Republic of Iraq
Ministry of Higher Education and Scientific
Al-Mustaqbal University College
Chemical Engineering and Petroleum Industries Department

Subject: Chemical Safety

Second Class

Lecture Four

LIQUID SOLVENTS

Organic solvents are often the most hazardous chemicals in the work place. Solvents such as ether, alcohols, and toluene, for example, are highly volatile and flammable.
Perchlorinated solvents, such as carbon tetrachloride (CCl4), are non-flammable. But most hydrogen-containing chlorinated solvents, such as chloroform, are flammable. When exposed to heat or flame, chlorinated solvents may produce carbon monoxide, chlorine, phosgene, or other highly toxic gases.

Always use volatile and flammable solvents in an area with good ventilation or preferably in a fume hood. Never use ether or other highly flammable solvents in a room with open flames or other ignition sources present, including non-intrinsically safe fixtures.

Solvent Exposure Hazards

Health hazards associated with solvents include exposure by the following routes:

-Inhalation of a solvent may cause bronchial irritation, dizziness, central nervous system depression, nausea, headache, coma, or death. Prolonged exposure to excessive concentrations of solvent vapors may cause liver or kidney damage. The consumption of alcoholic beverages can enhance these effects.

-Skin contact with solvents may lead to defatting, drying, and skin irritation.

-Ingestion of a solvent may cause severe toxicological effects. Seek medical attention immediately.

The odor threshold for the following chemicals exceeds acceptable exposure limits. Therefore, if you can smell it, you may be overexposed — *increase ventilation immediately!*
Examples of such solvents are:

-Chloroform
-Benzene

-Carbon tetrachloride

-Methylene chloride

NOTE: *Do not depend on your sense of smell alone to know when hazardous vapors are present.*
The odor of some chemicals is so strong that they can be detected at levels far below hazardous concentrations (e.g., xylene).

Some solvents (e.g., benzene) are known or suspected carcinogens.

Reducing Solvent Exposure

To decrease the effects of solvent exposure, substitute hazardous solvents with less toxic or hazardous solvents whenever possible. For example, use hexane instead of diethyl ether, benzene or a chlorinated solvent.

TOXINS AND IRRITANTS

The toxicity of a chemical refers to its ability to damage an organ system (kidneys, liver), disrupt a biochemical process (e.g., the blood-forming process) or disrupt cell function at some site remote from the site of contact. Any substance, even water, can be harmful to living things under the right conditions.

The **biological effects** – whether beneficial, indifferent or toxic – of all chemicals are dependent on a number of factors, including:

-Dose (the amount of chemical to which one is exposed)
-Duration of exposure (both length of time and frequency)
-Route of entry:
-Ingestion
-Absorption through the skin
-Inhalation
-Injection

NOTE: *Inhalation and dermal absorption are the most common methods of chemical exposure in the workplace.*

-Individual response and history

-One's exposure to other chemicals
-Mixing the toxin with other chemicals

The most important factor in toxicity is the dose-time relationship. In general, the more toxin to which an individual is exposed, and the longer they are exposed to it, the stronger their physiological response will be. However, an individual's response can also depend on several other factors, including:

-Health
-Gender
-Genetic predisposition
-An individual's exposure to other chemicals
-Previous sensitization

NOTE: *When a person becomes sensitized to a chemical, each subsequent exposure may often produce a stronger response than the previous exposure.*

-Chemical mixtures

NOTE: *Combining a toxic chemical with another chemical can increase the toxic effect of either or both chemicals.*

IMPORTANT: *Minimize exposure to any toxic chemical.*

General Safe Handling Guidelines

a. Read the appropriate MSDS.

b. Be familiar with the chemical's exposure limits.

c. Use a chemical fume hood.

d. *Always* wear appropriate PPE or (appropriate personal protective equipment).

e. *Never* eat, drink, or use tobacco products around toxins or store them near any hazardous chemicals.

f. Avoid touching your face or other exposed skin with contaminated gloves or other contaminated materials.

g. Store toxic gases in a gas exhaust cabinet.

Acute Toxins vs. Chronic Toxins

The dose-time relationship forms the basis for distinguishing between acute toxicity and chronic toxicity.

The **acute toxicity** of a chemical is its ability to inflict bodily damage from a single exposure. A sudden, high-level exposure to an acute toxin can result in an emergency situation, such as a severe injury or even death. Examples of acute toxins include the following:

-Hydrogen cyanide
-Hydrogen sulfide
-Nitrogen dioxide
-Ricin
-Organophosphate pesticides
-Arsenic

IMPORTANT: *Do not work alone when handling acute toxins. Use a fume hood to ensure proper ventilation, or wear appropriate respiratory protection if a fume hood is not available*.

Chronic toxicity refers to a chemical's ability to inflict systemic damage as a result of repeated exposures, over a prolonged time period, to relatively low levels of the chemical. Such prolonged exposure may cause severe injury. Examples of chronic toxins include the following:

-Mercury
-Lead
-Formaldehyde

Some chemicals are extremely toxic and are known primarily as acute toxins. Some are known primarily as chronic toxins. Others can cause either acute or chronic effects.

The toxic effects of chemicals can range from mild and reversible (e.g. a headache from a single episode of inhaling the vapors of petroleum naphtha that disappears when the victim gets fresh air) to serious and irreversible (liver or kidney damage

from excessive exposures to chlorinated solvents). The toxic effects from chemical exposure depend on the severity of the exposures. Greater exposure and repeated exposure generally lead to more severe effects.

Types of Toxins

Carcinogens are materials that can cause cancer in humans or animals. Several agencies including OSHA (Occupational Safety & Health Administration), NIOSH (National Institute for Occupational Safety and Health), and IARC (International Agency for Research on Cancer) are responsible for identifying carcinogens. There are very few chemicals known to cause cancer in humans, but there are many suspected carcinogens and many substances with properties similar to known carcinogens.

Examples of known carcinogens include the following:

-Asbestos
-Benzene
-Tobacco smoke
-Hexavalent Chromium
-Aflatoxins
-Carbon tetrachloride

Zero exposure should be the goal when working with known or suspected carcinogens.
Workers who are routinely exposed to carcinogens should undergo periodic medical examinations.

Reproductive toxins are chemicals that can adversely affect a person's ability to reproduce.
Teratogens are chemicals that adversely affect a developing embryo or fetus. Heavy metals, some aromatic solvents (benzene, toluene, xylenes, etc.), and some therapeutic drugs are among the chemicals that are capable of causing these effects. In addition, the adverse effects produced by ionizing radiation, consuming alcohol, using nicotine and using illicit drugs are recognized.

While some factors are known to affect human reproduction, knowledge in this field (especially related to the male) is not as broadly developed as other areas of

toxicology. In addition, the developing embryo is most vulnerable during the time before the mother knows she is pregnant. Therefore, it is prudent for all persons with reproductive potential to minimize chemical exposure.

Sensitizers may cause little or no reaction upon first exposure. Repeated exposures may result in severe allergic reactions.

Examples of sensitizers include the following:

-Isocyanates
-Nickel salts
-Beryllium compounds
-Formaldehyde
-Diazomethane
-Latex

NOTE: *Some people who often use latex-containing products may develop sensitivity to the latex. A sensitized individual's reaction to latex exposure can eventually include anaphylactic shock, which can result in death. To minimize exposure to latex, use non-latex containing gloves, such as nitrile gloves.*

Irritants cause reversible inflammation or irritation to the eyes, respiratory tract, skin, and mucous membranes. Irritants cause inflammation through long-term exposure or high concentration exposure. For the purpose of this section, irritants do not include corrosives.

Examples of irritants include the following:

-Ammonia
-Formaldehyde
-Halogens
-Sulfur dioxide
-Poison ivy
-Dust
-Pollen

-Mold

Mutagens can alter DNA structure. Some mutagens are also carcinogens. Examples of mutagens are:

-Ethidium bromide
-Nitrous acid
-Radiation

Neurotoxins are chemicals that affect the nervous system. Examples of neurotoxins include:

-Methanol
-Many snake and insect venoms
-Botulinum toxin