GENERAL DISCUSSION OF HYDROGEN SULFIDE FROM A USEFUL AND PRACTICAL STANDPOINT

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ABSTRACT

This paper deals with the practical aspects of safety when drilling wells that encounter hydrogen sulfide gas, the type and amount of equipment needed, the grade of air used, the use of air compressors, and the characteristics to look for when renting or buying safety breathing equipment. The paper explains the how and why of the physiological effects and after-effects of H_2S. The author feels an important part of the training for an H_2S environment is the knowledge of what happens when H_2S is taken into the lungs, the steps that must be taken to remove it, and how to prepare workers for an H_2S environment. The paper attempts to dispel many of the myths and old wives' tales heard concerning H_2S around the oilfield today.

Hydrogen Sulfide is comprised of two elements, hydrogen and sulphur. Hydrogen is a gas that is very flammable and can be ignited at about 500° F. Sulfides are culprits as far as breathing problems in the human are concerned. We have all read in many publications the toxicity tables of H_2S in relation to man. Let us look at how, and why, it affects man.

To simplify this matter let us review what happens in the normal breathing process. In normal breathing, air is taken into the lungs for a gas exchange with the blood. This exchange takes place in the alveoli, a small sack in the terminas of the respiratory system, and is a simple ionic exchange. The red blood cells have a high affinity for oxygen. The exchange picks up oxygen and releases carbon dioxide. This oxygen is taken to the cell where it is used to burn fuel, or body sugars. The fuel is taken in as the food we eat. In turn, when this oxygen and fuel is burned, carbon dioxide is released back into the blood stream and heat is produced to maintain body temperature at 98.6° F. The carbon dioxide is then carried back to the lungs, through the heart.

Breathing is controlled by sensors in the bloodstream, called chemoreceptors. These chemoreceptors send a message to the brain, indicating that there is not enough oxygen, or that there is too much CO_2 in the bloodstream, and that the breathing rate needs to be lowered or accelerated. The brain sends a message to the lungs, which in turn increases the blood gas exchange. When H_2S is taken into the lungs, along with ambient air, it causes a short in the electrical system in the body that sends electrical messages to and from the brain, which causes a cessation of breathing and a loss of muscle control, including that of the heart muscle at times.

Sulfides are a normal body trace mineral, and are necessary for normal body functions. The body can tolerate a certain amount of sulfides at a time. When an excess is taken into the body, such as when breathing H_2S, it poisons the body by causing a stoppage of the electrical current in the nerve cells. This is very similar to an overdose of other trace minerals, such as potassium, or magnesium. When this stoppage occurs, time is of the utmost importance to restore normal breathing, as these sulfides must be metabolized by normal body function, and oxygen must be put into the lungs and blood circulation maintained to the brain. The longer the brain cell is without oxygen, the greater the damage. Brain cells, unlike other body cells, cannot be replaced when they die. When part of the brain cells die, one has suffered brain damage. Normal body cells, such as the skin, replace themselves, but brain cells do not. Therefore, it is essential that artificial respiration for the victim be provided until normal respiration resumes. Normal respiration will resume when the sulfides are metabolized by the body. Artificial respiration

should be given either with a mechanical resuscitator, or by mouth to mouth. The fastest means is the most effective, to prevent damage to the brain cells.

Authorities generally state that brain damage starts in about three minutes. However, there will be some cases of death in this period of time. Mouth-to-mouth resuscitation is the first choice, as it is always available, easy to use, and effective. The human body requires about five per cent oxygen to maintain body functions. The normal ambient air contains about 21% oxygen. Therefore, if the person administering artificial respiration takes in 21% oxygen into his lungs and uses only 5% there will be an excess of oxygen breathed into the lungs of the victim, which is sufficient to maintain life. The problem with mechanical resuscitators is that usually they are not readily available, and most persons are not trained in their use. They must read the instructions before using, and time has elapsed. Mouth-to-mouth should be started immediately, and if a mechanical resuscitator is available, it should be sent for.

We have dealt only with the acute H_2S poisoning so far. Some of the subacute problems are burning and smarting of the eyes and the respiratory tract. This is due to H_2S (acid gas) coming into contact with the alkaline media of the eye, and with the mucosa of the respiratory tract, and forming a caustic, which is an irritant. Eye irritation is commonly called "gas eye," and is said to lead to blindness. Another prominent effect is a profound headache, that does not respond to normal treatment. Dizziness is also experienced. Some instances of skin irritation have also been reported.

Due to a lack of human subjects for experimentation, some facets of research on toxicity of humans are unknown. A question asked is, do people that have been exposed to H_2S become more susceptible to continued exposure? The general contention is that, yes, they do become more sensitive to low concentrations of H_2S than they were prior to initial exposure. Apparently, some persons are more susceptible to low concentrations of H_2S than are others, just as some people are to alcohol. The need for a physical examination is outlined in the OSHA 1910 rule. This examination includes the ear drums, for perforation, because with an acute ear drum puncture, air will enter the eustachian tube and then the lungs. Most punctured eardrums are of the chronic type, and scar tissue has closed the air passage. At any rate, a man with a punctured eardrum should not be allowed to work where breathing equipment is required. This would also be a company insurance liability.

High blood pressure is another thing to watch for. More exertion is required to work under an air mask than normal, and high blood pressure could enhance a heart condition. Physicians should also screen subjects for panic tendencies. It is also important for an employee to contact a physician, and be released as fit to work, after exposure to high concentrations of H_2S. A delayed complication can be pulmonary edema, also called water in the lungs.

There are many H_2S detection systems available on the market. Most of these systems are as effective as their maintenance schedule. Of all the systems examined by the author recently, less than half were in adequate working order, due to poor maintenance. These included rental companies that specialize in monitor systems. Therefore, when selecting a detection system, cost should be secondary to a simple calibration method, and ease of maintenance. To determine the equipment necessary for well-site safety, first consideration should be given to the safety of the personnel. If this is done, you will usually be in compliance with regulatory agencies.

A strong, steady wind is also a desirable element when working in an H_2S atmosphere. In the absense of wind, bug blowers should be installed. Many types of self-contained breathing units are available. One of the basic requirements that should be insisted on, is a pressure demand unit with an adequate supply of air that meets regulatory standards, supplied from bottles that have been filled by trained personnel, that in turn comply with OSHA standards. Compressors should not be used on site due to the danger of compressing carbon monoxide, hydrogen sulfide, or mineral oil along with other irritants. Recent investigation in the field has shown that of the compressors examined, none was equipped with carbon monoxide monitors. It was also found that common motor oil, rather than compressor oil, had been used. Use of motor oil in a compressor can result in permanent lung damage. Few, if any, of the compressors examined had any type of maintenance schedule. Filters had not been

changed, condensation had not been drained periodically during bottle filling, and many bottles were found to contain a large amount of fluid. None of the personnel questioned was aware that any of these problems could, or did, exist; and they had not been trained in the operation of the equipment.

Equipment may be purchased, or rented from a company specializing in respiratory protection and H_2S detection. There are obvious monetary advantages to both methods. Some of the hazards involved in owning equipment are poor maintenance, lost or damaged equipment, and lack of trained personnel to demonstrate the equipment use in the field. The hazards of using rental equipment are that, at times, it is not available when needed and that some rental companies do not maintain their equipment so as to be ready to use in an emergency situation, even with their own supervisory personnel on site.

A recent investigation of ten supervisors showed that three had not been trained to don a self-contained breathing unit, and that one supervisor was not aware of what type of poison gas to expect from the wellbore. This incident serves to demonstrate the lack of training of some rental companies' supervisors. Their practice seems to be to hire a roughneck one day, and call him an H_2S supervisor the next day. It also points up the current trend of some rental companies to approach H_2S safety from a monetary standpoint, rather than from the standpoint of the safety needs of the site personnel. Therefore, when considering the use of a rental company, carefully examine the entire program for the training of their supervisory personnel. A good rental company will approach your H_2S safety requirements from the standpoint of what is needed to protect your on-site personnel, rather than from the standpoint of selling you a "plan" which is based solely on price.