Hydrocarbon toxicity

Last updated: January 6, 2022

Summary

Hydrocarbons are a large class of organic compounds composed solely of hydrogen and carbon, all of which can be toxic if inhaled or ingested. Hydrocarbons have a wide range of household and industrial applications, especially as fuels (e.g., gasoline), solvents (e.g., turpentine), and lubricants (e.g., mineral oil). Chlorinated and aromatic hydrocarbons have a particularly severe toxicity and their occurrence is generally restricted to industrial uses. At low doses, exposure to household hydrocarbons may manifest with coughing, nausea, vomiting, signs of hypoxia, signs of CNS depression, and other neurological symptoms such as agitation, hallucinations, and tremors. High doses can cause potentially fatal arrhythmias. Chronic exposure may cause rashes, peripheral neuropathy, chronic headaches, and cognitive impairment. Chlorinated and aromatic hydrocarbons may furthermore cause severe symptoms already in acute exposure and at relatively low doses, including chloracne (a hallmark of dioxin toxicity) and other dermatological manifestations (e.g., skin irritation, hirsutism, skin pigmentation), loss of consciousness, numbness, and decreased immune response. In chronic exposure or at high doses, they may have nephrotoxic, hepatotoxic, neurotoxic, carcinogenic, and teratogenic effects. Industrial accidents have led to severe effects in the general population including in Vietnam, via contamination of Agent Orange with TCDD and the contamination of rice bran oil in Kyusho, Japan, with PCB in 1968 (Yusho disease).

Overview

- **Overview**
  - Not commercially produced; mostly byproducts in the manufacture of other chemicals (e.g., PCBs, pesticides), combustion processes (e.g., waste incineration, automobile emissions), or organic decomposition (e.g., compostation, sewage)
  - Very stable, lipophilic compounds that are absorbed via contaminated foods, mainly of animal origin (e.g., beef, dairy products, and chicken), or via environmental exposure, mainly as an occupational hazard involving inhalation or skin contact
  - Accumulate in fatty tissue and, therefore, eventually reach toxic levels with continued exposure to even small amounts
  - Almost all PCDDs and PCDFs are classified as probable human carcinogens (group 2A carcinogens)
- **Examples**
  - 2,3,7,8-tetrachlorodibenzodioxin (TCDD): best known for being a contaminant in the herbicide Agent Orange used by the US military during the Vietnam War and the release of several kilograms in Seveso, Italy, as a result of an industrial accident.
  - 2,3,7,8-tetrachlorodibenzofuran (TCDF)
- **Clinical features**
  - Acute toxicity: chloracne
    - Mild cases: increased oiliness of the skin, large number of blackheads around the eyes, fluid-filled cysts, hirsutism and hair thickening [1]
    - Severe cases: acneiform eruptions of pustules, cysts, and blackheads, mainly behind the ears and on the cheeks; scarring is possible
    - Treatment: symptomatic and exposure avoidance

- Cardiotoxicity (e.g., arrhythmias)
- Nephrotoxicity (e.g., nephritis, nephrosis, and renal failure)
- Hepatotoxicity (centrilobular fatty change, congestion, and necrosis of the liver due to free radical damage)

> Chloracne is a hallmark symptom of dioxin toxicity.

Polychlorinated biphenyls (PCBs)

- **Overview**
  - Formerly used in coolants and insulators for transformers and electrical capacitors, hydraulic fluids, as plasticizers for paints and plastics, and as sealants for caulking
  - Manufacturing was banned in the US in 1979.
  - Very stable, lipophilic compounds that are absorbed via contaminated foods, mainly of animal origin (e.g., beef, dairy products, and chicken), or via environmental exposure, mainly as an occupational hazard involving inhalation or skin contact
  - PCBs are mainly released into the environment from waste (e.g., electrical transformers, PCB-containing consumer products)
  - Classified as probable human carcinogens (group 2A carcinogens)
- **Examples**: 3,3',4,4'-tetrachlorobiphenyl, 3,3',4,4',5-pentachlorobiphenyl [2]
- **Clinical features**
  - Acute toxicity

- Chronic toxicity [4]
  - Cancer (mainly lung and liver)
  - Birth defects, delayed growth, developmental delay
  - Endocrinological dysregulation: estrogen inhibition/imitation, reduced thyroid hormones
  - Nephrotoxicity

Chlorinated alkenes

- **Overview**
  - Used in the production of polyvinyl chloride (PVC) plastics , as refrigerants, and in the organic synthesis for adhesives
  - Known to be toxic to aquatic life and classified as human carcinogens (group 1A carcinogens)
  - Some substances (e.g., trichloroethylene) have high vapor pressure and emit volatile organic compounds (VOCs) [5]
    - Can be emitted from solids and liquids
    - Pose short- and long-term health risks (see below)
    - Household items that emit VOCs include paints, cleaning supplies, pesticides, office equipment, and glues.
- **Examples**: chloroethylene (vinyl chloride), trichloroethylene, trichloroethylene , tetrachloroethylene, methylene chloride
- **Clinical features** [6]

- **Overview**
  - Hydrocarbons that contain at least one aromatic ring
  - Found in solvents, glues, nail polishes, cigarette smoke, car emissions, paints
- **Examples**
  - Benzene
  - Benzene derivatives: a hydrocarbon (e.g., xylene, toluene), amine group (e.g., aniline), or a nitro-compound (e.g., nitrobenzene) attached to a benzene ring

Polycyclic aromatic hydrocarbons

- **Overview** [7]
  - Class of organic substances characterized by the presence of at least two fused aromatic rings
  - Found in natural sources (e.g., coal, bitumen), but also form as the result of incomplete combustion (e.g., wood, garbage, tobacco, fossil fuels and their derivatives)
  - Ubiquitous contaminants in the environment
  - Exposure via the respiratory tract (e.g., breathing in vehicle exhaust), digestive tract (e.g., intake of charcoal-grilled meat), and skin (e.g., coal, tar)
  - Classified as possibly carcinogenic to humans (group 2B carcinogens)
- **Examples**: naphthalene, methylbenzene
- **Clinical features**
  - Acute toxicity: possible hyperpigmentation of the skin
  - Chronic toxicity

- No information available regarding developmental and/or reproductive effects

- **Examples**: chlorobenzene, chlorophenol
- **Clinical features** [10]
  - Acute toxicity: loss of consciousness, muscle spasms
  - Chronic toxicity: neurotoxicity (e.g., numbness, hyperesthesia, muscle spasms)

Aliphatic hydrocarbons

- **Overview**
  - Hydrocarbons joined in a linear chain or by a non-aromatic ring
  - Found in gasoline or kerosene (solvents, paraffin wax, lighter fluid, furniture polishes, and lamp oil)
- **Examples**: n-hexane, heptane, methane, ethane, propane, butane, octane

Terpene hydrocarbons

- **Overview**
  - Hydrocarbons containing isoprene
  - Used in the rubber, painting, or welding industries (in form of pine/turpentine oil)
- **Example**: turpentine