

Lecture 7

Gaseous Pollutants

| No. | Group | Examples |
|-----|-----------------------|---|
| 1 | Sulphur compounds | SO ₂ , SO ₃ , H ₂ S, mercaptants |
| 2 | Nitrogen compounds | NO, NO ₂ , NH ₃ |
| 3 | Oxygen compounds | O ₃ , CO, CO ₂ |
| 4 | Halogen compounds | HF, HCl |
| 5 | Organic compounds | Aldehydes, hydrocarbons |
| 6 | Radioactive compounds | Radioactive gases |

Note: Some of these contaminants undergo chemical reactions when they enter the atmosphere. As a result, the end product formed are more harmful than the original contaminants.

Unsaturated hydrocarbons react with nitrogen dioxide in sunlight to form smog.

Carbon monoxide (CO)

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- “ It is a **tasteless, colorless and odorless gas with slightly lesser density than air.**
- “ **Sources:** Incomplete combustion of fossil fuels and other carbonaceous matter, some industrial processes, solid waste combustion, cigarette smoke, transportation (The gas is emitted when vehicles burn gasoline and when kerosene and wood stoves are used to heat homes)

Carbon monoxide (CO)

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- “ **Natural source:** Volcanoes, lightening and photochemical degradation of some reactive organic compounds. CO is also formed biologically by certain brown algae, various microorganisms and also some oceanic organisms.
- “ **Mean residence time:** 1 month to 5 years

Carbon monoxide (CO)

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Effects:

- “ Combines with hemoglobin (reduce the normal capacity of blood to transport oxygen to the tissue) & may create problems for infants, the elderly & those with heart or respiratory diseases.
- “ The effects of carbon monoxide include headaches, reduced mental alertness, heart damage; it may even cause death, and it contributes to smog.

Carbon monoxide (CO)

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- “ At higher concentration of **100 ppm** it may cause people to experience dizziness, headache, lassitude and other symptoms
- “ A concentration of **4000 ppm** is lethal in less than one hour.
- “ 75.1% CO is produced by total fuel combustion, 7.7% from industrial processes, 9.3% from agricultural burning, 4.9% from solid waste disposal and 3% from miscellaneous sources.

CO₂ (Carbon Dioxide)

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Sources

- “ Decay of organic matter and respiration of organisms.
- “ Combustion of fossil fuels such as coal, oil and natural gas.
- “ About half of the excessive quantities discharged into the atmosphere are absorbed by the oceans while much are utilized in photosynthesis.

CO₂ (Carbon Dioxide)

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Effects

- “ Higher concentrations can affect respiratory function and cause excitation followed by depression of the central nervous system.
- “ Contact with liquefied CO₂ can cause frostbite.
- “ Workers briefly exposed to very high concentrations have effects like damage to the retina, sensitivity to light (photophobia), abnormal eye movements, constriction of visual fields, and enlargement of blind spots.

Sulfur oxides (SO_2 , SO_3)

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SO_2 (Sulphur dioxide):

- “ SO_2 is a **colorless gas** processing a pungent and **irritation odour** at higher concentration above 300 ppm.

Source

- “ Smelting, combustion of coal & oil (esp. coal)
- “ Ores of Cu, Zn, Pb and Ni etc. contain as much as 10 % or more of sulphur.
- “ **Lifetime:** 2 to 4 days

Sulfur oxides (SO_2)

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Effects

- “ It can harm human and animal lungs, as well as plants and trees.
- “ Exposure to SO_2 can cause impairment of respiratory function, aggravation of existing respiratory disease (especially bronchitis), decrease in the ability of the lungs to clear foreign particles.

Sulfur oxides (SO_2)

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- “ Sulfur dioxide is the main contributor to acid rain. It reacts with the oxygen in the air to become sulfur trioxide, which then reacts with water in the air to form sulfuric acid.
- “ Acid rain can slowly kill both animal populations in lakes and rivers and trees and other plants by damaging leaves and root systems.

Sulfur oxides (SO_2)

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“ It can deteriorate metal and stone on buildings and statues.

“ The effects of acid rain are not only local, but they can occur hundreds of miles from the sources of sulfur dioxide.

Sulfur trioxide (SO₃)

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- “ Sulphur trioxide is formed by oxidation of sulphur dioxide.
- “ It may exits in the form of vapor and readily combines with water to form H₂SO₄.
- “ **Source:** Combustion of sulphur containing material

Nitrogen oxides NO_x

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- “ The most abundant and important oxides of nitrogen forming air pollutants are Nitric Oxide (NO), Nitrogen Dioxide (NO_2), Nitrous oxide (N_2O)
- “ **Lifetime:** Less than 2 days

Nitric Oxide

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- “ It is colorless and relatively harmless gas, but its get readily converted into NO_2 by photochemical reactions.

Source:

- “ High temperature combustion, motor vehicles (40 % of NO_x discharge) & industry, biologically in nature
- “ Nitrogen Oxides are formed naturally by bacteria in soil and play an important role in plant growth.

Nitrogen Dioxide

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- “ It is reddish brown gas with pungent odor.
- “ The gas is corrosive, irritating and physiologically toxic.
- “ It reacts with water to form nitric acid, which may be a significant component of acid rain. It is formed primarily by photo oxidation of NO.
- “ Its fate is oxidation to nitric acid, nitrates or photo dissociation

Ozone

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- “ Ozone is a **gaseous, secondary pollutant** and is formed during photochemical smog in the atmosphere.
- “ The interaction of NO_2 with VOCs produces ozone in the presence of sunlight.
- “ If the air over the city does not move, pollutants become trapped close to the earth's surface forming smog and increasing ozone problems which can lead to breathing problems.

Ozone

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- “ High ozone levels at the ground level harm plants, including trees and crop plants, and causes the accelerated deterioration of materials such as rubber and fabrics.
- “ There is another type of ozone problem which came to attention in late sixties. Concerns were expressed on the destruction of ozone layer due to the use of supersonic transports. At present the destruction of ozone layer in the stratosphere due to the use of certain chemical compounds (chlorofluorocarbons or CFCs, methane etc.) is an environmental issue.

Hydrocarbons

- “ Hydrocarbons are composed of only hydrogen and carbon.
- “ The volatile organic compounds (VOC) are the compounds which take part in atmospheric photochemical process.
- “ VOCs are composed of hydrogen and carbon, and may also contain elements such as oxygen, nitrogen, sulfur, chlorine, and fluorine.
- “ Hydrocarbons are methane, benzene, propane, & chlorofluorocarbons (CFC's) etc.

Hydrocarbons

- “ Concentrations of many VOCs are consistently higher indoors than outdoors.

Effects:

- “ Eye and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some organics.
- “ Many organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.

Lead

- “ Lead is fairly abundant and is derived from ore bearing minerals.
- “ The gray metal can be easily molded, formed and worked.
- “ It can withstand weathering and chemical erosion.
- “ Lead has been used in the manufacture of pipes, paint house hold pottery, gasoline additives and storage batteries.

Lead

- “ Automobiles and leaded gasoline are major sources of atmospheric lead.
- “ Lead was more of a problem a few years ago when all vehicles used gasoline with lead additives.
- “ When lead gasoline is burned, lead is released into the air.