

Hydrogen Sulfide - Health Effects, Detection and Exposure Prevention

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Hydrogen sulfide is an extremely toxic and irritating gas. Early recognition and detection is crucial to protect employees from deadly exposures. Employees working in areas that contain or have the potential to contain hydrogen sulfide should learn to recognize the signs and symptoms of hydrogen sulfide exposure, how to monitor for hydrogen sulfide, and know how to take measures to protect themselves. Instrumentation is available to continuously monitor the atmosphere in confined spaces for hydrogen sulfide and other gases as well as oxygen deficiencies.

Hydrogen sulfide is regulated by OSHA and has a permissible exposure limit of 20 parts per million (ppm) ceiling concentration and a peak exposure limit of 50 (ppm) for no more than 10 minutes if no other measurable exposure occurs. Inhalation of concentrations of 500-1000 (ppm) will cause rapid unconsciousness and death through respiratory paralysis and asphyxiation.

Hydrogen sulfide can affect the body if it is inhaled or it comes in contact with the eyes, skin, nose or throat. It can also affect the body if it is swallowed. Inhalation of low concentrations may cause headache, dizziness and upset stomach. At higher concentrations hydrogen sulfide may cause loss of consciousness and death. Hydrogen sulfide has a strong odor of rotten eggs at low concentrations and a sweetish odor at higher locations. Odor should not be used as a warning of exposure since at concentrations of (20-30 parts per million) hydrogen sulfide may deaden the sense of smell by paralyzing the respiratory center of the brain and olfactory nerve.

There are two types of respiratory protection acceptable for protection from hydrogen sulfide gas, SCBA or Supplied airline respirator. Respiratory protection should only be used if engineering controls are not feasible to control exposure to hydrogen sulfide gas.

There are many incidents of on the job fatalities caused by hydrogen sulfide gas but with proper training, and monitoring equipment and safety and health procedures for entering confined spaces, employees can work safely without incident when encountering hydrogen sulfide gas at reservoirs and dams and other locations.

HYDROGEN SULFIDE SAFETY AND HEALTH ISSUES

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GENERAL PROPERTIES

- Colorless, transparent gas
- Heavier than air will settle in depressions
- Characteristic rotten-egg odor (low conc.)
- Sweetish odor at higher conc.
- Flammable LEL 4.3% UEL 46%
- Can exist as liquid at low temp and high pressure

TOXIC PROPERTIES

- Extremely toxic and irritating gas
- Can cause instant death
- Blocks the oxidative process of tissue cells
- Reduces the oxygen carrying capacity of the blood
- Depresses the nervous system
- Causes respiratory failure and asphyxiation

Where is Hydrogen Sulfide Found

- Naturally in crude production, natural gas, volcanic gases, hot springs
- Decomposition product from human and animal wastes: sewage treatment facilities, sediments of fish aquaculture, and manure
- Industrial sources include: refineries, natural gas plants, petrochemical plants, coke oven plants, kraft paper mills, food processing plants, tanneries
- Human sources: bacteria in mouth and gastrointestinal tract

HEALTH EFFECTS

- Irritating to eyes and respiratory tract
- Conjunctivitis, pain, lacrimation and photophobia may persist for several days
- Coughing, pain in breathing, pain in nose and throat
- Repeated exposure causes headache, dizziness and digestive disturbances
- Collapse and death

PHYSIOLOGICAL RESPONSES

- 10 ppm – eye irritation
- 50-100 ppm - conjunctivitis respiratory irritation
- 100 ppm – coughing, eye irritation - loss of sense of smell 2-15 minutes
- 500-700 ppm – loss of consciousness and death in 30 – 60 minutes
- 700-1000 ppm – Rapid unconsciousness and cessation of respiration and death

Effects of Exposure

- Repeated exposure to low concentrations causes conjunctivitis, photophobia, corneal bullae, tearing, pain and blurred vision
- Exposure to high concentrations causes rhinitis, bronchitis, and pulmonary edema
- Chronic poisoning results in headache, inflammation of the conjunctivae and eyelids, digestive disturbances, weight loss and debility
- Very High concentrations cause death

ODOR THRESHOLD

- 0.13 ppm – minimal perceptible odor
- 0.77 ppm – faint but perceptible odor
- 4.6 ppm – easily detectable moderate odor
- 27 ppm – strong unpleasant odor, but not intolerable
- Odor should not be used as a warning since the gas may deaden the sense of smell

Exposure Level Definitions

- Time Weighted Average (TWA) – 8 hours per day
40 hours per week
- Short Term Exposure Limit (STEL) – 15 min
TWA which should not be exceeded more than 4
times per day with 60 minutes between exposures
- Ceiling (C) – a concentration that should not be
exceeded during any part of the working exposure
assuming direct reading instruments are used
- Peak – a one time spike if no other exposure
occurs

OSHA REGULATIONS

- 20 ppm (ceiling)
- 50 ppm (peak – 10 minute exposure
allowed only once if no other measurable
exposure occurs)

ACGIH TLV's

- Recommended threshold limit values
- 10 ppm (8 hour time weighted average)
- 15 ppm (short term exposure limit above the tlv)
- STEL is defined as a 15 minute TWA exposure which should not be exceeded

DETECTION OF HYDROGEN SULFIDE

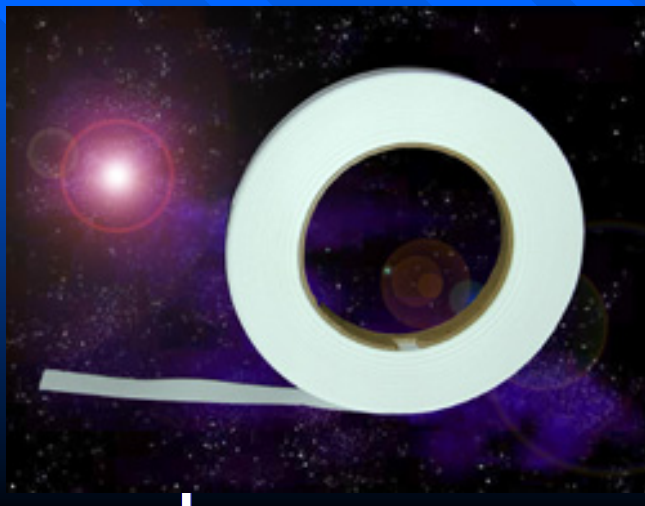
- detector tubes indicate amount of gas by color change of chemically coated granules in a glass tube
- Electronic monitors

Electronic Monitors

- Diffusion
- Internal sampling pump
- Single or multiple sensors
- Sensors require periodic replacement (1-2 years)
- Electronic Monitors must be calibrated with a known gas concentration

IMPREGNATED TAPE

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Electrochemical Monitors



DETECTOR TUBE PUMPS



EXPOSURE PREVENTION

- Conduct air monitoring before entering any confined space that may contain hazardous atmospheres
- Entering a confined space may require special confined space training
- Special procedures must be followed
- An entry permit may be required
- Rescue procedures must be in place

Definition of Confined Space

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross section
- Contains any other recognized safety or health hazards

Confined Space Requirements

- Training (entrants, rescuers, attendants and competent person)
- Permit vs. non-permit
- Air monitoring (continuous)
- Ventilation
- Rescue procedures in place

ENGINEERING CONTROLS

- If a confined space contains hydrogen sulfide on a regular basis as determined by periodic monitoring then the employer must implement engineering controls
- Exhaust or fresh air ventilation systems must be installed to remove the hydrogen sulfide gas and make the area safe for entry

AIR MONITORING

- Must be conducted prior to entry, and periodically (continuous monitoring is recommended)
- Monitor confined space from the outside or use extension probe or lower monitor into space
- Monitor must be calibrated for accuracy
- Conditions may change suddenly

AIR MONITORING (CONT)

- Monitor alarms may be set or preset
- Have back-up or stand-by equipment
- Be sure batteries are charged
- Electrochemical sensors will require periodic replacement
- Detector tubes have a 1-3 year shelf life
- Sensors will last 1-2 years

RESPIRATORY PROTECTION

- In air concentrations of 300 ppm or less
- Use an air-supplied respirator with full facepiece, helmet or hood
- Or use a self contained breathing apparatus with full facepiece
- In concentrations over 300 ppm use a SCBA full face in positive pressure mode

SCBA



AIR SUPPLIED RESPIRATOR



MEDICAL EMERGENCY

- If someone is exposed to a large amount of hydrogen sulfide move the person to fresh air at once
- If breathing has stopped perform artificial respiration
- Get medical attention as soon as possible

MEDICAL EMERGENCY

- Hydrogen sulfide is classified as a chemical asphyxiant and similar to carbon monoxide and cyanide gases.
- Hydrogen sulfide inhibits cellular respiration and uptake of oxygen, causing biochemical suffocation

EMERGENCY RESCUE

Should a co-worker ever be overcome by hydrogen sulfide gas, **do not attempt a rescue until you are properly protected yourself**

Remember at concentrations above 1000 ppm, collapse, coma, and death due to respiratory failure can occur within seconds after only a few breaths

Conclusion

- Hydrogen sulfide gas is a real danger in certain operations and confined spaces
- Hydrogen sulfide gas is deadly and kills workers annually
- Early recognition and detection are critical to prevent employee exposures
- Hydrogen sulfide causes health effects which employees should recognize

Conclusion

- OSHA requires that exposures be below 20 ppm with a one time peak of no more than 50 ppm
- If hydrogen sulfide is measured in excess of the OSHA PEL then engineering controls must be implemented
- Respiratory protection should only be used if engineering controls are not effective