

Introduction

Hydrogen sulphide (or H₂S) with its offensive smell resembling rotten eggs, is one of the most dangerous gases encountered. It has been responsible for more fatalities than all other toxic gases put together; and that includes carbon monoxide and hydrogen cyanide.

There are three reasons why:

1. **Toxic and fast acting.** It takes a larger dose than hydrogen cyanide, but is much faster acting.
2. **Deceptive.** It paralyzes the sense of smell and so is not a reliable guide to its presence.
3. **Extremely widespread.** Found in many places with no warning labels or placards.

Be aware that hydrogen sulphide is so widespread that all fire services personnel can expect to encounter it at sometime in their career.

Occurrence

Hydrogen sulphide comes from decaying animal or vegetable matter, and can be found in sewers, sewage treatment plants, liquid manure stores, and marshes. It can also be found in mines, from volcanoes, as well as oil and gas wells. Other sources include petroleum refineries, smelters and food processing plants.

While Australian natural gas wells have a low Hydrogen sulphide content, those in Alberta, Canada can have a hydrogen sulphide content up to 90%. At these levels it has to be separated out and converted to sulphuric acid.

Even clean air contains about 0.0002 ppm hydrogen sulphide, and yes, hydrogen sulphide producing bacteria live in the human colon and are the source of odours in flatulence

Uses

Hydrogen sulphide is used to manufacture phosphorus as well as a wide range of sulphur based chemicals. It is also used in purifying hydrochloric and sulphuric acid by precipitating out metal contaminants as insoluble metal sulphides.

Dangerous Goods

Hydrogen sulphide is transported as a liquefied gas under its own pressure (at approximately 8.5 atm) in steel cylinders under UN Number 1053 with the following Class diamonds:

- o Class 2 Division 2.1 flammable gas
- o Sub-Risk Division 2.3 toxic gas

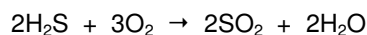


Properties

o Formula	H ₂ S
o Molecular weight	34.08
o CAS number	7783-06-4
o Appearance	Colourless gas
o Solubility	0.5 g/100 ml
o Relative density	1.19 (air = 1.00)
o Boiling point	-60.7 deg C
o Freezes solid	-85.5 deg C.
o Flash point	-118 deg C
o Autoignition temp.	260 deg C
o Flammable limits	4 - 14%

Each litre of liquid hydrogen sulphide forms 509 litres gas.

Burns to form water and sulphur dioxide, an extremely corrosive and toxic gas.



The conversion factors are

$$1 \text{ ppm} = 1.4 \text{ mg/m}^3$$
$$1 \text{ mg/m}^3 = 0.717 \text{ ppm}$$

Toxic Effects

Hydrogen sulphide attacks the body from two directions:

1. **It paralyses the nervous system.** If the concentration is high enough a person may lapse immediately into unconsciousness with no time to escape.
2. **It blocks oxygen.** It prevents an enzyme called cytochrome oxidase from transporting oxygen from red blood cells to body cells, in the same way as cyanide.

Symptoms of exposure can include headache, nausea, dizziness, insomnia, fluid on the lungs, facial paralysis, inability to balance and a grey-green discolouration of the teeth. Recovery is usually complete with mild exposures however permanent damage can occur with large exposures. These can include memory loss, facial paralysis and loss of physical coordination.

ppm	Effects
0.0047	Odour threshold (50% can detect rotten egg odour)
10	TWA (14 mg/m ³) 8-hr 40-hr week
15	STEL (21 mg/m ³) 15 min max, 4 times only per 8-hr day
10-20	Eyes – borderline concentration for eye irritation
30	Odour changes to sickly sweet
50-100	Eye damage begins – itching, watery eyes, blurring, pain when looking at light, rings appear around lights
100	IDLH
100	Sense of smell paralysed.
320 –530	Fluid build-up in the lungs. Can be fatal
530-1,000	Affects central nervous system, rapid breathing, loss of breathing
> 1,000	Fatal after one or two inhalations

Table: Concentration effects

Exposures

1. A workman died after inhaling vapours containing about 2000 ppm hydrogen sulphide from a ruptured outfall line of a poultry feather cooker which converted feathers into fertilizer.
2. A major hydrogen sulphide removal unit failed for 20 minutes at a natural gas refinery at Poza Rica, Mexico. It caused 22 fatalities and 320 hospitalisations in the surrounding districts.
3. A workman attempted to clean a drain with a solution of 90% sulphuric acid. There was a reaction in the drain which produced a large column of hydrogen sulphide.
4. A 14 years old boy found a cylinder containing hydrogen sulphide in a deep ravine. He broke off the valve with a rock and died instantly. The father's rescue attempt was also instantly fatal.
5. A farm worker was fatally exposed to toxic gases including hydrogen sulphide after using pressurised hot water to clean manure from gutters inside a calf barn.
6. Four men were overcome by hydrogen sulphide while digging in some pits in marshy land. The concentration was 3 ppm with force ventilation; unventilated it quickly rose to 540 ppm.

Confined spaces in general

A confined space can include storage tanks, bins, boilers, ducts, sewers, underground vaults, tunnels, pipelines, pits, wells and caves. It is any space where:

- o access is limited,
- o ventilation is inadequate,
- o toxic, asphyxiant or flammable gases may have accumulated, or
- o may be oxygen deficient.

Hydrogen sulphide is one of these gases that can accumulate in a confined space.

Rescue in confined spaces

A person overcome in a confined space creates a major dilemma for any would be rescuer, with that natural desire to help someone in trouble and the awareness there is little time.

However it serves little purpose if the would be rescuer becomes a victim. In fact it has been found 60% of all deaths in confined spaces have involved would be rescuers, and this implies more would be rescuers than initial victims.

There is the example of a family who ran a dairy farm with a large manure pit, which they entered many times with no ill effects. Until one day the 28 year old son entered the pit to perform some mechanical repairs. He collapsed and a 15 year old grandson rushed in the help, followed by a 63 year old nephew, then a 37 year old son and finally the 65 year old owner.

Each in turn collapsed and upon rescue, two were already dead, another two were pronounced dead upon arrival in hospital and the last one died 6 hours later. Something really bad happened to the air in the pit that day, and involvement hydrogen sulphide cannot be discounted.

Confined space entry

If there is ever a need to enter a confined space or to attempt a rescue, **DO NOT RUSH IN**. Consider the consequences first. Do not enter a confined space until adequate preparation has been made, and that includes availability of prompt rescue of anyone going in.

Each Fire Service should have a SOP/SOG for Confined Space Rescue (CSR) / Trench Rescue, and it should include, among other things, a means to detect and also warn of unsafe levels of hydrogen sulphide.

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