



Serious Accident Cases _ Reduce Fatal Accidents by Half!

Suffocation from Hydrogen Sulfide Poisoning during Inspection of Wastewater Treatment Facility



Summary of Accident



One employee of the consigned management company for a wastewater treatment facility was killed by the poisoning from hydrogen sulfide generated by the reactor while working on the safety work plate at the reactor inside the building of the wastewater treatment facility.

Cause of Accident



- > Generation of high concentration hydrogen sulfide due to inflow of high concentration wastewater;
- > Generation of hydrogen sulfide due to decomposition from failed removal of sludge;
- > Accumulation of sludge due to failed operation of separation facility;
- > Increased hydrogen sulfide from the use of polymer;
- > Inadequate natural ventilation by the air;
- > Failure to establish/implement the healthy work program for confined spaces;

Accident Preventive Measures



- Reduced wastewater concentration within the scope of designed concentration through installation of oil separator;
- Periodic removal of decomposed sludge;
- Installation of a separator for high-concentration organic matters;
- Replacements with the chemicals not generating hydrogen sulfide or implementation of biological treatment methods;
- Ventilation through installation of power fans for entire facility at rooftops and walls;
- Establishment/implementation of the healthy work program for confined spaces;

Applicable Statutes



The OSH Act, Local Rule on OSH Standard and KOSHA Guide, etc.

- Article 618 (Definition) through Article 644 (Issuance of Protective Gear, etc.) of the Local Rule on OSH Standard;
- KOSHA-Guide H-80-2017 (Implementation of Healthy Work Program for Confined Spaces and Technical Guidelines on Prevention of Health Problems)



Safety Starts by Spotting the Danger!

Safety & Health VR-Only Theater
360vr.kosha.or.kr



When a person with
oxygen deficit is identified,
Verify the Order of Emergency Care!



Call 119 immediately



Run CPR



Operate AED

Learn more about hydrogen sulfide!

Adverse Characteristics and Effects on Human Body by Hydrogen Sulfide

* Based on exposure from 8 hours of operation

Subject	Adverse Characteristics	Effects on Human Body	
		Concentration (ppm)	Health Effect*
Hydrogen Sulfide (H ₂ S poisoning)	- Hydrogen sulfide generated during decomposition of organic matters is highly toxic and flammable along with the odor of rotten eggs; - Even if the oxygen concentration is normal, hydrogen sulfide is capable of causing fatalities; - Around-the-clock ventilation is required during operations; - Bubble effect of hydrogen sulfide: The bubble effect means that hydrogen sulfide dissolved in the wastewater is instantaneously generated in high concentration when wastewater is stirred just as foam is generated when a carbonated drink is shaken;	10	-
		50~100	Mild irritation (eye, airway)
		200~300	Substantial irritation
		500~700	Unconsciousness/Death
		> 1,000	Unconsciousness/Death

• **Neurotoxicity** : Hydrogen sulfide in high concentration over 500ppm can cause momentary unconsciousness, which may lead to critical symptoms, such as death.

• **Respiratory system** : When the concentration of hydrogen sulfide reaches 100 to 200ppm, the olfactory nerve becomes paralyzed to deteriorate the sense of rejection against hydrogen sulfide, which often takes away opportunities to escape from danger since victims lower their guard against hydrogen sulfide with even higher concentration.

Pathogenesis of Hydrogen Sulfide (H₂S) Poisoning

- Chemical suffocant hindering aerobic respiration as it adheres to mitochondria involving in internal cell respiration
→ Instant death due to failure of oxygen transfer to cells.
- Occurrence Mechanism: Organic matter (C, H, O, N, S) → SO₄²⁻(Sulfat) + 2C + 2H₂O $\xrightarrow{\text{Sulfate-reducing bacteria}}$ 2HCO₃⁻ + H₂S↑
- The generation rate of hydrogen sulfide increases when the temperature is higher (15 - 45°C) and dissolved oxygen is lower at the dead air space;
- When the floor layer (scum, sediments, etc.) of settling basin and detention facility is destroyed (stirred), the generation rate of hydrogen sulfide increases rapidly;

Step 1 : Inflow of organic matters	Step 2 : Aerobic decomposition	Step 3 : Anaerobic decomposition	Step 4 : Exposure in the air
Inflow of various organic matters through inlets of sewage and wastewater	Consumption of oxygen by aerobic microbes	Generation of hydrogen sulfide from organic matter decomposition of sulfate-reducing bacteria	Massive exposure of dissolved hydrogen sulfide from stirring (destruction) of sludge layers
Gas concentration (estimated) Oxygen 21%, hydrogen sulfide 0ppm	Gas concentration (estimated) Oxygen 10~20%, hydrogen sulfide 1~10ppm	Gas concentration (estimated) Oxygen less than 10%, hydrogen sulfide 10ppm or higher	Gas concentration (estimated) Oxygen less than 10%, hydrogen sulfide 300ppm or higher

The KOSHA rents out
suffocation-prevention
equipment for free.

- Rental equipment: Concentration sensor for oxygen and harmful gas, ventilation fan, air-supplied respirator, air respirator, rescue tripod, etc.
- Inquiry for rental: 6 regional offices and 21 branch offices of the KOSHA (Main number: 1644-4544)