendly: it can be created from water using renewable sources such as wind and solar power.
- Hydrogen combustion only releases water vapor into the atmosphere.

APPLICATIONS AND DETECTION SCENARIOS

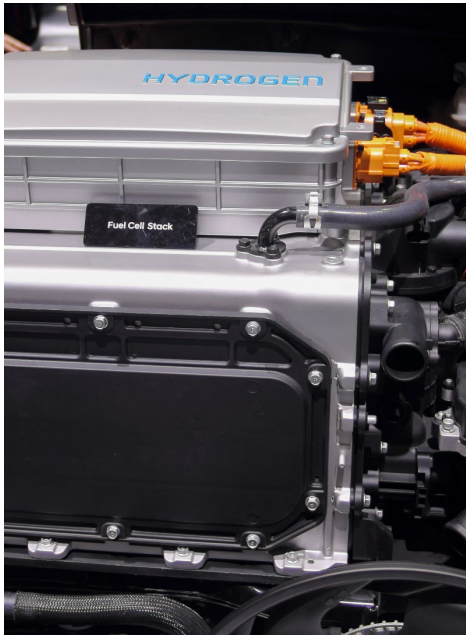
HEAVY INDUSTRY



LITHIUM BATTERY LEAKS

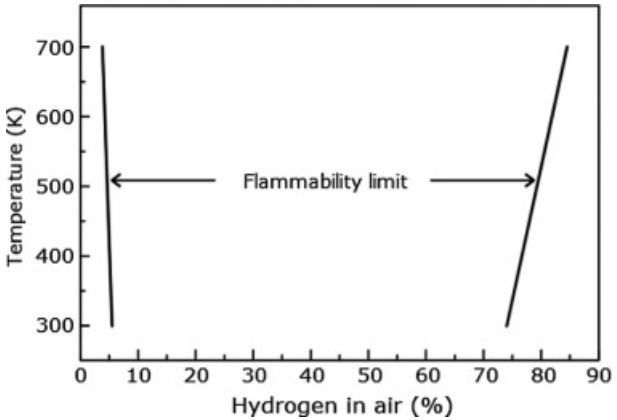
NATURAL GAS SUBSTITUTE IN GRIDS

FUEL CELLS



HYDROGEN SAFETY CONCERNS

- Hydrogen is one of the most explosive and oxygen-reacting gases known to man, combusting at even low concentrations (LFL 4% volume, UFL 74%volume).
- Hydrogen is colorless, odorless and tasteless.
- The availability of reliable and selective detection technologies will become vital for a safe transition.



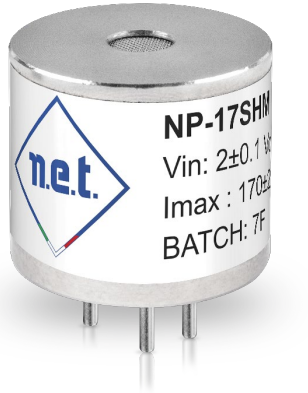
COMMON HYDROGEN DETECTION TECHNOLOGIES

ELECTROCHEMICAL CELLS

- ❑ Detection range: up to 5.000ppm (0.5%vol)
- ❑ Typical long-term drift: 2%/month
- ❑ Typical operating life: 24 months in air
- ❑ Cross sensitivity to other gases
- ❑ Potential replacement required after high exposures
- ❑ Can only operate in presence of Oxygen

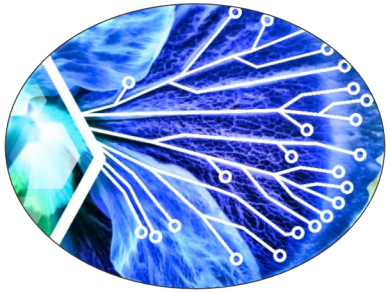
CATALYTIC BEAD SENSORS

- ❑ Detection range: up to 100% LFL (4%vol)
- ❑ Effectively Linear to 60% LEL
- ❑ Typical long-term drift: 5% LEL/3 Months
- ❑ Reacts to any flammable gas
- ❑ Potential replacement required after high exposures
- ❑ Susceptible to contamination and poisoning
- ❑ Can only operate in presence of Oxygen

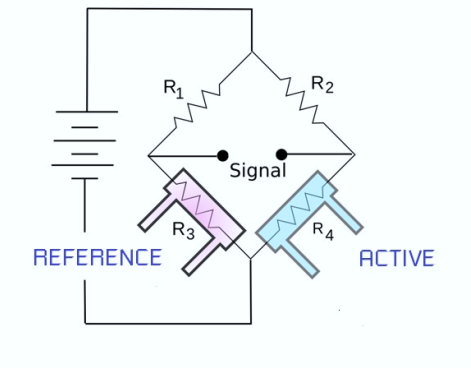


THERMAL CONDUCTIVITY SENSORS

- A thermal conductivity sensor, also known as a katharometer, is a common technology allowing measurement of the concentration of flammable gases, also above the Lower Flammability Level (LFL).
- Traditional thermal conductivity sensors suffer from high power requirements and demand high level of precision and craftsmanship in manufacturing.
- Employing very repeatable, high-volume Single-wafer CMOS (Complementary metal-oxide-semiconductor) MEMS technology, is significantly lowering production costs and power consumption.



NET KATHAROMETER GAS TECHNOLOGY



Both dies are heated using constant current and run in a classic Wheatstone bridge circuit.

- Thermal conductivity sensors measure the concentration of gases having thermal conductivity significantly different to a reference gas (normally, air), between 0 and 100% volume.
- Thermal conductivity sensors measure the change in heat loss of the active die in the presence of the target gas.
- Thermal conductivity sensors perform best in applications where interfering gases are absent, or their cross sensitivity is within the acceptable margin of error required by the application.

- Thermal conductivity sensors are most effective when detecting gases with low molecular weight, which correspond to greater thermal conductivity – such as **Hydrogen**, possessing possesses the highest thermal conductivity of all known gases, and Helium.

NET MAK (MEMS ANALOGUE KATHAROMETER)

KATHAROMETER

gas technology

- Detection range: ppm to 100% volume
- Long-term reliability (0.5 % F.S./year), no chemical reaction/contamination
- Reliable in harsh environments
- Fast response time (< 1.4 s)
- High resolution (2 ppm of H_2)
- Long expected lifetime
- Internal heat cavity, minimizing conduction and natural convection
- Can operate without the presence of Oxygen
- Industry proven technology (used for flow and vacuum pressure sensors)
- Low working temperature (~2ºC above ambient)
- intrinsically safe, while avoiding condensation
- MEMS membrane-based sensor: great resistance to mechanical shocks
- Environmental compensation
- Standard industrial size and footprint
- Standard industrial output (voltage, bridge, Modbus)

CONCLUSIONS

- Thermal conductivity is a promising technology for the detection of Hydrogen
- Effective in different application conditions, included harsh environments
- CMOS MEMS technology ensure reliable and cost-effective production
- Safe and stable technology: no chemicals, no optics/lamps, no resonating/moving parts
- Low power consumption
- A need for a strong environmental compensation and effective calibration

THANK YOU FOR YOUR ATTENTION

n.e.t. innovative gas sensing

BOOTH #745

Federico Pasquini | Director, Sales&Marketing
email | federico.pasquini@nenvitech.com
www.nenvitech.com

twenty years of advanced solutions for gas detection 20 YEARS ANNIVERSARY