Cyanide Poisoning What's the latest thinking?

Do you use cyanide in your operation? Are you prepared for a cyanide incident? Without the right knowledge, one can be harming rather than helping.

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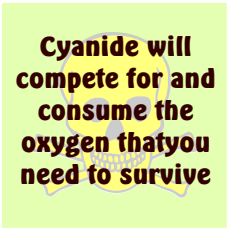
How dangerous is cyanide? According to The South African Medicines Formulary, a publication of the Dept. of Pharmacology, UCT, cyanide is one of the most rapidly-acting of all poisons. Death may occur within minutes. It inhibits enzymes controlling oxidative processes, resulting in cellular oxygen utilisation defects.

In layman's terms, we need oxygen to live, and if enough cyanide gets into your system it will compete for and consume the oxygen that you need to survive. You'll die as if you had been suffocated. So clearly, it is a very hazardous material to work with, and everybody that is required to work with cyanide must be made fully aware of the threat that cyanides pose if handled incorrectly.



Despite the fact that there is a global move away from the use of cyanides in electroplating, and some of the biggest advances in technology have been in been in the development of alkaline non-cyanide processes, large quantities of cyanide continue to be used in some electroplating workshops. Most of this cyanide is used in zinc plating with operators reluctant to move over to new technology for various reasons.

In a jobbing shop, it is difficult to totally eradicate cyanides from the production floor. Copper strikes, brass, silver and gold plating solutions are commonly based on cyanide. Modern cyanide-free alternatives have been developed, but from the evidence available, it seems that they are either prohibitively expensive and/or don't work in the same hassle-free manner as the original cyanide formulations. The experience may be different in other parts of the developed world, but certainly that is the impression in South Africa.

The biggest threat of cyanide poisoning is from the potential inhalation of HCN, Hydrogen Cyanide gas, which is produced when cyanide solutions mix with acids. Yet you can visit plating shops all over the country where the attitude to handling

cyanide is blasé at best. Puddles of cyanide solution lie on the floor. As the cyanide process is often close to a pickling process, spills of cyanide solutions can and do mix with acid solutions. The unique blue colour of these puddles (Prussian Blue) confirms that cyanide has mixed with iron to produce a ferrocyanide compound, by way of some interesting chemistry. The source of the iron is the dissolved iron from the acid pickle. Thankfully, the reaction ties up some of the cyanide that would otherwise escape as gas. The more iron available, the better, apparently! It's an absolute wonder that there are not more frequent reports of cyanide incidents from our industry. One can only speculate that the amounts generated in this manner are relatively small, that it's not happening in too confined a space and that there is sufficient ventilation to dilute this lighter-than-air gas to below lethal levels.

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How much cyanide is lethal? That's a debatable point. Many studies have been done, and there are differing opinions. According to the United States Department of Labour OHSA[1] a 1991 study reports an estimated LC(50)[2] in humans of 3,404 ppm for a 1-minute exposure; other sources report that 270 ppm is fatal after 6 to 8 minutes, 181 ppm after 10 minutes and 135 ppm after 30 minutes. [Hathaway et al. 1991]

This might make for an interesting debate for toxicologists studying a corpse, but if it's your corpse they're looking at, whether you are wiped out by 250 ppm or 500 ppm is not really helpful. In reality, relatively few fatalities have been reported related to cyanide poisoning and there have also been some amazing escapes, if you can believe some of the stories!

An acquaintance, who'd been involved in the industry some decades ago, recounted a dreadful experience where a plater used a cold drink bottle to deliver a sample of gold cyanide plating solution for analysis in the company's internal laboratory. The analyst wasn't in the room at the time of delivery, so the plater placed the bottle on a windowsill and left. Another worker entered the room and mistook the clear solution for water, which he drank. The man died a horrible death.

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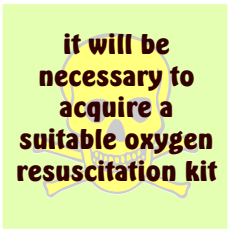
drinking a cyanide brass solution from a cold drink bottle, and another soul whose son tried to commit suicide by drinking a preparation of cyanide she had taken home from work to kill the weeds with. Amazingly, in all these cases, the subject survived despite getting rather ill.

Recognising Cyanide Poisoning

As cyanides are rapidly absorbed from the skin, mucosal surfaces and lungs, features of poisoning usually appear within seconds to minutes after exposure. Symptoms include giddiness, headache, palpitations, shortness of breath, loss of consciousness, followed by convulsions and death. Note that cyanosis (blue skin colour) is not present, the skin colour may be 'brick-red', and there is typically an odour of bitter almonds.[3]

Administering Oxygen the Best Emergency Response

From available evidence and experience relating to cyanide incidents, the consensus seems to be that the administration of oxygen is the best emergency response. It does seem to make sense, even to the layman that the administration of oxygen to a patient who is being starved of oxygen in his cells can only be beneficial, and there is very little chance of doing more harm, as can be the case with the uninformed use of some of the other suggested antidotes which will be discussed. In the United Kingdom the Health and Safety Executive is recommending Oxygen therapy as the preferred initial treatment for cyanide poisoning.[4]



In order to be able provide this treatment properly it will be necessary to acquire a suitable oxygen resuscitation kit, a cylinder with control valve, bag and mask device. Mouth to mouth resuscitation is risky due to the possibility of poisoning the helper. First aiders in the factory must be taught how to use the device properly.

The use of some antidotes called into question

Since 1997 the U.K. HSE decided against promoting the use of certain formerly recommended antidotes .

The first is an antidote that was recommended for administration in cases where the victim was known to have swallowed cyanide. This consisted of two solutions given orally, termed Solution A: ferrous sulphate dissolved in aqueous citric acid and Solution B: aqueous sodium carbonate given orally.

The solutions have a very limited shelf life and a recently published review has questioned their efficacy and drawn attention to their inappropriate use.[5] The U.K. HSE is also aware of cases of iron poisoning where the solutions have been used

incorrectly. The treatment is no longer being promoted.

Amyl nitrite has been recommended as an antidote for cyanide poisoning over many years and many material safety data sheets and other first aid publications still advocate its use. It is included in cyanide antidote kits. Particularly when the victim is already unconscious, ampoules of this yellowish liquid with its ethereal fruity odour, are crushed into a cloth and held under the victims nose. Something important to note is that amyl nitrite should not be used simultaneously with the administration of oxygen. Opinion seems divided on just how effective amyl nitrite is. It can be dangerous for persons already suffering from some types of heart problems. Substance abusers use it as a recreational drug that induces euphoria and it falls into the group of drugs commonly referred to as "poppers". Because of the misuse, it is not very freely available. Nor is it a stable product; the stock has to be constantly monitored, kept under special storage conditions and replaced regularly at fairly short intervals. The U.K HSE is not recommending its use, but has left it up to individual employers to decide if they would still prefer to keep amyl nitrate ampoules.

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Intravenous injection of dicobalt edetate is an antidote preferred by toxicologists when a seriously ill cyanide victim turns up at an emergency centre. The second option is intravenous injections of sodium nitrite followed by sodium thiosulphate. These injection packs form part of cyanide kits that are commercially available to factories working with cyanide. However, all cyanide antidotes are potentially toxic. There are several cases on file where these products were used when not indicated in the circumstances resulting in a worsening of the patient's condition and extending the stay in hospital. Treatment of this nature falls outside of a factory first-aiders area of competence. Even transporting the in-house cyanide injection kit to emergency rooms along with the patient has resulted in doctors starting administration of these chemicals when the diagnosis of cyanide poisoning was not actually correct. There are a number of conditions that can lead to displaying symptoms of dizziness, shortness of breath and loss of consciousness. Just because someone happened to be working with cyanide when these symptoms presented does not automatically indicate poisoning. In the U.K. the HSE recommends that employers who use cyanides should discuss the arrangements for the medical treatment of cyanide poisoning with their local hospital or other provider of

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medical care. It is no longer advising that these antidotes have to be kept on site. Toxicologists consulted in South Africa support this opinion.

Step by Step Guide for Dealing with Cyanide Poisoning

Speed is essential. Obtain immediate medical attention. In this regard it is advisable to build a relationship with a nearby medical facility favoured and supported by the company; the kind to which the company normally sends workers that suddenly get ill at work or who are injured on duty. This outfit should be informed that there is a limited risk of cyanide exposure at your facility, and be prepared for this eventuality.

Protect yourself and the casualty from further exposure during decontamination and treatment.

Inhalation: Remove patient from exposure. Keep warm and at rest. Oxygen should be administered. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and mask. Do not use mouth to mouth resuscitation.

Skin contact: Remove all contaminated clothing immediately. Wash the skin with plenty of water. Treat patient as for inhalation.

Eye contact: Immediately irrigate with water for at least ten minutes. Treat patient as for inhalation.

Ingestion: Do not give anything by mouth. Treat patient as for inhalation.

Prevention is Better than Cure

Whilst it is important to be equipped to deal with a cyanide accident and perhaps save a life, it is equally important to take every precaution to avoid the negative effects on workers health from long term exposure. The South African Medicines Formulary[6] informs that industrial exposure to hydrogen cyanide solutions has caused dermatitis, itching, scarlet rash, papules (red pimples), and nose irritation and bleeding. Perforation of the nasal septum has also occurred [NLM 1995]. Workers exposed to hydrogen cyanide at concentrations ranging from 4 to 12 ppm for 7 years showed an increase in symptoms such as headaches, weakness, changes in taste and smell, irritation of the throat, vomiting, effort dyspnea, lacrimation (weeping eyes), abdominal colic, precordial pain (chest pain over the heart), and nervous instability [ACGIH 1991].

This is where we should be looking to ensure safety and reduced exposure:

Storage of Cyanide - Cyanides should never be stored in the same store room as acids. If there is no dedicated cyanide store, then at the very least they should be stored with alkaline cleaners, caustic soda, and all alkaline products. Neither acids

nor flammable solvents should not be stored in close proximity to the cyanide store. The ideal store will have a contained floor area that does not allow liquids to flow into other work areas in the event of flooding and the like. It should preferably have an extractor fan which is used to draw out potential vapours for a few minutes before workers enter the store.

All weighing and measuring of cyanide should be performed in this store area, and it's best to have a permanent scale for this purpose sited in the store.

Workers should always be aware, and be keeping an eye on the person working with the cyanides in case something goes wrong.

Purpose designed and dedicated scoops should be used for measuring out requisite amounts needed. The powders should never be dispensed from a height so as to create a cloud of dust when transferring to a plastic bag or bucket, for instance.

Respirators & Protective Clothing - Personnel should be trained in the correct use an appropriate dust mask when working with the powders. *Note: A contaminated or incorrectly worn mask is worse than no mask at all.* Training in the correct use of Personal Protection equipment is absolutely vital. Overalls, gloves and aprons are needed when working with the majority of plating processes, but must be used in the prescribed manner.

Spills to floor and onto equipment should be dealt with immediately. Small amounts of contaminated powder recovered from the floor must be handled through a proper effluent treatment process. Brooms, mops and cloths used for damp mopping must be thoroughly rinsed in an appropriate rinse tank.

Identification - All chemicals must be identified with firmly affixed labels that are clear and indelible.

Samples should be housed and transported in clearly labelled, uniform, purpose-designed bottles made for use in an industrial environment. No other container should be used for samples in the factory. Preferably dedicated containers should be used for each category of sample; copper cyanide solutions in dedicated containers, zinc cyanide solutions in their own containers, etc.

Additions to tanks - It's usually advisable to draw liquid out of a tank into a separate mixing tank alongside, and then to slowly stir the cyanide additions into this tank. Again, using proper scoops and not dispensing from height. It's also important to liaise with the lab technician that prescribed the additions because that individual will know about the order of mix, and what is possible or not. For instance copper cyanide needs an excess of sodium or potassium cyanide, and additions to brass tanks can be very tricky with regard to solubility issues.

The working environment - It goes without saying that a plant should be layed out in such a fashion that spillages to floor are avoided, particularly as work is transported over the process line. Equally important is that the likelihood of carry over of acid into a cyanide plating process is totally excluded. Plant design must incorporate the requisite mechanically agitated clean pre-rinses to ensure no carry over.

Monitoring Alarm System - As one of the most sophisticated of options, a cyanide sensor with alarm may be installed. This will alert whenever the cyanide rises above the short term occupational exposure limit of 10 ppm.

Effluent treatment - Poor management of effluent in the factory and at the effluent treatment poses many threats. Stream separation is of great importance to prevent acids and cyanides mixing in gullies and in sumps in the building.

Disposing of concentrated cyanide solutions is a specialist's job. One of the best reasons for moving away from zinc cyanide solutions is the enormous hassle of getting rid of sludge, and of dealing with heavily carbonated solutions. Treatment of zinc cyanide effluent streams at the wrong pH or attempting to "bomb" the solution with overdoses of chlorine will liberate cyanogen gas, that is also extremely toxic.

Plating Aerosols - The hydrogen generation during plating gives rise to an aerosol mist directly above the plating tank. In a cyanide solution it follows that within that mist there is a proportion of cyanide. Adequate ventilation is essential and lip extraction is the ultimate guarantee of totally eliminating this mist. This is yet another reason to move away from cyanides.

Hygiene - Washing of hands before eating, only handling foods in dedicated safe areas, wearing proper protective clothing, keeping overalls clean, and changing out of contaminated clothing directly after splashes that get onto them are all obvious practices to follow.

Certainly, eating food whilst working on the plating line, and worse still, the practice of drinking water from taps at rinse baths should never be tolerated. Alarmingly, use of soft drink bottles for short term storage of brighteners, or bath samples happens far too often. The reported incidents demonstrate just how dangerous the consequences can be.

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