HYDROGEN SULFIDE KILLS

Richard W. Hamilton

The following is a fictionalized account of a tragic incident that we must be prepared to read as truth at some time in the future. Circumstances can and have caused it to happen. That it has not happened more frequently is plain luck.

"Dateline: Anywhere, World; Anytime, 20th Century.

"With her engines muttering, the purse seiner crawled alongside and bumped into the dock with a dull thud. Lines snaked out, slack was taken in, and tied securely. The captain, the plant manager, even the spotter pilot, crowded expectantly onto the deck to watch the unloading of the first catch in over a week. Since the plant had been operating spasmodically all summer long, the arrival of a boat with fish covering the bottom of her hold was an event with more than usual import.

"As the hose man stepped gingerly into the hold, the pumps were turned on and valves opened. In preparation for the jolt that always comes when water under pressure jets out of the black orifice at the end of a high pressure hose, the man spread his feet and braced himself. He felt the hose quiver and he involuntarily tensed himself. The water came--only it was not water. It was dark and thick. Instantaneous, unannounced, DEATH spewed out.

"Rescue attempts began immediately. A man instinctively lunged into the hold. He did not even reach his stricken comrade before he too was felled. Hooks were tried, more lunges, more limp bodies. Seven men lay unmoving in and around that ill-fated hold. Not until local authorities with gas masks arrived were rescue attempts successful. Miraculously, two men recovered; five died.

"What hellish substance caused this nightmare? Hydrogen sulfide gas." End of transmission.

THE GAS

The gas (H_2S) is composed of only two elements: hydrogen and sulfur. It is known chemically as hydrosulfuric acid. It is written symbolically as H_2S--indicating a composition of two atoms of hydrogen and one atom of sulfur. If air is assigned a density of one, then H_2S has a density of 1.186. This means that it is heavier than air and will remain in the bottom of a fish hold or storage tank.

The gas is easily detected by the human nose in extremely low concentrations. The odor--rotten eggs--may be recognized in concentrations as low as two parts per billion. One of the most dangerous and deceptive characteristics of H_2S is that it quickly fatigues the sense of smell, thereby stripping a person of his only source of warning. Concentrations as low as 10 ppm are toxic, even though 600 ppm may be survived for as long as 30 minutes. At high concentrations, collapse, coma, and death from respiratory failure may come within a few seconds after one or two breaths. Low concentrations produce irritation of the eyes, nose, mouth, and throat. Headache, dizziness, nausea, lassitude may also appear.

Another dangerous characteristic of the gas is that it has a flash point of 500° F. Thus, if H_2S is present in high-enough concentrations and comes in contact with a surface heated to this degree, an explosion and fire will result. The gas is potentially explosive in concentrations from 4.3 percent to 46 percent.

How Gas Is Produced

Hydrogen sulfide is produced in the laboratory by the reaction between calcium

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sulfide and magnesium chloride. Commercially, it is manufactured by reacting dilute sulfuric acid with iron sulfide, by emiting hydrogen vapor with vaporous sulfur, or by heating paraffin and sulfur. There are many important uses for H_2S--in manufacturing other chemicals, in metallurgy, and in research laboratories.

When produced on purpose and contained, hydrogen sulfide aids mankind. When produced accidentally and not contained, it may be one of the very deadly poisons. In this latter case, hydrogen sulfide is produced biologically--primarily by bacteria. Several types of bacteria produce H_2S, but we are concerned here with only those species that can produce toxic quantities of H_2S in the fishing industry.

What conditions are necessary for the microbial production of H_2S?

1. A temperature high enough for bacteria to grow.
2. Absence of oxygen.
3. A source of organic sulfur.

When these conditions coexist, even for a few hours, biologically produced H_2S may reach toxic concentrations.

An examination of any fishery installation will reveal several areas where these conditions might exist, either intermittently or permanently. When a suspension of protein material such as fish flesh and slime is allowed to stand untreated, even for a short while, a series of events occur that will lead to the evolution of H_2S.

Initially, there is a rapid microbial growth with a twofold result: (1) an anaerobic (no oxygen) environment is created, and (2) the temperature is raised. As this microbial degradation or fermentation proceeds, even more heat is evolved, and conditions favorable for the growth of H_2S-producing bacteria come into existence. After the favorable temperatures are reached, these bacteria attack the sulfur-containing amino acids--cystine, its reduced form, cysteine, and methionine. All of these amino acids occur in fish flesh. The release of large quantities of the morbid gas--hydrogen sulfide--follows. An external source of heat, from processing or daytime temperatures, may allow the fermentation stage to be shortened or preempted with the almost-immediate evolution of H_2S.

Thermophilic (heat loving), anaerobic, sporeforming bacteria, such as Clostridium nigrificans, are everywhere; when H_2S is detected, they are usually the culprits. Other bacteria in the same genus probably better known to the public are Clostridium tetani and C. botulinum, the causes of "lockjaw" and botulism poisoning, respectively.

A Lesson In Deduction

Armed with this knowledge, we are now prepared to objectively assess conditions at the site of the tragic accident. Analyzed samples of the contents of pipes and lines leading to and from the pumps revealed the presence of a supersaturated solution of H_2S along with a tremendous amount of organic material.

Let us list all the facts we know:

1. The plant has not operated for over a week.
2. The time is mid-August with daytime ambient temperatures in sunlight as high as 105-110° F.
3. Analysis of pipe contents revealed large amounts of organic material as well as H_2S. Since this factory uses fish as a raw material, we can assume the organic substance was of animal origin; also, that it contained the sulfur-containing amino acids cystine, cysteine, and methionine.
4. The sealed pipelines afforded an anaerobic environment.
5. Whatever killed the crewmen was not present in the hold when the hose man first entered it--because neither he nor the men around the hold complained of unusual conditions.
6. No outward danger signs were present to signal impending disaster.

The inescapable conclusion: The victims succumbed to hydrogen sulfide gas--because:

1. An anaerobic environment existed in the closed pipelines.

2. The summertime temperatures were high enough to enhance, or at least allow, the growth of H_2S-producing bacteria.

3. Organic sulfur was present in the form of fish proteins.

4. Hydrogen sulfide producing bacteria are found anywhere and their presence in the closed pipeline is almost a certainty.

5. With a shut-down of over a week, there was more than enough time for a lethal concentration of H_2S to be evolved.

How To Prevent This

The sorrowful sequence of events just described need never be repeated. Even though the potential circumstances for H_2S intoxication exist in many segments of the fishing industry throughout the world, the prevention of this type of accident is extremely easy:

1. All water lines leading to and from pumps should be flushed before and after each use.

2. Stickwater, bailing water, and other such solutions should never be stored untreated. They should be processed as quickly as possible--either acidified or otherwise treated so that bacterial growth will be prevented or retarded.

3. All storage tanks should be equipped with forced air ventilation.

4. With the many relatively inexpensive H_2S-testing kits now commercially available, routine testing of potential danger areas should be a must.