PROCESSING SOUR (H_2S) GAS SAFELY

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Good design, proper protection, modern breathing apparatus (including rescue equipment) and continuous training will eliminate almost all personnel problems as sour gas is processed.

The initial step in any sour gas operation is a thorough understanding of Hydrogen Sulphide gas characteristics as it is life threatening. Many lives have been lost due to sour (H_2S) poisoning, not because of equipment malfunction, but because of human malfunction. Workers taking chances is undoubtedly the leading cause of fatalities involving H_2S.

HOW MUCH H_2S IS SAFE?

American Standards tell us we can work for eight hours in a concentration of 10 parts per million without the benefit of a protective gas mask. This is referred to as the M.A.C. or the maximum allowable concentration for an eight hour day. *Please remember that 10,000 PPM is equal to one percent H_2S.* That's right, and 600 PPM is not even one tenth of one percent.

So many have died because they were told that one percent was nothing - only a little bit of H_2S - no need to wear masks - hold your breath - run in quick and open or close a valve. How many times has this been repeated at coroner's inquests as to why, when, how and by what means did Joe Blow come to his death while working in sour gas? The stories are countless.

H_2S paralyzes the olfactory nerves very rapidly. It is a colourless, inflammable gas having an offensive odor similar to rotten eggs and a sweetish taste. It is heavier than air with a specific gravity of 1.18.

It is on a par with cyanide as far as toxicity and about six times as lethal as Carbon Monoxide (CO). Toxic effects vary

with concentrations encountered. Low concentrations cause irritations to the air passages, mucous membranes and the cornea of the eye. High concentrations have systemic effects; acute poisoning results and death is rapid.

PARTS OF H_2S PER 1,000,000 PARTS OF AIR

10	Maximum allowable concentration for prolonged exposure.
70 - 150	Slight symptoms after exposure of several hours.
170 - 300	Maximum concentration that can be inhaled for one hour without serious consequences.
400 - 500	Dangerous after exposure of 30 minutes to one hour.
600 - 800	Fatal in exposure of 30 minutes or less

RECOMMENDED PROCEDURES

Treatment for Victims

DO NOT ATTEMPT TO RESCUE AN H_2S VICTIM WITHOUT A SELF CONTAINED BREATHING MASK. Attempting to 'hold your breath' or putting a wet handkerchief over your nose and mouth and attempting a rescue can kill you. Get the victim to fresh air immediately. Apply artificial respiration, using mouth-to mouth resuscitation or any other method normally taught in first aid.

If a mechanical resuscitator is available, use it. The pure oxygen supplied by these units is far superior to manual methods. The air you breathe into a person using mouth-to-mouth contains roughly 14 percent oxygen while a mechanical resuscitator supplies almost 100 percent oxygen. All too frequently workmen prepare their tools and equipment for an H_2S job and neglect or forget to have mask and rescue equipment on site. Many fatalities have been reported while no breathing and resuscitation equipment was available on the job.

In many cases, fatalities result because masks or resuscitators can not effectively be put into operation due to minimal or no training. This is where advanced training comes to the fore. If those working with H_2S are to be sent 'into the breach', they will be committing suicide if not fully and properly trained in all aspects of H_2S. Statistics bear this out.

Training

The importance of a good first aid training program cannot be overstressed. We teach many methods of saving lives in first aid, such as artificial respiration, control of bleeding, treatment for shock, etc. In recent years much has been accomplished in the area of closed chest heart massage for the victims of electrocution, heart attacks and related problems causing the heart to stop. This

can and does happen to H_2S victims. Experts tell us that companies that have a good first aid training program have a much more favorable personal injury frequency than those that do not.

Above all, regardless of the degree of exposure to H_2S, be sure that all personnel exposed (even minor cases) are put in the care of a physician as soon as possible. Side effects can include lung damage. Pneumonia can often result. Conjunctivitis of the eyes can follow exposure and medications should not be used unless prescribed by a physician. Dryness of the throat can also result. Return to work only upon the advice of the attending physician.

Your chance of recovery after cessation of breathing or circulation is about 50 percent after four minutes and virtually zero after 10 minutes.

Detection

Detection instruments are available which can respond instantaneously. They can be programmed to sound alarms, actuate ventilating and/or fire equipment and have other isolating and shut down features.

These new techniques are expensive but must be considered. To prevent the cost from being prohibitive when covering a large complex in its entirety, a survey should be conducted during construction. Outline specific areas for automatic H_2S detection instrumentation. For example, one area that should be mandatory is the air intake vents supplying air to the main control rooms, which are usually pressurized. This air would be immediately detected. Set these units at a very low range to give an early warning to operating personnel.

Too much detection equipment could result in a false sense of security. Operators may rely too heavily on them. They must not, however, be ignored. They are valuable for high hazard areas. If automatic H_2S detection equipment is used, set up a regular test schedule on a weekly basis, depending upon how efficiently they operate. Be sure a responsible company instrumentation employee carries out these weekly checks. He will work with the supplier to correct testing procedures.

All H_2S leaks, regardless of size, must be tracked down and repaired immediately. Portable instruments using the stain type glass tube which reacts to given gases including H_2S, are normally used to 'find' leaks. *Remember*, do not rely on your nose. Put on a mask first and then find your leak and repair it. Often minor leaks can be repaired with no operational shutdown.

Major leaks will be handled through normal shutdown procedures and de-pressuring to a flare system. Sypervisors must have

authority to ignite serious gas leads 'in the field' where flare systems are not used. Company policy may vary. Be cautioned, however, that large volumes of H_2S cannot be allowed to contaminate populated areas due to its high toxicity. Policy on this must be extremely explicit.

Permit System

When a sour plant goes on stream, the first communication procedure is through the permit system. Absolutely no job involving the operation of the plant should proceed without a permit issued from the main control room, duly signed and approved. The control room must know at every moment what is happening within the confines of the plant. If the permit system is allowed to break down, trouble could result with the possible eventuality of lives being lost.

The permit is not just a piece of paper with impressive signatures. It is permission to do a specific job within the plant, outlining the safety procedures that must be adhered to. It also outlines the operational procedures before, during and after a job is completed.

Many feel that a permit is not required for small insignificant jobs, but this is wrong. If the small job permit is neglected, the whole system would break down, eventually leading to trouble. Contractors within your plant can be the greatest offenders, mainly because they have not been properly instructed on plant procedure by the principal or plant operator.

Many near-miss and fatal accidents have been recorded due to a poorly instituted permit system. A booklet commonly called Safety Instructors for Contractors is widely used in Alberta to assist in the use of permits and other safety instructions.

Communication

Normal communication within the plant is by 'word of mouth', written permit, telephone, mobile telephone, portable radio and related equipment. Good communication is absolutely essential within any plant and, above all, the communication between plant and field must be 100 percent at all times.

In the event of a plant emergency shutdown, the field also must be ready to shut wells in on a moments notice. At the present time, wells can be shut in by remote control which alleviates a great deal of the problem. Systems at times do break down, so it is therefore paramount that several types of communication be available and ready for emergency situations.

PROTECTIVE EQUIPMENT

Personal Protective Equipment

A clean air supply must be maintained and meet CSA and OSHA standards. Many plants today use the piped air systems throughout their plants, employing the use of instrument and/or utility air. This can be dangerous. There are times when this air does not meet recommended standards and could be injurious to the user.

Continuous monitoring of piped air must be maintained. Poorly maintained compressor and filtering systems are often the culprits for poor quality air. More and more plants are using the high pressure cylinder or stored air systems; that is the use of 300-cf air cylinders in a cascade system. The amount of air required for a given plant will dictate the number of cylinders required. Do not deplete your emergency air supply. The high pressure compressors used to fill these cylinders require considerable time to recharge.

Several compressor models are available, capable of producing anywhere from 3 - 15 cf per minute. It is better to have an excess of stored air than run short during an emergency when masks are required.

Types of Equipment

In sour plants, 'demand' and/or 'pressure demand' units are the basic equipment used. The demand units supply air to the user as demanded when breathing; the pressure demand units are basically the same except that the face piece is 'pressurized'.

Pressurized and non-pressurized units are manipulated by a simple switch on the regulator. However, when purchasing your unit, you must specify whether demand or pressure demand, as the exhalation valves on the face piece differ. Personally, I would consider only pressure demand for breathing equipment involving toxic gases.

Breathing equipment comes in many styles and sizes. They are all approved and any that are not should be ignored. The 45 cf unit is basically used in sour gas plants as emergency rescue equipment or for short term work. The 7 cf work units, complete with air lines, are normally used for maintenance work. But you are restricted to the length of hose attached to a supply of air. The 7 cf air cylinder is for emergency escape or egress from a contaminated area after disconnecting the air line.

Demand and pressure demand units are approved for *all* atmospheres.

Recent Approvals

Within recent years an improved concept in the demand - pressure demand units is the Positive Pressure System, which will eventually, in the writer's opinion, replace all earlier breathing air regulator systems. In reality it is an advanced pressure demand system mentioned earlier. This system positively ensures a continued air supply to mask users, thus eliminating demand and/or pressure demand switches employed on earlier models.

May I recommend that the people responsible for breathing mask purchases contact a knowledgable sales person prior to purchase. This will ensure that your personnel are exposed to the latest developments in this field.

MAJOR CHECKPOINTS

Following are a few additional points that warrant consideration for safety in sour plant operations:

1. Much is to be said regarding plant safety manuals, but do not go overboard; issue to supervisory personnel for training purposes and make copies available to employees to use for reference.

2. If not already implemented, introduce a noise abatement program, including audiometric hearing tests for all new and old employees.

3. Install yearly in-plant fire training programs, including supervisory attendance at Texas Fire School, Ansul Fire School or any other approved schools.

4. Every man in plant should have approved first aid training.

5. Regular simulated rescue training for both company and contractor personnel should be carried out.

6. Pre-check all company and contractor personnel using safety equipment prior to yearly turnarounds. At the same time, be sure those persons chosen as safety guards during such turnarounds are competent and qualified to do the job.

7. Check your communication for in-vessel work.

8. Have adequate breathing equipment for all personnel for turnarounds.

9. No long hair or beards be allowed in any sour gas plant or operation - both could impede proper face-piece fitting.

10. Adhere to all Governmental and Compensation Board safety regulations covering gas plant operation.

11. Do you have adequate H_2S warning signs for emergency use in plant?

12. How is your security?

13. Do you always use two people to do an H_2S maintenance job - the "Buddy System"?

14. Do you have approved bonding and grounding where applicable?

15. Do you have safe blinding procedures for sour lines and vessels? This is *extremely important.*

The foregoing, by no means, covers all aspects of sour gas operations. The surface has, nevertheless, been scratched. People problems still exist and we must address ourselves to this end.

REFERENCES

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Archibald, R. G. "Processing Sour Gas Safely", Hydrocarbon Processing, 1977.

TABLE 1—Toxicity of hydrogen sulfide to men

H_2S Percent (PPM)**	0-2 Minutes	2-15 Minutes	15-30 Minutes	30 Minutes-1 Hour	1-4 Hours	4-8 Hours	8-48 Hours
0.005 (50) 0.010 (100)	.....	.....	.....	Mild conjunctivitis; respiratory tract irritation	.....	.....	.....
0.010 (100) 0.015 (150)	.....	Coughing; irritation of eyes; loss of sense of smell	Disturbed respiration; pain in eyes; sleepiness	Throat irritation	Salivation and mucous discharge; sharp pain in eyes; coughing	Increased symptoms*	Hemorrhage and death*
0.015 (150) 0.020 (200)	.....	Loss of sense of smell	Throat and eye irritation	Throat and eye irritation	Difficult breathing; blurred vision; light shy	Serious irritating effects	Hemorrhage and death*
0.025 (250) 0.035 (350)	Irritation of eyes; loss of sense of smell	Irritation of eyes	Painful secretion of tears; weariness	Light shy; nasal catarrh; pain in eyes; difficult breathing	Hemorrhage and death*	.....	.....
0.035 (350) 0.045 (450)	.....	Irritation of eyes; loss of sense of smell	Difficult respiration coughing; irritation of eyes	Increased irritation of eyes and nasal tract; dull pain in head; weariness; light shy	Dizziness; weakness; increased irritation; death	Death*	.....
0.050 (500) 0.060 (600)	Coughing; collapse and unconsciousness	Respiratory disturbances; irritation of eyes; collapse	Serious eye irritation; palpitation of heart; few cases of death*	Severe pain in eyes and head; dizziness; trembling of extremities; great weakness and death*	.....	.....	.....
0.060 (600) 0.070 (700) 0.080 (800) 0.100 (1000) 0.150 (1500)	Collapse* unconsciousness; death*	Collapse;* unconsciousness; death*	.....	.....	.....	.....	.....

* Data secured from experiments with dogs which have a susceptibility similar to men. ** PPM-parts per million.