Based on chemical composition environmental sciences essay

Pollution can be defined as any undesirable change in the physical, chemical and biological characteristic of air, water or land that may or will harmfully affect human life or that of desirable species, our industrial processes, living conditions and cultural assets.

5. 1. 2 Classification of pollutants

Generally a pollutant is classified as biodegradable and non-biodegradable. Biodegradable pollutants are those which degrade easily such as sewage, whereas non-biodegradable pollutants are those which do not degrade or degrade very slowly, such as plastic.

5. 2. 1 Air pollution

It is any undesirable change in the quality of air that harmfully affects our wellbeing. Atmosphere, the gaseous layer called ‘ air’ is the life blanket of earth, the essential ingredient for all living things. It is composed of mixture of gases (Nitrogen – 78. 08 %; Oxygen – 20. 98 %; Argon 0. 93 %; Carbon dioxide 0. 035 %; ozone, Hydrogen, Helium, in trace amounts) water vapour, a variety of fine particulates and suspended materials. It constitutes about 80 % of man’s daily intake by weight. Human beings breathe nearly 22, 000 times a day, inhaling about 16 kg of air. Therefore, preserving or maintaining the air in its pure form becomes necessary, failing which it (air) may have profound health effects and other consequences. The atmosphere can cleanse itself of the impurities firstly by its vertical and horizontal mixing (dispersion – favoured by wind) and secondly wash out the pollutants to certain extent by rain. But, the presence of high concentration of air pollutants such as Sulphur oxides (SOx), nitrogen oxides (NOx), Hydrocarbons (HCs), carbon monoxide (CO) and particulates, affects the

natural cleansing mechanism of the atmosphere, alters the percentage of concentration of gases naturally present in the atmosphere causing air pollution.

Classification of Air Pollutants

Agents or contaminants that cause or induce the formation of air pollution are called air pollutants. All air pollutants may be categorised according to origin, chemical compositions and state of matter.

Based on Origin:

Primary Pollutants: are those emitted directly in to the air and are found in the same chemical form in which they aree released. E. g., Particulate matter, SO2, NOx, CO, HC. Secondary Pollutants: these are generated in the environment by interactions between two or more primary pollutants. E. g., O3, PAN, H2SO4, HNO3

Based on Chemical composition:

Organic Compounds: Hydrocarbons are organic compounds containing only carbon and hydrogen. Aldehydes and ketones contain oxygen as well as carbon and hydrogen e. g. Formaldehyde and acetone. Inorganic Compounds: It includes carbon monoxide (CO), carbon dioxide (CO2), carbonates, sulphur dioxides (SO2), nitrogen oxides (NOx), ozone (O3), hydrogen fluoride and hydrogen chloride.

Based on State of matter:

Particulate pollutants/ Suspended Particulate Matter (SPM) are fine sized solids and liquids including dust, fumes, and smoke, fly ash, mist and soot

particles. Gaseous pollutants: formless fluids that completely fill up the space into which they are emitted. E. g. Carbon dioxides, sulphur oxides, nitrogen oxides, hydrocarbons and oxidants.

Types of air pollution

1. Indoor Air Pollution:

It is due to burning wood, animal dung, crop residues and coal for cooking and heating within the closed walls. Most of the victims of indoor pollution are women and girls, who have primary responsibility for cooking and tending the house. About 2. 5 billion people, almost all in developing countries suffer from high levels of indoor air pollution.

2. Outdoor Air Pollution:

Industrial enterprises and automobiles are primary sources of atmospheric (outdoor) pollution. Increasing industrialization and urbanization have created growing demands to use the outdoor atmosphere as a waste disposal medium. Densely populated and rapidly growing cities such as Bangkok, Manila, Mexico city and New Delhi are often entombed in a pall of pollution from trucks and cars, and from uncontrolled industrial emissions. Outdoor air pollution harms more than 1. 1 billion people, mostly in cities.

Sources of air pollution

Bulk of the air pollution sources are linked to anthropogenic activities, a gift of modern lifestyle. Natural causes like the volcanoes, forest fires, sea salts, anaerobic decomposition of organic matter, other atmospheric reactions, etc. add up to this. Volcanic eruptions release great amounts of nitrogen oxides. Anaerobic decomposition of organic matter generates methane

which on oxidation in the air produces carbon monoxide. Decay of organic substances also produces stinking gases. Oxidation of marine organic matter under sunlight and biological oxidation by oceanic organisms generates carbon monoxide on the ocean surface which diffuses in the air.

Natural Sources:

The atmosphere is polluted due to various natural processes, some of which are windblown dust, smoke, fly ash, gases from forest fires, gases and odours from swamps and marshes, pollen, fungi spores from microorganisms, salt spray from the ocean, fog in humid low lying areas and natural terpene hazes from pine trees in mountainous region. Table – Natural sources of air pollutionProcessPollutants ProducedVolcanoesForest firBiological decayStorm windOcean releasePlants and micro organismSulphur dioxide, fly ashCO, Fume, smokeMethane(CH4), ammonia (NH3) Hydrogen sulphide (H2S)Dust particlesCO2, Salt sprayPollens, fungi spores

Anthropogenic or Man-made Sources:

In contrast to natural sources of air pollution there are contaminants of anthropogenic origin. The use of fossil fuels for heating and cooling, for transportation, for industry, and for energy conservation, and the incineration of the various forms of industrial, municipal and private waste, all contribute to air pollution. The pollution sources caused by man-made actions can be grouped under four categories. Mobile transportation: i. e., motor vehicles, aircrafts, railroads, ships, and the handling or evaporation of gasoline. Stationary combustion: i. e., residential, commercial, industrial power and steam powered thermal power plants. Industrial Processes: i. e.,

chemical, metallurgical and pulp and paper industries and oil refineries. Solid waste disposal: i. e., household and commercial refuse, coal refuse and agricultural burning.

Major anthropogenic sources of air pollution can also be grouped as -

1. Domestic

Burning of coal produces a lot of, smoke, soot, dust, CO, SO2, NOx

2. Automobiles

Motor vehicles play an important role in air pollution (automobile emission). Automobile emissions have been identified as the major source of air pollution in Kolkota metropolitan region. It is contributing nearly 60 – 70 % of air pollution. India is the 5th largest car producer in the world in 2011. It is also the leading producer of three-wheelers (878 000 in 2011-12). The number of government registered vehicles on roads has reached 142 million in March 2011. (OICA, The International Organization of Motor Vehicle Manufacturers 2010 Statistics). The countries vehicle population has grown in alarming proportions during the last decade. Gasoline combustion produces carbon monoxide, various hydrocarbons such as aldehydes (HCHO), polycyclic aromatic hydrocarbons (PAH), nitrogen oxides, sulphur oxides, organic acids and ammonia and carbon particles and heavy metals like lead. Incomplete burning of fuel produces a hydrocarbon, 3, 4-benzpyrene. Source: OICA (The International Organization of Motor Vehicle Manufacturers 2010 Statistics)

No. of Motor Vehicles (in millions) in Major Cities- March 2011

City

Cars

Motor Vehicles

Delhi2. 17. 2Bangalore0. 714. 5 (2012)Chennai0. 603. 5Kolkata0. 441. 8 (2007)Hyderabad0. 493. 0Pune0. 292. 1Lucknow1. 2naMumbai0. 561. 5

3. Industries

a. Fertilizer Plants - They produce oxides of sulphur and nitrogen, hydrocarbons, PM and fluorine. b. Thermal Plants - fly ash, soot and sulphur dioxide, CO, NOx. c. Textile Industries - cotton dust, nitrogen oxides, chlorine, naphtha vapours, smoke and sulphur dioxide. d. Steel Plants and metallurgical operations - carbon monoxide, carbon dioxide, sulphur dioxide, phenol, fluorine, cyanide, particulate matter, copper, lead, zinc etc. e. Petroleum - Fossil fuels include petroleum and coal; emissions are mainly sulphur dioxide. Additionally, carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxides, hydrocarbons, particulate matter and traces of metals are produced. f. Paper and Pulp - PM, SO2, H2S, Methyl mercaptang. Food processing - often releases dimethyl sulphide and various types of odour. 4. Agriculture - Chlorinated hydrocarbons, phosphates, nitrates etc. Major air pollutants fall in six main categories of air pollutants: oxides of carbonsulphur dioxideoxides of nitrogenhydrocarbonsAerosol and VOCsinorganic and organic particulate matter

Particulate Matters

Particulates or particulate matter (PM) or fine particles is a generic term used to represent a complex group of air pollutant also called soot, are a subdivision of solid particles or liquid droplets suspended in a gas or liquid. Particulate matter (PM) is a complex mixture of airborne particles. They differ in origin, size, and their chemical composition, all of which are <10 µm in size. Their size ranges from coarse windblown dust to very fine particles from chemical reactions. They can be inorganic components like nitrates, sulphates, metals, carbon particles or organic compounds like aerosols, POPs etc. These fine particles are disperse in air and can freely move over great distances. Most of particulates comes from burning in fireplaces and wood stoves, automobile exhaust, etc. Particles larger than 100 µm diameter settle quickly. They can be dust, soot aggregates, sand particles and sea spray. Particles with aerodynamic diameter less than equal to 10 µm are known as PM10. Particles with aerodynamic diameter less than equal to 2. 5 µm are known as PM2. 5. The lesser the diameter, more will be the penetrating ability and greater will be the hazard. Larger particles are retained in the nose. Particle between 5- < 10 are arrested in the nasal cavity and trachea. Further small particles between < 5 are deposited on the walls of trachea and the smallest particles RSPM can reach and settle in the alveoli. The symptoms of the upper respiratory tract infections are stuffy nose, sinusitis, sore throat, hay fever, cough, and irritation of eyes. The symptoms of the lower respiratory tract infections are wheezing, phlegm, dysponea, pain in chest etc. RSPM slow the ciliary beat and mucous flow inflammation of lung tissue. PM causes alterations in blood chemistry and can increase

susceptibility to viral and bacterial pathogens. Particulates like arsenic, PAH, radioactive nuclei are carcinogens.

Aerosols

Aerosols are tiny particles suspended in the air. Aerosol is formed by the dispersion of solid or liquid material in the atmosphere. Examples are smoke, oceanic haze, air pollution, smog. On an average, globally, aerosols from human activities contribute to about 10 percent of the total amount of atmospheric aerosols. Most of this is concerted in the Northern Hemisphere, due to industrial development, slash-and-burn cropland, and overgrazed grasslands. Natural aerosols also in the air arise from volcanoes, dust storms, forest fires, foliage, and sea spray. However, polluting aerosols are created by the PM like carbon particles. Anthropogenic activities, such as fossil fuel burning and the change of natural surface cover, also create aerosols. Thick layer of aerosols in the troposphere can affect the climatic conditions by preventing the entry of the solar radiation. When deposited on the leaves they influence photosynthesis. Aerosols scatter the organic metallic pollutants distant and wide. Sulfate aerosols exert a cooling effect on the climate and NOx form smog. CFCs are organic compound comprising carbon, chlorine, and fluorine, produced as a capricious derivative of methane and ethane and commonly known as Freons. A subclass of the CFCs is the hydrochlorofluorocarbons (HCFCs), which includ hydrogen in addition; commonly they are identified by the DuPont trade name Freon. The most common example is dichlorodifluoromethane (R-12 or Freon-12). CFCs had been extensively used as refrigerants, propellants and solvents. The production of CFC compounds is being phased out by the negotiation of

Montreal Protocol since these contribute to depletion of ozone in the stratosphere. Presently, gases, such as helium, propane/isobutane mixtures are used as refrigerants.

POPs

Persistent organic pollutants (POPs) are toxic organic class of compounds that harmfully affect both the health and the environment throughout the world has become a global concern. As they can be easily transported by wind and water, most of the POPs produced in one country affect man and nature far-off from the place they are used and released. They endure for an extended period in the environment and can amass and go into from one trophic level to the next through the food chain. In 2001, United States with 90 other countries and EU signed the United Nations treaty in Stockholm, Sweden. Under the treaty the countries decided to trim down or eliminate the production, use, and/or release of 12 main culprits, known as ‘ dirty dozen’.

The dirty dozen:

1. Aldrin Pesticide, closely related to dielrin; extensively used on corn and cotton and for termite control. 2. Dieldrin Pesticide widely used on corn and cotton pests. It is also a metabolite of aldrin. 3. Chlordane Pesticide on crops, lawns, and gardens and a fumigant for termite control. 4. Heptachlor Insecticide for household and agricultural uses. It is also a component and a breakdown product of chlordane. 5. DDT Pesticide; used for controlling malaria since 2nd world war; discovered by Paul Mueller. 6. Endrin Used as insecticide, rodenticide, and also to control birds. 7. Hexachlorobenzene (HCB) used as pesticide and fungicide used on seeds, is also an industrial

byproduct. 8. Mirex used as insecticide and as flame retardant. 9. Toxaphene Insecticide used on cotton pests. 10. PCBsPolychlorinated biphenyls, widely used in electrical equipment.

11. Polychlorinated Dioxins and

12. Polychlorinated Furans - Two notorious classes of " unintentional" pollutants, produced as byproducts of incineration and industrial processes.

Volatile Organic Compounds

(VOCs) refers to the class of organic chemical compounds which have significant vapor pressures and which can affect the environment and human health. There are various types of VOCs present ubiquitously. VOCs include both natural and man-made chemical compounds. It is the anthropogenic VOCs that are regulated, especially for indoors environment where concentrations can be highest. Commonly VOCs are used in household products like paints, paint strippers, and other solvents; wood preservatives; aerosol sprays, cleansers and disinfectants, moth repellents and air fresheners, stored fuels and automotive products, dry-cleaned clothing. Common examples of VOCs are Acetone, Benzene, Ethylene glycol, Formaldehyde, Methylene chloride, Perchloroethylene, Toluene, Xylene, 1, 3-butadiene and an important class called terpenes, such as myrcene. Exposure to VOCs is primarily through inhalation, which may affect the mucosa of the eyes, nose, esophagus and respiratory passage. Continued exposures to VOCs have shown to cause various types of malignancy. These chemicals also as endocrine organ disrupters because they can mimic and interrupt the naturally occurring hormones actions in the human body.

Some Common VOCs and Their Toxic Effects

Name

Usage

Symptoms and Target Organs

1, 1, 1- Trichloro ethaneUsed as a dry cleaning agent, and as propellant. Symptoms: irritation of eyes, skin, exhaustion, restlessness, irregular respiration, muscle fatigue; Target organs: eyes, skin, CNS, liver1, 4 – DichlorobenzeneUsed as an air deodorant and as insecticideSymptoms: irritation of eyes, skin, nasal passage, throat, respiratory tract, causes bronchitis, hypochromic anemia, headache, sleepiness, weakness and fatigue, dizziness, nausea, incoherence, confusion vomiting, , chemical pneumoniaTarget organs: eyes, skin, respiratory system, CNS, blood2 – ButanoneUsed as a solvent, and in manufacturing synthetic resinSymptoms Irritation eyes, skin, nose; headache; dizziness; vomiting; dermatitisTarget Organs Eyes, skin, respiratory system, CNSAcetoneUsed as a solvent, in the production of lubricating oils and as an intermediate in pharmaceuticals and pesticides. Symptoms Irritation eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitisTarget Organs Eyes, skin, respiratory system, CNSBenzeneConstituent in motor fuels, solvent for fats, inks, oils, paints, plastics and rubber. Also used in manufacturing of detergents, pharmaceutical, explosives and dyestuff. Symptoms Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]Target Organs Eyes, skin, respiratory system, blood, central nervous system, bone marrowCancer Site

[leukemia]Chloro benzeneUsed in the manufacture of dyestuffs and pesticidesSymptoms Irritation eyes, skin, nose; drowsiness, incoordination; central nervous system depression; in animals: liver, lung, kidney injuryTarget Organs Eyes, skin, respiratory system, central nervous system, liverChloroformUsed as a solvent – widely distributed in atmosphere and waterSymptoms Irritation eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen]Target Organs Liver, kidneys, heart, eyes, skin, central nervous systemEthyl benzeneUsed as a solvent and in the manufacture of styrene related productsSymptoms Irritation eyes, nose, respiratory system; headache, lassitude (weakness, exhaustion), dizziness, confusion, malaise (vague feeling of discomfort), drowsiness, unsteady gait; narcosis; defatting dermatitis; possible liver injury; reproductive effectsTarget Organs Eyes, skin, respiratory system, central nervous system, liver, reproductive systemFormaldehydeUse din particle board, insulationSymptoms Irritation eyes, nose, throat, respiratory system; lacrimation (discharge of tears); cough; wheezing; [potential occupational carcinogen]Target Organs Eyes, respiratory systemCancer Site [nasal cancer]XyleneUsed as a solvent, as constituents of paint, lacquers, varnishes, inks, dyes, adhesive, cement, and aviation fluid. Also used in manufacture of perfumes, insect repellent, pharmaceuticals and the leather industry. Symptoms Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitisTarget Organs Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneysPerchloroethyleneUsed in dry cleaningSymptoms Irritation eyes,

skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogenTarget Organs Eyes, skin, respiratory system, liver, kidneys, central nervous systemCancer Site [in animals: liver tumors]StyreneAt high temperature becomes a plastic; used in manufacture of resins, polyesters, insulators, and in drug manufacturingSymptoms Irritation eyes, nose, respiratory system; headache, lassitude (weakness, exhaustion), dizziness, confusion, malaise (vague feeling of discomfort), drowsiness, unsteady gait; narcosis; defatting dermatitis; possible liver injury; reproductive effectsTarget Organs Eyes, skin, respiratory system, central nervous system, liver, reproductive systemTetrachloroethyleneUsed as a solvent in degreasing and dry cleaningSymptoms Irritation eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogenTarget Organs Eyes, skin, respiratory system, liver, kidneys, central nervous systemCancer Site [in animals: liver tumors]TolueneUsed in manufacture of Benzene, as a solvent for paints and coatings or as a component of car and aviation fuels. Symptoms Irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damageTarget Organs Eyes, skin, respiratory system, central nervous system, liver, kidneysTrichloroethyleneUsed as a solvent in vapour degreasing. Used as an intermediate in production in pesticides, waxes, gums, resins, tars, and paints. Symptoms Irritation eyes, skin; headache, visual disturbance,

lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]Target Organs Eyes, skin, respiratory system, heart, liver, kidneys, central nervous systemCancer Site [in animals: liver & kidney cancer]

The various classes of air pollutants, their source and their impacts are summarized in the given table:

Pollutant

Source/Cause

Effect

1. Carbon monoxidePrimarily by incomplete combustion. Automobile exhaust, atmospheric photochemical reactions, biological oxidation by marine organisms, etc. Affects the respiratory activity since haemoglobin has more affinity for CO than for oxygen. Thus, CO combines with Hb forming carboxyhaemoglobin (COHb) and thus reduces the oxygen-carrying capacity of blood. This results in blurred vision, headache, drowsiness, and death due to asphyxiation (lack of oxygen). 2. Carbon di oxide though not a pollutant at normal level and is harmful in excess levels. Burning of fossil fuels, forests depletion (that remove excess carbon dioxide and help in maintaining the oxygen-carbon dioxide ratio). Prime GHG that result in global warming. 3. Sulphur dioxideIndustries, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions. Respiratory problems, severe headache, reduced productivity of plants, yellowing and corrosion to limestone and marble, damage to leather, increased corrosion of iron, steel, zinc and aluminium. 4.

Hydrocarbons Polynuclear Aromatic Compounds(PAC) and Polynuclear Aromatic Hydrocarbons(PAH)Automobile exhaust and industries, leaky fuel tanks, leaching of toxic waste from dumping sites, coal tar lining of some water supply pipes. At high concentrations Carcinogenic5. Chlorofluoro carbons (CFCs)Refrigerators, air conditioners, foam shaving cream, spray cans and cleaning solvents. Inert in the troposphere, destroy stratospheric ozone layer which then permits harmful UV rays to enter the atmosphere. 6. Nitrogen OxidesAutomobile exhausts, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptionsFormation photochemical smog, acid rain and causes respiratory ailments such as inflammation, pneumonia, lung cancer; at higher concentrations causes leaf damage or affects the photosynthetic activities of plants7. Nitrous oxide (N2O)Nitrogenous fertilizers, deforestation, and biomass burningGreenhouse effect8. PAN – peroxy acetyl -nitratePhotochemical reactions of hydrocarbons and nitrogen oxides. Irritation of eye, throat and respiratory tract, damage to clothes, paint and rubber articles, damage to leaves and stomatal tissue in plants. 9. Particulate matter Lead halides (lead pollution)Combustion of leaded gasoline productsRespiratory problems, asthma. 10. Asbestos particlesMining activitiesAsbestosis11. Silicon dioxideStone cutting, crushing and grinding, pottery, glass manufacturing and cement industries. Silicosis12. Biological matter like the pollen grainsFlowersAllergy13. Fungal spores, bacteria, virus, etcMicrobesAllergy and Infectious diseases14. Dioxins and FuransFrom combustion of chlorinated substanceCarcinogen and possibly targets all the organ systems

Occupational Health Hazards

Berylliosis –

It is a kind of pneumoconiosis - is a systemic granulomatous disease, mainly affecting the lungs. This occupational health hazard can affect employees working in beryllium alloy industry, ceramic objects, foundry, cathode ray tubes, gas blanket, projectile, and nuclear reactors. Its incidence can happen in 2 forms: acute nonspecific pneumonitis and chronic granulomatous disease with interstitial fibrosis, which may cause respiratory failure and ultimately death. Chronic disease may assume full form in 10 to 15 years after exposure. Most patients with chronic interstitial disease have only slight to moderate disability from impaired lung function and other symptoms. With each acute exacerbation, though, the prognosis worsens. The list of signs and symptoms mentioned in various sources for Berylliosis includes Respiratory system symptoms in acute cases, Coughing, difficulty in breathing, chest pain, tiredness, loss of body weight, allergic rashes all over the body, cyanosis; Pulmonary granulomas, pulmonary nodular accumulations and pulmonary inflammatory cells, orthopnoea, haemoptysis, clubbed fingernails, corneal leisons in chronic cases with prolonged exposure

Asbestosis

Asbestos are very common. More than 3, 000 products used currently include asbestos. Most of the products in heat and sound insulation, fireproofing, furnaces, floor tiles, electric wires, wall and ceiling panels, cements, contain asbestos. Workers who work with asbestos products often develop asbestosis. The use of asbestos has been banned in goods such as pipe coverings, hairdryers, artificial fireplace logs. Asbestosis is labeled as a

monosymptomatic disease as because the first symptom is only shortness of breath. Other symptoms are persistent cough, chest tightness, chest pain and appetite loss. Asbestosis is a scarring and scraping of the lungs that leads to respiratory problems and cardiac failure.

Silicosis

Silicosis is a pulmonary disease caused by breathing in of silica dust. Silicosis is also known as grinder's asthma, grinder's rot, mason's disease, miner's asthma, miner's phthisis, potter's rot, rock tuberculosis, and stonemason's disease. Crystalline silica is a naturally occurring mineral, a main component in quartz, sand, flint, agate, granite, etc. The most common early symptoms include cough, tiredness, apetite loss, chest pains, shortness of breath and bluish skin at the extremities. As crystalline silica exposure continues, the symptoms worsen. This is because the lung cell and tissues become more corroded and little efficient to carry out normal functions. More rigorous symptoms of silicosis include all the above symptoms along with fever, loss of weight, night sweating, cyanosis and respiratory failure. When crystalline silica is breathe in, it causes swelling of the lung tissue. This inflammation leads to the formation of scar tissue on the lungs. The scar tissue blocks the normal inflow of oxygen into the lungs and into the bloodstream. Silicosis also increases the susceptibility to bacterial or fungal infections. It can also cause lung cancer and tuberculosis. If left untreated, it is ultimately fatal.

Anthracosis

The early, milder form of the illness from inhalation of coal dust is known as anthracosis (anthrac - coal, carbon). This is often asymptomatic or without symptoms and is found more or less in all city dwellers due to air pollution.

Protracted exposure to considerable amounts of coal dust can result in more grave forms of the disease, the coal workers' pneumoconiosis.

5. Black lung disease

It is commonly known as 'coal worker's pneumoconiosis' is a syndrome caused by the extended exposure to coal dust, which progressively is deposited in the pulmonary tissues. It is a chronic respiratory illness. Pneumoconiosis can be silicosis, asbestosis and the coal workers' pneumoconiosis or black lung disease. Silicosis and asbestosis, as stated earlier, is caused by the accumulation of silica and asbestos in the lungs. Black lung disease leads to black pigmentation of the lung and black salivation. The main cause of black lung disease is the inhalation man made carbon particles. It is widespread among the coal miners, and the workers connected with the production of graphite and carbon black. The inhaled coal particles assemble in the lung and cause its discoloration. But ultimately, this transforms into small coal lumps or nodules, which gradually enlarges in size. These are located in the lymph nodes and connective tissues of the lungs, and is impossible to be removed from the body. Finally they obstruct the air flow through the respiratory passages. Smoking, though not related, can add to the further deterioration of the lung, and thereby exacerbating the situation. Usual symptoms of the disease are shortness of breath, constant cough and blockage of the air passages. However, sometimes the patients may be asymptomatic.

Global impacts of air pollution

Global Warming

Major part of the incoming solar radiation to the earth's atmosphere is reverted back into the space. Nevertheless some heat is absorbed by the GHGs like the carbon dioxide. The other gases that add up are water vapour, methane, chlorofluorocarbons (CFCs) and nitrous oxide. This helps to keep the earth cozy and warm much like the greenhouses in cold countries. Greenhouse effect is an indispensable and a natural phenomenon. Each year the temperature is rising due to pollution and the concentration of these greenhouse gases is also mounting. This is called global warming. Estimates say that at the present pace of increase, the average temperature of the earth will increase by 3oC to 8oC in the next century. This will have the subsequent effects on: Changes in climatic pattern. Distribution of plants and animals. Changes in the pattern of agriculture and food productionMelting of snow caps resulting in increase of sea levels. This will lead to the submergence of parts of coastal cities of Calcutta, Mumbai, New York, London etc.

Greenhouse gases and Greenhouse Effect

The term 'greenhouse gases' refers to the atmospheric gases that absorb the spectrum and emit them back within the thermal range of infrared radiation. These gases can significantly affect the global temperature. The temperature of the earth surface would have been nearby 59 degree Fahrenheit colder than the present temperature in absence of these gases. Everything is not good about these greenhouse gases. GHGs have a tendency to to trap the solar radiations, which ultimately leads to a increase in the surface

temperature of the earth. This is known as greenhouse effect or global warming. Gases are usually compared to one another on the basis of their Global Warming Potential (GWP), GWP of a GHG is their warming effect over a period of time compared to the same amount of carbon dioxide. Carbon dioxide is the universally accepted point of reference and its GWP is accepted as 1. It is the most significant greenhouse gas added by anthropogenic activities. Water Vapor is produced due to evaporation of water or through sublimation of ice. Ultimately, this water vapor is comes down from the atmosphere by rainfall. Water vapor nearly constitutes 33 to 66 % of GHGs. Carbon Dioxide: is produced by respiration of flora and fauna (including human beings) and burning of fossil fuels. In small amounts it is also produced by geothermal processes, such as volcanic erruption. According to recent estimates carbon dioxide concentration in the Earth's atmosphere has risen to 391 ppm by volume. It constitutes 9 to 26 percent of greenhouse gases. Methane: comprise 4 to 9 percent of greenhouse gases. This gas is produced by a process called methanogenesis. Methane is also produced by organic waste decomposition. The permafrost region in the northern hemisphere when begin to thaw with rising temperatures release huge quantity of methane. Methane comprises for 20 percent of the enhanced greenhouse effect. Its GWP is 25 with an atmospheric lifetime of roughly 12 years. Nitrous Oxide used as an aerosol propellant and as an anesthetic is 296 times more powerful and persist in the atmosphere for 114 years. Ozone is both natural as well as anthropogenic and constitutes approximately 3 to 7 percent of greenhouse gases. Chlorofluorocarbons (CFCs) are the most popularly known haloalkanes, which are harmful for the environment. Methyl chloride is the only main naturally produced

organochlorine molecule made up about 0. 6 ppb of that total; almost all others are anthropogenic. HFCs make up only a small portion but they are extremely potent greenhouse gases. They are used in refrigeration in air-conditioning and as foam blowing agents, solvents, firefighting agents and aerosol propellants. HFC, they can be up to 20, 000 times more powerful greenhouse gases having atmospheric lifetime of up to 260 years. PFCs, by-products of aluminium smelting are also used in semi-conductor manufacture. PFCs are 5, 700 to 10, 000 times more potent GHG withan an atmospheric lifetime of up to 50, 000 years. Sulphur Hexafluoride is the most potent greenhouse used in Nike Air shoes, making of tyres, electrical insulation, manufacture of semiconductor and in the magnesium industry. It is 23, 900 times more powerful GHG than carbon dioxide, and persists for about 3, 200 years. Other than these, gases such as nitrogen trifluoride and perfluorocarbons but owing to their presence in small quantities, these gases are not considered to be as important as others.

Ozone depletion and cfc and polar stratospheric clouds

Refer to Unit 7

Refrigerants

Common Refrigerants used are of three types that are used in refrigeration and air-conditioning systems. These refrigerants are " halogenated," means they contain chlorine, fluorine, bromine, astatine, or iodine. They are :- Chlorofluorocarbons (CFCs) - R-11, R-12, and R-114Hydrochlorofluorocarbons (HCFCs) - R-22 or R-123Hydrofluorocarbons (HFCs) - R-134a. According to National Refrigeration Safety Code catalogs, refrigerants are grouped into three groups: Group I or safest of the refrigerants - R-12, R-22, and R-

502Group II or toxic - R-40 (Methyl chloride) and R-764 (Sulfur dioxide)Group III or flammable refrigerants - R-170 (Ethane) and R-290 (Propane).

Additional Refrigerants - R-717 Ammonia (NH3)

Ecofriendly approaches

HFC-152a can replace R-134a having similar operating features as R-134a but cools even better. An environmental advantage of HFC-152a is its global warming rating of 120, which is 10 times less than R-134a. This still higher than that of CO2. Greenfreeze uses a mixture of propane (R290) and isobutane (R60Oa), or pure isobutane gas as refrigerant to replace the ozone-destroying molecules.

Photochemical smog

The industrial revolution is the key to the increase in pollutants in the atmosphere. smog episodes in the 19th and 20th centuries and were named as " pea-soupers". Before 1950, the bulk of pollution was from the burning of coal . Under suitable conditions smoke and sulfur dioxide (burning of coal) combined with fog to produce industrial smog. industrial smog can be extremely poisonous to humans and other living organisms. The most notable was the London smog that occurred in December, 1952 when 5 days of tranquil unclear weather created a deadly atmosphere that sued about 4000 lives. Presently, burning of fossil fuels like petroleum and diesel can produce another air pollution dilemma known as photochemical smog. Photochemical smog is a situation that occurs when the primary pollutants like NO2 and VOCs interact under the solar radiation to produce a mix of hundreds of diverse and hazardous chemicals known as secondary pollutants. Cities like Los Angeles, New York, Sydney, and Vancouver

habitually experience photochemical smog. High concentrations of NO2 and VOC are associated with industrialization and transportation. The timing of day serves as a significant factor in the aerial quantity of photochemical smog. Precipitation can ease the effect of photochemical smog as the contaminants are washed out of the air with the precipitation. The prerequisites for photochemical smog formation areSolar radiationNitrogen oxides (NOx). Volatile organic compounds (VOCs). Temperatures should be more than 18 degrees Celsius. Two most dominant toxic components: ozone (O3) and peroxyacetyl nitrate (PAN). Nitrogen dioxide can be formed by one of the following reactions. Notice that the nitrogen oxide (NO) acts to remove ozone (O3) from the atmosphere and this mechanism occurs naturally in an unpolluted atmosphere.

O3 + NO ------- ☾ NO2 + O2

NO + RO2 ----- ☾ NO2 + other products

Sunlight can degrade nitrogen dioxide

NO2 + sunlight ----- ☾ NO + O

The atomic oxygen (O) then reacts with oxygen molecules producing ozone (O3).

O + O2 ----- ☾ O3

Nitrogen dioxide (NO2) react with the radicals produced from VOC in a sequence of reactions to form peroxyacetyl nitrates (PAN).

NO2 + R ---- ☾ PAN

Major Chemical Pollutants in Photochemical Smog: Sources and Environmental Effects

Toxic Chemical

Sources

Environmental Effects

Nitrogen Oxides

(NO and NO2)

- combustion in both automobiles and industry- microbial action in soil- wild fires- volcanoes- lightning- decreased visibility due to yellowish color of NO2- contributes to heart and lung complications- NO2 can retard plant growth- increased susceptibility to infection

Volatile Organic Compounds (VOCs)

- from use as solvents- incomplete combustion of fossil fuels- naturally compounds like terpenes from trees.- irritation eye irritation and respiratory tracts- carcinogenic- decreased visibility due to blue-brown haze

Ozone (O3)

- photolysis of NO2- stratospheric ozone intrusions- constriction of bronchioles- coughing, wheezing- irritation eye irritation and respiratory tracts- decreased crop yields- retarded growth ofplant- damages plastics- breaks down rubber- harsh odor

Peroxy acetyl Nitrates (PAN)

- formed by the reaction of NO2 with VOCs- irritation eye irritation and respiratory tracts- highly toxic to plants- protein damage

National Ambient Air Quality Standards (NAAQS)

National Ambient Air Quality Standards (NAAQS) were previously reported in the year 1994 under the Air Act, 1981. The World Health Organizations norms-2005 and our revised NAAQS vary amongst each other. WHO recommended five parameters of which only four are to be monitored i. e. PM10/ PM 2. 5, Sulphur Dioxide, Nitrogen Dioxide and Ozone. The GOI prescribed 12 parameters, mainly, PM10, PM2. 5, SO2, NO2, CO, NH3, Ozone, Lead, Benzene, Benz-a pyrene, Arsenic and Nickel. CPCB started National Air Quality Monitoring Programme in 1984, in seven Indian cities later renamed as National Air Monitoring Programme (NAMP) in 1988 – 1989. The Central Pollution Control Board monitors PM2. 5, ground level Ozone, Carbon Monoxide, Lead, Hydrocarbons, Ammonia, Benzene, etc., at designated sites in few cities and Sulphur Dioxide, Nitrogen Dioxide and PM10 at all locations under National Air Monitoring Programme (NAMP).

National Air Quality Monitoring Programme

There are over 342 monitoring stations all over the country. The monitoring is carried out with the help of CPCB, SPCB, NEERI, Nagpur, and Pollution control committees. The monitoring of weather parameters are also combined with the air quality data. They are wind speed, wind direction, air temperature, humidity, rainfall, solar radiation, air pressure etc. the observation is carried out four hourly sampling for gases and eight hourly

sampling for PM, twice a week so as to have 104 observations/ year. The cheapest tool for monitoring air pollution is by its odour. Laboratory analysis of air pollutant is done by PM samplers, stack samplers and High volume air samplers.

High Volume Sampling:

A high volume air sampler has an air drawing machine that draws in the air through a special filter paper. The flow rate is adjusted while air sample is sucked in and the sample can be drawn in over a precise time period. This controls the volume of the air sample taken. Any measurable substance deposited on the filter paper is examined and evaluated further. High volume sampling yields a quantitative analysis of the air pollutants.

Buckets Samplers:

The sampler is a bucket made of plastic with a detachable bag placed inside it. The valve present on the nozzle of the pail is opened to draw in air. This operates by means of a pump that sucks in the air. Once filled with air sample, the bag can be separated and sent for analysis.

Air Pollution Control Equipments:

A few control systems at source used by vehicles and industries are -

Systems to Reduce Particulate Matter

Wet Scrubbers: is used to remove pollutants usually from furnace flue gas. The polluted stream of gas being is let in by force through a scrubbing liquid. They are used in large thermal plants, asphalt plants, iron and steel plants, manure plants, etc. Electrostatic Precipitator (ESP): a particulate collecting

device which uses the strength generated by an induced electrostatic charge to remove PM from any flowing gas. ESPs are used in petroleum refineries, paper and pulp factories, etc. Dust Cyclones: fluids and solids mixtures are separated by using gravitational and rotational property such as in oil refineries, cement industry.

Systems to Reduce NOx

Exhaust Gas Recirculation (EGR): the incoming air intermixed with the recirculated exhaust gas, results in dilution of the mixture with noble gas which in turn reduces the adiabatic flame temperature and also lowers the unnecessary oxygen in diesel engines. The peak burning temperature falls since the specific heat capacity of the mixture is raised by the exhaust gas. Catalytic Converter: a device to reduce the toxicity of effluent gases that are produced by internal ignition engines.

Systems to Decrease Volatile Organic Compounds (VOC):

Gas Flare: When flammable, unusable waste gas and liquids are discharged by pressure relief valves, the device is used to burn them off generally used in landfills. Biofilters: living matter is used to trap and biologically degrade pollutants.

Air pollution in India

As per WHO guidelines, the atmospheric PM levels should not be more than 20 micrograms / cubic meter but PM levels in the city of Ludhiana are 251, whereas that of Delhi and Mumbai is 198 and 132, respectively. As per recent survey conducted by Centre for Science and Environment (CSE) Gwalior and Raipur stands amongst the top five gravely polluted Indian cities

in the context of particulate matter. These cities bear more than three times PM above the acceptable standards

Control of Air Pollution

At Source: (In the Industries)Raw material substitution (replacing of high sulphur containing fuel with low-sulphur fuels), substituting toluene for benzene, titanium fro lead, and calcium phosphate for beryllium. Process modification: Pollution reduction can be achieved by new or modified process. For example the use of exhaust hoods and ducts over several types of industrial ovens has allowed the recovery of valuable solvents that could have otherwise become air pollutants. Dipping process instead of spraying can be implemented. Equipment alterations: With newer types of equipment, which are less pollution-prone, can cut down air pollution. Removal of pollutants at source: Using of air pollution control devices such as Cyclones, Scrubbers (Fig 6. 3), Electrostatic precipitators, bag house fabric filters play a vital role in controlling of air pollutants at source. Dilution: Dilution is promoted by the self-cleansing mechanism of the environment. The pollutants released from the tall stocks or chimneys of the industry are dispersed into the atmosphere by strong wind, which helps in diluting the pollutants. In Vehicles: Discarding of old Vehicles: The car companies should sell or dispose off technologically obsolete vehicles. For example, though the United States consumes 100 times more petrol than India, the vehicles in the two countries pump the same amount of Benzene, a potent carcinogenic into the air. Therefore the vehicles in India should meet the latest Euro standards like MPFi system. Catalytic Converters: Catalytic converters are fitted between the engine and the tail pipe, which convert most of the exhaust into

less damaging gases via a chemical reaction. Improving fuel Quality: The quality of fuel used in automobiles is also an important factor in curbing air pollution. For example, reformulating or changing the composition of diesel or petrol in the refinery reduces pollution. Sulphur content in diesel supplied was brought down to 0. 5% in 1996 and it was further down to 0. 25% in 1997. It is necessary to have low sulphur content in diesel for complying with the emission norms ahead of EURO-II (from Euro-I to Euro-II norms, sulphur content in diesel is low by 0. 3%), the refineries is required to take initiatives for bringing down the sulphur content. Methyl tert-butyl ether, also known as methyl tertiary butyl ether and MTBE, is a volatile, flammable and colorless liquid that is immiscible with water. MTBE is an oxygenate and used as gasoline additive to raise the octane number, helping prevent engine knocking. Other compounds available as gasoline additives are ethanol and tert-amyl methyl ether (TAME). Unleaded Petrol - where lead has been removed from the petrol by adding aromatic compounds. (This produces another problem of releasing too much of cancer causing benzene, therefore alternative fuel is necessary). Introduction of unleaded petrol for new cars was introduced from April, 1995 and mandatory supply of unleaded petrol started from 1998. The lead content in the Delhi air has reduced by more than 60% with the introduction of unleaded petrol. Alternative Fuels: Like Ethanol, Methanol, Compressed Natural Gas (CNG), Liquid petroleum gas (LPG) highly reduces air pollution. Even biofuels like biodiesel or soy diesel plays a vital role in curbing air pollution. Fuel Cells: The hope of the future, for vehicles where hydrogen reacts with oxygen to produce electricity in a cell. Its only by product is water vapour. Vehicular Emission Check: Continuous checking of vehicular emission for permissible limits, strict

enforcement of law and periodical survey of the emission control equipment is absolutely necessary for controlling air pollution. Legal measures: The Government must impose taxes and levies on industrial units that contribute to maximum level of air pollution. The Governemnt has enacted the Air Act, 1981 and EPA, 1986. Green Vegetation: To reduce the spreading of air pollutants emanating from industrial sources, growing green vegetation around the industry has been recommended by scientists. The neem tree is reported to be helpful in checking atmospheric pollution caused by vehicular and industrial emission. Therefore, neem trees should be planted in the cities that face acute pollution problems.

Emission Norms

Emission norms are prescribed levels of pollutants fixed by the government for the vehicle that they would emit when running on roads. They are the limits up to which the CO, HC and NOx gases are allowed. All the manufacturers need to enforce and obey the same for vehicles being manufactured from the date of enforcement. The Automobile Research Institute, Pune is the certifying authority for the vehicles fulfilling the standards.

Table - Source – Society of Indian Automobile Manufacturers

Car

(g/km)

Year

CO

HC

Nox

HC+Nox

1991

14. 3 - 27. 1

2. 0-2. 9

1996

8. 68 - 12. 4

3. 00 - 4. 36

1998*

4. 34 - 6. 20

1. 50 - 2. 18

2000

2. 78

0. 97

B. S II

2. 2

0. 5

B. S II

2. 2 - 5. 0

0. 5 - 0. 7

B. S III

2. 30

0. 2

0. 15

B. S III

2. 3 - 5. 22

0. 20 - 0. 29

0. 15 - 0. 21

Euro norms refer to the allowable and acceptable emission levels for both petrol and Diesel vehicles that have been applied in Europe. The GOI has adopted the Euro norms for the method of testing. Euro-1 norms in India are known as INDIA 2000 since it will be effected from 1/4/2000. The norms corresponding to Euro-2 are called 2005 norms but these have not yet been indicated by the Indian Government. The Euro norms necessitate the makers to decrease the prevailing polluting emission levels in a more effective manner by adopting certain technical changes in their vehicles. The manufacturers adopt the following changes to have a EURO I compliant vehicles. (a) (a) Retuning of carburetor(b) Secondary air intake(c) Recirculation of exhaust gas(d) Increase in catalyzer capacity(e) Catalyzer

coated with trimetalIn Euro II compliant vehicle the carburetor is replaced by Multi-point Fuel Injection System (MPFI). Bharat Stage emissions standards are emissions standards introduced by the GOI to regulate the output of air pollutants such as NOx, CO, HC, SOx, and PM. In a lot of cases they are related to European emissions standards. The first Indian emission regulations were became effective in 1989. From 2000, India started embracing European emission and fuel regulations for four-wheeled light-duty and for heavy-dc. Indian own emission regulations still apply to two- and three-wheeled vehicles. The implementation schedule of EU emission standards in India is summarized in TableTable 1: Indian Emission Standards (4-Wheel Vehicles)

Standard