

# Hydrogen Cyanide

“The Little Molecule that Kills”

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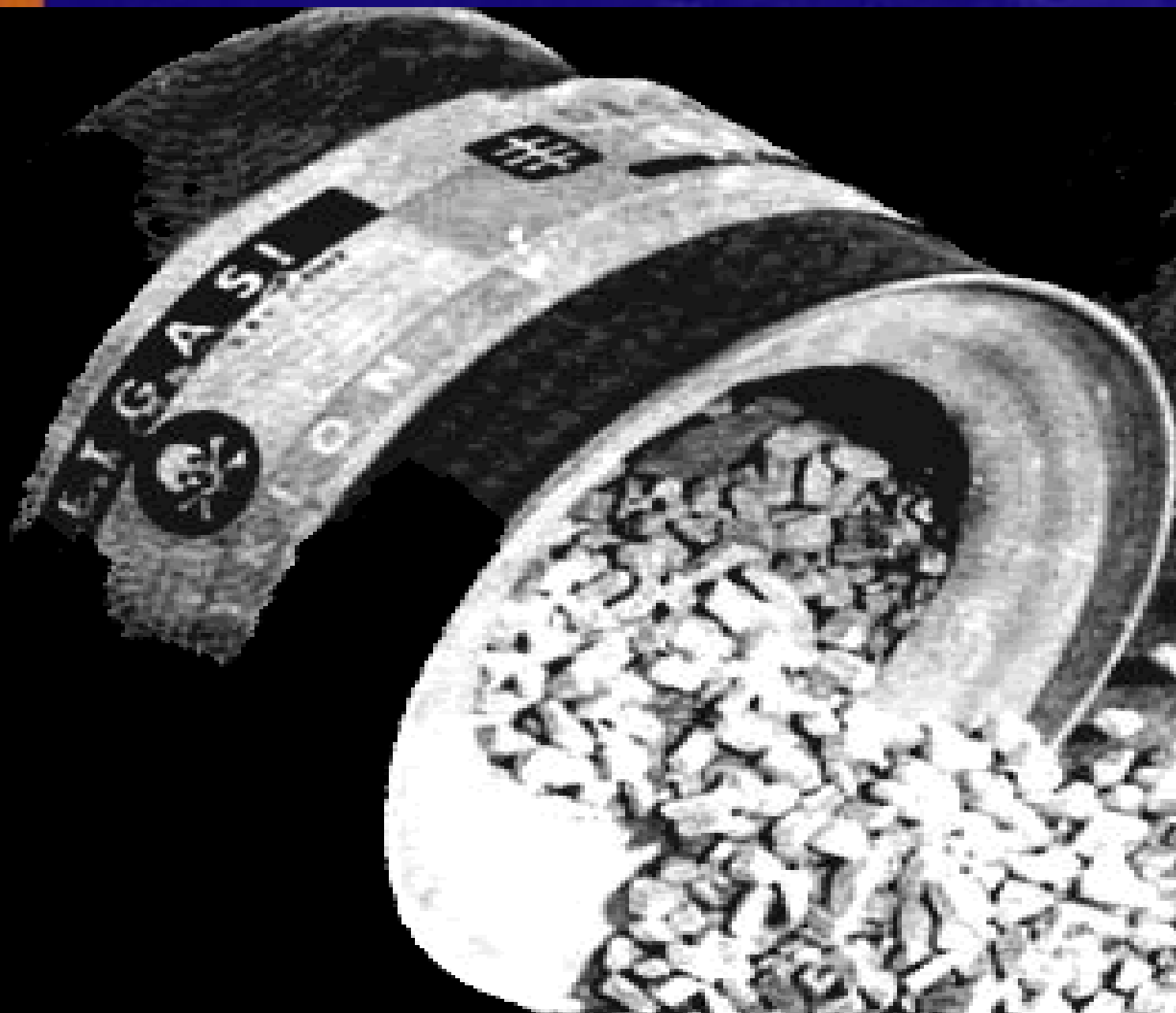
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# What is Hydrogen Cyanide ?

- Hydrogen Cyanide is a highly toxic substance that interferes with energy production in our cells.
- It is a product of combustion of materials containing carbon and nitrogen





# Scope of the problem

- Smoke inhalation causes 5000-10,000 deaths and more than 23,000 injuries in the US annually.
- Of these, it includes 5000 firefighter injuries and 36 deaths
- Smoke inhalation is an important and frequently overlooked cause of cyanide poisoning.
- We will examine a substantial body of evidence that suggests that cyanide can be as great a threat as carbon monoxide in fire smoke

## Hydrogen Cyanide vs. Carbon Monoxide

- Both are colorless and odorless.
- They dull their victim's cognitive function.
- They impair their victim's situational awareness.
- Interferes with victim's "fight or flight" response.



# Awareness of the problem

- Responding EMS personnel and firefighters are primarily focused on carbon monoxide poisoning (CO) and hypoxia (lack of O<sub>2</sub>) in smoke inhalation patients.
- Hydrogen Cyanide is an increasingly common by product of fire smoke in structure fires.

# Awareness of the problem

- Most EMS personnel think of cyanide poisoning as the result of some industrial accident or act of terrorism.
- However, cyanide poisoning due to smoke inhalation is by far the most common situation in which an EMS professional will encounter cyanide poisoning.

# Sources of Cyanide in Fire Smoke

- Natural Substances
  - Wool
  - Silk
  - Cotton
  - Paper
- Synthetic Substances
  - Plastics
  - Nylons
  - Styrofoam
  - Polyurethane Foam

# Modern Building Materials

## An Increasing Concern

- Over the last two decades there has been a shift away from wood and natural materials toward lighter construction materials, synthetics and petroleum based products.
- Hydrogen cyanide should now be considered to be present in all occupied structures.

# Modern Building Materials

## An Increasing Concern

- These materials ignite and burn 2 to 3 times faster than conventional materials.
- They emit gas or smoke that will also ignite 2 to 3 times faster and burn 2 to 3 times hotter.

# Modern Building Materials

## An Increasing Concern

- These materials result in more fires reaching flashover .
- There is a shorter time between initial ignition and flashover.
- Smoke inhalation victims have less time to escape and are more likely to be incapacitated by the toxic smoke and gas.
- There is increased risk of secondary injuries, especially thermal burns.

# Swedish National Testing and Research Institute

- Assessed the emission of HCN and CO under both non-flaming (pyrolyzing) and flaming conditions during the burning of wool, nylon, synthetic rubber, melamine, and polyurethane foam.
- All of these substances liberated high quantities of HCN when burned, particularly under pyrolyzing conditions.
- HCN is approximately 35 times more toxic than CO during acute exposure.

# What factors affect the amount of cyanide generated in a fire

- HCN is generated under conditions of high temperature, low oxygen, and the recycling of combustion products.
- These conditions characterize closed space structure fires.



# The Station Nightclub Fire

- Approximately 440 people were in the Station Nightclub on a Friday night, February 20, 2003.
- Fire started when pyrotechnics ignited polyurethane foam lining the walls of the stage area.
- Blaze quickly spread to the ceiling and then ignited the wood paneling on its way to becoming a full blown structure fire.

# The Station Nightclub Fire

- The emergency response was rapid and well executed.
- 9-1-1 calls were made about 35 seconds and one minute after ignition.
- First engine arrived at the scene less than 5 minutes after the initial 9-1-1 call and began applying water 1 minute thereafter.
- 100 people died.

# The Station Nightclub Fire Investigation

- The National Institute of Standards and Technology (NIST) conducted simulations of this fire.
- They measured temperature, CO, O<sub>2</sub> and HCN 1.4 meters above the floor and 1.6 meters from the stage in sprinklered and unsprinklered conditions.
- Within 90 seconds of ignition, concentrations of CO and HCN soared as oxygen levels plummeted to create conditions incompatible with sustaining life.
- Flashover conditions occurred approximately 60 seconds after ignition.

# Cyanide's role in fire mortality

- The Paris Study
  - Levels of cyanide in victims who died were significantly higher than those in victims who survived.
  - All those who died had very high or lethal levels of cyanide.

# Providence Road Island

- In early 2006, firefighters in Providence were tested for HCN after three separate structure fires. Eight of the twenty seven had elevated levels that required treatment. One firefighter collapsed on scene and had to be treated for HCN poisoning.

# Action of Cyanide

- Inhibits the production of Adenosine Triphosphate (ATP) in the Mitochondria (the “powerhouse) of the cell.
- No ATP, no energy, cells cease to function

# Symptoms of Cyanide Poisoning

- Weakness/Dizziness
- Flushing of skin
- Tachypnea
- Anxiety
- Headache
- V-Fib/V-tach
- Tremors
- Seizure
- Bizarre Behavior
- Stupor
- Paralysis
- Coma
- Respiratory arrest
- MI
- Death

# Treatment of Cyanide Poisoning

- Older kits
  - Sodium Thiosulfate
  - Sodium Nitrite
  - Amyl Nitrite
  - Problematic



# Treatment of Cyanide Poisoning

- New stuff
  - Hydroxocobalamin
  - Related to vitamin B-12
  - Binds to cyanide and neutralizes it, rendering it no longer toxic.

# Treatment of Cyanide Poisoning

- 5 Grams of hydroxocobalamin IV infusion over 15 minutes.
- Can be repeated once.

# Treatment of Cyanide Poisoning

- Supplied as two vials 2.5 Grams each.
- Commercially available as a Cyanokit





• Questions?