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IIT(BHU) VARANASI
STUDENTS' NOTES
UNDERGROUND MINE ENVIRONMENT
FIFTH SEMESTER

TOPIC-AIR POLLUTION

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The community air pollution is not only caused by variety of sources

but also exert a significant impact on individual total environment including plant, animal, buildings.

Air pollutant may be gas, liquid or particulate matter ie suspended aerosols composed of solid & liquid. Conc. of atm. pollutant depend mainly on mass into atm. and the atm. condition that affect their fate & transport.

Types

Natural sources of air pollution include pollen, marsh gas, dust and smoke emitted into atm. Anthroposoping entering into atm from stationary & mobile source. Stationary sources include mineral factories, Elec. Power Plant, Smelters, Petroleum Refinery & small scale industry while mobile source include all sort

of transport vehicle (rail, road, air)

Air pollutants can be classified as Primary & Secondary

Primary pollutant enter directly from various sources into air. Sec. pollutant are formed by chemical reaction between primary pollutant and other constituent such as solar radiation, water vapour.

1. Primary pollutant and Effect

Among the primary air pollutant most important are particulate matter and gaseous pollutant are CO, HCl, HC, SO_2 , NO_x . Particulate matter comprises solid particles or liquid droplet small enough to remain suspended in air e.g. soot, smoke, dust, asbestos, fibrous, pesticides, some metals (Hg, Pb, Cu, Fe etc) and also some biological agents like dust mite and pollen grains.

Atmospheric particulates having $d_{\text{eq}} > 10 \mu\text{m}$ generally settle out in less than a day, whereas particulate less than

10.4 Air can remain suspended in air for weeks / suspended particulate matter in dust can cause an aggregate human problems like Asthma, bronchitis, nasal passage prevent any particle from entering.

Particles less than 2.5um also called Respirable Suspended Particulate Matter (RSPM) reaches the alveoli of lung and damage the lung tissue. Soluble aerosols are dissolved in blood, while insoluble aerosol are carried by lymphatic system. Exposure to asbestos can cause cancer, lead is the most serious pollutant from automobile exhaust has detrimental effect on children's brains. Particulate matter can cause mutagenic and carcinogenic effect such as Pb/Cd/Hg/As and hazardous organism absorbed on particulate such as poly aromatic hydrocarbon.

Nitrate particulate are toxic to metabolic activities of plants. Use of fuel in combustion pollutants and crops to feed to human health issue.

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Particulates including dust, soot, aerosol can bring about severe damage to building, monuments when accumulated in upper atmosphere. Particulate matter may significantly alter the radiation thermal - budgets of the atmosphere, lowering the temperature of the atmosphere.

a. Carbon Monoxide

CO is a product of incomplete combustion of fossil fuels.

Nearly 50% of CO originates from automobiles. It is also present as short lived in atmosphere and is oxidised into CO_2 . It is highly poisonous to most animals. When inhaled CO reacts with haemoglobin of red blood corpuscles and form a stable co-ordinated complex carboxyhaemoglobin which restricts the transport of O_2 from lungs to cells by reducing oxygen carrying capacity of blood.

The classical syndrome of CO exposure are headache and dizziness.

b. Hydrocarbons also Volatile Organic Carbon (VOCs)

They are compound composed of carbon and hydrogen. They are produced naturally during decomposition of organic matter and by certain type of plant. Methane, the most abundant hydrocarbon in the atmosphere is evolved from soil and swamps. Benzene and its derivatives e.g. formaldehyde are carcinogens (substance that cause cancer). Formaldehyde emitted from indoor source such as newly manufactured carpentry causes indoor pollution. Some relatively non-toxic hydrocarbons contribute to the generation of secondary pollutant. They are also generated during the burning of coal. They have variety of effect on human and animal health. Some of them injure the respiratory tract and others cause to cancer.

Many HC at a specific dose are toxic to plants. HCs may escape to the atmosphere when a car's tank is filled with gasoline. If gasoline is spilled and evaporated,

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c. Sulfur Di Oxide

It is the major constituent found in the emission of transport by electric power plant, smelting industries, manufacture of fertilizers, sulfuric acids and oil refineries. It does not remain in gaseous state for longer time in the atmosphere.

It may be converted through complex reaction to fine particulate sulphate or it reacts with atmospheric moisture in presence of sunlight to form H_2SO_4 an important component of acid rain.

Oxides of sulfur are major contributors to lung disease, cough and choking.

Higher conc. of SO_2 causes acute chronic asthma. It is a severe allergic agent which may be infected by the bacteria leading to dangerous allergic infections. It also affects plant growth, yield and nutritive properties of plant.

High SO_2 conc. causes bleaching of chlorophylls leading to leaf necrosis tissue death of leaves. Historic monuments are very severely affected by SO_2 . It corrodes metals and damages stones and other materials.

d. Nitrogen Oxides (NO_x)

They are formed mainly from Nitrogen and Oxygen during combustion of fossil fuels and high temperature in atmospheric engines. NO_x stands for an intermediate mixture of NO , NO_2 and N_2O . Nitrogen Oxides causes the reddish brown haze known as Brown Air in traffic congested city air which contributes to heart and lung problem and maybe carcinogenic. NO_2 inhibits plant growth and reduces the productivity of a no. of plant species at higher concentration. It causes chlorosis and reduces the food manufacturing capacities of plant. Low conc. of NO_2 irritates the mucous membrane, while higher concentration causes bronchitis, internal bleeding, pneumonia and oxygen deficiency.

NO_x corrodes metal due to acidification when the oxides are converted to nitrates formed in the atmosphere, visibility is impaired.

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NO_x also contributes to the acid rain because they combine with water droplets to produce HNO₃ and other acids.

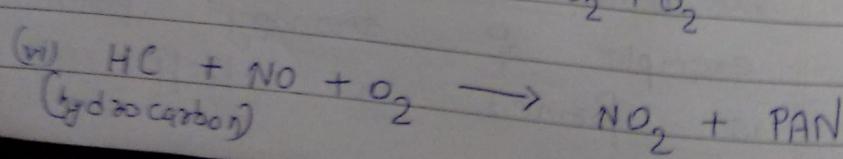
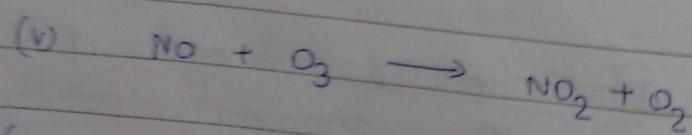
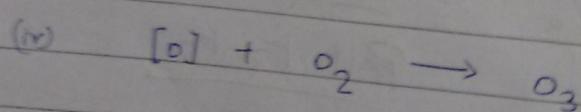
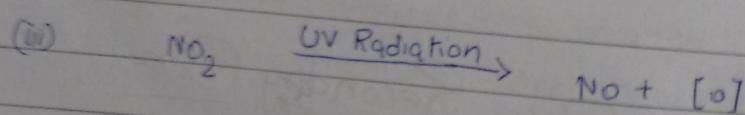
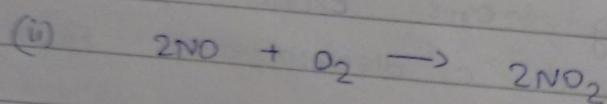
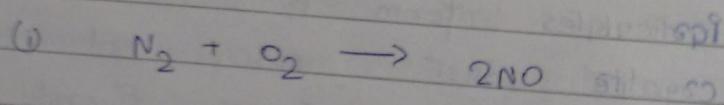
e. Fluorides

Fluorides mostly in gaseous hydrogen fluoride form is released in the atmosphere. Whenever the clay, rocks, coal and one containing it are heated. Volcanic eruptions also contribute significantly as a natural source to fluorine fluoride pollution. Glass furnace, Phosphate fertilizers factories and aluminium industries are major sources of fluorides. Particles form of fluoride namely cryolite dust, sodium aluminium fluorides containing oxides. Excess fluoride ingestion leads to a disease called Fluorosis.

Q. Secondary Air Pollutants

g. Photochemical Smog is a classical example of secondary pollutants. It is formed in traffic congested

metro cities where warm conditions and intense solar radiations are present. Photochemical smog is composed mainly of oxygen Peroxy Acetyl Nitrate (PAN) and NO_x. If it is often called Brown Air where solar radiation is intense. In cases of less solar radiation, smog formation is incomplete and the air is referred to Grey Air. Automobile exhaust contains hydrocarbons and NO. These play an important role in ozone and PAN formation. A simplified set of the photochemical reaction involved in smog formation is as follows.



b. Ozone

Ozone may damage plant as well as animal life. In plants the main damage occurs in leaf in form of Fleck on the surface. At very low conc., ozone may reduce growth rates while not producing any feasible energy. If present in higher conc. O_3 kills leaf tissues. The death of white pine trees planted along the highway in England & USA is believed to be in part of Ozone Pollution.

O_3 production is directly related to the light intensity, temperature and sunshine hours. Therefore O_3 is a pollutant of hot summers. O_3 aggravates lung diseases in humans. It is also associated with lung cancer. O_3 and effective oxidants corrodes the heritage building surfaces, damage marble statues and other cultural assets.

O_3 destroys paints, textile and causes rubber cracking. Several plant species are also very susceptible to PAN in smog. PAN damages the

chloroplast and thus the photosynthesis activity and growth of plants is reduced. In human PAN causes severe irritation of eye and negative effect on respiratory system.

c) Acid Rains

Acid rain refers to several ways in which acid forms. The atmosphere are deposited on the earth. Acid deposition includes wet and dry depositions. Wet deposition refers to acidic water received through rain, fog and snow. Dry deposition refers to wind blown acidic gases and particles in the atmosphere which settle down on the ground. NO_x and SO₂ are produced during combustion of coal and petroleum. They are highly reactive in air. They rapidly oxidize into acids which quickly dissolves in water and are washed out to the ground as acid rain. pH of acid rain is less than 5.6 and could be as low as 4.

Quantification of Sound

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- Intensity is a measure of amount of energy flowing through a unit area in unit time

$$I = \frac{P^2}{\rho c}$$

P = RMS Pressure

ρ = kg/m^3 ($\text{air} = 1.2 \text{ kg/m}^3$)

c = vel of sound ($\text{air} = 330 \text{ m/s}$)

I = Intensity ~~Pa~~ ($\text{Pa}^2 \text{m}^3 \text{s} / \text{kg m}$)

Scale = 20×10^{-6} to ~~to~~ 20 Pa

so, $\left(\frac{P}{P_0}\right)^2 = \left(\frac{20}{20 \times 10^{-6}}\right)^2 = 10^{12}$
too large
(to plot)

taking $\log \left(\frac{P}{P_0}\right)^2 \leftarrow \text{Bell}$

$10 \log \left(\frac{P}{P_0}\right)^2 \leftarrow \text{decibel or dB}$

- So, Sound intensity level,

$$L_I = 10 \log \left(\frac{I}{I_r}\right) \text{ dB}$$

I = Intensity level at a place

I_r = Reference intensity level
 $= 10^{-12} \text{ W/m}^2$