Cyanide Incident Results in Death At Indiana Plating Shop

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Cyanide chemistries are still used in some plating processes. However, the choice to use cyanide is not made lightly. Most electroplaters are very conscious of the hazards associated with using cyanide and realize that death can result from the accidental release of toxic hydrogen cyanide gas. However, inhalation of the gas is not the only way that cyanide may kill. This case study will explore the unusual events and subsequent accident at a large Midwestern job shop that cost a worker his life.

Background

The employees of this plating facility were well aware of the dangers of cyanide zinc plating. They had been plating with cyanide for more than 50 years, and never had a problem with the chemistry. However, the shop owners chose a non-cyanide zinc plating bath for a new automatic rack plating machine. Unfortunately, certain wire goods could not be plated successfully in this new chemistry, and the old cyanide formulation had to be used in the programmed hoist line. Tests were still being conducted to find a cyanide free formulation to plate the wire goods at the time of the accident.

Case Study

This case study involves an incident of probable cyanide poisoning resulting from ingestion of zinc plating solution. The worker, a 56 year old man who had not been feeling well the day before, reported to work as usual. His duties included racking/unracking parts and making additions to the tanks on the plating machine. The man informed his supervisor that he hoped he wouldn't have to do any heavy lifting since he wasn't feeling well that morning. Unfortunately, there were no toxicology studies or blood test done to either confirm or deny the cyanide poisoning as the direct cause of death. However, the death was ruled cyanide poisoning by the coroner's office.

Description of the Cyanide Incident—Time Line of Events

The day started much like any other day:

7:00 AM—Friday morning started off with the usual work that must be done to prepare for running the day's production. The largest automatic plater, a programmed hoist rack machine, needed to have the zinc ball anodes replenished. The victim of this accident asked his team leader if they were going to be loading heavy parts again today. The worker said that he was not feeling well and hoped the work would not be as strenuous as the day before. Fortunately, the parts were lighter in weight and loading and unloading the work bars would be much easier on this day.

7:15 AM—Relieved that work would be easier, the employee began to load anodes into the zinc plating bath. The zinc tank was 12 ft x 20 ft x 6 ft deep and contained approximately 7,500 gallons of solution. The plating bath contained 12 oz/gal of sodium hydroxide (NaOH) and 6 oz/gal sodium cyanide (NaCN), along with some other chemicals, most of which were non-hazardous. The tank was set up as a "cell" plater with 9 in. between the anodes. The anode rails are mounted permanently on the tank with submerged wire baskets for the zinc ball anodes. The normal procedure was to place 1 in. thick 48 in. x 48 in. sheets of plywood over the top of the anode rails, which were spaced every 36 in. across the width of the tank. This provided a stable platform from which the worker could drop the zinc balls into the baskets. Once the boards were in place, two 5-gal buckets of zinc balls were placed close to the anode rails and refilling began. The worker knelt down and used one hand for support. He dropped the anode balls into the baskets with his free hand. Periodically, he would slide the boards back and repeat the procedure until all the anodes were replenished in that plating cell. Then, the anodes in the next plating cell were replenished in the same manner.

Everything was proceeding as usual until the worker suddenly fell forward dropping his face into the plating solution.

7:25 AM—Anodes had been replenished in this machine in this manner for more than 15 years without incident. Also, the worker had done this job hundreds of times before and never had the first problem. Only something went horribly wrong on this morning! The worker lost his balance and his face and head went into the plating bath. However, since no one saw it happen, the exact details of this accident still are unknown.

7:30 AM—The worker quickly rinsed himself off in the near-by safety shower. Another teammate who observed him at the shower quickly came to give aid and flooded him with additional water from a near-by hose. Although the worker did not appear to have swallowed any of the solution, he did get it in his eyes, nose and mouth. He coughed, spit and even laughed a little, about the incident. However, a couple of minutes later he suddenly dropped to the floor and lost consciousness.

His team-mate immediately phoned 911 for Emergency help.

7:35 AM—The emergency responders arrived in minutes and everyone hoped the situation would improve quickly. However, such was not the case. The EMS team had oxygen, but no cyanide antidote kit. Unfortunately, as soon as they found out the worker had fallen into cyanide, they acted as if he were covered with anthrax! The responders did not give any aide to the victim, not even oxygen. About that time, a fire rescue truck arrived. As soon as the firemen heard the word "cyanide" they responded by spraying the unconscious worker with more cold water from a fire hose. Then, when they deemed it safe, they put him in the ambulance for the 5-minute

trip to the emergency room at the local hospital.

7:45 AM—Although his breathing was labored, he was still alive at this time. Unfortunately, he died while being transported to the hospital. Toxicology testing was not completed.

7:50 AM—The coroner listed the cause of death as "cyanide poisoning." Although the owners of the company requested that an autopsy be performed, the coroner refused to comply. He felt the risk of exposing health care professionals to cyanide during an autopsy was too great. Therefore, he ordered the body cremated, without further testing, as soon as possible. Also, the coroner was asked by the company to order a toxicity screen on a blood sample which had been taken from the worker. However, that, too, was not done, and the blood was destroyed.

Discussion

Emergency medical responders are fearful of hazardous chemicals. Usually they don't have the specialized training required to treat workers that have been injured with corrosive, poisonous chemicals. The situation becomes worse if the chemical has received much negative publicity. For example, for many years cyanide was used in the gas chamber to execute criminals. Hollywood "spy thrillers" show actors committing suicide by swallowing a cyanide capsule. It isn't any wonder that the word "cyanide" strikes fear in the hearts of most people.

There are many different forms of cyanide with some being more toxic than others. The toxicity of cyanide depends upon the chemistry of the solution in use. Much of the cyanide used in electroplating is complexed with metals such as copper or zinc. A complexor is a chemical that readily combines with another chemical and takes on a unique structure. And, cyanide is one of the world's greatest complexors. In fact, the ability of cyanide to complex with metals made the first electroplating baths possible. Cyanide that is complexed with metals such as iron, copper and zinc is less toxic than sodium and potassium cyanide. This is because the cyanide is not "free" to react with other metals. Therefore, the most dangerous cyanide found in electroplating is "free" sodium cyanide. The plating bath in this incident had less than 1 ounce per gallon of free cyanide. Cyanide is not readily absorbed through the skin, although some people do develop a cyanide rash after skin exposure. However, the manufacturer of cyanide states that it can be absorbed into the skin over time and direct contact is not advisable. The fastest routes of entry into the body in cyanide poisoning are usually ingestion and inhalation.[1]

How Cyanide Kills

Cyanide produces an acute, toxic reaction in the human body and is not a carcinogen.[2] Humans need oxygen from the air to keep the cells in the body alive. Oxygen enters the body through the lungs and combines with the hemoglobin in the blood. Hemoglobin is an iron complex that gives blood its red color. The oxygen is released from the hemoglobin for use by the cells in a complex chemical reaction. Cyanide interferes with this process by combining with the hemoglobin. This prevents the blood from taking up oxygen to transfer to the cells. The result is death by asphyxiation. This usually is a process that first renders the victim unconscious when the brain does not receive enough oxygen.

Cyanide poisoning represents a special challenge to ensure a positive outcome. The best method of treatment is to destroy cyanide in the blood by a chemical reaction with sodium thiosulfate. The procedure is to inject the antidote chemical directly into the blood stream as soon as possible. However, this should be done by a trained health care professional and the antidote may have some serious side effects. For example, one person went into cardiac arrest after receiving an injection of sodium thiosulfate by emergency responders.

Some people incorrectly believe that amyl nitrite is the antidote for cyanide poisoning. This chemical is administered by inhalation and is done by breaking an ampoule in a gauze pad and holding it over the nose and mouth area. However, amyl nitrite does not destroy the cyanide in the blood. This chemical is only a "vasodilator" and opens up the air passages to the lungs. Then, more oxygen can then enter the blood stream. If the victim is still breathing, this may be an effective treatment. However, supplemental oxygen will greatly improve the person's chances for ultimate survival. Also, since amyl nitrite is a controlled substance, employees have been known to take it for recreational use.

In order to get the cyanide antidote kit a medical doctor must write a prescription for it.[3] Like any other drug, the kit has an expiration date and must be periodically replaced. The antidote kit must be readily accessible or it serves no purpose. Some shops have put it in a box with a glass door that must be broken for access. Another method is to use an alarm system which sounds a warning when the box is opened. Also, this would notify others to summon help.

Procedures for Plating Shops

The MSDS should be consulted for specific details on the first aid procedures for cyanide poisoning. However, the following are general guidelines that may be used before the emergency responders arrive:

- Wash off cyanide solution with warm water not cold water which may induce shock.
- Lay person down and give amyl nitrite ampoule. It can be administered by holding a cloth over the ampoule at the nose and mouth area or holding it inside an oxygen mask.
- Give supplemental oxygen from a mask with pressurized cylinder.
- Have emergency medical paramedics give the Sodium Thiosulfate injection.

According to the MSDS for sodium cyanide (CP/Phibrochem), the following is emergency information for sodium cyanide (143-33-9): Inhalation of approximately 200 ppm HCN in air or approximately 200-300 mg of NACN can cause immediate unconsciousness or death.

Emergency & First Aid Procedures

Warning! Do not attempt to administer first aid without first assuring self-protection from exposure. Fatal dosages are possible from unprotected skin contact or inhalation of fumes. Put on full protective equipment before offering first aid.

Eye Contact—Immediately, flush with copious amounts of water for at least 15 minutes while holding eyelids apart. Washing within one minute is essential to achieve maximum effectiveness. Get medical attention.

Skin Contact—Wash affected area thoroughly with soap and water. Remove contaminated clothing and launder with alkaline bleach before reuse. If irritation should develop, get medical attention.

Inhalation—Break an amyl nitrite pearl (ampoule) in a cloth and hold lightly under nose for 15 seconds. Repeat five times at about 15 second intervals. Repeat as necessary using a fresh amyl nitrite pearl every three minutes until 3 or 4 pearls have been given. If not breathing, give artificial respiration using mechanical devices. Do not administer mouth to mouth respiration! If breathing is difficult, give oxygen. Get immediate medical attention.

Ingestion—A deadly poison! Never give anything by mouth to an unconscious person. Do not induce vomiting. Administer antidote kit if available, following instructions. Administer oxygen and amyl nitrite inhalant as for inhalation treatment as required and seek immediate medical attention.

Conclusion

Because of the fast action of cyanide in poisoning cases, one cannot expect much help from outside emergency responders when cyanide is involved in an incident. Any delay in treatment will adversely impact the outcome. Due to the need for immediate action, it is essential that a cyanide antidote kit and medical oxygen are available on-site. Also, supervisors should be trained in the use of amyl nitrite and oxygen as well as first aid and CPR. The management of this company has a "no person in or over any open tank" shop rule. This is a zero tolerance rule and good idea for any plating shop.

Unfortunately, no one will ever know for certain what caused this worker's death. It may well have been some other cause such as a stroke or heart attack. However, because cyanide was present, and no blood testing nor autopsy was done to disprove it as a factor, cyanide poisoning was listed as the cause of death.

References

1. Material Safety Data Sheet (MSDS 2020), CP/PHIBROCHEM, NJ, 02/15/01, Sodium Cyanide.
2. ATSDR Agency for Toxic Substances and Disease Registry, Division of Toxicology www.\cdc.gov.
3. Cyanide Antidote Kit, Eli Lilly Company, Indianapolis, IN.

About the Author

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