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Pollution Control and Abatement Technology

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Abstract- **Man and Environment:**

Generally, people are indifferent to their environment. Newton's third law states: 'Every action has an equal and opposite reaction'. This will equally apply to man's relationship with nature as it relates to application of force on inanimate objects. While man sought domination over nature in 5,000 years of recorded history, he has, in the last 50 years, begun to realise that his welfare and his very existence are deeply intertwined with the natural cycles and systems.

Man is unique in many ways and one of these is his ability to subordinate nature and natural resources. So long as the requirements of his economic activities were small in relation to global stocks of critical natural resources, he could count on improving his welfare. However, his economic activities have increased at an exponential rate during the past several decades with the result that the earth's resource base and life support systems have become vastly depleted. The principal manifestations of these impacts are on the global climate, the intricate web of forests, ecology and diversity of living beings and increased transparency of the earth's atmospheric protective shield to harmful ultra-violet radiation. All these are related directly and indirectly with man's economic activities and with each other. They all have serious implications for his future well-being.

Pollution is the deliberate or accidental contamination of the environment with man's waste. Generally "Anything that is released into the environment can be termed pollution".

Keywords: -- Types of pollution, Causes, Effects, Control and Abatement.

INTRODUCTION:

Environment is defined in the Chamber's Dictionary as a surrounding or conditions influencing development or growth. It can be defined as a system which includes all living things, viz., air, water, soil, vegetation, flora and fauna. Man is a slave to environment. The child may have all kinds of capacities but they cannot be developed fully without a proper environment. Environment starts influencing the child from the stage of embryo. This influence has been called 'Social Heredity' by Western scholars.

Our late Prime Minister, Indira Gandhi, who was known as a champion of environmental conservation, stated at the United Nations Conference of Human Environment held in Stockholm in June 1972, 'one cannot be truly human and civilised unless one looks upon not only all fellowmen but all creations with the eyes of a friend'.1

MEANING OF ENVIRONMENT:

The child when he comes to this world finds himself surrounded by innumerable objects and circumstances which influence him. All these except the child form the environment.

P. Gisbert says, 'Environment is anything immediately surrounding an object and exerting a direct influence on it'.
T.D. Elliot defines environment 'as the field of effective stimulation and interaction for any unit of living matter'.
E.J. Ross says 'environment is an external force which influences us'.2

ENVIRONMENTAL POLLUTION:

Pollution is the deliberate or accidental contamination of the environment with man's waste. The word pollution is derived from the Latin word Pollutionem which means to defile or make dirty.3

DEFINITION:

Many authors have defined pollution differently .R.W. Edwards (1972) defined it as "The release of substances or energy into the environment by man in quantities that damage either his health or resources".

According to E.P.Odum "Pollution is an undesirable change in the physical, chemical or biological characteristics of our air and water that affect human life or desirable species or that may waste or deteriorate our raw material resources".

Generally "Anything that is released into the environment can be termed pollution".4

Pollutants are residues of the things we make use and throw away or leave in the environment. Such pollutants are broadly classified into two major categories. They are the bio-degradable and non-degradable.

The waste food or plant products (Organic in origin) which are thrown away as domestic sewage etc., can be reacted by micro-organisms and those decaying /decayed material can be recycled to produce energy (bio gas) or may form manure. Such pollutants are called Bio-degradable pollutants.

At the same time metallic wastes like aluminium cans, polythene bags, chemicals like pesticides and insecticides left in the environment may find its way into the animal as well as human life through different food chains. Pollutants like radionucleids or nuclear wastes and DDT are accumulated in the food organisms and ultimately reach the human beings. This is described as the biological magnification. These pollutants cannot be easily degraded or decayed. These pollutants are called as non-degradable pollutants.

TYPES OF POLLUTION:

The destruction caused in the habitats of living organisms and to the human life, may be classified as follows:

I. Air pollution
II. Aquatic pollution or Water pollution
III. Land pollution or Soil pollution
IV. Marine pollution or Sea pollution
V. Noise pollution
VI. Thermal pollution

The above kind of classification is mainly based on the pollutants occurring in the habitats of living organisms including man.5

I. AIR POLLUTION

Air is the medium that immediately surrounds the animals. The air in the atmosphere is inevitable for the living organisms. It is the air that contains gases like nitrogen (78.08%), oxygen (20.99%) and carbondioxide (0.03%). Besides, the gases like hydrogen, argon, neon, helium, methane, krypton, ozone, xenon etc., are also found. Water vapour is also an important component of the normal atmosphere.

An average man breathes about 2000 times a day inhaling about 16 kg of oxygen. It is therefore very essential, the air in the atmosphere to be clean. However, the air in the atmosphere is being polluted every day. Hence, air pollution is a serious environmental hazard to the living organisms including man.6

Definition of air pollution:

i) According to American medical association "air pollution is the excessive concentration of foreign matter in the air which adversely affects the well-being of individuals or causes damage to property".

ii) Air pollution may be defined as "any atmospheric condition in which certain substances are present in some concentrations that they can produce undesirable effect on man and his environment".7

Causes of air pollution:

Industrialization, modernization, urbanization, overuse of pesticides and agrochemicals, combustion of fossil fuels and burning of fuel wood are the major sources of air pollution.

1. Agriculture: Hydrocarbons released by plants, pollen grains, insecticides, weedicides, fungicides etc., cause air pollution.

2. Dust: Dust in the atmospheric air is increased by dust storm, wind, volcanoes, automobiles etc.

3. Industries: Combustion of fossil fuels like coal petroleum etc., cement dusts, poisonous gases etc., cause air pollution.

4. Automobiles: The combustion of petrol and diesel in automobiles produce carbon monoxide, carbon dioxide and oxides of nitrogen, oxides of sulphur that are major air pollutants.8

EFFECTS OF AIR POLLUTION:

1. When air is polluted with poisonous gases, death occurs quickly. Eg., Bhopal episode. At Bhopal about 3000 people and thousands of cattle were killed by methyl isocyanate leakage from an insecticide plant on December 2, 1984.

2. Continuous addition of carbon dioxide in the air by means of combustion of fuels and deforestation has resulted in the increase in the earth's temperature. This warming up of the earth is termed greenhouse effect or global warming. This will lead to the melting of polar ice caps and increase in the sea level. So the low-lying areas will go under the sea.

3. Photochemical smog contains ozone and PAN. It damages leafy vegetables, cereals, textile crops, ornamental crops, forest trees etc.
4. Sulphur dioxide and fluorides cause chlorosis in plants.
Cadmium increases blood pressure and also causes heart diseases.
5. Sulphur dioxide causes nausea and headache.
6. Cancer is induced by ash, soot, smoke, chromium, nickel and radioactive elements.
7. Arsines bring about RBC break down and jaundice.
8. Carbonyl chlorine causes coughing.
9. Carbon monoxide reduces oxygen carrying capacity of blood.
10. Nitrous oxide and sulphur dioxide mixes with rain to form acid rain which destroys vegetation and aquatic animals in lakes, ponds etc.9

CONTROL OF AIR POLLUTION:

Various preventive measures are adopted to control air pollution. They are as follows.

i) Bag filters (Fabric filters):
In the bag filter system, the polluted gas from industrial process is made to pass through the fabric that filters out the particulate pollutant and allows the clear gas to pass through. A typical filter is a tubular bag made of woven fabric.

It is closed at the upper end and hopper attached at the lower end. The diameter of the bag is 1 meter and height is 7 meter to 10 meter. The bag is connected to a dust hopper fitted with a dust discharge device. This device is used to control the emission of toxic gases from the industries.

ii) Substitution of raw materials:
If the use of particular raw material results in air pollution, then it should be substituted by another purer grade raw material which reduces the pollution. Hence, more refined liquid petroleum gas or liquefied natural gas can be used instead of high contaminant fuels such as coal and wood.

iii) Process modification:
The existing process may be changed by using modified techniques to control emission at source. For example if coal is washed before pulverisation, then fly ash emissions are considerably reduced.

iv) Maintenance of equipment:
Air pollution is caused due to poor maintenance of the equipment. It includes the leakage around pipes, valves and pumps etc. Routine check-up of the seals and gaskets of the equipment minimise the emission of pollutants.

v) Emission from automobiles:
The emission from the automobiles can be controlled by fitting catalytic converter or positive crankcase ventilation valve devices in the vehicles.

vi) Height of the chimney stack:
The height of chimney stack in the factories should be raised to 50 to 60 meters from the earth surface. Thus, the residual particulates emitted from the factories are dispersed and spread evenly over a wide area.

vii) Planting of trees:
Plants control air pollution by utilizing carbon dioxide and releasing oxygen in the process of photosynthesis. This purifies the air for the respiration of living things. Hence, plenty of trees should be planted especially around industrial areas to prevent air pollution.

viii) Zoning:
It means setting of separate areas for industries far away from the residential areas. This method of controlling air pollution can be adopted at the planning stage of the city.

xi) Air pollution laws:
Pollution laws are enacted and detailed regulations are laid down for controlling air pollution. The central air act, 1981 enacted by the government for prevention and control of air pollution.10

II. WATER POLLUTION

Water is essential for the survival of any form of life. On an average, a human being consumes about 2 litres of water everyday. Water accounts for about 70% of the weight of human body. About three fourth of the earth surface is covered by water. But, less than 1 percent is available for human consumption and the remaining 97 percent is found in ocean as salt water and 2 percent is locked up in ice caps and glaciers.

Definition of water pollution:
"Water pollution can be defined as the presence in water some foreign substances or impurities (organic, inorganic and biological substances) in such quantity so as to constitute a health hazard by lowering the water quality and making it unfit for use".

Causes of water pollution:

1. Domestic wastes: Domestic wastes consists of soaps, detergents, urine and faecal matters of animals and the water used for cleaning utensils in houses. It contains pathogenic bacteria and other micro organism. These domestic wastes discharged into the rivers causes water pollution.

2. Industrial wastes: The industries releases wastes such as acid, alkalies, oils and greases, cynaides, sulphates, heavy metals like mercury, lead, cadmium etc., into the rivers which causes severe water pollution.

3. Oil pollution: Oil causes pollution in sea water. Oil pollution occurs due to loading and unloading of oil in the ship at the harbour, off shore oil production, ship accidents and leakage from oil pipelines crossing water habitat such as rivers, reservoirs and seas.

4. Temperature: The thermal and nuclear power stations use water for cooling their machineries. Hence, the water is considerably warm. If such warm water is discharged into the water bodies, it causes water pollution.

5. Radioactive wastes: The discharge of radioactive substances into the water from the nuclear power stations may seriously pollute the water.

6. Agricultural wastes: Fertilizers, pesticides, insecticides, herbicides etc., used in the fields are washed into the rivers or ponds and pollute the water.11

Effects of water pollution:

1. Sewage pollution depletes the oxygen content of water. The depletion of oxygen is dangerous to aquatic plants and animals.
2. In Japan Minamata disease appeared in 1905 due to mercury poisoning. About 17 persons died and 23 became permanently disabled due to discharge of mercury into the sea.
3. Mercury, cadmium and cobalt cause diarrhoea.
4. Excess amounts of chlorides cause the death of planktons and fishes.
5. More amounts of silt results in the entry of silt into the fish gills and causes death.
6. Oil pollution reduces oxygenation. The respiration and metabolism of aquatic organisms will become difficult.
7. Excess sewage discharge increase the algal blooms and dinoflagellates. These blooms release a toxin that can kill fishes which is called red tide.
8. Diseases like jaundice, cholera, typhoid, dysentery, diarrhoea etc., are transmitted through contaminated water.
9. Nitrogen in water causes methaemoglobinema. It is characterized by suffocation and respiratory disorders due to failure of haemoglobin to carry oxygen.12

Control of water pollution:

The following measures can be taken to control water pollution.

i) Purification of waste water (sewage and industrial waste water): The major process involved in the purification of waste water are sedimentation, dilution and storage.

a) Sedimentation: Large or small size organic solid particles are present in the industrial or domestic water. The waste water is collected and allowed to stand in the sedimentation tank for few hours. Then, the suspended organic solid particles settle to the bottom of the tank. These suspended particles are removed from waste water by sedimentation process.

b) Dilution: It is considered as the most economical method of waste water treatment. In this method, large quantities of fresh water are added to dilute the waste water. This increases the dissolved oxygen contents in the waste water.

c) Storage: The diluted waste water is stored in the storage pond. It is used for irrigation and fish culture.

ii) Recycling and reuse: Water pollution can be controlled by reusing the industrial and domestic wastes after proper treatment. Domestic sewage can be used for irrigation and fish culture after treatment in stabilization and oxidation ponds. The industrial by products can be extracted from the waste water by filtration or selective absorption method and reused. Treated waste water can be reused for industrial water supply, irrigation and cooling process in thermal plants.

iii) Discharge into water sources: It is advisable not to discharge industrial waste or domestic waste into the fresh water habitats like rivers, ponds and lakes.

iv) Thermal pollution: For minimising thermal pollution, hot water should be cooled before release from factories.

v) Judicious use: Pesticides and fertilizers should be used in very little quantity to avoid chemical pollution of water.

vi) Legislation: For effective control of water pollution, legal provisions regarding water pollution should be enforced by the government machinery comprising of highly qualified and experienced personnel.13

III. SOIL POLLUTION

Garbage and solid wastes are unavoidable in any society. In big towns and cities a person is responsible for producing the waste materials at the rate of 4 kg per day in the form of paper, plastics, garbage, rubber, glass, ceramic and so on. Garbage contains pathogenic organisms and toxic substances. Pesticides and herbicides reach the soil through the rainwater. As a result, the natural ecosystem is very much affected.14

Causes of soil pollution:

Soil pollution is caused from the following resources.

1. Soil pollution by industrial wastes: Industrial wastes discharged from pulp and paper mills, chemical industries, oil refineries, sugar factories, textile, steel, fertilizers, pesticide industries etc., disposed into the soil causes soil pollution.

2. Urban wastes: The urban wastes contain substances like garbage, plastics, glasses, metallic cans, fibres, paper, fuel residues, leaves etc., contribute to soil pollution.

3. Radioactive substances: These are formed from explosions of nuclear devices and radioactive waste produced by nuclear testing laboratories and industries which penetrate the soil and accumulate there creating soil pollution.

4. Agricultural wastes: The excessive application of chemical fertilizers (nitrogen, phosphorous and potassium) and pesticides (DDT, BHC, aldrin, endrin, endosulphan, malathion, parathion etc.) into the soil causes soil pollution.

5. Metallic wastes: Trace metals such as arsenic, lead, cadmium, selenium etc., added into the soil by the synthetic chemical and fertilizer industries causes soil pollution.

6. Soluble salts: Industries discharge their particulate pollutants in the form of calcium sulphate, calcium carbonate and bicarbonates as soluble salts. These are deposited in the soil and pollute the soil.15

Effects of soil pollution:

1. Chemical insecticides induce gene mutation in human beings when they reach man through food chain.
2. DDT causes cancer.
3. Pesticides cause birth defects in man and animals.
4. DDT reduces calcium metabolism in birds and animals.
5. Ionizing radiation cause cancer and malformations in man and animals.
6. Acid rain reduces pH of soil and destroys crops and forests.
7. Pathogens from garbage cause several diseases.
8. Heavy metals reduce crop yields.

Control of soil pollution:

i) Minimum use of pesticides
ii) Atomic power plants should be properly insulated.
iii) Radioactive wastes should be buried safely in the ground.
iv) Solid wastes can be composted to man use.
v) Urbanization should be minimized.
vi) Non degradable substances should be safely disposed.

IV. MARINE POLLUTION

Sea is the largest ecosystem of our planet. According to the International hydrographic organization there are about 50 seas. These seas are not exposed to the worse type of environmental dangers.16

Marine pollution is defined as the discharge of waste substances into the sea resulting in vigorous harm to living resources, hazards to human health, hindrance to fishery and impairment of quality of sea water. Marine pollution is resulted in changes of physical, chemical and biological conditions of the sea water. This water is also unfit for human consumption and industrial purposes because of high salt content.

Causes and effects of marine pollution:

1. Nuclear wastes: The most dangerous marine pollution is occurred due to dumping of nuclear wastes into the ocean by some nuclear power plants. These radioactive wastes caused harmful effects to almost all living organisms of ocean.17

2. Pesticides: Pesticides are another source of sea water pollution. It is estimated that 25 percent of the pesticides will finally reach the ocean through the rivers. The pesticides such as DDT, BHC, aldnin, endrin etc., are more toxic and dangerous to marine living organisms.

3. Toxic metals: The industrial effluents discharges into the ocean increases heavy metal concentration in certain areas of the world. Heavy metals such as mercury, lead and nickel, cadmium are fatal to sea life. Minamata disease in Japan was caused by factory discharging mercury into the sea. The mercury poison is passed to men and animals by consuming the marine fishes. Mercury poisoning in human leads to sensory loss in limbs, impaired vision, hearing loss, numbness, convulsions and death.

4. Population explosion: According to a report by department of ocean development, there are 40 heavily polluted areas along the Indian coast. Most of the metropolitan port cities and thickly populated coastal town facing severe marine pollution problems. Untreated domestic sewages discharged into the sea increases the growth of microscopic plant life and phytoplankton.

5. Hot water: The nuclear power plants use huge quantity of fresh water for cooling the machineries. After cooling, the warm water is discharged into the sea. It causes the depletion of dissolved oxygen content in sea water and affects the marine life.

6. Oil pollution in sea: Major causes of oil pollution is sea water are due to cargo tanker washing at sea, loading and unloading of oils in ships at harbours, maritime accidents due to collision, fire, explosion etc., and oil wastes from refineries discharged into the sea. The wreckages of oil tankers in the open sea form a major cause of marine oil pollution in marine environment. High tides washing oils into the shores and damaging recreational facilities on beaches.

Control of marine pollution:

i) Control of oil pollution: Several methods have been used to control the oil floating on the sea. These methods are as follows.

a) Skimming the oil off the surface with a suction device.
b) The floating oil can be absorbed by suitable absorbing material like polyurethane foam.
c) Oil can be sunk to the bottom of the sea by spreading a powder of high density over the oil patch.
d) Photolysis and physico-chemical changes in oil leads to formation of tar balls which would sink in sea water decreasing its toxicity.
e) Burning the oil on the open seas help to evaporate volatile substance more quickly from the oil slick.

ii) Role of micro-organisms: Recently oil eating bacteria are being increasingly used to control oil pollution problems in sea water. Certain bacteria like "Pseudomonas" can consume esteric compounds and hydrocarbons from the oil. Thus, the oil eating bacteria reduces oil pollution much faster in sea water.

iii) Legal control: According to the maritime zone Act. 1976, the government has provided sufficient power to control marine pollution.18

IV. NOISE POLLUTION

Noise is a physical form of pollution. Its effects are more directly on the receiver (man). Noise pollution is caused by industrialised urban life, loud speakers installed at places of worship, marriage, birthday parties etc., and vehicles.19 One decibel is equal to the faintest sound that can be heard by human ears. Some people feel discomfort with the sound of 85 dB. Pain is usually felt at 145 dB. Noise is considered to be a physical pollutant.20

Definition of noise pollution:
"Any unwanted electromagnetic signal that produces effect and which interferes with human communication, comfort and health".

According to Odum "Noise pollution is the unwanted sound dumped into the environment without regard to the adverse effect it may have" displeasing

Causes of noise pollution:
Major causes of noise pollution are
1. Industries: Progress in technology has resulted in noise pollution. Textile mills, printing presses, engineering establishments and metal works etc.,contribute heavy noise pollution.
2. Vehicles: The main menace of noise comes from vehicles. It mainly includes road traffic noise, rail traffic noise and aircraft noise.

3. Neighbourhood noise: This type of noise comes from residential areas. Common noise producers are TV, VCR, VCD, radio, transistors, telephones, grinders, mixers, loud speakers, washing machines, electric motors, air conditioners, coolers etc.,

Effects of noise pollution:
Noise is generally harmful and a serious health hazard. It has far reaching consequences and has many physical, physiological as well as psychological effects on human beings.

1. Physical effects: The physical manifestation of noise pollution is the effect on hearing ability. Repeated exposure to noise may result in temporary or permanent impairment of hearing. Human ears have sensory cells and delicate tympanic membrane or ear drum. They can also be permanently damaged by repeated sounds of high intensity, sudden loud noise and explosion. The buildings also undergo physical damage by cracks, broken windows, doors and glasses etc., by sudden and explosive sounds.

2. Physiological effects: The physiological effects of noise pollution are several as given below.
a) Increase in the rate of heart beat.
b) Narrowing of arteries.
c) Fluctuations in arterial blood pressure by increasing the level of cholesterol in the blood.
d) Pain in heart and decrease in heart output.
e) Headache by dilating blood vessels of the brain.
f) Brain also affected by loud and sudden noise produced by air crafts. It is also affects the pregnant woman and foetus.

3. Psychological effect: The psychological effects of noise pollution are mentioned below
a) Depression and fatigue which considerably reduces the efficiency of a person.
b) Insomnia as a result of disturbed sleep.
c) Straining of senses and annoyance as a result of persistent noise from motorcycles, industries, telephone rings etc.
d) Emotional disturbance.

Control of noise pollution:
It is evident that noise pollution provide nuisance to human and health hazards. Noise pollution can be effectively controlled by taking following measures.
i) Control at receivers end: People working in noisy installations must be provided ear protection aids like ear plugs, ear-muffs, noise helmets, headphones etc., to protect them from the adverse effect of noise pollution.

ii) Suppression of noise at source: The following measures are taken to reduce the noise at source. These are as follows.
a) Designing, fabricating and using quieter machines to replace the noisy ones.
b)The gap found in between doors and windows should be packed with sound absorbing materials.
c) Proper lubrication and better maintenance of machines.
d) Installing high noise producing machine in sound proof chambers.
e) Using silencers to control noise from automobiles exhausts.

iii) Zoning of noise polluted areas: Noise Producing industries, bus terminals, railway stations, aerodromes etc., should be established away from the residential areas. Increased distance between source and receiver may minimise the noise pollution. Silence zones should be maintained near residential areas, educational institutions and hospitals.

iv) Planting of trees: Planting green trees along roads, hospitals, educational institution etc., to reduce the noise pollution.

v) Legislative measures: Strict legislative measures need to be enforced to control noise pollution. Some of these measures are given below.
a)Banning the installation of loud speakers, horn and amplifiers along the road sides, near the educational institutions and hospitals.
b)Banning air horns in automobiles.
c)The district administration should enforce the noise pollution act to curb the menace of noise pollution and the offenders should be prosecuted.21

IV. THERMAL POLLUTION

The transfer of heated effluents from the industries to the water bodies (sea or river or pond) in different quantities and concentrations that would be detrimental to the environment is known as the thermal pollution. Various industrial plants like thermal, atomic, nuclear, oil field generators etc., utilize water for cooling purposes.

Definition of thermal pollution:

According to Dr. R. Patrick "thermal pollution reduces the number of aquatic species and destroys the balance of life in streams as is evidenced by the biological indices of community diversity".

Owen defined thermal pollution as "the warming up of an aquatic ecosystem to the point where desirable organisms are adversely affected".

Causes of thermal pollution:

1. Nuclear power plants: Nuclear power plants including nuclear experiments and explosions discharge huge quantities of hot water into nearby water bodies. Emission from nuclear reactors and processing installations are also responsible for increasing the temperature of water bodies. Heated effluents from power plants are discharged at 10°C higher than the intake waters and severely affect the aquatic flora and fauna.22

2.Coal fired power plants: They constitute the major cause of thermal pollution. Their condenser coils are cooled with water from nearby lake or river and discharge the hot water back to the same lake or river. This increases the temperature of water to about 15°C. The heated effluents decrease the dissolved oxygen content of water. It results in killings of fish and other marine organisms.

3. Industrial effluents: Industries like textile, paper, sugar and fertilizer using turbo generators. It requires huge amount of cooling water for heat removal. Normally the discharged water from these industries will have a higher temperature ranging from 6°C to 9°C than the intake water.

Effects of thermal pollution:

1. Reduction in dissolved oxygen: The dissolved oxygen content decreases with increase in temperature of water. Dissolved oxygen content is 14.6 ppm in water at a temperature 32°F 6.6 ppm at 64°F. Thus the fishes could not tolerate the high water temperature and they would die from oxygen depletion.

2. Increase in toxicity: The rising temperature increases the toxicity of the poison present in water. A 10°C rise in temperature doubles the toxic effect of potassium cyanide and an 80°C rise in temperature triples the toxic effect of poison causing total mortality of fishes.

3. Change in water properties: A rise in temperature changes the physical and chemical properties of water. The increasing vapour pressure decreases the viscosity of water. The decrease in density, viscosity and solubility of gases increases the settling speed of suspended particles. It seriously affects the food supplies of aquatic organisms.

4. Interference with reproduction: The activities such as nest building, spawning, hatching, migration and reproduction etc., in fishes depend on optimum temperature. For example, the maximum temperature at which lake trout will spawn successfully is 8.9°C. The Atlantic salmon eggs hatch in 114 days in winter (2°C) and in 90 days at 7°C. The warm water not only disturbs spawning but also destroys the laid eggs.

5. Change in metabolic rate: In fishes, the rate of metabolism increases with rise in temperatures. Hence the respiratory rate, oxygen demand, food intake and swimming speed in fishes increase. The rate of oxygen consumption in brown trout rises steadily till lethal temperature of 28°C. Salmon

fishes swims twice as fast in water at 15°C than at 0°C. But above 15°C its speed declines.

6. Increased vulnerability to disease: Activities of several pathogenic micro-organisms are accelerated by highertemperature. Several pathogens become more virulent and the fish less resistant. Hence the pathogens vigorously attack aquatic animals. The bacteria chondroccus is responsible for the massive death of blue black salmon. Hot water also causes bacterial disease in salmon fish.

7. Changes in algal population: Excess nutrients from the wash-out waters from farmlands are combined with thermal pollution. This causes excessive algal growth and other undesirable changes. High water temperatures promote blue-green algal population which disrupt aquatic food chain.23

Control of thermal pollution:

Control of thermal pollution is extremely important because in future its dangerous effects on aquatic ecosystem may be worse. To reduce the magnitude of the thermal pollution, the outlet heated water can be made to give up some amount of heat to the environment and then may be discharged into the water bodies. The following methods can be used to control the high temperature caused by thermal pollution.

a) Cooling towers: The water used for cooling purposes is again return to the water bodies (river or lake) after passing through the condenser. This is termed as cooling process. Cooling towers transfer some amount of the heat from cooling water to the surrounding atmosphere by the process of evaporation. In a cooling tower, the flow of air is affected by the natural or mechanical means. Cooling tower is generally used to eliminate heat from the cooling water to control the problems of the thermal pollution.

b) Cooling ponds: It is the simplest method of cooling thermal discharges. Heated water from the industries is passed into the cooling ponds or reservoirs. In the surface water, the atmospheric air mixes with the heated water and maximizes dissipation of heat to the environment. Heat loss also occurs by mixing up of heated water over the cold water in the cooling ponds.

c) Artificial lakes: Artificial lakes are manmade bodies of water in which the heated water can be discharged into the lake at one end and the water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.24

Abatement of Environmental Pollution:

The department is implementing a number of welfare and development programmes for the two disadvantaged sections of an population via., women and children. Environmental dimension include

a) Environmental awareness

b) Use of environmental resources materials in organizing pre-school activities

c) Planting trees by children

d) Audio visual presentation for use of environment resources

e) Cleanliness and sanitation personal and at school premises

f) Role of community in creating a healthy environment for children 25

Prevention of Pollution:

The solution to pollution is dilution. Several methods are used to control pollution.

1. In some commercial swimming pools, ozone is injected into contaminated water. Ozone oxidizes microorganisms and pollutants and the water is purified.

2. Factories must be established far away from the residence.

3. Machineries in factory must have pollution control equipment.

4. The National Environmental Engineering Research Institute (NEERI) at Nagpur has recommended the sewage treatment ponds such as stabilization pond or oxidation pond to treat the sewage.

5. Citizens must obey the legislations to control pollution.

6. People must be educated on the ill-effects of polluting their own natural resources.

7. Government should encourage research for developing new techniques for pollution control.

8. To reduce polluted water artificial-rearing of fishes is needed.

9. Thenitrogenous wastes are thrown far away from human settlements.

10. The use of biocides must be reduced because they give side effects.

11. Loud speakers should be set at low sound to reduce sound pollution.

12. Silence zone is necessary to reduce noise.

13. Industrialists must take necessary steps to control pollution.

14. Trees absorb noise and thus reduce noise pollution. So thick vegetation must be grown around industries, cities and on the sides of roads.

15. The Central and State Governments have established Pollution Control Boards for regulatory enactments on environment and Pollution Control Boards for regulatory enactments on environment and Pollution Control. They have powers to-

a) Inspect the effluents emission from industries.

b) Order the industries to install air pollution and effluent treatment units.

c) Prohibit highly polluting industries.

In Tamilnadu, pollution control activities are regulated by Tamilnadu Pollution Control Board which was formed in 1982.26

CONCLUSION:

The youth and school children can take up an active role in pollution abatement. Their village can be taken as model. They can identify the ways in which all the domestic sewage can be collected in a particular area and further they can be used for irrigation or for fish culture.

The youth can also see that the water quality of the particular area is good. For this they can collect water samples from the pond, wells and streams in their locality and get them analysed to know their pollution status. Pollution control boards have well equipped laboratories and they can aid in analysing the water samples.

The youth can also educate the people who are not aware of the environmental problems in their village and see that their village is clean and tidy without any accumulation of garbage which would have way for the growth of mosquitoes and other diseases causing organisms.27

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