

**Dräger**

# Russell Warn

Product Support Manager – Portable Detection

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I provide product support on portable gas monitors and accessories:  
This can be anything from applications, device operations, to troubleshooting

- 35+ years in the safety industry
- 17+ years with Draeger
- Started in the industry as a field service technician with Henry's Safety Supply in Billings, MT
- Support of Product Manager for product launches
- A pipeline to Global Product Management





# DrägerSensors® A core competence

February 2020, Houston

# SENSOR TECHNOLOGY

## ➤ Electrochemical Sensors (EC)

- Oxygen and Toxic Gases
- Filter Media

## ➤ Catalytic Oxidation Sensors (Cat)

- Combustible Gases
- Thermal Conductivity Detection

## ➤ Infra-red Sensors (IR)

- CO<sub>2</sub> & Ex Versions

## ➤ Photo Ionization Sensors (PID)

- Broad-Range VOC Sensor
- X-am 7000 & X-am 8000



# Basic Terms for EC Sensors

- LEL Lowest concentration (percentage) of a gas or vapor in air capable of producing a flash of fire in presence of an ignition source (arc, flame, heat). Concentrations lower than LEL are 'too lean' to burn. Also called lower flammable limit (LFL).
- PPM Parts Per Million – 10,000 ppm = 1%Vol (1 second in 11.6 days)
- PPB Part Per Billion – 1,000 ppb = 1 ppm (1 second in 31.69 years)
- %Vol Percent by Volume – 1%Vol = 10,000 ppm = 10,000,000 ppb
- T<sub>90</sub> Response time to 90% of the applied gas value
- T<sub>50</sub> Response time to 50% of the applied gas value

# Basic Terms

Relative Sensitivity – Response to 1 ppm target gas based on the sensor’s standard calibration.

Examples: XXS OV sensor:

- 1 ppm methanol displays 0.35 ppm

- 1 ppm propene displays 0.65 ppm

Measurement range/ relative sensitivity		C <sub>2</sub> H <sub>4</sub> O <sup>1)</sup>
	0 to 200 ppm C <sub>2</sub> H <sub>4</sub> O (ethylene oxide)	1.00
	0 to 200 ppm C <sub>3</sub> H <sub>6</sub> O (propylene oxide)	0.85
	0 to 100 ppm C <sub>2</sub> H <sub>4</sub> (ethene)	0.60
	0 to 100 ppm C <sub>3</sub> H <sub>6</sub> (propene)	0.65
	0 to 100 ppm C <sub>2</sub> H <sub>3</sub> Cl (vinyl chloride)	0.60
	0 to 200 ppm CH <sub>3</sub> OH (methanol)	0.35
	0 to 100 ppm CH <sub>2</sub> CHCHCH <sub>2</sub> (butadiene)	1.40
	0 to 100 ppm HCHO (formaldehyde)	0.80
	0 to 300 ppm (H <sub>3</sub> C) <sub>2</sub> CHOH (isopropanol)	0.35

Correct application: gas reading ÷ relative sensitivity = actual gas value

1 ÷ 0.65 = 1.54 display correction factor for propene

# XS & XXS ELECTROCHEMICAL (EC) SENSORS










# ELECTROCHEMICAL (EC) SENSORS

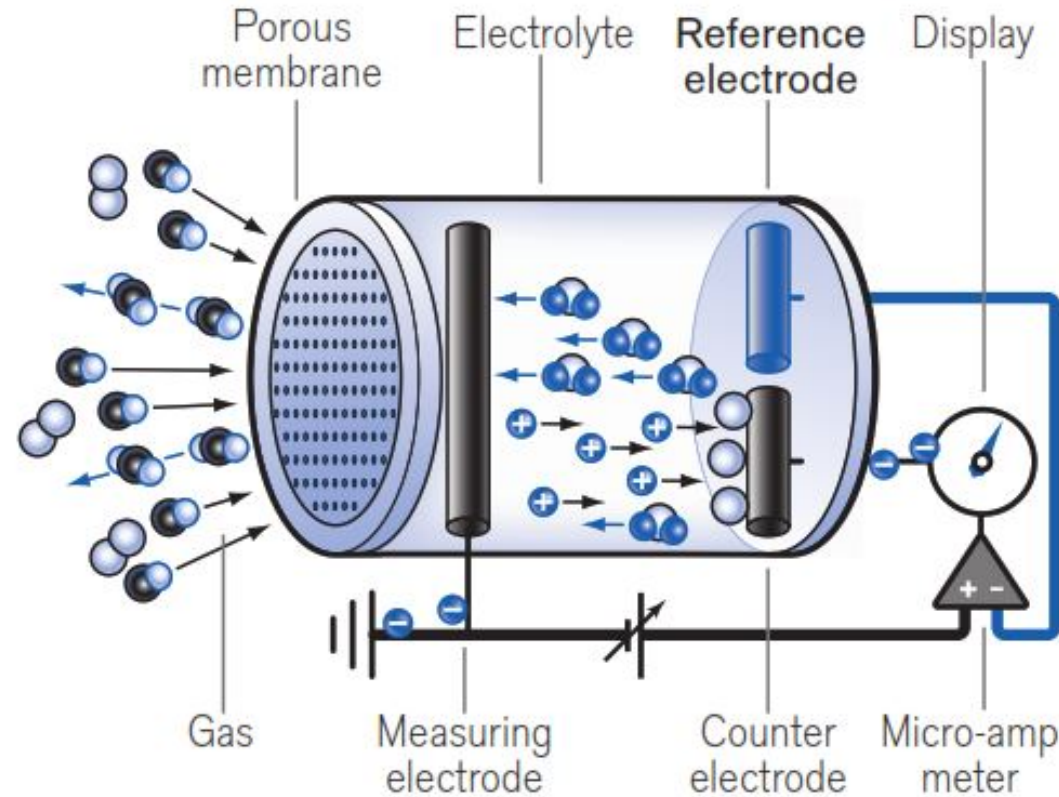
- Response is based on a chemical reaction that produces an electrical response/signal.
- The more gas that is present, the larger the signal that is generated by the sensor.
- This signal is directly proportional to the gas that is present.



# ELECTROCHEMICAL (EC) SENSORS

## Electrochemical sensor

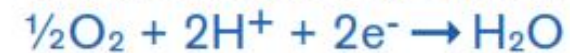
-  **CO-Molecule**  
Target gas, enters into the measuring electrode
-  **CO<sub>2</sub>-Molecule**  
Reaction product, leaves the measuring electrode
-  **H<sub>2</sub>O-Molecule**  
part of the electrolyte
-  **H<sup>+</sup> Hydrogen-Ion**  
positive charge (because one electron is missing)
-  **Oxygen atom**
-  **Oxygen-Molecule**  
from the ambient air
-  **Electron**



Chemical reaction at the measuring electrode



Chemical reaction at the counter electrode



# ELECTROCHEMICAL (EC) SENSORS

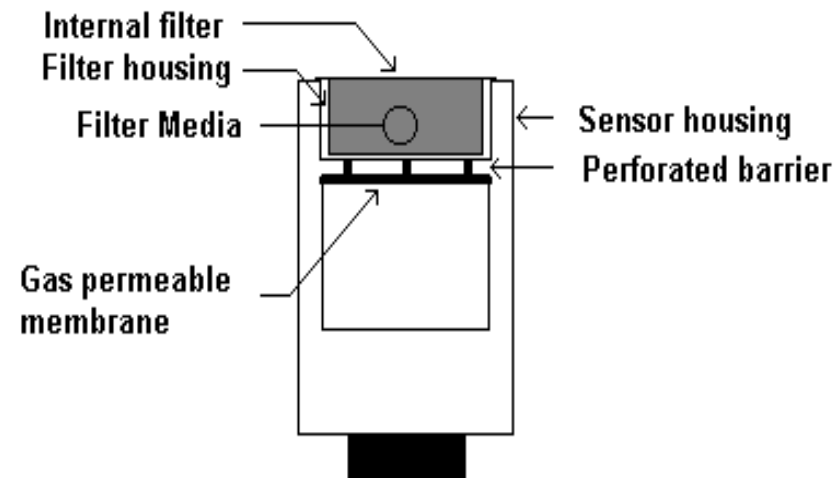
How are the sensors made specific to one particular gas or vapor?

- Choice of Inlet Filter Media, Diffusion Membrane, Electrolyte, Electrodes, and Bias Voltage
- Dräger's Three-Electrode Technology maximizes response to the gas of concern and minimizes the response to other chemicals.
- Gases with similar elements, chemical properties, or chemical bonds may produce similar reactions.
- Gases with opposite chemical properties may produce a negative reaction.

# FILTER MEDIA – XS SERIES SENSORS

## Chemical Filters

- **D3T for CO Sensor**
  - OV's and H<sub>2</sub>S
- **B2T for NO and Odor Sensor**
  - H<sub>2</sub>S and SO<sub>2</sub> removal
- **K1T for SO<sub>2</sub> Sensor**
  - H<sub>2</sub>S



# FILTER MEDIA - XXS SERIES SENSORS

## Chemical Filters

- **B2X**
  - Use with XXS HCN, HCN PC or Odorant Sensor to remove H<sub>2</sub>S and SO<sub>2</sub> interference
  - P/N 6812424
  - pkg 5ea
- **KX**
  - Use with XXS SO<sub>2</sub> Sensor to remove H<sub>2</sub>S interference
  - P/N 6811344
  - pkg 1ea



# ELECTROCHEMICAL (EC) SENSORS

What is the expected life of a sensor?

- This varies with the type of sensor.
- The Draeger XS Sensors for CO, H<sub>2</sub>S & O<sub>2</sub> have Two, Three or Five-year Warranties and the standard XXS CO, H<sub>2</sub>S & O<sub>2</sub> sensors now carry a Five-year warranty when sold in a multi-gas monitor.
- The XS stands for “eXtra Stability”, this design allows the sensor to operate longer and more stable over it’s life.
- Life is NOT always determined by exposure to gas, but is more dependent on time.

# ELECTROCHEMICAL (EC) SENSORS

How can Draeger warranty their O<sub>2</sub> sensor for 3+ years when most O<sub>2</sub> sensors last only about 12-18 months?

- It is not dependent on the amount of gas exposed to the sensor, this results in a longer life.
- The Dräger O<sub>2</sub>, as well as most of our sensors are not consumptive = **what goes in one end is regenerated at the other end**

Formula for electrochemical reaction  
for the DrägerSensor XS EC O<sub>2</sub> LS:



# ELECTROCHEMICAL (EC) SENSORS

How does Temperature effect the sensor?

- In general; these chemical reactions occur quicker and stronger at higher temperatures and slower and weaker at lower temperatures.
- Temperature compensation circuits accurately compensate for changes in ambient temperature.

# ELECTROCHEMICAL (EC) SENSORS

Does Pressure make any difference on the measurement by the sensor?

- Higher ambient pressures will “force” more gas into the sensor and thus produce higher readings.
- The Dräger EC sensors have a pressure compensation port which minimizes the effects of pressure.



# ELECTROCHEMICAL (EC) SENSORS

## Does Humidity effect the Sensor?

- Humidity by itself has minimal effect on the sensor reading.
- However, should condensation occur, and a layer of water covers the sensor, this will prevent the gas from entering the sensor.
- Sensors in very low humidity for extended periods can have water evaporate from the electrolyte causing a reduced sensitivity.
- With exposure back to normal humidity (50% RH), the sensor will re-saturate itself.

# ELECTROCHEMICAL (EC) SENSORS

Can Dust and other Particulate matter make a difference?

- Should enough dust cover the sensor inlet, it could slow down or block gas from entering the sensor.

# ELECTROCHEMICAL (EC) SENSORS

What exactly is a “Smart” Sensor?

- Typically this means that when plugged into a monitor, the instrument recognizes what the sensor is designed to measure.
- An EEPROM on the sensor is used to store the data

# ELECTROCHEMICAL (EC) SENSORS

What is special about the XS Series Dräger-Sensor?

- The XS-2, XS, and XS-R Sensors contain much more data; Gas ID, Calibration Data, Operating Parameters, Temperature Compensation, Measuring Ranges, Alarm Values, etc.
- This information stays with the sensor when installed in another instrument.
- Transportable Calibration !!!

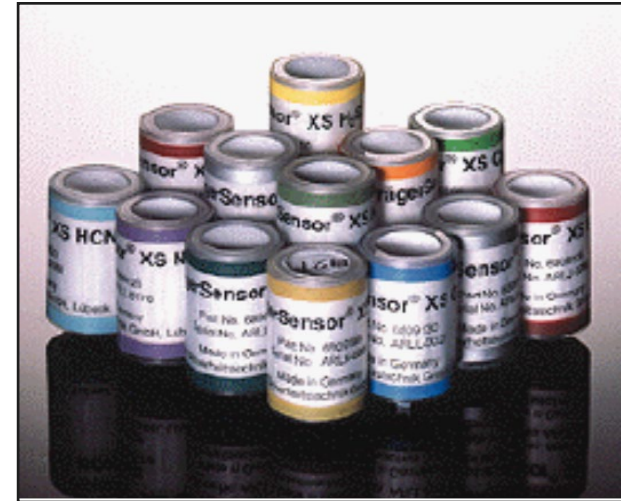
# ELECTROCHEMICAL (EC) SENSORS

How often do you need to calibrate DrägerSensors?

- Per our specifications the CO, H<sub>2</sub>S and O<sub>2</sub> Sensors only require calibration every 12 months (once a year)!
- Most Other Sensors, once every three to six months.

# AVAILABLE DRÄGER-SENSORS® XS EC

- Oxygen
- Carbon Monoxide
- Carbon Monoxide - HC
- Hydrogen Sulfide
- Hydrogen Sulfide 1000
- Sulfur Dioxide
- Organic Vapors
- Organic Vapors - A
- Hydrides
- Hydrogen Peroxide\*
- Nitrogen Dioxide
- Nitric Oxide
- Phosphine 1000
- Hydrogen Cyanide
- Mercaptans
- Chlorine
- Chlorine Dioxide
- Carbon Dioxide
- Amines
- Hydrogen
- Hydrogen HC
- Hydrazine\*
- HF/HCl\*
- Phosgene

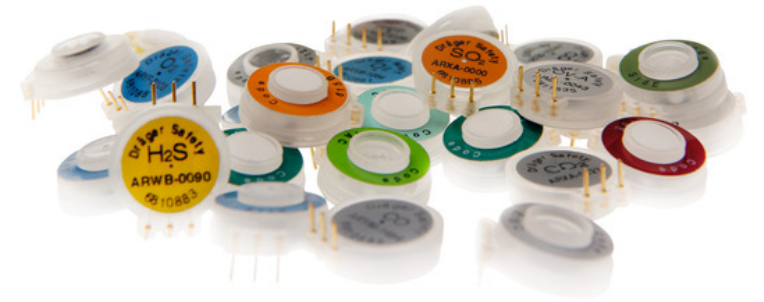


Used in Pac III, MiniWarn, X-am 7000

\*Pac III or X-am 5100 only

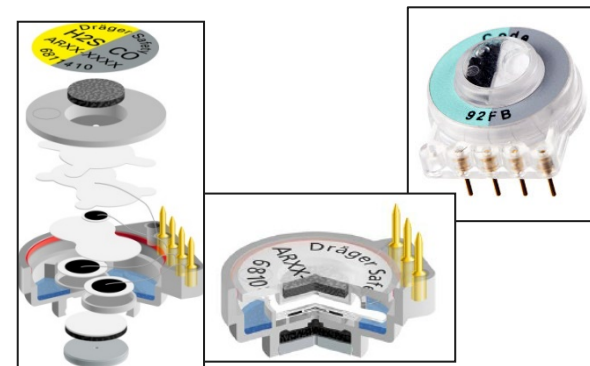
# XXS ELECTROCHEMICAL (EC) SENSORS

- The DrägerSensors XXS have the same or even better measuring performance than the according XS sensors.
- The data sets of the gases are stored in the according instrument
- The XXS sensors are not meant for replacement in the Pac 3500 and Pac 6000.
- The XXS sensors are replaceable in the Pac 5500/7000/6500/8000/8500, X-am 2000/2500, X-am 5x00, X-am 3500 and X-am 8000.
- The instruments have to be recalibrated when a sensor is changed.



# XXS ELECTROCHEMICAL (EC) SENSORS

- Amines
- Ammonia – NH<sub>3</sub>
- Carbon Monoxide – Low Concentration
- Carbon Monoxide - CO
- Carbon Monoxide – High Concentration
- CO with H<sub>2</sub> compensation
- CO-LC/O<sub>2</sub> Combination
- CO/H<sub>2</sub>S Combination
- CO-LC/H<sub>2</sub>S-LC Combination
- **CO-LC/HCN Combination – coming soon**
- Carbon Dioxide – CO<sub>2</sub>
- Chlorine – Cl<sub>2</sub>
- Hydrides (Phosphine, Arsine, Diborane, Silane)
- Hydrogen – H<sub>2</sub> – Low Concentration
- Hydrogen – High Concentration (4.0%)
- Hydrogen Cyanide PC - HCN
- Hydrogen Cyanide - HCN
- **H<sub>2</sub>S/O<sub>2</sub> Combination**
- Hydrogen Sulfide – H<sub>2</sub>S
- Hydrogen Sulfide – Low concentration
- Hydrogen Sulfide – High concentration
- Nitrogen Dioxide – NO<sub>2</sub>
- Nitrogen Dioxide – Low Concentration
- Nitric Oxide – NO
- Odorants (ie: THT, mercaptans)
- Organic Vapors
- Organic Vapors – A
- Oxygen - O<sub>2</sub>
- Oxygen – 100%
- Ozone – O<sub>3</sub>
- Phosgene – COCl<sub>2</sub>
- Phosphine – PH<sub>3</sub> – High Concentration
- Sulfur Dioxide – SO<sub>2</sub>



Used in **Pac xx00**, X-am 1-2-3-5-8000



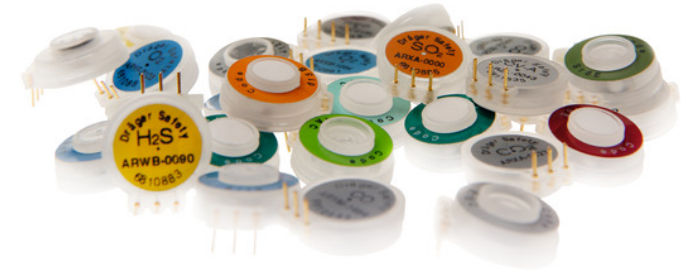
# COST OF OWNERSHIP EXAMPLE

- O<sub>2</sub> Sensor
- 50 X-am 2500 instruments vs Brand X
- Five-Year timeframe

	Price	Qty	Year 1	Year 2	Year 3	Year 4	Year 5	Total
X-am 2500	\$938	50						\$46,900
Brand X	\$695	50		\$225		\$225		\$57,250

# DRÄGER-SENSOR® ADVANTAGES

- Unmatched Warranty on CO, H<sub>2</sub>S, O<sub>2</sub>!!!
- Long periods (up to 1 year) between routine required calibrations.
- Widest variety of gases and vapors detected.
- The O<sub>2</sub> sensor is NOT based on a consumptive reaction.
- Long sensor life.
  - O<sub>2</sub> sensors with expected lifespan of 5+ years.
    - There are 10+ year old O<sub>2</sub> sensors being used in the field today.
- Fast response times with XXS sensors provides for a higher safety level.
  - Also, means less gas is needed for testing.
- Standard XXS O<sub>2</sub>, CO, and H<sub>2</sub>S sensors now covered by a five-year warranty when delivered installed in a multi-gas monitor.
  - All multi-gas monitors sold since December 1, 2018.
  - X-am 2500 always carried five-year warranty on these sensors.
  - Replacement sensors carry standard three-year warranty.



# DRÄGER-TUBES®

Don't forget Dräger-Tubes® or CMS! SKC can help you out with all your needs!



**Free Ground Shipping on tubes with orders of 10 boxes or more.**

# QUESTIONS?

**Here's Chuck Nachreiner to facilitate the question and answer session.**

**Take it away, Chuck!**

# Many thanks

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