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Fixed Gas Detection 101

Your Host

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GAS DETECTION FUNDAMENTALS

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Agenda

- What is a Gas?
- Gas Hazards
- Gas Detection Applications
- Detection Technology: Combustible Gas
  - Catalytic Bead Sensor
  - Non-Dispersive Infrared
  - Photo Ionization (PID)
- Detection Technology: Toxic & Asphyxiate Gases
  - Electrochemical
  - Chemcassette®
- Summary

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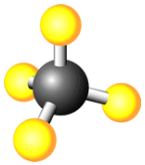
What is a Gas?



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Three Types of Gas Hazards

Flammable or Explosive

Property Damage
Loss of Life
Personal Injury
Destruction of Environment

Toxic

Physical Harm
Loss of Life

Asphyxiates

Physical Harm
Loss of Life

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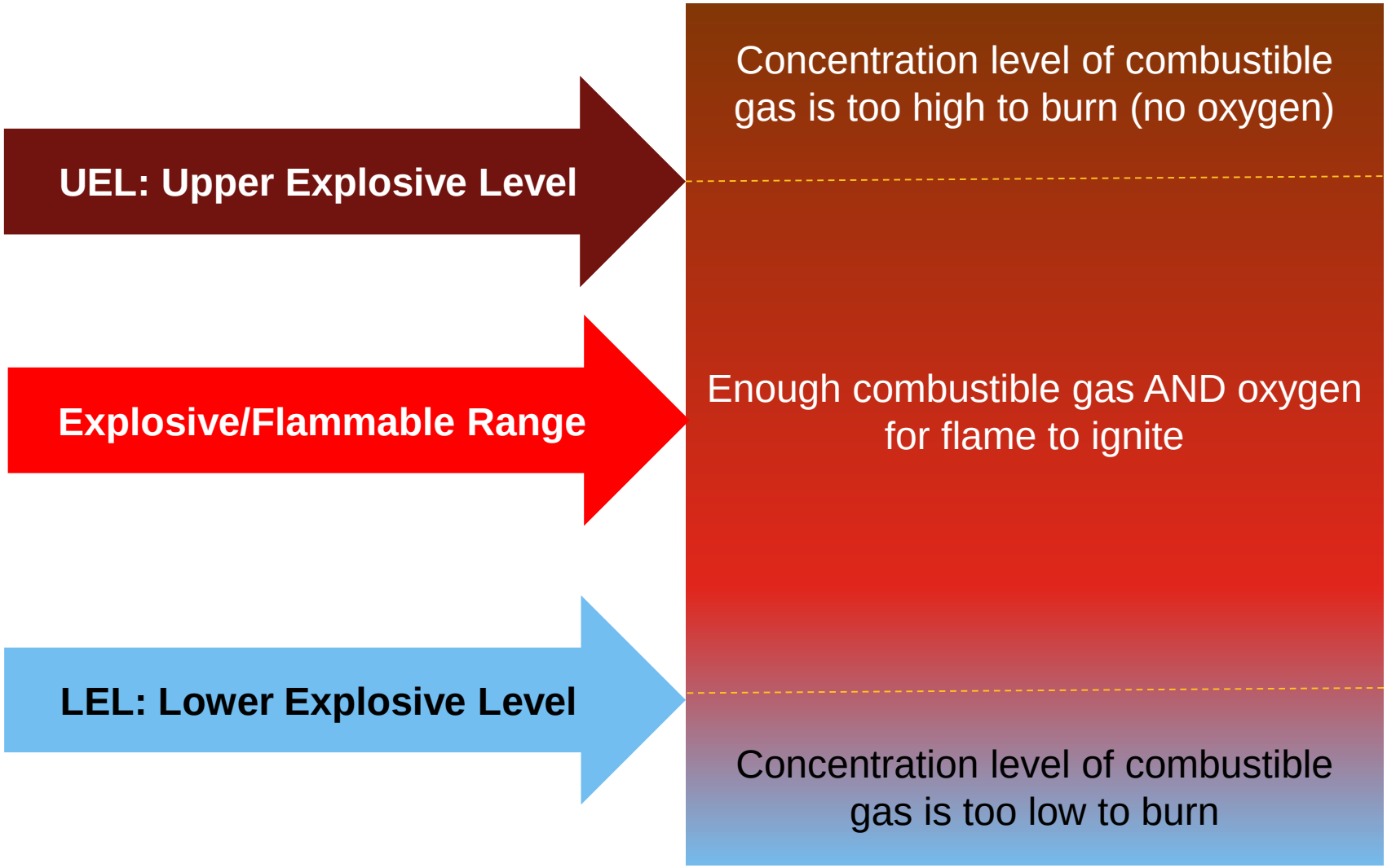
Combustible Gas

Terms to Know:

Concentration Level (Combustible Gasses)



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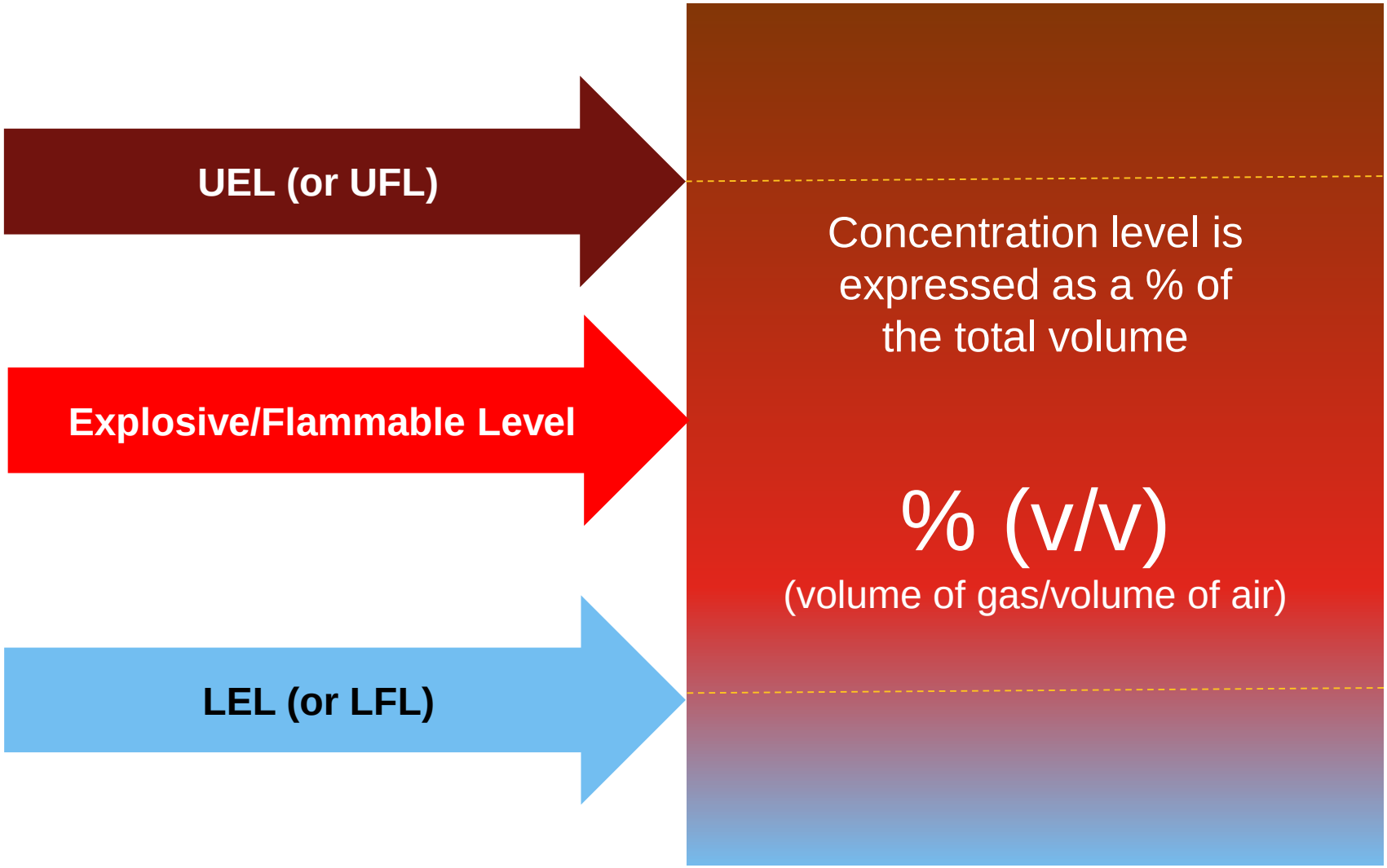
Terms to Know:

Concentration Level (Combustible Gasses)



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Examples of Combustible Gases

	Gas	LEL	UEL
C_3H_8	Propane	2.2%	9.5%
H_2	Hydrogen	4%	75%
CH_3CH_2OH	Methanol	6%	36%
C_2H_6	Ethane	3%	12%
CH_3OH	Ethanol	3%	19%
CH_4	Methane	5%	15%

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Toxic Gas

Terms to Know: Concentration Levels

PEL	Permissible Exposure Limit	The legal limit for exposure to a substance.
TWA	Time Weighted Average	Average exposure over a specified time, usually 8 hours.
STEL	Short-Term Exposure Limit	Average exposure over a short period of time, usually 15 minutes.
TLV	Threshold Limit Value	A worker can be exposed day after day for a working lifetime without adverse effects.
IDLH	Immediate Danger to Life or Health	Exposure level will immediately endanger life/health.

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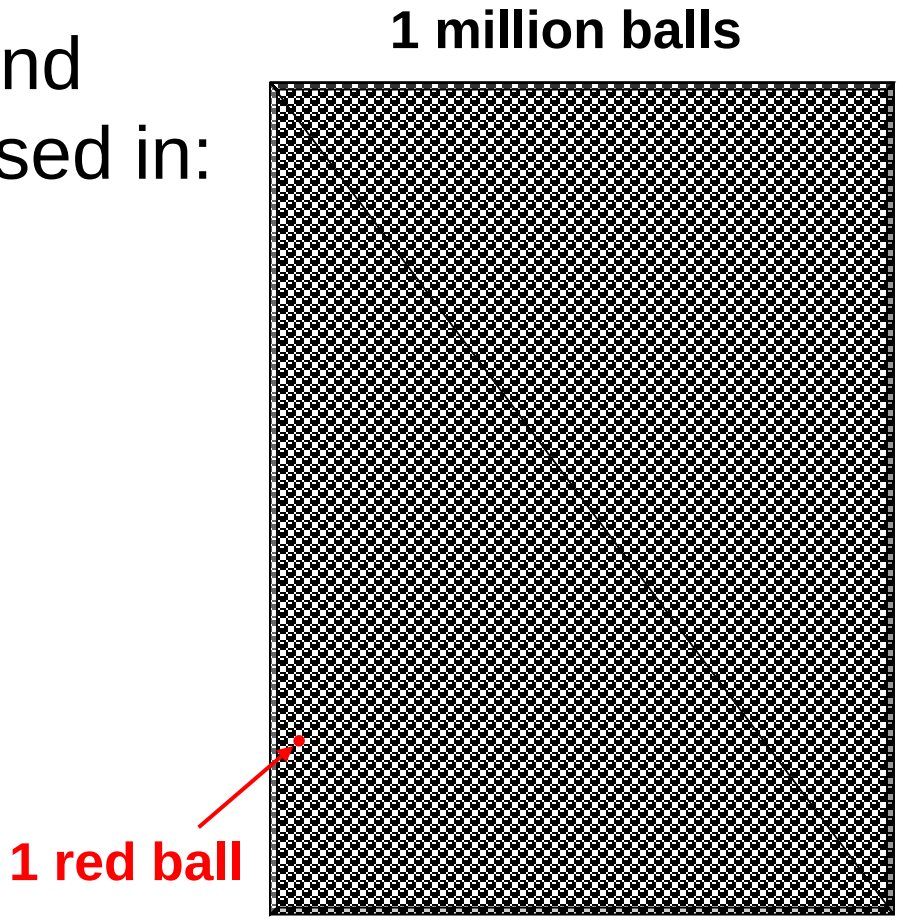
Terms to Know: PPM/PPB

PEL, TWA, STEL, TLV and IDLH are usually expressed in:

- PPM Parts Per Million
- PPB Parts Per Billion



Examples of Toxic Gases

NH_3	Ammonia
CO	Carbon Monoxide
CL_2	Chlorine
H_2S	Hydrogen Sulfide
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
SO_2	Sulfur Dioxide

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Asphyxiate Gas

Asphyxiate Gases

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Gas Detection Applications

Typical Areas that Require Gas Detection

Food Processes

Power Generation

Water Treatment

Cold Storage

Laboratory / Medical

Parking Structures and Tunnels

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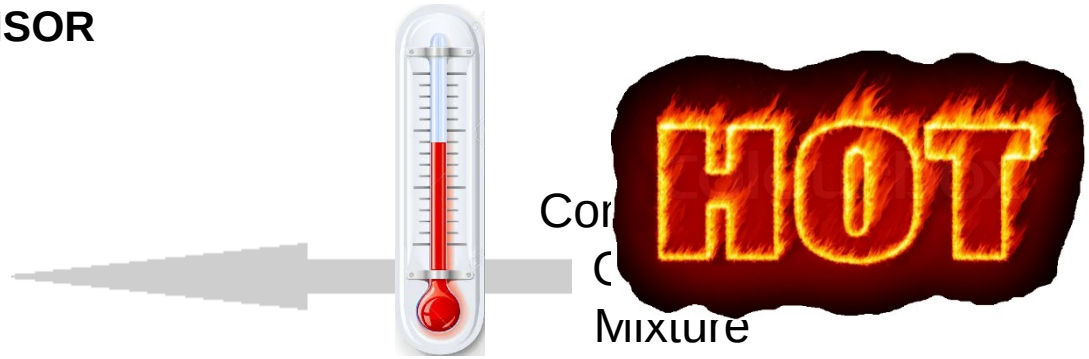
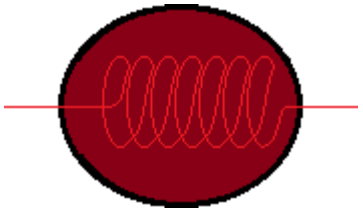
Using Technology to Detect Gas

Detection Technology – Combustible Gas

CATALYTIC BEAD SENSOR





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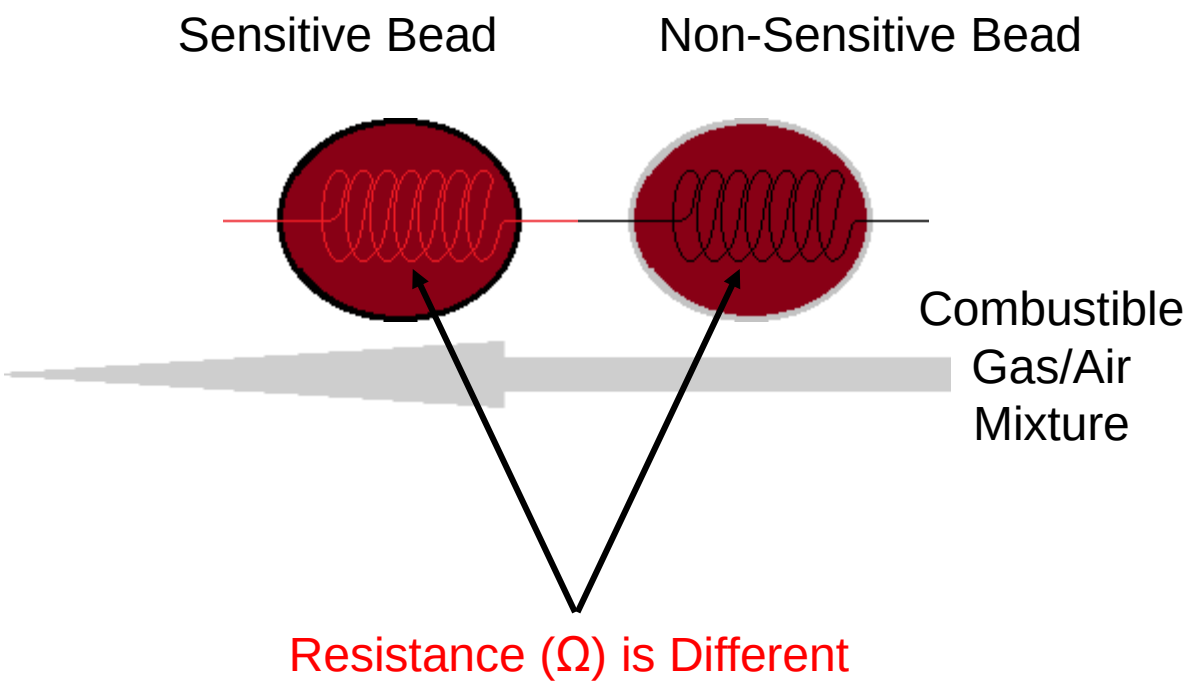
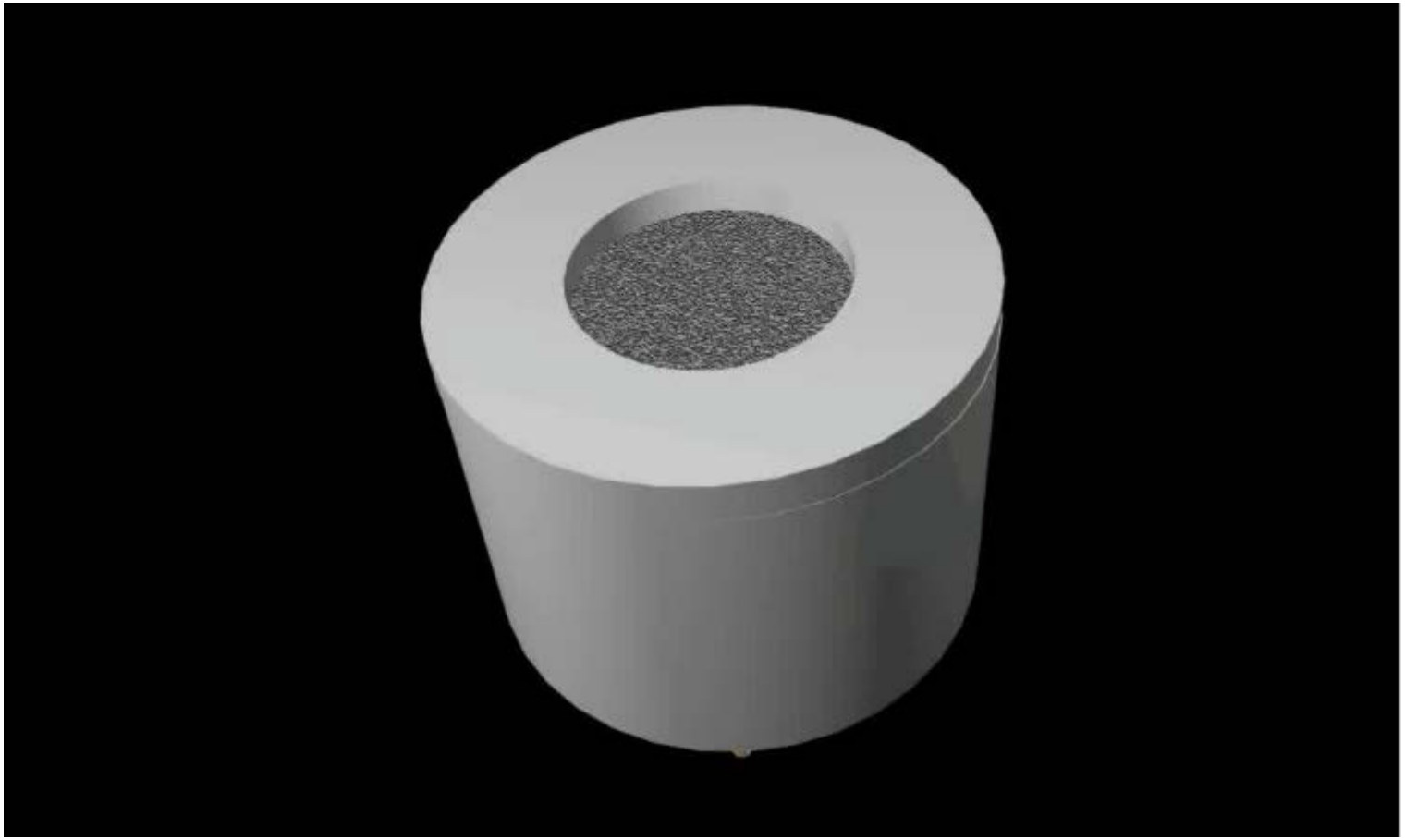
Detection Technology – Combustible Gas

CATALYTIC BEAD SENSOR



Catalytic Bead Sensor Operation



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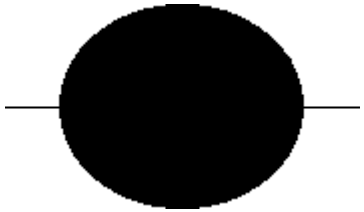
Detection Technology – Combustible Gas

Catalytic Poisoning



Catalytic Gas Detection Pros & Cons

Advantages

- Relatively low cost
- Accurate and linear over sensor detection range relative to calibration gas
- Broad band sensor
- Long history, proven technology

Limitations

- Unable to identify type of gas detected
- Requires sufficient O_2 to support operating principle
- High power consumption
- Not fail safe
  - Poisoned by: sulfurs, silicones, Phosphors & leads
  - Inhibited by: chlorinated & fluorinated hydrocarbons
- Combustible gas readings may not reflect the true concentration of a combustible gas hazard.

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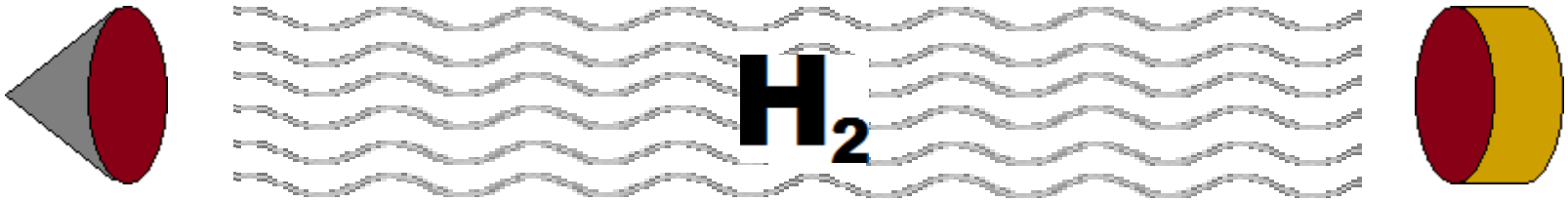
Detection Technology – Combustible Gas

Non-Dispersive Infrared (NDIR)



IR Lamp

IR Detector

Infrared Inactive

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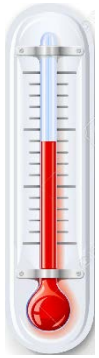
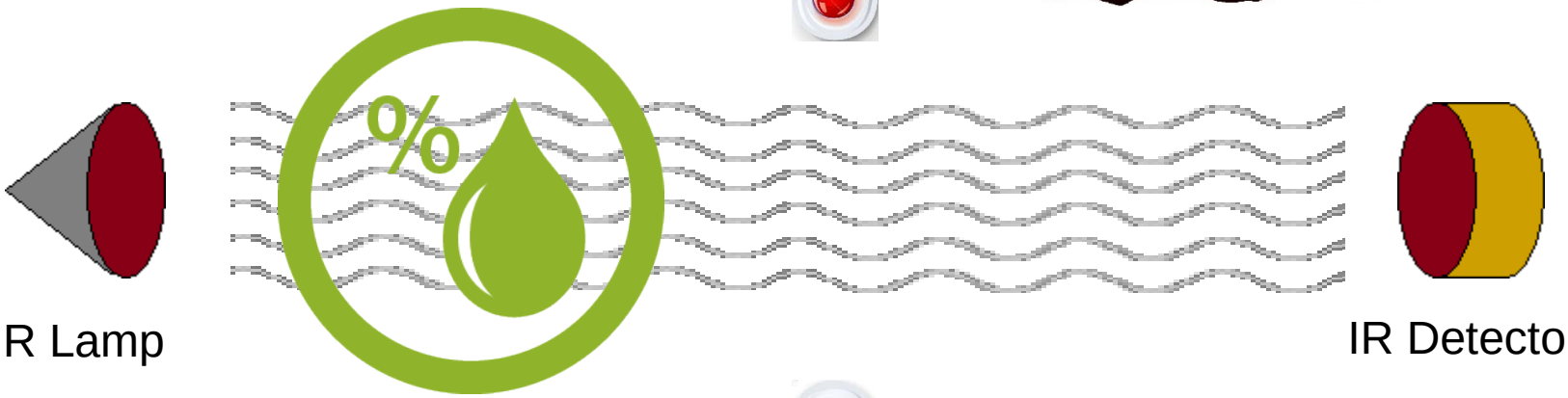
Detection Technology – Combustible Gas

Non-Dispersive Infrared (NDIR)





IR Lamp

IR Detector

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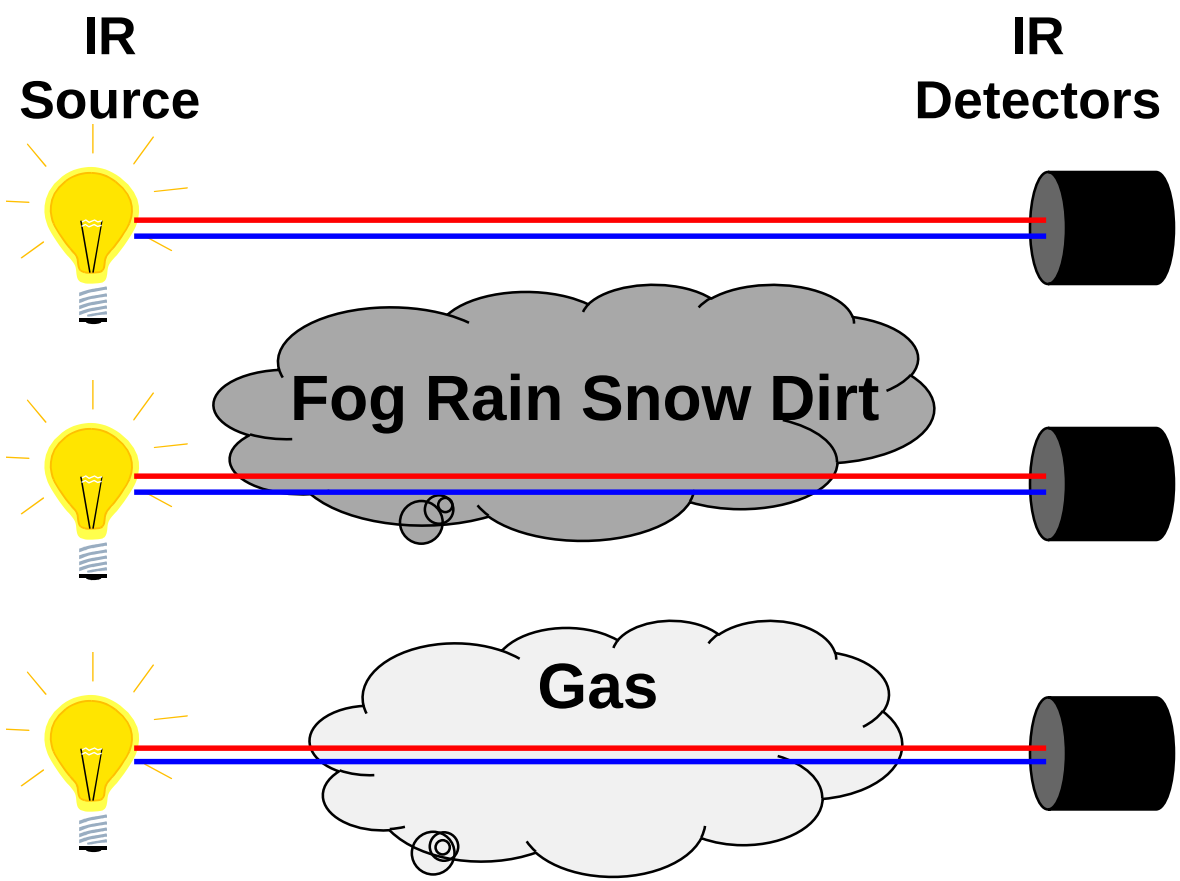
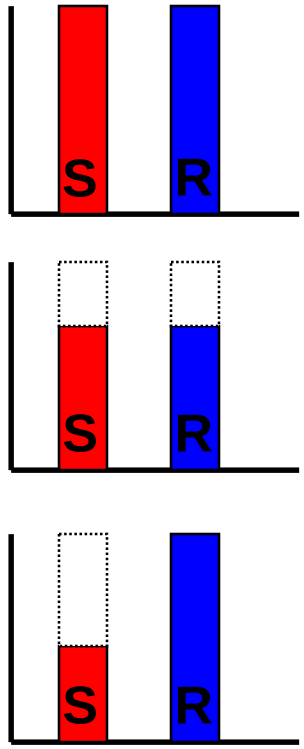
Detection Technology – Combustible Gas

Non-Dispersive Infrared (NDIR)



Sample & Reference signal strengths



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Infrared Gas Detection Pros & Cons

Advantages

- Does not require presence of O_2
- Not affected by typical catalytic poisons
- Lower power consumption than catalytic bead sensor
- Accuracy very stable
- Sensor available for 100% v/v CH_4
- 5 year MTBF - lower cost of ownership over lifespan

Limitations

- Cannot detect hydrogen, acetylene, carbon disulfide
- High cost compared to catalytic bead sensor
- Affected more by changes in temperature and pressure.
- Response is linear to methane but non-linear to other hydrocarbons

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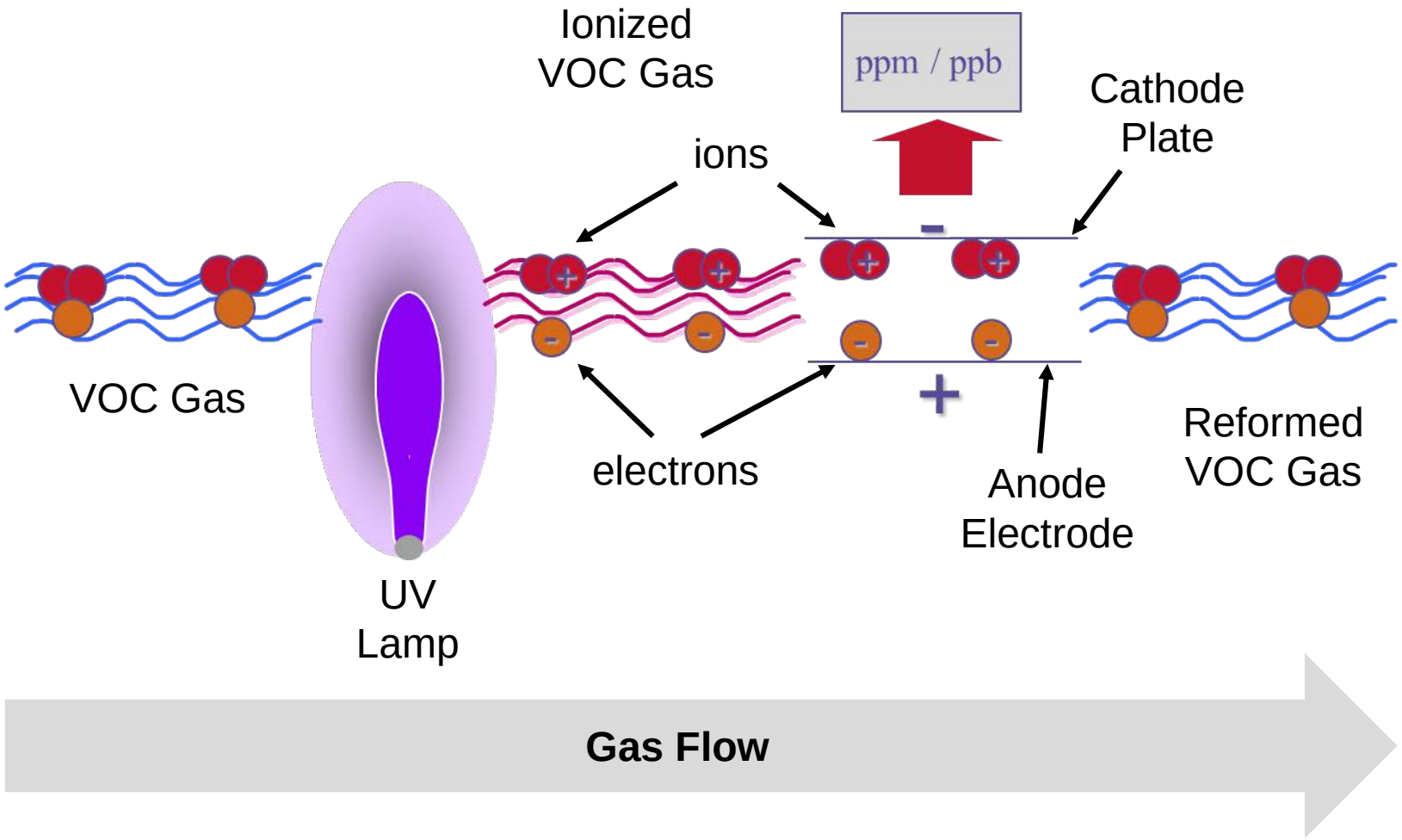
Detection Technology – Combustible Gas

Photoionization Detector (PID)

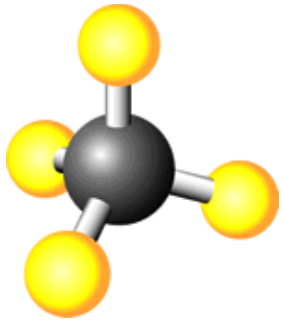


Detection Technology – Combustible Gas

Photoionization Detector (PID)

Nitrogen (N_2) has an eV of 15.58
Oxygen (O_2) has an eV of 12.08
Argon (Ar) has an eV of 15.76
Carbon Dioxide (CO_2) has an eV of 13.78
Other constituents of Air have eV's between 12.13 and 24.59

Ammonia has an eV of 10.2
Benzene has an eV of 9.25
Ethanol has an eV of 10.48
Hydrogen Sulfide has an eV of 10.46
Isopropanol has an eV of 10.16
o-Xylene has an eV of 8.56
p-Xylene has an eV of 8.45



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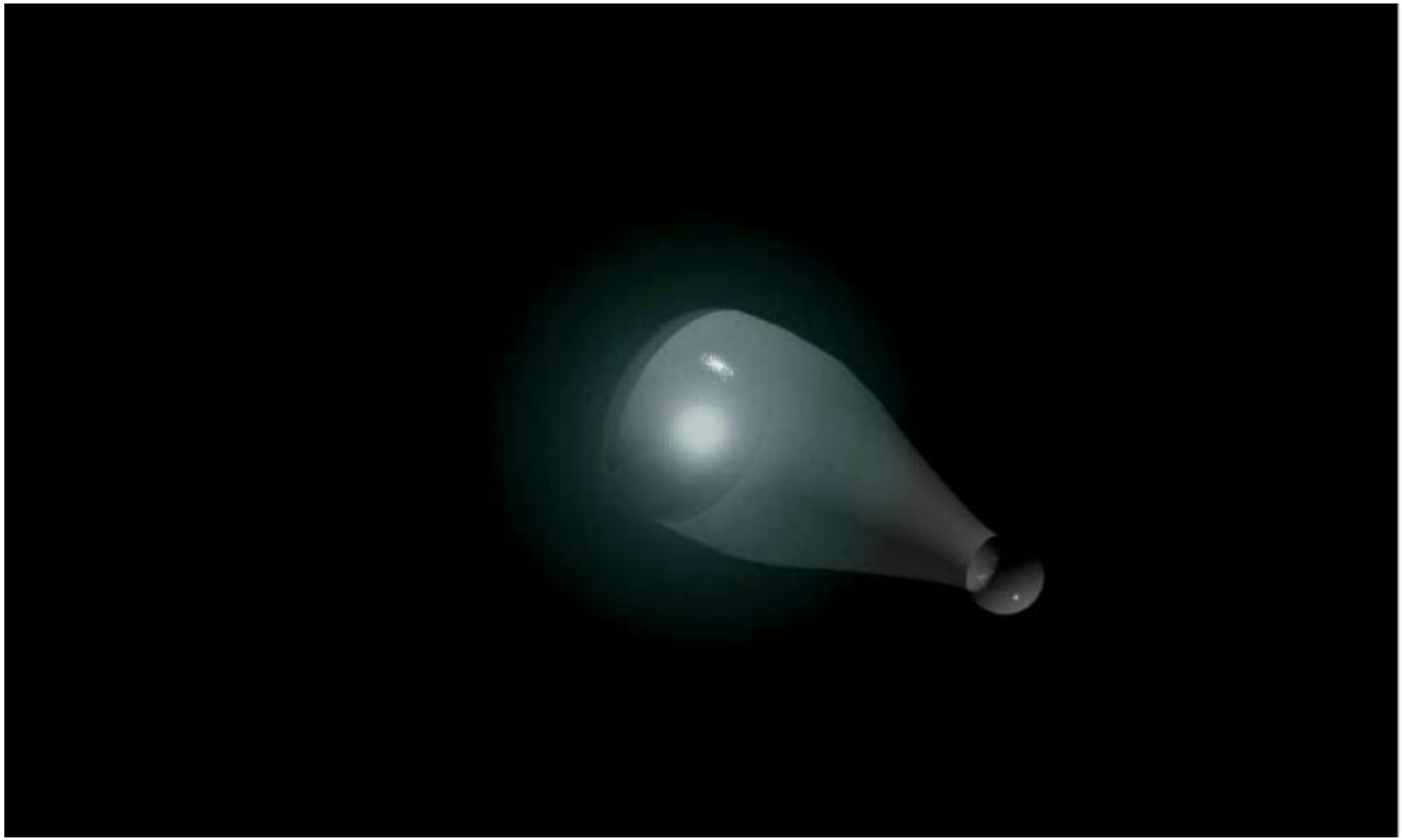
How does a PID work?



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PID Gas Detection Pros & Cons

Advantages

- Relatively low cost detection of a wide range of combustible VOCs, many of which are toxic
- Sensitive to PPM levels – be aware of the lowest detectable limit capability
- Accurate and linear over sensor detection range; but readings are relative to the gas used for calibration – typically isobutylene
- Does not require presence of O_2
- UV Tube is self-cleaning due to the creation of Ozone by the detector

Limitations

- VOCs usually detected by means of broad range sensors
- Broad range sensors provide overall reading for general class or group of chemically related contaminants
- Unable to identify type of gas being detected
- Sensor maintenance may be required

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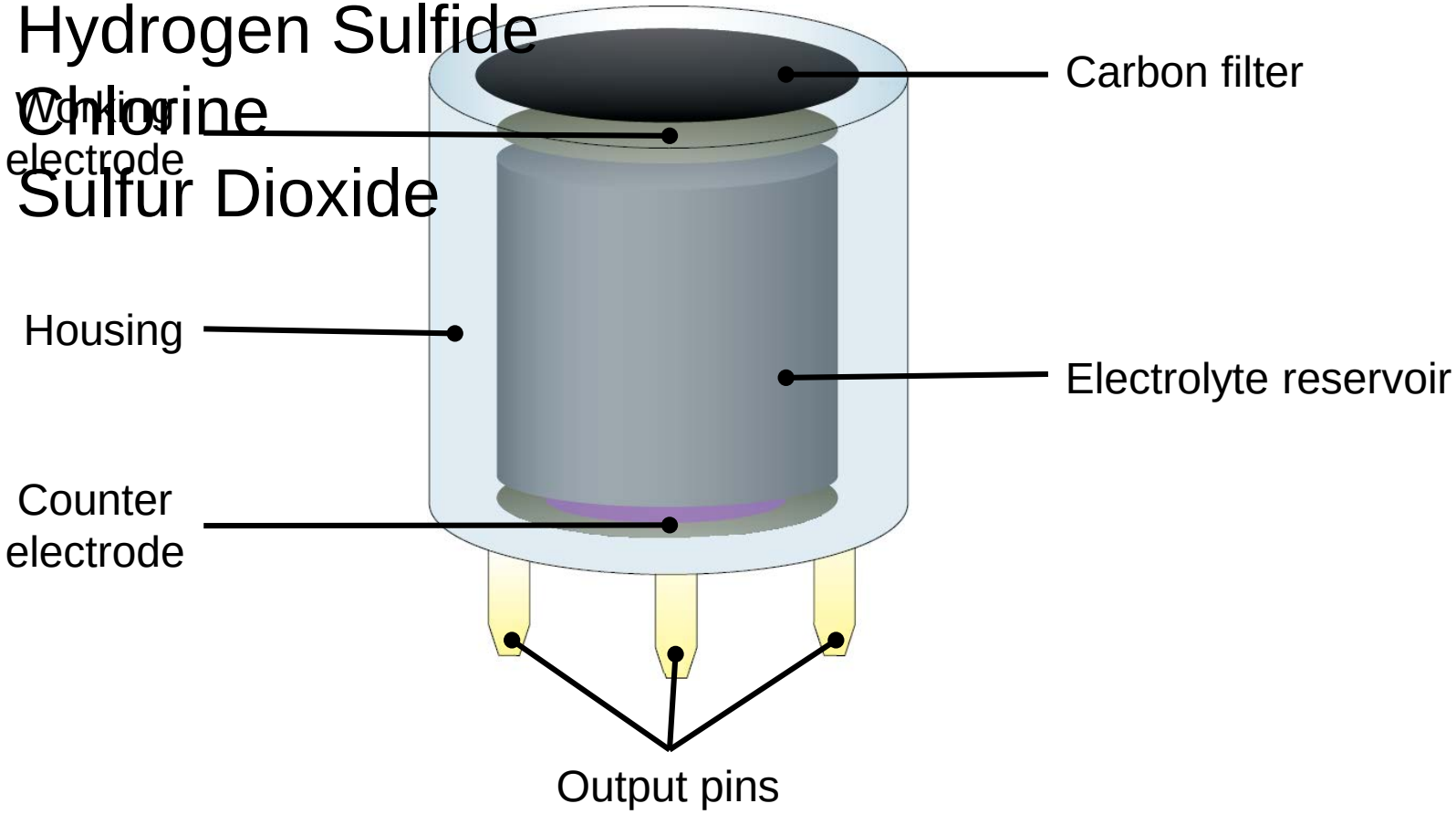
Detection Technology – Toxic Gas

Electrochemical Cell

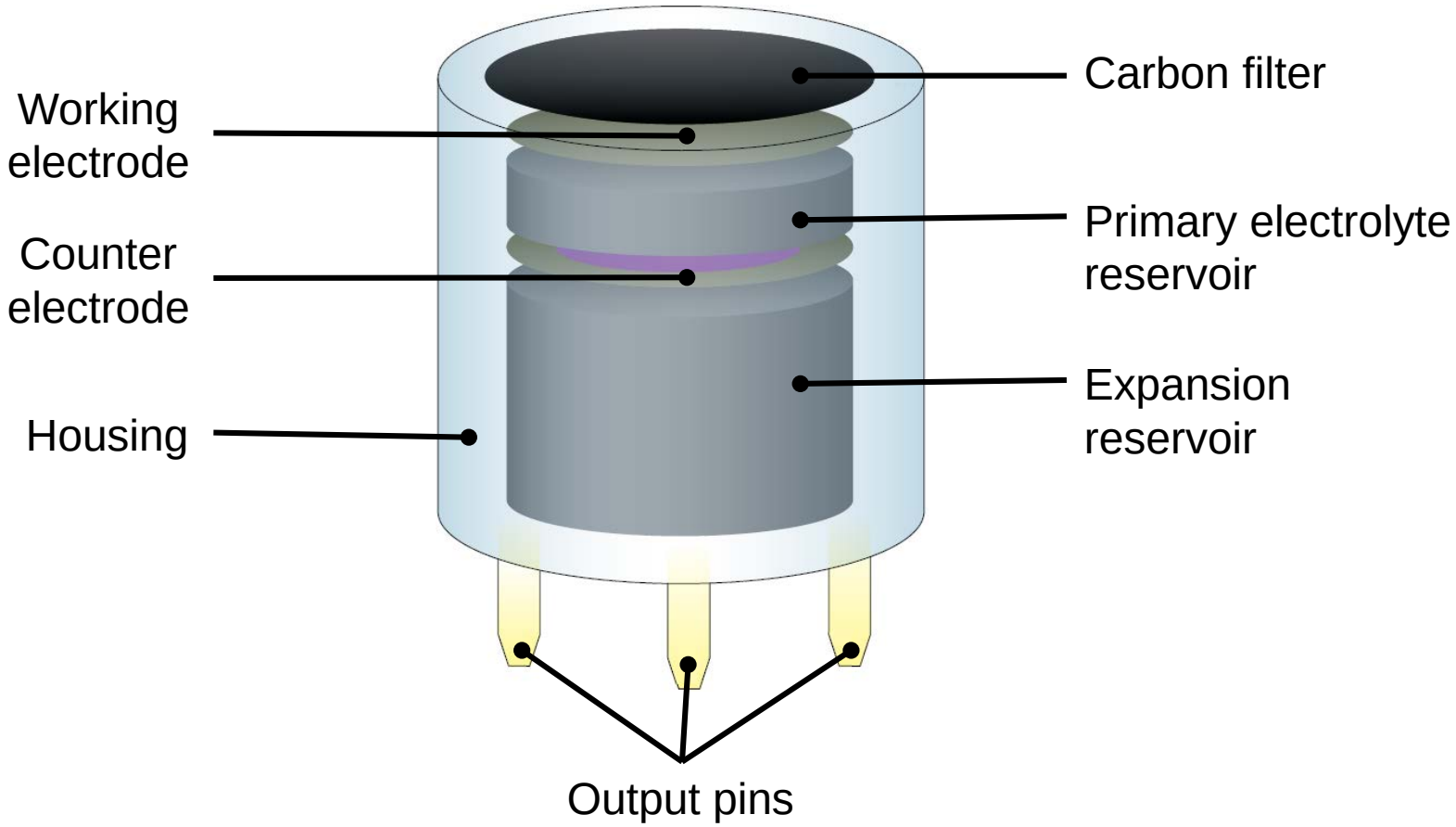
Toxic Gasses:

- Carbon Monoxide
- Hydrogen Sulfide
- Chlorine
- Sulfur Dioxide



Detection Technology – Toxic Gas

Electrochemical Cell (SureCell™ Technology)



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Electrochemical Toxic Gas Sensor Operation

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Electro-chemical Cells Pros & Cons

Advantages

- Relatively low cost
- Sensitive to ppm concentration
- Accurate and linear over sensor detection range
- Typically fail safe operation

Limitations

- Cross sensitivities – response to gases other than the target gas
- Electrolyte contamination
- Some sensors very sensitive to humidity and temperature transients, eg: NO, ETO

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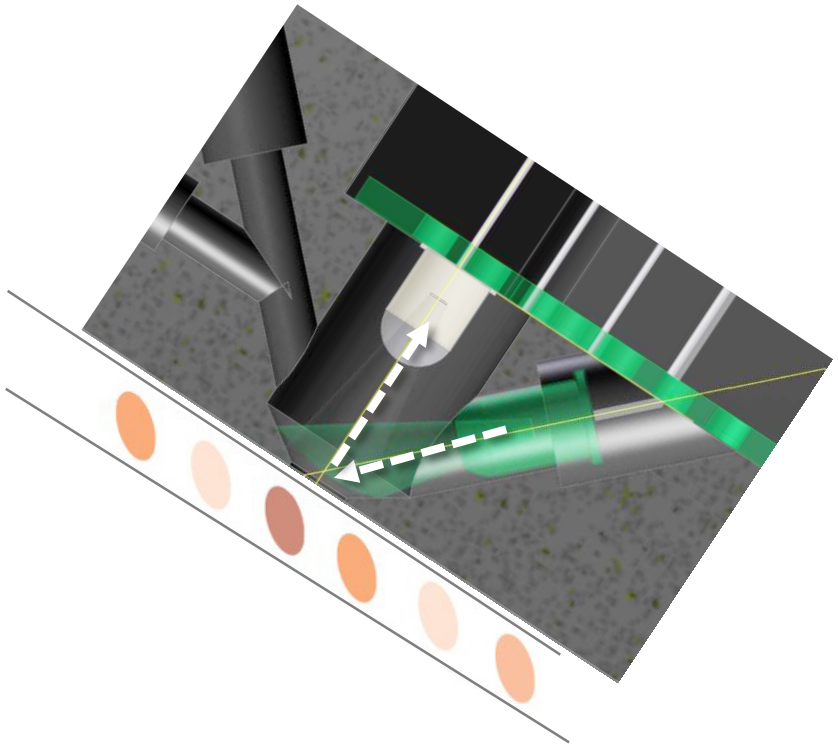
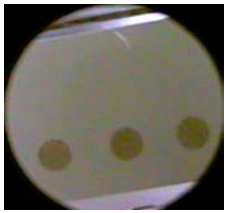
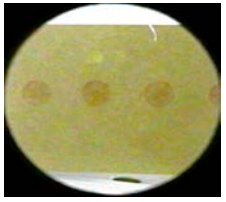
Detection Technology – Toxic Gas

Chemcassette®





25 ppb
Arsine



1 ppm
Hydrogen Fluoride

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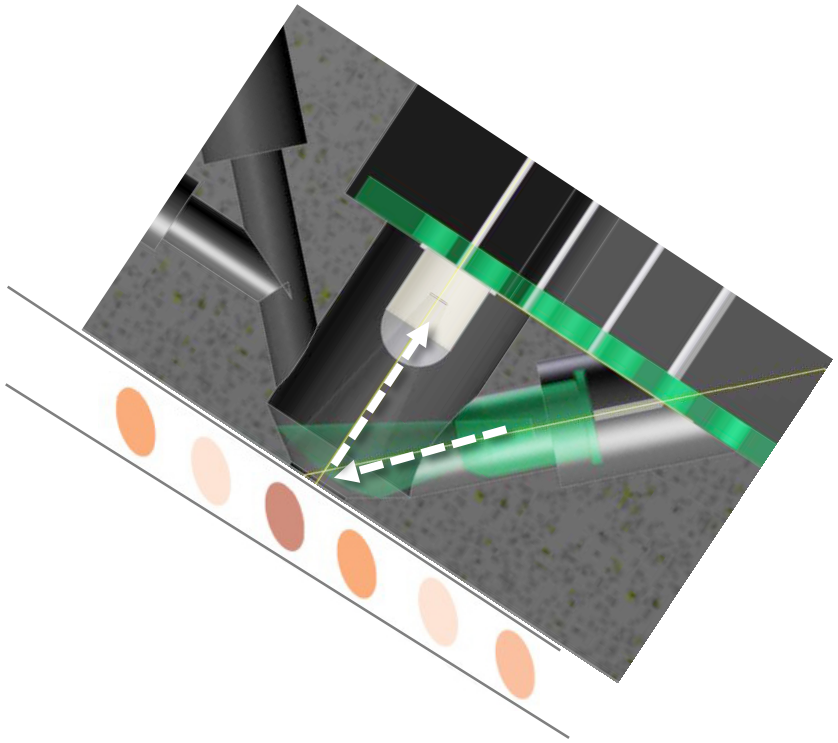
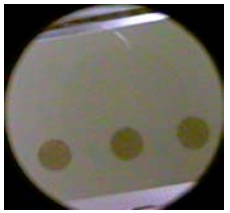
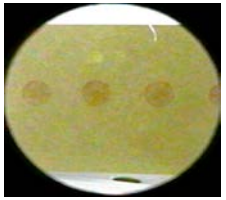
Detection Technology – Toxic Gas

Chemcassette®





25 ppb
Arsine



1 ppm
Hydrogen Fluoride

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Chemcassette Technology

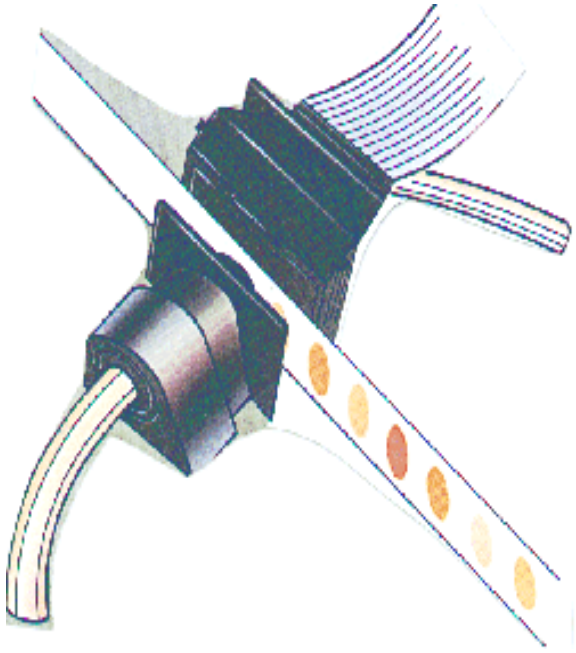
Paper Tape Gas Detection Pros & Cons

Advantages

- Very sensitive measurement
- Specificity to target gas
- Accurate and linear
- Wide range of tapes available

Limitations

- Tapes are time sensitive
- Cost
- Temperature & Humidity



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Summary

- Three types of gas hazards:
  - Combustible or flammable
  - Toxic
  - Asphyxiates

- Combustible or Flammable
  - Catalytic Bead Sensor
  - Non-Dispersive Infrared (NDIR)
  - Photo Ionization (PID)

- Toxic and Asphyxiate Gases
  - Electrochemical – SureCell™
  - Paper Tape – Chemcassette®

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Comparison of Gas Detection Techniques

Technology	Advantages	Disadvantages
Catalytic Bead	Simple, measures flammability of gases. Low cost proven technology.	Can be poisoned by lead, chlorine and silicones that remains an unrevealed failure mode. Requires oxygen or air to work.
Electrochemical	Measures toxic gases in relatively low concentrations. Wide range of gases can be detected.	Failure modes are unrevealed unless advanced monitoring techniques used. Requires oxygen to work.
Infrared	Does not require oxygen to work. Not affected by poisons or inhibitors. Accuracy very stable. Normally fails safe.	Cannot detect hydrogen, acetylene, carbon disulphide. High cost compared to catalytic bead sensor. Affected more by changes in temperature and pressure.
PID	Does not require presence of oxygen. Sensitive to PPM levels. UV Tube is self-cleaning.	Unable to identify type of gas being detected. Sensor maintenance may be required
Paper Tape	Highly sensitive and selective for toxic gases. Leaves physical evidence of the gas exposure.	Can require sample conditioning and extraction systems. Complex and expensive.

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Graphic References

- PPM: https://i.ytimg.com/vi/rGRjYBDwFmU/hqdefault.jpg
- Fire
  - http://www.texturex.com
- Asphyxiation symbol: http://image.shutterstock.com/z/stock-vector-warning-safety-signs-set-61223860.jpg
- Triangle-sign-flammable-gas
  - www.dreamstime.com
- Toxic-Gas diamond sign
  - www.healthcareasia.org
- HOT word (with flaming letters)
  - www.colourbox.com
- Cold word (with frozen letters)
  - www.shutterstock.com
- Humidity (green circle with water drop & percent sign)
  - www.neofarmers.com
- Thermometers (red & blue mercury)
  - www.123rf.com

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