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## The ins and outs of Hydrogen Sulfide

This handbook provides employers and workers with important information regarding hydrogen sulfide ( $H_2S$ ). Through education and training, this information will help employees understand the hazards and necessary safety precautions of working around  $H_2S$ .

Employees need to know how to recognize the presence of  $H_2S$  and protect themselves against its lethal effects. In addition, they must also know how to rescue and perform first aid on victims overcome by  $H_2S$ .

This handbook will provide information on the following items:

- H<sub>2</sub>S.
- Where do you find H<sub>2</sub>S?
- Properties of H<sub>2</sub>S.
- Detection of H<sub>2</sub>S.
- Protection against H<sub>2</sub>S hazards.
- Effects of H<sub>2</sub>S.
- Rescue procedures.
- Safety measures.

After gaining a thorough understanding of this information, you will be ready for further training on the use of breathing air equipment.

## What is Hydrogen Sulfide?

 $\rm H_2S$  is composed of two hydrogen atoms and one sulfur atom. It is a colorless gas which is flammable, toxic and corrosive. It is heavier than air and tends to settle in low-lying areas. The gas is typically associated with industrial, petroleum and biological operations such as drilling, refining and water treatment.

At low concentrations (~5-10 parts per million, or ppm),  $H_2S$  is often associated with a stench resembling rotten eggs and can be irritating to the lungs, nose and eyes. At slightly higher concentrations,  $H_2S$  may have a sick, sweet odor; however, at concentrations between 100 and 150 ppm, no odor can be detected because  $H_2S$  causes paralysis in the olfactory nerve, which affects the ability to smell. For this reason, the sense of smell should never be used to detect the presence of  $H_2S$ .

When exposed to dangerously high concentrations of about 1000 ppm, H<sub>2</sub>S can cause near instant death.

The gas is also known by a variety of names within the industry:

- Stink Damp.
- Sour Crude.
- Rotten Egg Gas.
- Sulfur Hydride.

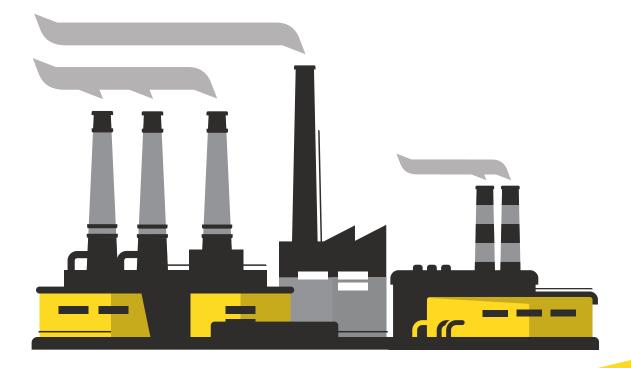
## Where is H<sub>2</sub>S found?

Other than industrial areas, you can also find  $H_2S$  in natural settings. Natural gas and petroleum are known to contain large amounts of the gas. Additionally,  $H_2S$  can be traced to natural gas deposits and mineral rock.

The dangerous gas forms due to organic materials decomposing without oxygen. For example,  $H_2S$  may form from sewage in a septic tank, but can also be found in sewers, cesspools and stagnant water, such as a swamp.

Industries and locations where occupational exposure to H<sub>2</sub>S may be present include:

- Gas plants.
- Oil and gas wells.
- Refineries.
- Pulp mills.
- Sewers.
- Commercial laboratories.
- Petrochemical plants.
- Oil batteries.



At extreme temperatures, such as 460 degrees Fahrenheit, H<sub>2</sub>S will auto ignite.



# Properties of H<sub>2</sub>S

It is important for you know the properties of  $H_2S$  beyond simply being colorless and having a rotten egg stench.

H<sub>2</sub>S is always dangerous, even at low concentrations. While it tends to settle in low-lying areas, the gas is heavier than air and as a result, is rarely dispersed by wind movement or air currents.

The gas is more dangerous than carbon monoxide and is also highly corrosive to certain metals. Since it is a colorless gas at all concentrations, you cannot detect  $H_2S$  visually. You must also keep in mind that you can't rely on your sense of smell to detect  $H_2S$  because at high  $H_2S$  concentrations, you will rapidly lose the ability to smell.

You should also keep an eye on water and oil.  $H_2S$  can dissolve in those liquids but be released if agitated or heated. At extreme temperatures, such as 460 degrees Fahrenheit,  $H_2S$  will auto ignite.

# Effects of H<sub>2</sub>S

You will experience varying effects of  $\rm H_2S$  depending on the amount you're exposed to, as measured in parts per million. Levels above 100 ppm are considered immediately dangerous to your health and life. The following table is based off information from OSHA:

0.1-1.5 ppm	You'll notice the rotten egg stench.
2-5 ppm	Long exposure may result in nausea, headaches and teary eyes.
20 ppm	Experience fatigue, loss of appetite, dizziness, poor memory and headaches.
50-100 ppm	Further digestive issues come about, in addition to respiratory tract irritation and slight conjunctivitis.
100 ppm	You start to lose sense of smell after 2-15 minutes and experience further coughing, eye and throat irritation, altered breathing. Death may occur after 48 hours.
100-150 ppm	Loss of smell.
200-250 ppm	Further irritation, vomiting and prolonged exposure can cause fluid buildup in the lungs.
500-700 ppm	Collapse in 5 minutes. Serious eye damage after 30 minutes. Death shortly after.
700-1000 ppm	Immediate collapse within 1 to 2 breaths. Death occurs minutes later.
1000-2000 ppm	Near instant death.

## Further effects of H<sub>2</sub>S

When you breathe  $H_2S$ , the gas goes directly to your lungs and immediately enters your bloodstream. The body, hoping to protect itself, then as rapidly as possible, breaks down  $H_2S$ .

Dangerous conditions arise if you breathe in more  $H_2S$  than your body can oxidize, which then leads to poisoning and the paralyzation of the nerves that control breathing.

Certain physiological factors determine the effect H<sub>2</sub>S by an individual:



Duration.



Frequency.



Individual health makeup.



Intensity.

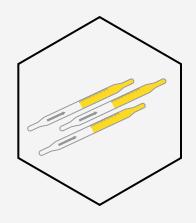
Even previous meals can have a devastating effect. For example, if you've consumed alcohol in the last 25 hours, a small amount of  $\rm H_2S$  can prove deadlier than usual.

There are acceptable exposure limits for workers. The current OSHA Permissible Exposure Limit (PEL) is 20 ppm CEILING, 50 PPM 10-minute MAXIMUM PEAK. The NIOSH Recommended Exposure Limit (REL) is 10 ppm, 10 minute ceiling. NIOSH has established 100 ppm as the concentration which is considered Immediately Dangerous to Life or Health (IDLH).

Even previous meals can have a devastating effect. For example, if you've consumed alcohol in the last 25 hours, a small amount of H<sub>2</sub>S can prove deadlier than usual.

## Detection of H<sub>2</sub>S

Luckily, there are many methods to detect and alert you to  $H_2S$ . While you should never rely solely on your nose, your sense of smell is usually the first, and sometimes last, to notice the dangerous gas. Instead, utilize the following means of detection:



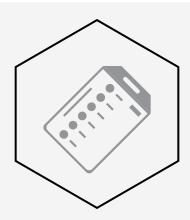
#### **DETECTOR TUBES:**

NIOSH-certified clear tubes about the size of a pen, they provide an appropriate measure of H<sub>2</sub>S concentrations. The tube changes color depending the H<sub>2</sub>S level. However, the accuracy will depend on the training of the operator.



#### **FIXED OR REMOTE MONITORS:**

Fixed monitors are typically used in larger sites for continuous monitoring. If H<sub>2</sub>S levels increase above certain limits, an alarm will be activated. Fixed alarms are commonly programmed to set off an alarm at 10 ppm.



#### **BADGES**:

Resembling a credit card, these monitors can be carried and will change colors depending on the gas levels. Some can also set off an alarm if exposure exceeds a certain level.



#### **COATED STRIPS:**

Lead acetate strips usually turn brown or black due to H<sub>2</sub>S. The degree of the color indicates the gas's concentration. While helpful for determining if H<sub>2</sub>S is present, coated strips should not be the only tools used as an indicator because they are not accurate.

Work sites should utilize various tools to detect  $H_2S$ . When used together, work sites are ensuring safety. When  $H_2S$  is detected, you should leave the area right away, even if you don't know how much gas is in the air. Only return when the amount of gas has been measured and found to be at a safe level. Employees who have been exposed will also have to be monitored for overexposure.

Individuals with asthma may experience lingering effects from  $\rm H_2S$  exposure.

## **Protection against H2S**

Education and protection go hand in hand when you're working in areas potentially contaminated by H<sub>2</sub>S. Every work site should ensure the proper educational programs are in place, in addition to employees knowing about evacuation drills and contingency plans.

Safety equipment needs to be adequate enough to protect workers from the hazards of  $\rm H_2S$  and readily placed to ensure easy access. Above all, employees must adhere to all safe work practices to avoid even the slightest oversight. They can do so by attending educational sessions to know how to respond to exposure incidents.

Work sites must also conduct routine assessments, monitor for  $H_2S$  and keep track of medical records and statistics regarding workers exposed to  $H_2S$ . The usage of windsocks will help workers keep track of wind direction.

General equipment is required, such as eyewear and protective clothing, but more specialized gear is also needed. Because skin absorption is minimal, employers will want to focus on establishing and maintaining a respiratory protection program.

Education and protection go hand in hand when you're working in areas potentially contaminated by H<sub>2</sub>S.

## **Breathing protection**

Most self-contained breathing apparatuses (SCBA) supply air for 30 minutes, although other cylinders are available for shorter or longer usage.

The other type of breathing protection is a positive-pressure, supplied air respirator (SABA). The over-the-shoulder, hip-mounted cylinder is also a full-face mask. It is lighter than the SCBA, but restricts the user due to the length of the hose.

The duration of supplied air in an escape respirator depends on the cylinder's size, but generally is limited to approximately 5 minutes.

In cases of emergency, an escape-only respirator unit can be used. The device only takes seconds to don, as there are no belts, straps or face pieces. The duration of supplied air in an escape respirator depends on the cylinder's size, but generally is limited to approximately 5 minutes.

## Issues with respirator use

Some individuals may encounter special problems when using respirators, as some of these devices can impose limitations on the wearer.

Special problems that may arise include:



**FACE HAIR.** An effective seal will be prevented, even after one day's growth of stubble.



**CORRECTIVE EYEGLASSES.** Glasses with temple bars or straps should not be worn due to interference with the face seal.



**CONTACT LENSES.** Shouldn't be used with breathing equipment because of a drying effect.



**PSYCHOLOGICAL**. Disturbances such as claustrophobia can be hazardous to the wearer.



**SEALING ISSUES.** Sealing problems may arise that are easier to spot than others. Noticeable sealing problems include scars, very prominent cheekbones, hollow temples and deep skin creases.

Due to the dangers of  $H_2S$ , employees must remember the limitations that come with wearing air breathing protection. As such, a test may be needed if medical or facial changes alter the worker's model and size of the respirator mask.

Only attempt to rescue if you are trained and have the appropriate PPE.



### First-aid and rescue

You must try to keep calm, think and above all, do not panic if a co-worker has been overcome by H2S due to an accident. Only attempt to rescue if you are trained and have the appropriate PPE. Remembering your training and safety procedures can help save your co-worker's life:

- 1. Call for help if possible.
- 2. Only attempt rescue while wearing a SCBA or other air respirator.
- 3. Move co-worker to fresh air as quickly as possible. Move upwind or crosswind from H<sub>2</sub>S source.
- 4. If co-worker is breathing, administer oxygen while keeping him or her in a resting position.
- 5. Thoroughly wash eyes if affected by  $H_2S$ .
- 6. Begin artificial respiration.
- 7. Promptly transport the victim to a hospital while continuing to give artificial respiration.
- 8. Inform hospital your co-worker has been exposed to H<sub>2</sub>S.

Even with a quick revival, all H<sub>2</sub>S victims require medical attention due to lingering effects.

### Safety measures

Every work site should have various safety measures in place to protect against  $H_2$ S exposure. Take the following precautions:

- Observe condition signs and audio and visual alarms.
- Check wind direction.
- Enter site slowly.

Other safety measures include:

- A minimum of two defined safety escape routes.
- Gas ignition hazards must be clearly marked.
- Continuous atmosphere monitoring.
- Explosion-proof mechanical ventilators.
- H<sub>2</sub>S awareness training program and emergency procedures.
- Maintenance of communication systems.
- Detection equipment.
- A buddy system for mutual safety.
- Strict enforcement of "no smoking" regulations.
- Care to avoid low-lying areas.
- Observe warning signs.
- Maintenance of protection equipment, including air breathers.
- H2S warning signs should be posted throughout the work site.

Elsewhere, work sites should strive to label all piping and valves that carry  $H_2S$ . This includes easy access to the Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) for  $H_2S$ .

Proper testing of confined spaces to ensure good ventilation is also required before workers enter those areas.

#### Sources:

Previous e-book

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