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ENVIRONMENTAL SCIENCE AND ENGINEERING

UNIT NO 2

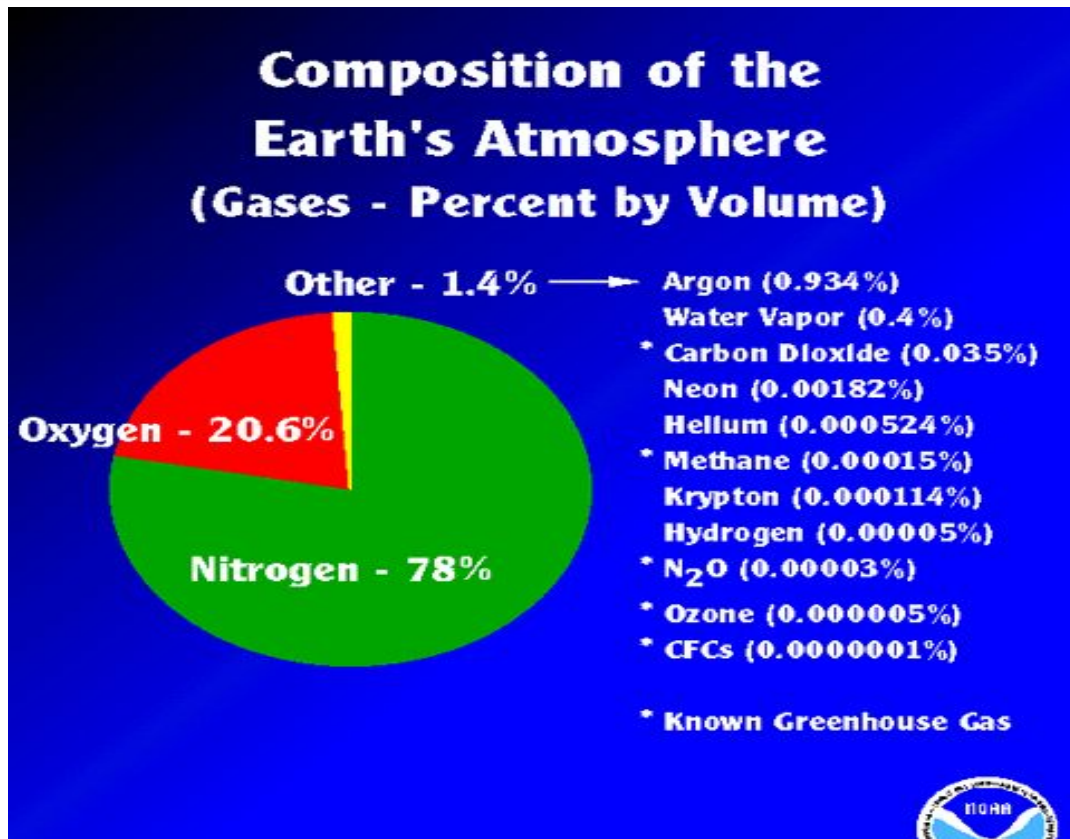
ENVIRONMENTAL POLLUTION

- Definition, causes , effects and control measures of Air pollution
- Definition, causes , effects and control measures of Water pollution

SCIENCE & HUMANITIES



AIR POLLUTION



Definition

Air pollution may be defined as 'the presence of one or more contaminants like dust, smoke, mist and odour in the atmosphere which are injurious to human beings, plants and animals'.

SOURCES OF AIR POLLUTION

1. Natural sources

2. Man-made or anthropogenic sources

Natural sources

Natural sources cause large scale air pollution which is beyond the man's control.

Eg: Volcanic Eruptions, forest fires, biological decay, pollen grains, marshes, radioactive materials etc.

These pollutants are caused by the natural sources.

Man-made (anthropogenic) activities

Eg : Thermal power plants, vehicular emissions, fossil fuel burning, agricultural activities etc.,

CLASSIFICATION OF AIR POLLUTANTS

Depending upon the form(origin) of pollutants present in the environment, they classified as

(i) Primary air pollutants.

(ii) Secondary air pollutants

Primary air pollutants : Primary air pollutants are those emitted directly in the atmosphere in harmful form.

Eg : CO, NO, SO₂, etc.,

Indoor Air pollutants

Indoor air pollutants are primary air pollutants. The most important indoor air pollutant is radon gas.

Sources (causes) of indoor air pollutants

1. Radon gas is emitted from the building material like bricks, concrete, tiles, etc., which are derived from soil containing radium.
2. It is also present in natural gas and ground water and is emitted indoors while using them.
3. Burning of fuels in the kitchen, cigarette smoke, liberates the pollutants like CO, SO₂, formaldehyde, BAP (benzo-(a) pyrene).

Secondary air pollutants : Some of the primary air pollutants may react with one another or with the basic components of air to form new pollutants. They are called as secondary air pollutants.

Eg : $\text{NO}/\text{NO}_2 \rightarrow (\text{HNO}_3/\text{NO}_2)\text{etc.}$,

Common air pollutants sources (causes) and their effects:

According to the World Health Organization (WHO), more than 1.1 billion people live in urban areas where outdoor air is unhealthy to breathe. Some of the common air pollutants are described below.

1. Carbon monoxide (CO)

Description

It is a colourless, odourless gas that is poisonous to air-breathing animals. It is formed during

The incomplete combustion of carbon containing fuels.



Human sources (causes)

Cigarette smoking, incomplete burning of fossil fuels. About 77% comes from motor vehicle exhaust.

Health Effects

Reacts with hemoglobin in red blood cells and reduces the ability of blood to bring oxygen to body cells and tissues, which causes headaches and anemia. At high levels it causes coma, irreversible brain cell damage and death.

Environmental Effects

It increases the globe temperature.

2.Nitrogen dioxide (NO₂)

Description

It is a reddish-brown irritating gas that gives photochemical smog. In the atmosphere it can be converted into nitric acid (HNO₃).



Human sources (causes)

Fossil fuel burning in motor vehicles (49%) and power industrial plants (49%).

Health Effects

Lung irritation and damage.

Environmental Effects

Acid deposition of HNO_3 can damage trees, soils and aquatic life in lakes, HNO_3 can corrode metals and eat away stone on buildings, statues and monuments. NO_2 can damage fabrics.

3. Sulphur dioxide (SO_2)

Description

It is a colourless and irritating gas. It is formed mostly from the combustion of sulphur containing fossil fuels such as coal and oil. In the atmosphere it can be converted to sulphuric acid (H_2SO_4) which is a major component of acid deposition.

Human sources (causes)

Coal burning in power plants (88%) and industrial process (10%).

Health Effects

Breathing problems for healthy people.

Environmental Effects

Reduce visibility, acid deposition of H_2SO_4 can damage trees, soils and aquatic life in lakes.

4.Suspended particulate matter (SPM)

Description

It includes a variety of particles and droplets (aerosols). They can be suspended in the atmosphere for short periods to long periods.

Human sources (causes)

Burning coal in power and industrial plants (40%), burning diesel and other fuels in vehicles (17%), agriculture unpaved roads, construction etc.,

Health Effects

Nose and throat irritation, lung damage, bronchitis, asthma, reproductive problems and cancer.

Environmental Effects

Reduce visibility, acid deposition and H_2SO_4 droplets can damage trees, soils and aquatic life in lakes.

5.Ozone(O_3)

Description

Highly reactive irritating gas with an unpleasant odour that forms in the troposphere. It is a major component of photochemical smog.

Human sources (causes)

Chemical reaction with volatile organic compounds (emitted mostly by cars and industries) and nitrogen oxides.

Environmental Effects

Moderates the climate.

6.Photochemical smog

Description

The brownish smoke like appearance that frequently forms on clear, sunny days over large cities with significant amounts of automobile traffic.

Human sources (causes)

It is mainly due to chemical reaction among nitrogen oxides and hydrocarbons by sunlight.

Health Effects

Breathing problems, cough, eye, nose and throat irritation, heart diseases, reduces resistance to colds and pneumonia.

Environmental Effects

Ozone can damage plants and trees. Smog can reduce visibility.

7. Lead (Pb)

Description

Solid toxic metal and its compounds, emitted into the atmosphere as particulate matter.

Human sources (causes)

Paints, smelters (metal refineries), lead manufacture, storage batteries, leaded petrol.

Health Effects

Accumulates in the body, brain and other nervous system damage and mental retardation (especially in children); digestive and other health problems, some lead-containing

chemicals cause cancer in test animals.

Environmental Effects

Can harm wildlife.

8. Hydrocarbons (aromatic and aliphatic)

Description

Hydrocarbons especially lower hydrocarbons get accumulated due to the decay of vegetable matter.

Human sources (causes)

Paint, smelters, chromium manufacture, chromium plating.

Health Effects

Perforation of nasal septum, chrome holes, gastro intestinal ulcer, central nervous system disease and cancer.

Indian ambient air quality standards

Air quality standards are legal limits, placed on the concentration of air pollutants in a community where people and things are exposed.

Ambient air quality standards are permissible exposure of all living and nonliving things for 24 hours per day, 7 days per week. Indian Ambient air quality standards are given in the table below.

Category	Area	Concentration in $\mu\text{g}/\text{m}^3$			
		SPM	SO ₂	NO _X	CO
A	Industrial and mixed use	500	120	120	5000
B	Residential and rural	200	80	80	2000
C	Sensitive(hill stations,tourist resorts,monuments)	100	30	30	1000

Control Measures of air pollution

The atmosphere has several built-in self cleaning process such as dispersion, gravitational settling, flocculation, absorption, rain washout and so on, to cleanse the atmosphere. In terms of a range control of air pollution, control of contaminants at their source is a more desirable and effective method through preventive or control technologies.

I. Source control

Since we know the substances that causes air pollution, the first approach to its control will be through source reduction. Some actions that can be taken in this regard are as follows:

1. Use only unleaded petrol.
2. Use petroleum products and other fuels that have low sulphur and ash content.

- 3.Reduce the number of private vehicles on the road by developing an efficient public-transport system and encouraging people to walk or use cycles.
- 4.Ensure that houses, schools, restaurants and places where children play are not located on busy streets.
- 5.Plant trees along busy streets because they remove particulates and carbon monoxide and absorb noise.
- 6.Industries and waste disposal sites should be situated outside the city centre preferably downwind of the city.
- 7.Use catalytic converters to help control the emissions of carbon monoxide and hydrocarbons.

II. Control measures in industrial centers

1. The emission rates should be restricted to permissible levels by each and every industry.
2. Incorporation of air pollution control equipment in the design of the plant layout must be made mandatory.
3. Continuous monitoring of the atmosphere for the pollutants should be carried out to know the emission levels.

Equipments used to control air pollution

Air pollution can be reduced by adopting the following approaches.

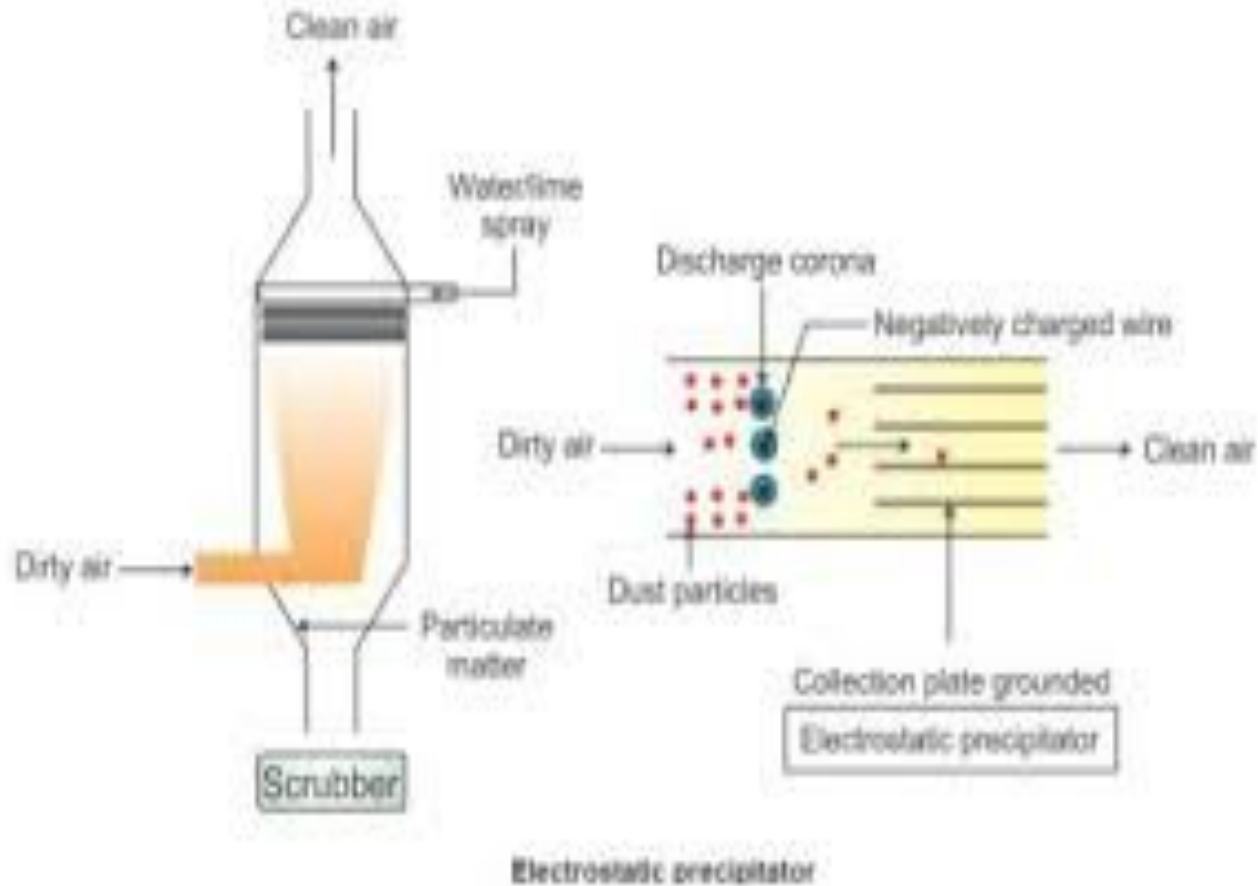
(i) To ensure sufficient supply of oxygen to the combustion chamber and adequate

temperature so that the combustion is complete, eliminating much of the smoke consisting of partly burnt ashes and dust.

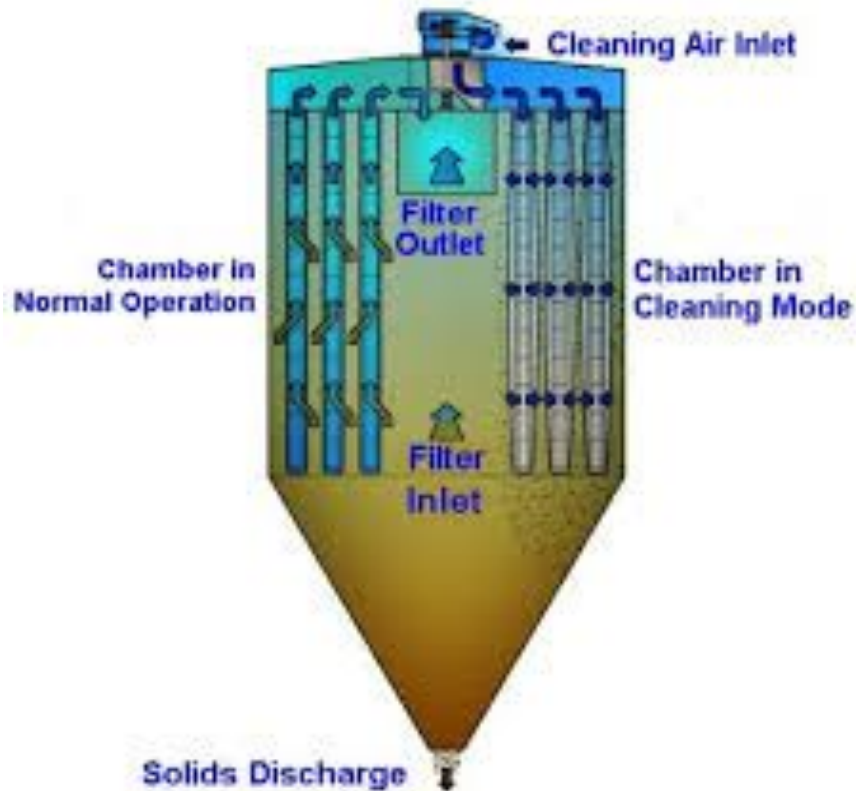
ii) To use mechanical devices such as scrubbers, cyclones, bag houses and electro-static Precipitators, reducing particulate pollutants. The four figures are commonly used control methods for removing particulates from the exhaust gases of electric power and industrial plants. All these methods retain Hazardous materials that must be disposed of safely. The wet scrubber can also reduce Sulphur Dioxide emissions.

(iii) Chemical treatment to deal with factory fumes.

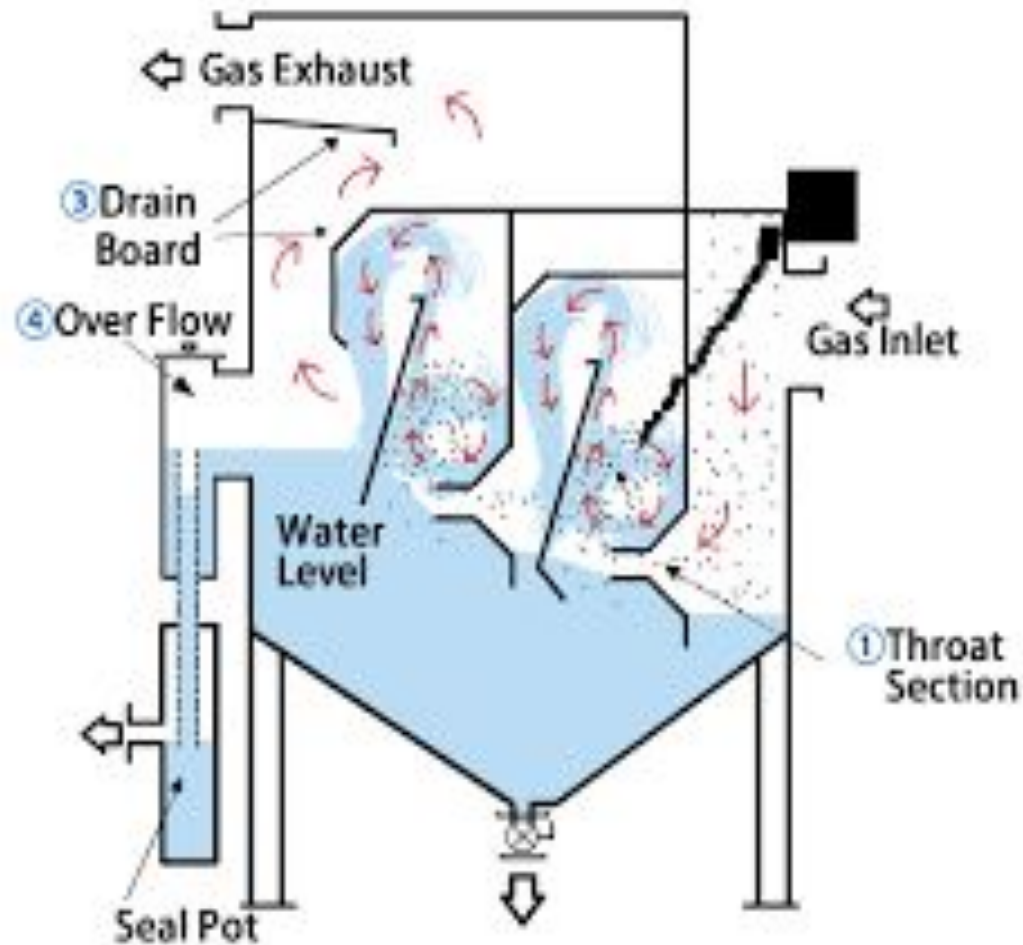
The disposal of the collected air pollutants is equally important for successful control of air Pollution.



Baghouse filter



Wet scrubber



WATER POLLUTION

Definition

Water pollution may be defined as 'the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on aquatic life.'

The pollutants include sewage, industrial chemicals and effluents, oil and other wastes. Besides, chemicals from the air dissolved in rainwater, and fertilizers, pesticides and herbicides leached from the land also pollute water.

Types, effects and sources (causes) of water pollution

Water pollution is a chemical, biological or physical change in water quality that has harmful effects on living organisms or makes water unsuitable for desired uses.

1.Infectious Agents

Eg ; Bacteria, viruses, Protozoa and parasitic worms

Human Sources (causes)

Human and animal wastes.

Effects

Variety of diseases.

2.Oxygen Demanding Wastes (Dissolved oxygen)

Eg : Organic wastes such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria.

This degradation consumes dissolved oxygen in water. Dissolved oxygen (DO) is the amount of oxygen in a given quantity of water at a particular pressure and temperature. The saturated point of DO varies from 8-15 mg/lit

Human Sources (causes)

Sewage, animal feedlots, paper mills and food processing facilities.

Effects

Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen- consuming aquatic life to die.

3.Inorganic Chemicals

Eg : Water soluble inorganic chemicals.

(i) acids

(ii) compounds of toxic metals such as lead (pb), arsenic (As) and selenium (Se)

(iii) salts such as NaCl in ocean water and fluorides (F-) found in some soils.

Human Sources (causes)

Surface runoff, industrial effluent and household cleansers.

Effects

- (i) Can make fresh water unusable for drinking or irrigation.
- (ii) Causes skin cancers and neck damage.
- (iii) Damage the nervous system, liver and kidneys.
- (iv) Harm fish and other aquatic life.
- (v) Lower crop yields.
- (vi) Accelerates corrosion of metals exposed to such water.

4.Organic Chemicals

Eg : Oil, Gasoline, plastics, pesticides, cleaning solvents, detergents.

Human Sources (causes)

Industrial effluents, household cleansers, surface runoff from farms.

Effects

(i) Can threaten human health by causing nervous system damage and some cancers.

(ii) Harm fish and wildlife.

5.Plant Nutrients

Eg : Water-soluble compounds containing nitrate (NO_3^-), phosphate (PO_4^{3-}) and ammonium (NH_4^+) ions

Human Sources (causes)

Sewage, manure and runoff of agricultural and urban fertilizers.

Effects

- (i) Can cause excessive growth of algae and other aquatic plants, which die, deplete dissolved oxygen in water and kill the fish.
- (ii) Drinking water with excessive levels of nitrates lower the oxygen carrying capacity of the blood and can kill urban children and infants.

6.Sediments

Eg : Soil,silt,etc.,

Human Sources (causes)

Land erosion

Effects

- (i) Can reduce photosynthesis and cloud water.
- (ii) Disrupt aquatic food webs.
- (iii) Carry pesticides, bacteria and other harmful substances.
- (iv) Settle out and destroy feeding and spawning grounds of fish.
- (v) Clog and fill lakes, artificial reservoirs, stream channels and harbours.

7. Radioactive Materials

Eg : Radioactive isotopes of iodine, radon, uranium, cesium, and thorium.

Human Sources (causes)

Nuclear power plants, mining and processing of uranium and other ores, nuclear weapons production and natural sources.

Effects

Genetic mutations, birth defects and certain cancers.

8.Heat (Thermal Pollution)

Eg : Excessive heat

Human Sources (causes)

Water cooling of electric power plants and some types of industrial plants. Almost half of all water withdrawn in the United States each year is for cooling electric power plants.

Effects

(i) Lowers dissolved oxygen levels and makes aquatic organisms more vulnerable to disease , parasites and toxic chemicals.

(ii) When a powerplant first opens or shuts down for repair, fish and other organisms adapted to a particular temperature range can be killed by the abrupt change in water temperature known as thermal shock.

9. Point and Nonpoint Sources of Water Pollution

(i) Point Sources

Point sources discharge pollutants at specific locations through pipes, ditches or sewers into bodies of surface water.

Eg : Includes factories, sewage treatment plants, abandoned underground mines and oil tankers.

(ii) Non-point sources

They are usually large land areas or air sheds that pollute water by runoff, subsurface flow

or deposition from the atmosphere. Location of which cannot be easily identified.

Eg : Include acid deposition and runoff of chemicals into surface water from croplands,

livestock feedlots, logged forest, etc.,

Control measures (methods) of water pollution

1. The administration of water pollution control should be in the hands of the state or central government.

2. Scientific techniques are necessary to be adopted for the environmental control of catchment areas of rivers, ponds or streams.
3. The industrial plants should be based on recycling operations, because it will not only stop the discharge of industrial wastes into natural water sources but by products that can be extracted from the washes.
4. Plants, trees and forests control pollution and they act as natural air conditioners
5. Forest in and around big cities and industrial establishments are capable of reducing the sulphur dioxide and nitric oxide pollutants to a greater extent from the atmosphere. Hence the national goal should be “Conservation of Forests” and campaign should be “Planted more trees” . The global destruction of forests should be discouraged or at least minimized and afforestation should be encouraged because no one on this earth will escape from the adverse effects of a balding earth..

6. It is not available to discharge any type of waste, either treated, partially treated or untreated, into streams, rivers, lakes, ponds and reservoirs. The industries are expected to develop close-loop water supply schemes and domestic sewage may be used for irrigation.

7. Highly qualified and experienced persons should be consulted from time to time for effective control of water pollution.

8. Public awareness regarding adverse effects of water pollution is a must. So there should be propaganda for water pollution control on radios, TVs etc.,

9. Suitable laws, standards and practices should be framed to regulate the discharge of undesirable flow of water in water bodies and such regulations should be modified from time to time in order to accommodate the changing requirements and technological advancements.

10. Basic and applied research in public health engineering should be encouraged.

11. The possible reuse or recycle of treated sewage effluents and industrial wastes should be emphasized and encouraged.

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