

Hazards of Emergency Response to Molten Sulfur Incidents

Some emergency responders are not aware of the seriousness of the hazards posed by molten sulfur. Attitudes of complacency arising from views such as “its molten sulfur”, “it’s a solid”, “the fittings are severely corroded” or “the product just stinks” have led to the potential for serious exposures to constituents of molten sulfur. In the past several years some of the most seasoned hazmat responders have been exposed to the off gas byproducts of molten sulfur. Most have been fortunate and walked away with only minor health effects. Although molten sulfur is a Class 9 miscellaneous hazardous material it presents many health hazards including exposure to hydrogen sulfide (H₂S), sulfur dioxide (SO₂), sulfur trioxide (SO₃), and elevated temperatures of up to 320 degrees F. Both SO₂ and SO₃ are acute irritants of the eyes and respiratory tract. The severity of irritation increases with increasing concentrations and duration of exposure, and prolonged exposures can cause permanent damage to the respiratory tract; however, neither of these products can cause immediate incapacitation or “knockdown” to the responder. In contrast, at high levels, H₂S is a potent nervous system toxin that can rapidly incapacitate a responder within one or two breaths, thus, H₂S is the primary acute inhalation concern when addressing molten sulfur incidents.

Key Points:

H₂S has a characteristic rotten egg odor and can be smelled at very low levels (low parts-per-billion range or ppb). H₂S can be smelled at levels much lower than those that cause adverse health effects; however, higher concentrations of about 100 ppm, H₂S cannot be smelled so lack of odor is not a good indicator of whether high levels are present. At concentrations of around 700 ppm or higher, H₂S causes almost immediate unconsciousness or “knock down”. Individuals without proper respiratory protection attempting to rescue those who have been overcome can easily become overcome themselves, and this has resulted in many multiple fatality incidents over the years.

It is important to know the occupational exposure standards and guidelines for H₂S exposure. There is a significant difference between the American Conference of Industrial Hygienists (ACGIH) and Occupational Safety and Health Administration (OSHA):

- NIOSH - IDLH is 100 ppm,
- OSHA - PEL-Ceiling is 20 ppm, with an excursion exposure of up to 50 ppm for 10 minutes only if no other measurable exposure occurs,
- ACGIH - TLV is 1 ppm
- ACGIH - TLV-STEL is 5 ppm.
- ***For all entries into an area with unknown airborne concentrations or concentrations above 100 ppm, an SCBA or supplied air respirator IS required.***

H₂S, SO₂ and SO₃ are all products that can accumulate in the vapor space of a molten sulfur tankcar or vessel. The most common exposures of these products to hazmat responders come during manway gasket repair or tightening or checking product temperatures during heating operations. The exposures are usually limited to the tankcar’s walk platform area and are usually not a problem with a solidified ground spill or for personnel supporting the response operation.

What health effects can occur from exposure to H₂S?

H₂S acts within the body at the cellular level to interfere with the cell's ability to produce energy. Health effects from exposure to H₂S depend on the concentration of H₂S in air and the duration of exposure. H₂S is rapidly detoxified by the body and low levels of H₂S can be smelled but do not result in health effects. Higher levels of H₂S may irritate the eyes, throat, and lungs. Very high levels that may overwhelm the ability of the body to detoxify H₂S can result in immediate collapse, loss of consciousness, and death after a few breaths. The table below describes health effects associated with increasing concentrations of H₂S in air.

H₂S Health Effects

H ₂ S Concentration (ppm)	Health Effect
<1.0	Odor threshold
5-10	Obvious odor (rotten eggs)
50	Noticeable eye irritation
100	Loss of smell
200	Rapid loss of smell, stings eyes and throat
250	Pulmonary edema (fluid in lungs) with prolonged exposure
500	Dizziness, breathing ceases in a few minutes
700	Rapidly produces unconsciousness, stops breathing
1000+	Single breath can cause collapse, coma, and stop breathing

Is there a medical test for H₂S exposure?

Breakdown products of H₂S can be measured in the blood and urine shortly after an acute exposure. However, the test is not considered useful since diet and other sources of these substances make interpretation difficult. Individuals exposed to H₂S are not usually tested for H₂S or its breakdown products.

What is the treatment for H₂S exposure?

The most important treatment for an exposure to H₂S is the safe, immediate, removal of the individual to fresh air. Depending on the degree of exposure and the general physical condition of the exposed person, an individual's condition may improve rapidly once safely removed to fresh air. Medical treatment for severe exposures is generally supportive to maintain adequate breathing and blood flow during recovery. If necessary, basic emergency life-support measures may be instituted on-site including cardiopulmonary resuscitation if needed. Individuals who have sustained a high level exposure resulting in symptoms other than mild eye or respiratory tract irritation should seek medical evaluation.

For lower level H₂S exposures associated with eye irritation or milder effects, the primary treatment again is removal from exposure. There are no specific antidotes for milder exposures. H₂S is rapidly detoxified and does not accumulate in the body.



Rescue of impaired individuals

It is important to re-emphasize that one or two breaths of a very high level of H₂S can cause immediate collapse and unconsciousness. For example, if an individual is found unconscious and H₂S exposure is suspected, rescuers must take the following actions to protect themselves from also being overcome by H₂S before attempting to rescue the individual.

Due to the poor warning properties of H₂S, supplied air or SCBA are the proper choice for respiratory protection. Ensure that the rescuers have adequate respiratory protection in the form of a supplied air respirator or self-contained breathing apparatus (SCBA). **Remember:**

- ***Not all respirator cartridges can be used for protection against H₂S exposure,***
- ***Very few respirators can be used for purposes other than escape, Check with your cartridge manufacturer!***
- ***If your respirator has H₂S approved cartridges, but sure to use a "FULL FACE" style.***

Perform real-time air monitoring for H₂S to ensure that the concentration of H₂S is below levels considered potentially hazardous.

There are many reports of individuals who were overcome when they tried to rescue an individual without taking appropriate precautions.

Protective Clothing:

When a response to a molten sulfur incident occurs, product temperatures are usually still greatly elevated. In the molten state, sulfur can reach temperatures around 320 degrees F. Direct skin contact with molten sulfur at these temperatures can cause severe skin burns even in small amounts. Finally, although the dust from solid sulfur does not pose a skin absorption hazard, the dust can ignite through static electricity discharge therefore it should be considered a potential flash fire hazard. Thus, the use of flame retardant clothing (FRC) should be considered.

Conclusions:

Although molten sulfur is not often recognized as an inhalation hazard by hazmat responders, components within the mixture can have serious respiratory and central nervous system effects. H₂S is one of the few chemicals encountered by the hazmat responder that has few warning properties at dangerous concentrations and can lead to immediate incapacitation. One must be particularly aware of the hazards associated with H₂S whenever responding to an incident involving molten sulfur. Proper respiratory protection is essential when unknown concentrations of H₂S are present during an incident in order to protect first responders from over-exposure to H₂S.