MIDSTREAM PROJECT EXECUTION 20th Anniversary

KAHUNA

Understanding Hydrogen Sulfide (H2S) Hazards

AMERICAN SOCIETY OF SAFETY PROFESSIONALS

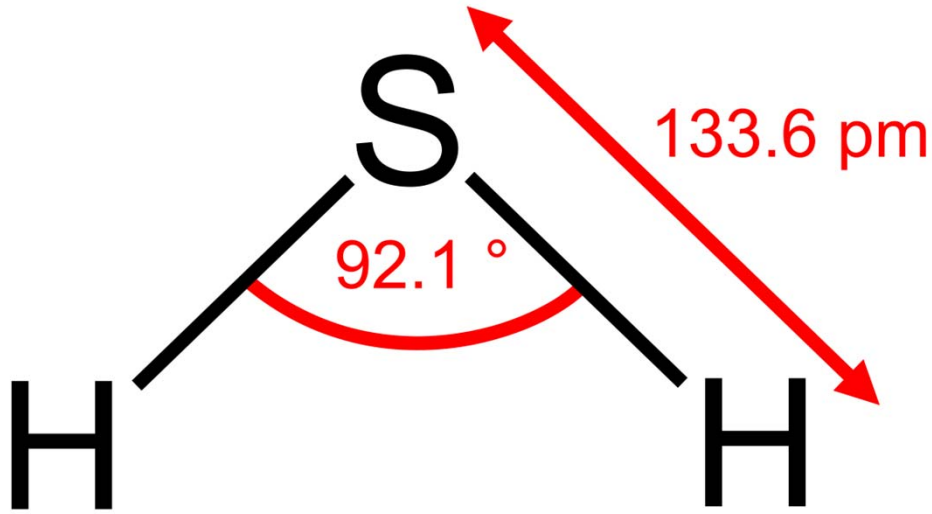
Oil, Gas, Mining, & Mineral Resources Practice Specialty

Agenda Overview

- What is hydrogen sulfide
  - health effects
  - regulatory and industry exposures
  - training
- Sampling and measuring methods
  - measuring and sampling methodology
  - potential problems measuring and sampling

Why Are We Concerned?

- Can be explosive
- Various health effects
  - Multiple organs
  - Varying concentrations
- Chemical asphyxiant
- Unable to smell gas
- Can result in other toxics



Regulatory and Industry Standards

OSHA **20 parts per million (ppm)** Ceiling (C)

NIOSH **10 ppm** C Recommended Exposure Limit (REL)

API **10 ppm** recommended alarm

ACGIH Threshold Limit Value (TLV)

- **1 ppm** Time Weighted Average (TWA)
- **5 ppm** Short Term Exposure Limit (STEL)
- No C value

energy API

American Petroleum Institute

OSHA

CDC NIOSH National Institute for Occupational Safety and Health

ACGIH®

Community Exposure Standards

ASTDR MRL 0.07 parts per million (ppm)

1 to 14-day inhalation exposure duration

EPA RfC 1.4 ppb

continuous inhalation exposure during a lifetime

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Routes of Exposure

Pathway	Description
Inhalation	Rapidly absorbed by the lungs
Absorption	Through skin is minimal
Sensory	Rotten egg odor

Health Effects - Acute

Low concentrations

Irritate the eyes, nose, throat and respiratory system

Effects can be delayed for several hours

Rotten egg smell

CANNOT be relied upon

Moderate concentrations:

Severe eye irritation, respiratory irritation, headache, dizziness, nausea vomiting, staggering, excitability

High concentrations:

Shock, convulsion, inability to breathe, extremely rapid unconsciousness, coma, **death**

Health Effects - Chronic

Low concentrations

- Suspected cause of Alzheimer's-like symptoms
  - Loss of memory
  - Loss of mental acuity
  - Possible effects on voluntary nerve response

NOTE: Based on very few studies, some of which have not been peer-reviewed

Effects At Various Concentrations

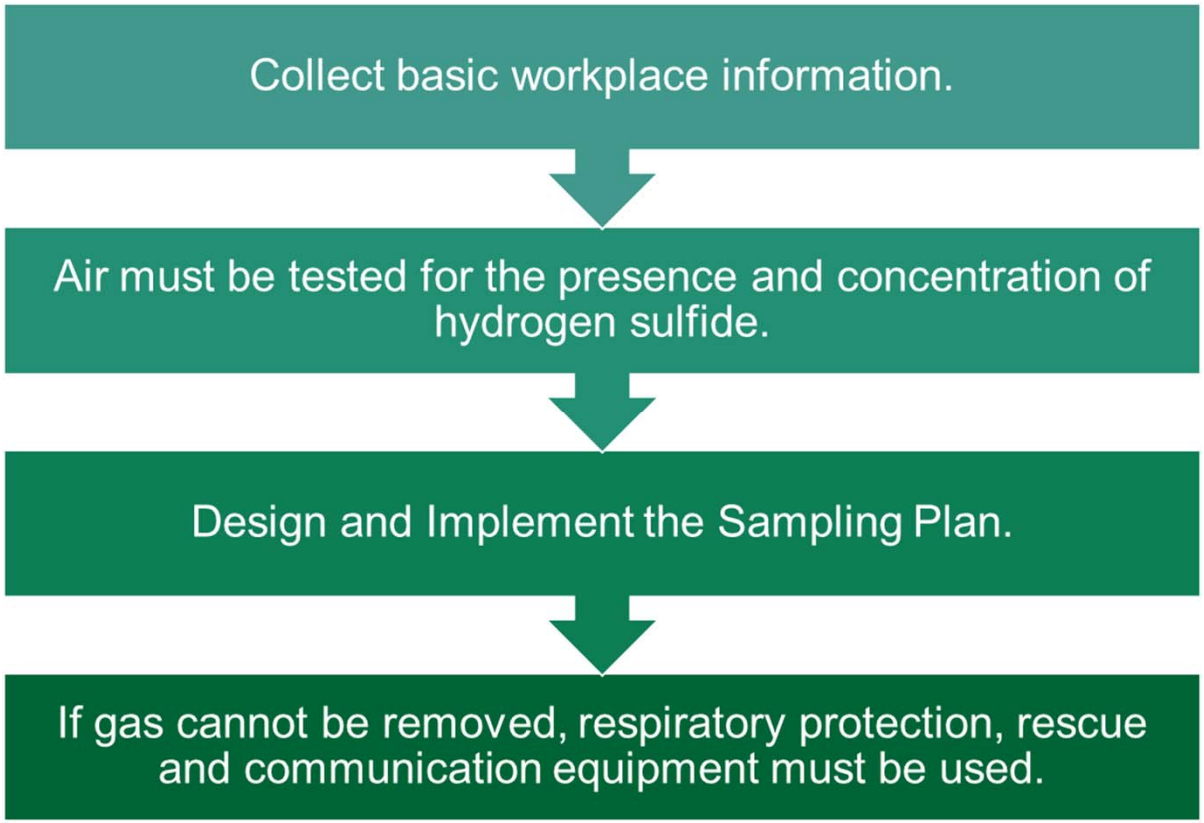
Concentration (ppm)	Symptoms/Effects
0.00011 - 0.00033	Typical background concentrations
0.025	Detectable odor
0.15	Offensive odor
1	8-hour TWAACGIH (5 ppm STEL)
10	Sore eyes (NIOSH REL)
20-30	Strong intense odor (20 OSHA C)
50	Conjunctival irritation
100	Olfactory fatigue (NIOSH IDLH)
250	Prolonged exposure may cause death
300-500	Pulmonary edema
500	Dizziness, respiratory arrest imminent
1000	Unconscious immediately, imminent death

- **Low**
- **Medium**
- **High**

Training

- API Z-390.1-2017
  - Defines what must be included in training
  - Sets a 3 – 4 - hour minimum course length
  - Requires certification of student's knowledge
  - Requires 1-year refresher training
- COURSES
  - Veriforce/PEC H2SClear
  - Safety Skills H2S
  - ANSI-CAP

Planning Considerations



Monitoring and Sampling

- Real-time Monitoring
  - Electrochemical Cells
  - Metal Oxide Sensors
  - Colorimetric Tubes
  - Gold Film Sensors
- Sampling – collection of air to be analyzed to determine “exact” concentration

Monitoring Equipment

- Electrochemical Cells
  - Most typically used in field personal monitors (single or multi gas)
  - Range: 0 – 100 ppm
  - Resolution: 0.1 ppm
  - Accuracy: ± 2 ppm or ± 5%, whichever is greater
  - Response time (T90): 10 – 20 seconds
  - Interferences: Heat, high humidity, low oxygen, NO_2, SO_2, PH_4, mercaptans, high VOCs

Monitoring Equipment

- Metal Oxide Sensors
  - Adapted to personnel monitoring by introduction of nanotechnology
  - Range: 0 – 200 ppm
  - Resolution: 1 ppm
  - Accuracy: ± 2 ppm or ± 10%, whichever is greater
  - Response time (T90): <15 seconds
  - Interferences: Low oxygen

Monitoring Equipment

- Colorimetric tubes
  - Single point in time measurement
  - Range: 0.2 to 600 ppm
  - Resolution: tube range dependent; best = 0.1 ppm
  - Accuracy: sampling method dependent; typically 20 – 30%
  - Response time (T90): 15 seconds – 10 minutes
  - Interferences: Temperature extremes, high humidity, NO_2, SO_2, mercaptans, acids

Monitoring Equipment

- Gold Film Sensors
  - Large and bulky for personal monitoring, good for area monitoring
  - Range: 3 ppb – 10 ppm
  - Resolution: 201 ppt
  - Accuracy: ± 1 ppb to ± 0.3 ppm, varies as level increases
  - Response time (T90): 12 seconds
  - Interferences: NO_2, PH_4, mercaptans

Problems with Monitoring Equipment

- Accuracy and response time of typically used equipment can cause serious employee exposures.
- Accuracy and lack of data analysis can lead to Time-weighted Average exposure exceeding occupational health limits.
  - NIOSH 10 ppm can be exceeded without showing a monitor exceedance.
- ACGIH TLV is often exceeded due to operating limits set by companies.
- Employees remove monitors in situations to get work done.

Sampling Methods

- OSHA Method ID-141
  - Silver Nitrate impregnated gel tube
  - Range: 0.5 ppm – 20 ppm
  - Accuracy: ± 5.1%
- NIOSH Method 6013
  - Coconut shell charcoal tube
  - Range: 0.6 ppm – 14 ppm
  - Accuracy: ± 11.8%

Sampling versus Monitoring

- Sampling provides a more accurate picture of actual employee exposure to H_2S if an adequate number and frequency of samples are collected.
- Sampling is more costly than monitoring.
- Sampling does not provide as complete a data set as monitoring.
- Typically, companies do not fully analyze monitoring data

Possible Solutions

- Evaluate and upgrade, if necessary, monitoring equipment.
- Utilize a safety system management software product to auto analyze monitoring data.
- Design a limited sampling program around the analyzed monitoring data.

Conclusions

- H_2S is present throughout the oil and gas industry
- H_2S is highly toxic
  - Can cause death at relatively low concentrations
- Employee protection is typically reliant upon real-time monitoring (RTM)
  - RTM has limitations
- A comprehensive sampling and monitoring program is necessary to truly protect employees

Thanks for listening!

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