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Gas Hazards in Underground Tanks and Wells

May 1966 is a month that will not be soon forgotten by seven Michigan families. It was in this month that seven men were killed by poison gases in underground chambers. Five of these tragic deaths occurred in Riga, Michigan, and the remaining two occurred at Midland.

RIGA CASE HISTORY

Two employees of a fertilizer company in Riga, were assigned to install a new float valve in an old 35-foot-deep well used as a holding cistern for a new 300-foot-deep well. The cistern was covered with a concrete slab with entry by way of a covered manhole. The first worker entered the cistern, and as he dropped to a plank platform six feet below the opening, he was instantly overcome and fell unconscious into the water below. The man on the surface immediately ran to the nearby plant for help. Several workmen responded, and two entered the cistern to render aid. They, too, met the fate of the first worker. A passerby who had been drawn to the scene by the crowd which had now gathered, was told by an excited bystander that several men in the cistern were drowning. Upon hearing this, he shouted, "I can swim, I can swim," and pulled away from a fertilizer company employee who was trying to restrain him. Now there were four bodies at the bottom of the old well.

Figure 1 Safety rule number one is illustrated; Worker is wearing a safety harness connected to a lifting line, and adequate lifting power is available. (Note hand winch which will enable quick, safe, lifting of worker in case of an accident)

Shortly afterwards the fire department arrived at the scene with proper rescue equipment. The fire chief entered the old well wearing a self-contained breathing apparatus similar to the underwater breathing equipment used by skin divers. After reaching the plank platform he removed his face mask to shout instructions to those on the surface, and he too was instantly overcome.

Tests of the cisterns atmosphere revealed that hydrogen sulfide gas in a concentration of about 1000 parts, per million parts of air or more, was present when the five deaths occurred. Water pumped up from the deep well contained dissolved hydrogen sulfide gas which was released in the cistern. Hydrogen sulfide is detectable as the smell of rotton eggs in concentrations of only two-tenths parts per million. At 20 parts per million it will irritate lungs and mucous membranes, and at 150 parts per million causes olfactory nerve paralysis. This renders the nose unuseable as a detection aid when concentrations at this level and above are encountered. At 600 parts per million severe systemic symptoms quickly occur with death following if exposure is prolonged, and at concentrations of 1000 parts per million or more, death is almost instantaneous. Mode of attack is through pulmonary paralysis and irritation.

MIDLAND CASE HISTORY

Two maintenance men employed by the Meridan High School in Midland County, commenced work on a malfunctioning pump in the dosing chamber of the school's septic tank. (The dosing chamber is the second tank in the system. It receives liquid overflow from the main tank and periodically pumps this effluent to the drainfield.) One man entered the dosing chamber to check and adjust the float valve of

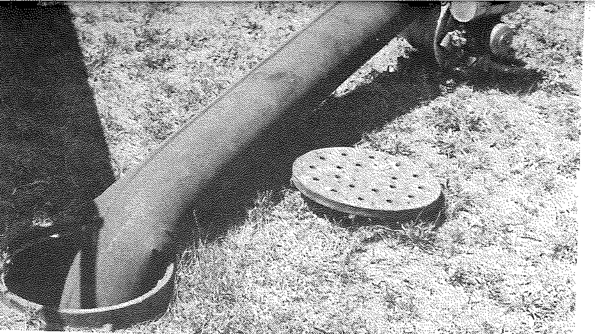

Figure 2 A portable fan and duct will purge toxic or explosive gases from an underground enclosure.

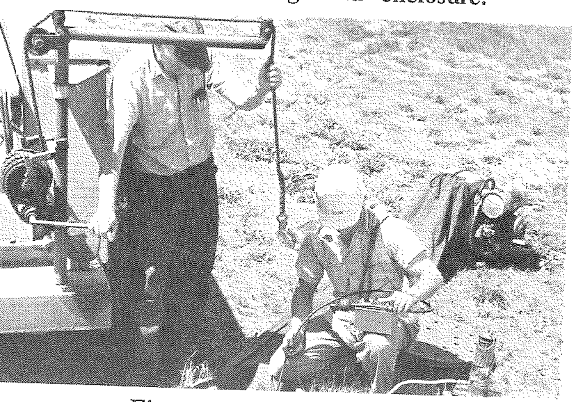

Figure 3 Test the atmosphere before entering with a combustible gas indicator. Note, Wolf safety lamp in foreground.

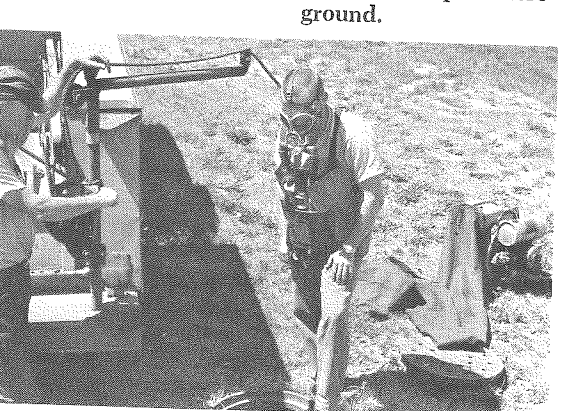

Figure 4 Self-contained breathing apparatus should be worn when making emergency entries or if there is a doubt about the air quality.

the drainfield pump. Work continued and it was decided to finish the job after supper. Later that evening the man entered the chamber again and collapsed immediately. The other workman on the surface quickly entered the tank to help the unconscious man, but he too was overcome. Help was recruited from the nearby athletic field, and a rescuer entered the tank with someone on the surface holding his arm. The rescuer managed to lift one of the victims partially out of the tank but he too collapsed. Fortunately the man on the surface maintained his grip and pulled the would-be rescuer out of the tank. He soon revived in the open air, and told investigators that the two victims seemed to be alive when he attempted to pull them out. No one else attempted to enter the tank, and when rescue workers recovered the victims, they were dead.

Gas samples drawn from the dosing chamber, and analyzed at the Michigan Department of Public Health Laboratories in Lansing, revealed moderate concentrations of hydrogen sulfide, (not fatal in itself) and methane. Also present in a high concentration was carbon dioxide gas. The primary cause of death was from prolonged asphyxia in the oxygen-deficient atmosphere caused by replacement of the oxygen by otherwise non-toxic carbon dioxide and methane. The quick collapse was attributed to the hydrogen sulfide gas.

LACK OF SAFETY PRECAUTIONS

Both of these tragic incidents were very similar in nature. In both cases gas or gases collected in underground enclosures were responsible for the deaths. In neither case were even the simplest safety precautions initially taken. All of the workmen involved were apparently unaware of the potential dangers in careless entrance of underground chambers. Also the lack of trained, properly equipped rescue personnel on the premises added four more unnecessary deaths in the Riga incident.

SAFETY RECOMMENDATIONS

It is recommended that everyone concerned with septic tanks, pump chamber wells, cisterns, tunnels, storage tanks or any similar enclosures, take precautions when they are required to enter one of these structures where toxic, flammable, or asphyxiant gases may accumulate. Sources of gas are: methane from organic decomposition, hydrogen sulfide and carbon dioxide from water supplies, artificial or natural gas leakage from utility pipelines, and residual gases or fumes in storage tanks.

Although this article is directed to gas hazards in underground structures, the same cautions apply to aboveground tanks or other enclosures. Some industries, notably the utility companies and chemical manufacturers have developed elaborate procedures that must be followed before and during entry to enclosures. Where such safety procedures are observed, accidents caused by confined gases seldom occur.

The person who can benefit most from this article is the maintenance man whose duties rarely require him to enter enclosures where gases may accumulate, and because of this, has little or no knowledge of the hazards involved. A prime example of this is the Riga and Midland incidents, where all of the deaths would have been prevented if the four following minimum safety rules had been followed.

1. No fewer than two people and preferably three should work on any such job. One man should remain at the surface at all times. The person descending into the opening should have a lifeline attached to him by means of a safety harness. The line should extend to the surface, and adequate pulling power should be available to haul up the individual quickly.

2. An air supply system, in the form of a portable fan and connecting flexible ductwork with a flow rate of 500 cfm, (commonly used by telephone cable repair crews) should be used 20 to 30 minutes before anyone enters the opening, to purge any toxic or explosive gas, and to supply oxygen in a deficient atmosphere. The fan should also be continued in use to supply fresh air when the work commences.

3. It is best to test for contaminants before anyone descends. A combustible gas indicator (explosive meter) does this job adequately. More accurate tests of specific gas type and concentration can be made with a series of direct reading tubes. A Wolf safety lamp can also be used to ascertain whether there is sufficient oxygen to support human life. Since these instruments require training in their use and interpretation, a combustible gas indicator which is direct reading, would be the most practical for routine work.

4. Self-contained breathing apparatus should be worn when it is necessary to enter into an opening where there is any question whether the air supply procedure (item 2) has provided a safe atmosphere. Any of the Bureau of Mines approved type devices can be safely used. See the Revised list of approved breathing protection devices, to select the proper type.

SUMMARY

Because of the proven hazards in entering underground or aboveground tanks and enclosures, anyone dealing with these structures is well advised to heed the warnings cited in this article, and follow the safety rules.

—B.D.B