SAFETY AS IT APPLIES TO HYDROGEN SULFIDE DRILLING

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ABSTRACT

With the extensive search for energy materials, more wells are being drilled into zones that are capable of producing hydrocarbons containing hydrogen sulfide. This paper will deal with training and preplanning to handle the special problems associated with the drilling of sour gas wells.

INTRODUCTION

More wells are being drilled in zones capable of producing hydrocarbons containing hydrogen sulfide because of the increased search for energy. It is necessary that additional equipment and special precautions be taken to drill these wells and put them in production safely. The purpose of this report is to assist in problems which might be encountered in sour gas operations.

CONTINGENCY PLANS

In order to determine what will be required for hydrogen sulfide drilling, it is necessary that as much information as possible be developed to aid in well planning. What is the proposed depth of the well? What formation will production be from? What is the terrain around the well site? Is it a populated area? What are the planned mud weights and mud program? What is the expected bottom hole pressure and the expected hydrogen sulfide concentration? Is this a wildcat well or is data available from surrounding wells? You can see that additional information is necessary for your prewell planning.

It is only after we have the answers to these questions that we can develop the contingency plan. With the potential flow, pressures, and hydrogen sulfide concentration, we are able to use the Padquill-Gifford equation to determine our area of possible exposure.

The following equations can be used to determine the area you should plan to protect:

a. For determining the location of the 100 ppm radius of exposure:

$$X = [(1.589)\ (\text{mf } H_2S)\ (Q)]^{0.6258}$$

b. For determining the location of the 500 ppm radius of exposure:

$$X = [(0.4546)\ (\text{mf } H_2S)\ (Q)]^{0.6258}$$

Where: X = radius of exposure, ft

Q = maximum volume determined to be available for escape in SCF/D

mf H_2S = mole fraction of hydrogen sulfide in the gaseous mixture available for escape

The contingency plan should include:

1. A map showing homes, schools, business and public roads around the location
2. A list of people and which houses they occupy, phone numbers, and number of people residing there
3. A list of houses that are vacant and those occupied only on the weekend
4. A survery of livestock in advance, with a plan for moving them should difficulty develop
5. Plans for blocking of roads and control of spectators
6. Notification to regulatory bodies, highway patrol, ambulances, doctor and sheriff's office, including phone numbers

7. Plans for safety equipment with a list of supplies and additional equipment in the area
8. Delegation of responsibility to predetermine who will be in charge should the well get out of control—a very important aspect of the plan.

We will not cover all aspects of the contingency plan here; however, I believe you can see the importance of developing the plan at an early date.

LOCATION

The American Petroleum Institute bulletin API-RP49, "Safe Drilling of Wells Containing Hydrogen Sulfide," should be reviewed before plans are made to build the location. A large location is needed for drilling hydrogen sulfide wells so equipment such as mud tanks, shale shakers, gas separators, etc. can be rigged up away from motors and structures to allow for the movement of air to aid in dissipation of H_2S should gas reach the surface. Failure to move these can result in additional cost of having to wear breathing equipment on the job when H_2S concentration exceeds 10 ppm (a very low concentration) in the work area.

PRE-SPUD MEETING

The Pre-Spud Meeting is very important, as all possible problems which might develop can be here brought out for discussion. This gives the service companies a chance to evaluate their equipment and methods so they will be prepared. These people who attend this meeting know their services will be used and can make their plans, as equipment may have to be bought or brought in from other areas. This meeting should advise as to time scheduling so equipment will be available when needed. Pipe and christmas tree for hydrogen sulfide service require special processing.

PERSONAL PROTECTIVE EQUIPMENT

A self-contained breathing unit of the pressure-demand type must be provided for each person on location. Each must be trained in proper use of the mask and life-saving equipment on location. A person who is not familiar with this equipment would not be able to put it into service or assist another person who might be overcome by the gas. The cost of providing safety equipment would be approximately $1500 per breathing unit on the job.

There should be a double resuscitator on location and everyone should be trained in its use. Protective equipment should include rescue ropes, first aid kits, windsock, flare gun, stretcher, hydrogen sulfide detectors, etc., in addition to breathing units and resuscitators. The pressure-demand breathing unit makes it possible to work with a positive pressure in the face mask, thus excluding entry of toxic gases. Hoseline units are becoming more prevalent, though special care must be taken to assure air supply is not interrupted.

Electrical gas monitors are used in automatic detection of H_2S gas. The price of these units is determined by the number of sensor points required. The basic cost is approximately $1000 per sensor. Four sensor points are usually employed on a drilling rig, being placed at bell nipple, shale shaker, mud hopper area and rig floor. The logger often furnishes this equipment, thus providing a 24-hour operator on the site. Some operators have breathing air compressors placed on the rig site. This is a controversial and expensive issue, as it would be difficult to charge cylinders if gas is a problem at the surface. I am afraid the charging would cease and the air supply would soon be depleted.

TRAINING

The strength of your defense against problems depends on the training given. Everyone on the job must be trained in the proper use of protective breathing equipment, gas testing equipment, resuscitators, first aid, etc. Many service people come to the job site daily as part of their job, yet they feel they are not involved and do not need training. It is necessary to train everyone who is to be involved, and to guard against those not trained being on the job site when a hazardous zone is approached.

Allow time for training your crew and service employees. If you get into trouble and are involved in corrective actions, it is too late to train. We have found that the training of all at an early date, and then a retraining when the drilling reaches 1000 ft above the hazardous area, works very well as the early trainng helps to put down rumors about the gas. The equipment is demonstrated at the early date to show that protective equipment is available and that the Company has the employee's interest in mind.

During training, one of the first questions is how much hydrogen sulfide can be inhaled before it causes damage? The following figures are approximates and vary as to the tolerances of the individual.

10 ppm. There is an unpleasant odor like rotten eggs.
20 ppm. Safe to work in for up to eight hours of exposure.
100 ppm. The throat and eyes sting and burn and the sense of smell is lost in a very few minutes.
500 ppm. Causes dizziness and loss of consciousness. Breathing may stop in a few minutes.
700 ppm. Causes unconsciousness very quickly and death will occur if the individual is not rescued promptly.

It takes very little of the gas to cause death. It is imperative that steps be taken to prevent any personal contact with the gas. The toxicity of hydrogen sulfide is very close to that of hydrogen cyanide and because of this, protective breathing equipment is a necessity when working with concentrations above 20 ppm. Self-contained breathing equipment such as a "back pac" breathing air unit is very satisfactory. It consists of an air-tight mask, a hose, and a cylinder which contains approximately 30 minutes of breathing air. This unit, when worn properly, isolates the respiratory system from the atmosphere, thereby affording complete respiratory protection.

How do you know if breathing equipment is needed? There are many different kinds of equipment used to monitor H_2S. One of the simplest to use is a small bellows-type detector which consists of a pump and a glass tube containing a chemical sensitive to hydrogen sulfide. A sample of air is pulled through the chemical and if H_2S is present, the chemical turns dark. The length of the stain is then measured on a scale which indicates the concentration of the gas in parts per million. When in doubt about the gas concentration of an area, always put on protective breathing equipment before taking a gas sample or moving into the area to work.

Training and pre-planning to handle problems are most important. Blowout preventer drills with everyone reporting to the stations with breathing equipment operating and ready to conduct their task can prove beneficial if the need develops. Drills should be conducted for all on a regular basis to develop proficiency.

Special instructions should be given on the use of the choke manifold and its capacity. All should be aware of the bursting pressures of the piping. Early inspections should determine if the choke, lines, separators, and flare lines are of ample strength and properly anchored to prevent whipping and vibration. Once a line starts surging, it is too late to make any changes.

Records should be kept of all training received by crew members. This information should be recorded on the daily drilling report with a log kept of all service personnel who are trained. When a service company is needed, you should request those people whom you have already trained and have on your list.

GOOD DRILLING PRACTICES

Review of many wells shows that a well-planned mud program, utilizing records of previously drilled wells along with good drilling practices, is the key to drilling sour gas wells without difficulty. Jobs which experience problems, such as loss of circulation, gas kicks, fishing jobs, and equipment down time, set the stage for hydrogen sulfide at the surface. Your early planning should include how to handle plugged bits, loss circulation, gas kicks, and other problems which are common.

To minimize the time the pipe is out of the hole, bit and downhole assembly changes should be planned in advance. Special care should be taken to assure the hole is being kept full and that you are not swabbing the hole when tripping. The "rush attitude" on trips can put you in a difficult situation.

Inhibitors

Wells are drilled with and without inhibitors, but this can be very risky if you do not have a history of your possible pressures and H_2S concentrations. One of the many benefits of using inhibitors is the chemical reaction killing the hydrogen sulfide gas in the well bore. This protects the drill pipe and prevents odors from reaching the surface.

Drill Stem Test

Hazards are not present until the pay zone is

reached, yet we see the guards being let down when thoughts of testing the zones is discussed. A drilling contractor cannot risk the loss of his drill pipe to test through the drill pipe. Most tests are now conducted by well service contractors, using special tubing after the drilling rig has been moved.

Evacuation Plan

Routes of escape, public warnings, emergency phone numbers, control post, guards, etc. must be placed in your plan in case they are needed.

CONCLUSION

A hydrogen sulfide well can be drilled safely if proper planning is used in conjunction with good drilling practices and a well monitored mud program.

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