

BIOCHEMICAL ASPECTS/ EFFECTS OF MIC & CARINOGENS IN THE AIR

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Physical Properties

- Methyl isocyanate (MIC) is a volatile colorless highly flammable liquid that evaporates quickly when exposed to the air.
- It has a sharp, strong odor.
- The chemical formula for methyl isocyanate is C_2H_3NO , and the molecular weight is 57.05 g/mol.
- Synonyms are isocyanatomethane, methyl carbylamine and MIC.
- Methyl isocyanate is used in the production of pesticides, polyurethane foam, and plastics.

- Methyl isocyanate is an intermediate chemical in the production of carbamate pesticides (such as carbaryl, carbofuran, methomyl, and aldicarb).

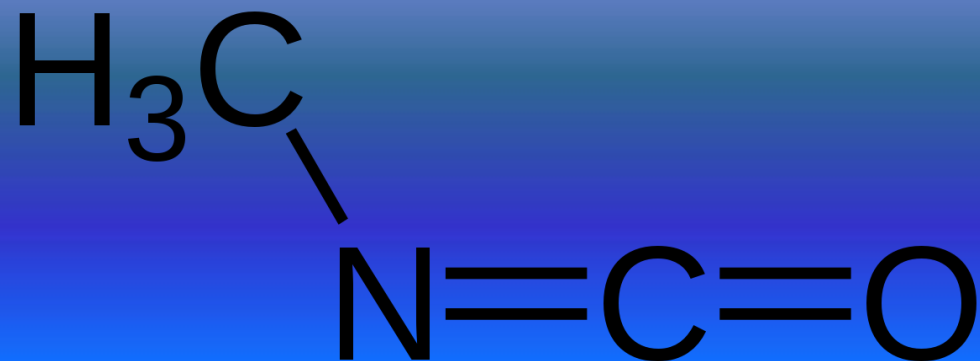


Fig.: Chemical structure of MIC

Sources and Potential Exposure

- No information is available on the levels of methyl isocyanate in ambient air or water.
- Occupational exposure to methyl isocyanate may occur for those workers who use insecticides and herbicides produced from methyl isocyanate.
- Few known exposures to the general public have occurred.
- Methyl isocyanate has been detected in cigarette smoke.

Health Hazard Information

- In Bhopal gas tragedy, pulmonary edema was the cause of death in most cases, with many deaths resulting from secondary respiratory infections such as bronchitis and bronchial pneumonia.
- Other effects noted from acute inhalation exposure to methyl isocyanate in humans are respiratory tract irritation, difficulty breathing, blindness, nausea, gastritis, sweating, fever, chills, and liver and kidney damage.
- Survivors continue to exhibit damage to the lungs (e.g., bronchoalveolar lesions and decreased lung function) and the eyes (e.g., loss of vision, loss of visual acuity, and cataracts)

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- Animal studies have reported pulmonary edema, upper respiratory tract irritation, respiratory lesions, and weight loss
- Acute animal tests in rats have shown methyl isocyanate to have extreme acute toxicity from inhalation exposure and high acute toxicity from oral exposure.

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- After the Bhopal, India, accident, an unusually high percentage of survivors had disorders of the reproductive system, including leukorrhea, pelvic inflammatory disease, excessive menstrual bleeding, and suppression of lactation.
- Other adverse effects included increases in the number of stillbirths, spontaneous abortions, and increased infant mortality.
- Animal studies have reported increased incidence of fetal deaths and decreased fertility.

Bhopal Gas Tragedy

- The Bhopal disaster or Bhopal gas tragedy was an industrial accident.
- It happened at a Union Carbide subsidiary pesticide plant in the city of Bhopal.
- On the night of 2-3 December 1984, the plant released approximately 40 tonnes of toxic methyl isocyanate (MIC) gas, exposing more than 500,000 people to toxic gases.
- A mixture of poisonous gases flooded the city, causing great panic as people woke up with a burning sensation in their lungs.
- Thousands died immediately from the effects of the gas. Many were trampled in the panic that followed.

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- The first official immediate death toll was 3,598 in 1989. Another estimate is that 8,000 died within two weeks, that an additional 8,000 have since died from gas-related diseases.
- There was adverse health effects in greater than 170,000 survivors.
- Pulmonary edema was the cause of death in most cases, with many deaths resulting from secondary respiratory infections such as bronchitis and bronchial pneumonia..
- Survivors continue to exhibit damage to the lungs (e.g., bronchoalveolar lesions and decreased lung function) and the eyes (e.g., loss of vision, loss of visual acuity, and cataracts).
- Reproductive effects and increased number of stillbirths and spontaneous abortions were noted in the survivors of the Bhopal, India accident.

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- Till today (16th April 2020) five deaths are reported due to COVID-19 in Bhopal and all were survivor of Bhopal Gas Tragedy indicating that they are more vulnerable to such pandemic.



Fig.: Inside the Union Carbide: the site from where MIC was released



Fig.: A viral photograph of a victim of Bhopal Gas Tragedy.

Why disaster happened?

- The disaster happened because water entered a tank containing MIC.
- This caused a chemical reaction which resulted in the buildup of much CO₂, among other things
- The resulting reaction increased the temperature inside the tank to reach over 200 °C (392 °F).
- The pressure was more than the tank was built to withstand.
- The tank had valves to control the pressure. These were triggered in an emergency, which reduced the pressure. As a result, large amounts of toxic gases were released into the environment.

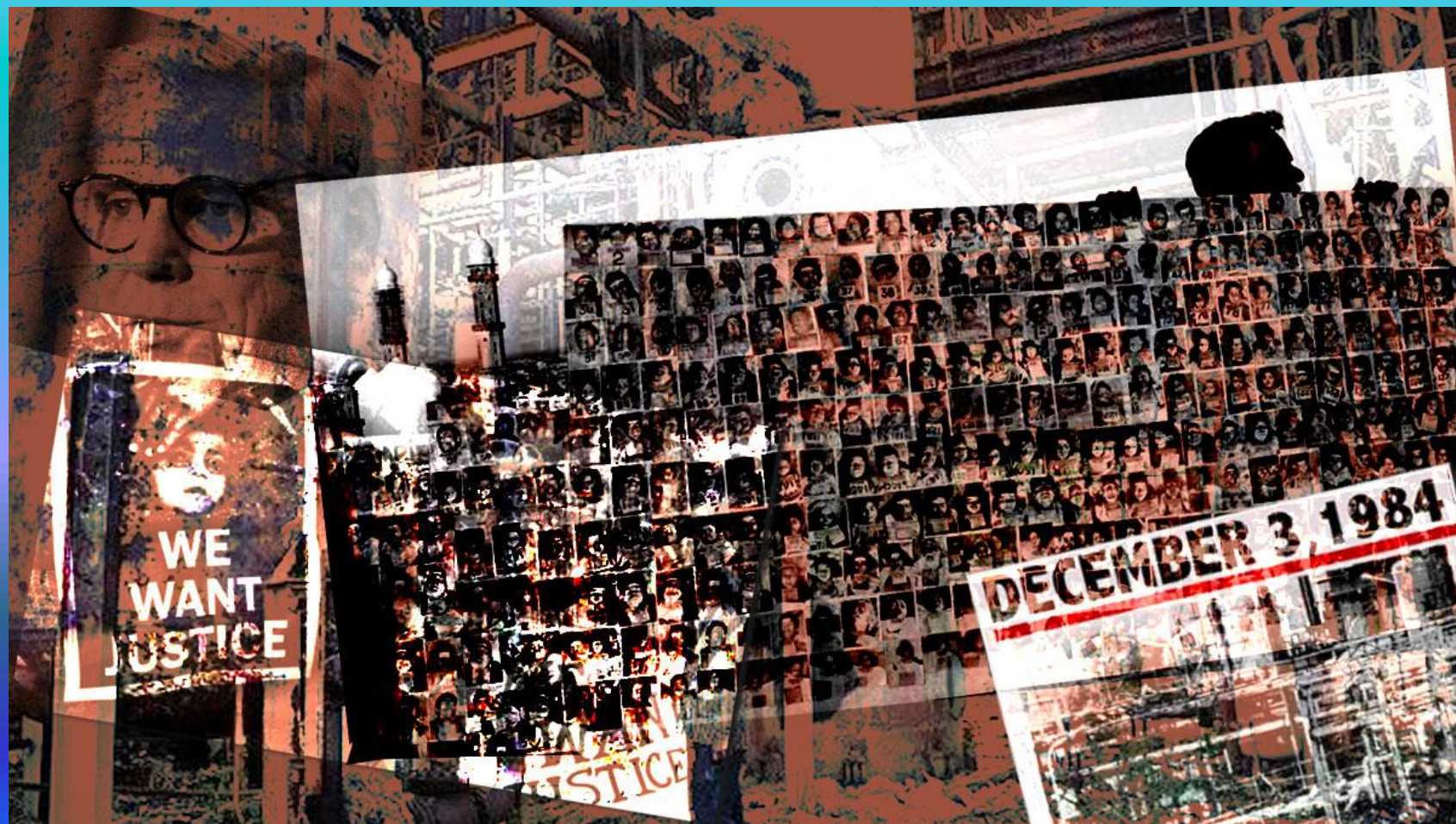


Fig.: Protest erupted after Bhopal Gas Tragedy.

Aftermath

- The Bhopal disaster is frequently cited as the worst industrial disaster.
- The International Medical Commission on Bhopal was established in 1993 to respond to the long term health effects of the disaster.
- Protest erupted to demand justice.
- Civil and criminal cases were filed in the District Court of Bhopal, India, involving UCC and Warren Anderson, UCC CEO at the time of the disaster.

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- In June 2010, seven former employees, including the former UCIL chairman, were convicted in Bhopal of causing death by negligence and sentenced to two years imprisonment and a fine of about \$2,000 each, the maximum punishment allowed by Indian law.
- An eighth former employee was also convicted, but died before the judgement was passed.
- Anderson died on 29 September 2014.
- In 1998, the Supreme Court of India reached a settlement with Union Carbide: They had to pay 470 million US dollars to the Indian state.

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- At that time Union Carbide made a turnover of about 9.5 billion dollars, 20 times that amount. In return, there would be no further prosecution. Only very little money actually reached the victims.
- Dow Chemical Company purchased UCC in 2001, seventeen years after the disaster.
- The terrain where the plant stands is still contaminated with mercury and other carcinogenic substances.
- Dow chemical who owns Union Carbide refuses to decontaminate the soil.
- Greenpeace has estimated that decontamination would only cost around 30 million USD.

Carcinogens in the Air

- Air pollution has been recognized as a cancer risk for many years.
- Tiny dust-like particles just millionths of a metre wide, called ‘particulate matter’, make up a part of outdoor air pollution.
- The International Agency for Research on Cancer (IARC) of the World Health Organization has declared that the smallest particles known as PM10 and PM2.5 are linked to lung cancers caused by pollution.
- It is not fully understood how these particles can damage DNA in cells and cause cancer.
- The tag of group 1 carcinogen is given when there is “sufficient evidence of carcinogenicity” in h

- Exposure to outdoor air pollution causes lung cancer and also leads to increased risk of bladder cancer.
- In its release, WHO-IARC has noted that this evaluation is based on the review of more than 1,000 scientific papers from studies on five continents, taking into account the carcinogenicity of various pollutants in outdoor air pollution, especially particulate matter and transport-related pollution.
- The findings are from large studies in Europe, North and South America and Asia.
- Outdoor air pollution is now in the same bracket as other deadly cancer-causing substances, including tobacco, asbestos and ultraviolet radiation.

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- More than 2,800 different chemicals have been identified in the air or emission sources.
- Only about 10% of these chemicals have been evaluated for genetic or carcinogenic effects.
- Hydrocarbons, nitrogen-containing organics, and halogenated organics account for nearly 60% of the airborne chemicals that have been studied.
- The sources that emit the highest number of these potentially carcinogenic chemicals are sources involving combustion (e.g., tobacco smoke, automobile exhaust, power plants, industry, households or biomass burning).
- Quantitative estimates of the risk of airborne carcinogens in outdoor air consistently show that polycyclic organic matter (POM) from products of incomplete combustion (PICs) make the largest single contribution to human cancer risk.

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- Diesel is a human carcinogen
- Benzene is correlated with cancer which is found in motor fuel, solvents, explosives, smoke
- Volatile Organic Compounds (VOC) are also carcinogen.
- On the other hand, household air pollution is the result of cooking and heating households using solid fuels (i.e., wood, charcoal, coal, dung, crop wastes) on open fires or traditional stoves.
- In poorly ventilated dwellings, fine PM concentrations in and around the home can exceed acceptable levels for up to 100-fold.
- 3.2 million deaths worldwide resulted from air pollution, including 223,000 from lung cancer.



Thank You