HYDROGEN SULFIDE

Hydrogen sulfide is a flammable, colorless gas with a rotten egg odor. The gas is released into the environment from natural and industrial sources. Individuals who live near areas where this gas is released could be exposed to levels affecting their health.

The purpose of this factsheet is to provide an overview of frequently asked questions regarding hydrogen sulfide in the environment and its possible health effects, as well as current regulatory guidance.

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General Facts

What is hydrogen sulfide?

Hydrogen sulfide is a gas that naturally occurs in the environment in crude petroleum, natural gas, volcanic gases and hot springs. It can also be produced from bacterial breakdown of organic matter.

It is flammable, colorless and noticeable by its rotten egg odor. Hydrogen sulfide is heavier than air, so it stays low to the ground. People can smell the specific odor at low concentrations in air ranging from 0.0005 to 0.3 parts per million (ppm). The odor coming from rotting landfill debris and seaweed (sargassum) are common examples of odors people usually smell when nearby.

Hydrogen sulfide is also produced via industrial activities, for example, in petroleum refinieries, natural gas plants, petrochemical plants, coke oven plants, food processing plants and tanneries.

What happens to hydrogen sulfide when it is released into the environment?

When hydrogen sulfide is produced it can be released into air, water and soil. Its release mainly occurs as a gas and spreads in the air where it can remain up to 42 days, depending on the weather. In air it can possibly change into sulfur oxide and/or sulfates. When it is released into water, it readily evaporates. In soil, hydrogen sulfide is consumed by bacteria and is changed to sulfur.

Why is hydrogen sulfide a concern?

Studies have shown that exposure to hydrogen sulfide could cause adverse health effects to the respiratory system (the body's airways, including the nose, throat and sinuses) and possibly the nervous system. The health effects can be short- and/or long-term, depending on the gas concentration and exposure duration, as well as the overall health of a person.

People living near landfills are often concerned that the odors coming from a landfill will make them sick. At low levels, it is uncertain whether it is the chemical itself or the related odors that make people feel ill. In most cases, health effects fade when people are no longer in the area of concern.

How can I be exposed to hydrogen sulfide?

Exposure to hydrogen sulfide occurs primarily through breathing contaminated air. Other sources of exposure could be via drinking water and skin contact with hydrogen sulfide contaminated soil. Oral and skin contact are identified as minor exposure routes as hydrogen sulfide readily evaporates in water, where it is consumed by bacteria and changed to sulfur.

A small amount of hydrogen sulfide is also produced by bacteria in your mouth and digestive tract.

Individuals who live near landfills, wastewater treatment plants and farms with manure[1] storage or livestock confinement facilities, may breathe in air that contains higher levels of hydrogen sulfide. Also, people who work at the aforementioned facilities may be exposed to higher concentrations of this gas through the air in the workplace.

How can hydrogen sulfide potentially affect health?

Studies suggest that the respiratory system is one of the most common parts of the body to suffer health effects from exposure to hydrogen sulfide. Another system of the body possibly effected by high levels of hydrogen sulfide exposure is the central nervous system, which includes the brain and spinal cord.

People exposed to low levels may experience the following symptoms when the concentrations are between 2 ppm and 100 ppm:

- Irritation to the eyes, nose and throat
- Breathing difficulty
- Headaches
- Poor memory
- Tiredness
- Loss of balance

People exposed to high levels (100 to 2,000 ppm), even for a short period of time, may experience severe health effects depending on the concentration of the gas and duration of exposure.

Effects observed when individuals are exposed to concentrations between 100 ppm and 300 ppm include:

- Altered breathing
- Drowsiness
- Coughing
- Eye irritation
- Loss of smell
- Throat irritation
- Conjunctivitis (pink eye)
- Pulmonary edema (fluid in the lungs)
- Increase in severity of symptoms after several hours

Effects observed when individuals are exposed to concentrations between 500 ppm and 2,000 ppm include:

- Loss of balance
- Rapid unconsciousness
- Severe damage to the eyes
- Death (possible when directly exposed in enclosed environments without any airflow and/or ventilation)

Can hydrogen sulfide cause cancer?

The International Agency for Research on Cancer (IARC) and Department of Health and Human Services (DHHS) have not determined if hydrogen sulfide can cause cancer.

The U.S. Environmental Protection Agency (EPA) has determined that there is not enough evidence to show that there is an association between cancer and hydrogen sulfide exposure.

[1] Manure: animal feces used as fertilizer in agriculture

Can I die from direct hydrogen sulfide exposure?

Death from hydrogen sulfide exposure mostly occurs at high levels in confined spaces with little or no ventilation.

How does hydrogen sulfide affect children?

There is little information about how hydrogen sulfide affects children. Studies have not yet shown if children are more sensitive to the gas compared to adults. To date, research has also not shown if hydrogen sulfide causes birth defects in people. Animal studies show that low levels of hydrogen sulfide exposure during pregnancy do not to cause birth defects in animals.

Hydrogen Sulfide Regulation and Advisories

What level of hydrogen sulfide is recommended in residential and recreational areas?

The U.S. Environmental Protection Agency (EPA) has set acute exposure guideline levels (AEGL), which are used to describe exposure limits in the general population below which adverse health effects are not likely to occur for chemicals found in the air like hydrogen sulfide. The AEGL is classified into three levels based on different exposure durations (10 minutes to 8 hours) and severity of toxic health effects. For more information on EPA AEGL values for hydrogen sulfide, see Attachment A Table 1.

The World Health Organization set the maximum limit of hydrogen sulfide at 150 micrograms per cubic meter (µg/m^3) (0.015 ppm) for an average concentration over 24 hours. Also, to prevent unpleasant odors, a 30-minute average ambient air concentration not exceeding 7 µg/m^3 (0.007 ppm) is recommended.

Does the federal government have guidelines to protect workers?

Yes, the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) regulate hydrogen sulfide for workers in certain industries and working conditions where there is risk of exposure to high concentrations.

What levels of hydrogen sulfide are considered safe for workers?

OSHA set an acceptable maximum exposure concentration of 20 ppm for a time limit of 15 minutes that should not be exceeded per working day.

NIOSH recommends a maximum exposure concentration of 10 ppm for a time limit of 10 minutes that should not be exceeded. NIOSH also determined that 100 ppm is immediately dangerous to life and health of workers.

Biomonitoring and Blood Testing

Can a medical test determine if I have been exposed hydrogen sulfide?

While there are tests to measure hydrogen sulfide and its breakdown products (metabolites) in blood and urine, the tests cannot predict the likelihood of health effects. Furthermore, the test has to be done very soon after exposure to get accurate results as hydrogen sulfide and its breakdown products leave the body rapidly.

Individual Concerns

How can I protect myself and my family from being exposed to hydrogen sulfide?

Since hydrogen sulfide is present in the natural environment, there always will be some exposure to this gas. Individuals who live nearby natural or industrial sources of hydrogen sulfide could be exposed to higher levels. However, these levels are still much lower than levels that cause health effects when exposed to hydrogen sulfide at work.

Exposure can be reduced by avoiding areas that produce hydrogen sulfide. Keeping the windows and doors closed when experiencing the rotten egg smell can be helpful as well.

I have asthma. Can hydrogen sulfide trigger an asthma attack?

People who are asthmatic may be more sensitive to hydrogen sulfide and therefore could suffer from breathing difficulty at levels considered above natural environment levels. Airway problems, such as the obstruction of the bronchi, have been reported among asthmatics exposed to 2 ppm of hydrogen sulfide.

Can hydrogen sulfide affect the health of pets and farm animals?

Pets and farm animals exposed to high levels of hydrogen sulfide for a short period of time could suffer from adverse health effects including death.

Farm animals such as sheep, cattle, goats and pigs could be more susceptible to high hydrogen sulfide concentration when there is a sudden release of hydrogen sulfide from manure[1] pits present on farms.

References:

[ATSDR] Agency for Toxic Substances and Disease Registry. 2020. ToxFAQ™ for Hydrogen Sulfide. Atlanta, GA [updated 2017 January; accessed 2020 August 12] Available from: https://www.atsdr.cdc.gov/toxprofiles/tp114.pdf.

Chou CH. 2003. Draft Hydrogen sulfide: human health aspects. 41pp. World Health Organization. Geneva, Switzerland [updated 2003; accessed 2020]. Available from: https://apps.who.int/iris/bitstream/handle/10665/42638/9241530537.pdf.

[NRC] National Research Council (US). 2010. Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 9. Washington (DC): National Academies Press (US): 4. Washington, DC [updated 2010; accessed 2020 September 7]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK208170/.

[OSHA] Occupational Safety and Health Administration. 2020. Hydrogen Sulfide. Washington, DC [Accessed 2020 August]. Available from: https://www.osha.gov/SLTC/hydrogensulfide/hazards.html.

Rumbeiha W, Whitley E, Anantharam P, Kim DS, Kanthasamy, A. 2016. Acute hydrogen sulfide–induced neuropathology and neurological sequelae: Challenges for translational neuroprotective research. Annals of the New York Academy of Sciences 1378: 1-5.

[VDH] Virginia Department of Health. 2020. Hydrogen Sulfide Factsheet. Richmond, VA [updated 2018 October; accessed 2020 August 12] Available from: https://www.vdh.virginia.gov/epidemiology/epidemiology-fact-sheets/hydrogen-sulfide/?pdf=5920.

Attachment A Table 1: Overview of U.S. Environmental Protection Agency (EPA) acute exposure guideline levels (AEGL) for hydrogen sulfide exposure in residential settings. *Adapted from the National Research Council (US)[2].*

Classification	Exposure Time					Potential Health Effects
	10 min	30 min	60 min	4 hr	8 hr	
AEGL 1 [ppm]	0.75	0.60	0.51	0.36	0.33	Nondisabling effects that can be reversed once exposure stops.
AEGL 2 [ppm]	41	32	27	20	17	Disabling health effects that can be irreversible and long lasting.
AEGL 3 [ppm]	76	59	50	37	31	Lethal health effects that could lead to death.

AEGL - acute exposure guideline levels
hr - hours
min - minutes
ppm - parts per million

[2] Source: National Research Council (US). 2010. Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 9. Washington (DC): National Academies Press (US): 4. Washington, DC [updated 2010; accessed 2020 September 7]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK208170/

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If you have questions or comments about this factsheet, we encourage you to contact us.

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