

Water Pollution

The state of deviation from the pure condition of water due to mixing of foreign substances whereby its normal functions and properties are affected is known as water pollution. Polluted water is harmful for animals and plants as well as unfit for domestic, industrial and agricultural uses.

The domestic wastes from rural and urban areas, sewage and garbage from industries, hotels, chemicals and sludge of hospitals, industries and factories are the major factors for the water pollution. Polluted water has any one or more of the following signs

- i). It has bad taste to drink.
- ii). It has offensive odour.
- iii). It has unpleasant color
- iv). There is unchecked growth of weeds.
- v). It may have oil or grease floating on the surface.

Sources of water pollution

The main sources that are responsible for water pollution are

1. Sewage and domestic wastes: It includes excreta of animals and human, dead and decay parts of animals and plants, sewage, sludge, soap, detergents, untreated municipal sewages etc. Most of parts of wastes come from cooking room. These all pollutants mix directly or indirectly to the source of water.
2. Industrial effluents: It contains toxic materials, chemicals and hazardous compounds like aldehyde, ketones, phenols, cyanides, oils grease, dyes, acid, alkalies corrosive metals like Pb, Hg, Sb, etc from industries, hospitals, auto-work shop, laboratories etc.
3. Agricultural discharges: The residues of chemical fertilizers, pesticides, insecticide and herbicides retain on the soil surface and dissolve in water due to which uncontrolled growth of weed occurs and ponds, lakes etc are converted into grassy lands. Mixing of residue of pesticides, fertilizers, insecticides with drinkable water causes diseases like dysentery, cholera, typhoid etc.
4. Thermal pollutants: Coal-fired or nuclear fuel fired steam power plants are the sources of thermal pollutions in which only a fraction of the heat is converted in to useful works and the rest is wasted. The condenser of power plants are drained to water sources like river or lakes at high temperature which decreases the D.O. of water and adversely affect aquatic life.
5. Siltation: it is the process of mixing of soil and rock particles into water. It is serious problem for hilly region. It is mainly due to flooding and soil erosion.
6. Radioactive materials: Different human activities like mining and processing of ores to produce radioactive substances, uses of radioactive weapons, use of radioactive materials in power plants and uses of radioactive isotopes in medical, industries and research works are the main sources of radioactive materials.

Types of water pollutants

According to nature and compositions, water pollutants are of following types

1. Inorganic pollutants: It includes broad range of pollutants such as acids and bases like HNO_3 , HCl , NaOH , Ca(OH)_2 , NH_3 etc, soluble salts like carbonates, acetates, nitrates, sulphates, bicarbonate etc and inorganic pesticides.

2. Organic pollutants: it includes oxygen demanding wastes, plant nutrient, sewage, synthetic organic compounds and oils.
3. Sediments: they are the most extensive pollutants of surface water and are produced by soil erosion, agriculture and construction activity.
4. Radioactive materials: Different human activities like mining and processing of ores to produce radioactive substances, uses of radioactive weapons, use of radioactive materials in power plants and uses of radioactive isotopes in medical, industries and research works are the main sources of radioactive materials.

Effect of water pollution

Water is the most interrelated substance with living things and human. So its pollution can cause immense harm to public health. Some effects of water pollutions are immediate produced while other are only reflected after months or year later. Some effects of water pollutions are given here,

1. Spread of infectious diseases: Water is the carrier of pathogenic micro organism and can cause adverse effect to public health. The water borne diseases like typhoid, paratyphoid fever, dysentery, cholera, polio etc. different skin diseases, poor blood circulation etc are the main problem of polluted water.
2. Destroy of aquatic ecosystem: sewage and run off (fertilizers) from agricultural lands provides nutrients to the algae, weeds in the bottom of water sources and increase the over growth of the plants which cover the pond, lake and finally they turn in to grassy lands. Growth of plants in the water source causes the D.O.
3. Destroy of aquatic life: Residue of pesticide, herbicide, toxic, oils, acid and alkaline chemicals directly affect the aquatic life. It causes the decrease in D. O. Such pollutants retard the breeding rates and damage the plants and animals.
4. Damage of property of water: Pollutants destroy the natural properties of water. It causes acidity, turbidity, alkalinity and increase in temperature of water.
5. Contamination of marine food sources: Marine food stuff are contaminated by polluted water which is ultimately affect human health.

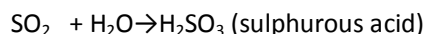
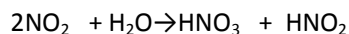
Control measures

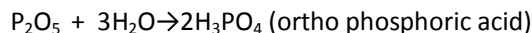
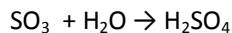
1. The wastes from industries, factories, pharmaceutical and hospitals must be managed properly.
2. Most of wastes must be preceded for recycling.
3. Sufficient and accessible dumping site must be managed in rural and urban areas.
4. Public awareness campaign should be launched by central as well as local authorities.
5. Sewage, industrial wastes should be preceded for aerobic and anaerobic treatment.

Acid rain

Especially in the industrial areas, countries are suffered by the harmful rain. The atmosphere is polluted by different oxides of non metals like CO, CO₂, NO, NO₂, N₂O₅, SO₂, SO₃, P₂O₅, As₂O₃ etc produced from industries, factories,. These non metallic oxides combine with water in atmosphere to form acids and fall in the form of droplets on earth surface which is called as acid rain.

Reactions of formation of acid rain from different non metallic oxides are





Effects of acid rain

Acid raining is becoming more tremendous problem and challenge for coming generation. Developed industrial countries are affected badly till now but other countries will be victimized by acid rain very soon. Natural scenery, natural beauties, fertile lands, forests, grassy lands and artificial creations are going to be destroyed day by day. Some of the adverse effects of it are,

1. It increases the acidity of soil which becomes unfit for crops production.
2. It destroys forests, grassy lands, fertile lands
3. It destroys Buildings, marbles and wooden materials, statues and sculptures, Historical places etc.
4. It causes stone leprosy.
5. It corrodes metallic materials, pipes.
6. Natural beauties like mountains, falls, rivers, coastal areas etc are destroyed.
7. It disturbs the terrestrial, arboreal as well as equatorial ecosystems.
8. It causes sterility in animals, pieces, birds and retards production vegetations.

Control measures

1. It can be controlled by applying alternative sources of energy instead of coal and gasoline.
2. It can be controlled by banning of use of high fuel consuming vehicles, motor, lorry, vans.
3. It can be controlled by removing old and low quality machine.
4. It can be minimized by planting green trees on the road way sides and near industrial areas.
5. It can be controlled by treating smoke of industries with suitable metals.
6. Word wide campaign of awareness must be run.

Alkalinity

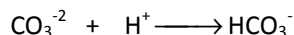
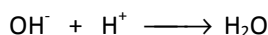
Alkalinity is the water quality parameter that determines the presence of dissolved hydroxide, carbonates and bicarbonates in the water. These may either be present alone or in the mixture form. Alkalinity also causes the hardness of water and increases turbidity of water. Such water can corrode water pipes, boiler and can damage lever, kidney etc.

Determination of alkalinity

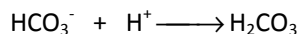
The extent of alkalinity present in the water is determined by volumetric titration of supplied water sample with standard acid using double indicator, first with phenolphthalein indicator and then second with methyl orange indicator.

In first titration, sample of water is taken in a conical flask and 2-3 drops of phenolphthalein is added as indicator. Then, it is titrated against standard acids solution taken in burette till pink color gets discharged. It is termed as

phenolphthalein end point and volume consumed in the burette is noted. At this stage, hydroxides are completely neutralized and carbonate changes into bicarbonates as,



In second titration, methyl orange indicator is added and titration is further continued till the color of the solution changes from yellow to pink color. It is termed as methyl orange end point and volume is noted from beginning. At this stage, bicarbonate is completely neutralized to carbonic acid as,



Let, x ml= volume of acid required up to phenolphthalein end point

Y ml= vol. of acid required from beginning to methyl orange end point.

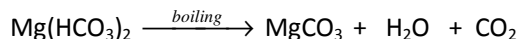
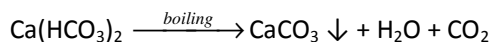
Conditions(vol. in ml)	CO_3^{2-}	HCO_3^-	OH^-
If $X=0$ ml	Nil	present	nil
If $y=x$ ml	Nil	nil	present
If $X=1/2y$	Present	nil	nil
If $X>1/2y$	Present	nil	Present
If $X<1/2y$	Present	present	nil

®Calculation from practical

Hardness of water

The water which gives low or no froth with soap and detergent is known as hard water. Hard water is due to the presence of bicarbonates, sulphates, chlorides, nitrates of calcium and magnesium. Hard water is of two types

1. Temporary hardness: Temporary hardness of water is due to presence of bicarbonate of calcium and magnesium in the water. It can be easily removed by simply boiling of water. Calcium bicarbonate and magnesium bicarbonates are converted into carbonate forms which settle down.



2. Permanent hardness: permanent hardness is due to presence of sulphate, chlorides, nitrates of calcium and magnesium. Such water can n't be removed by boiling and advanced methods are applied. First of all total hardness of water is determined by titrating with EDTA and then permanent hardness is determined by same method. Temporary hardness is determined by subtracting amount of permanent hardness from total hardness.

For total hardness: For determination of total hardness of water, a sample of 50 ml cold water is titrated with EDTA by using solo chrome black T prepared in the basic buffer solution till wine red color changes into clear blue color.

S.N	Vol. of water	Vol. of EDTA(Burette reading)			Concurrent reading
		Initial	Final	Different	
1	50 ml				
2	50 ml				

3	50 ml				
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Effect of hard water

1. Soap and detergents do not give froth properly.
2. It corrodes water pipe, metallic pots
3. It fades the color of clothes, mats etc.
4. It affects kidney, liver damage.

Determination of total hardness

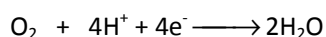
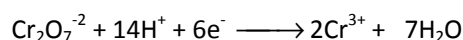
Both temporary and permanent hardness of water are determined by complexometric titration using EDTA (ethylene diamine tetra acetate) as a complexing agent in presence of solochrome black T indicator.

®Remaining from practical

Chemical Oxygen Demand (COD)

The chemical oxygen demand is defined as the amount of oxygen expressed in gram per liter consumed under specified conditions in the oxidation of organic and oxidisable inorganic materials. It is quick method in comparison to BOD for the determining the total organic and oxidisable inorganic pollution in a sample of water. Pollution like cellulose which are not measurable by BOD test since it can't be bio-degraded by the oxygen dissolved in water; are easily measured by COD test. In COD test, acidified $K_2Cr_2O_7$ is used instead of oxygen which is stronger oxidizing agent than oxygen.

The COD evaluation is carried out by adding a known excess of aq. $Cr_2O_7^{2-}$ to the water sample and then estimating the unconsumed $Cr_2O_7^{2-}$ by titrating it with Fe^{2+} solution [Mohr's Salt Solution, $FeSO_4(NH_3)_2SO_4 \cdot 6H_2O$]. When water sample is high polluted with organic wastes, the oxygen demand will exceed the maximum equilibrium solubility of O_2 in water and such a water sample may not have any dissolved oxygen. The basic reaction involved in the COD test is



From above reaction,

$$1 \text{ mol of } Cr_2O_7^{2-} \text{ consumed} = 6/4 = 1.5 \text{ moles of oxygen}$$

Calculation, Let amount of $Cr_2O_7^{2-}$ initially taken = x mol

And amount of $Cr_2O_7^{2-}$ left (unused) = y mol

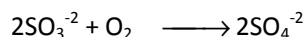
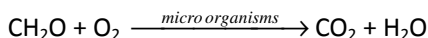
Then amount of $Cr_2O_7^{2-}$ consumed = (x-y) mol

$$(x-y) \text{ mol of } Cr_2O_7^{2-} \text{ consumed} = 1.5 \times (x-y) \text{ mol oxygen}$$

Dissolved Oxygen (DO)

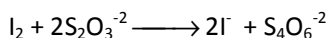
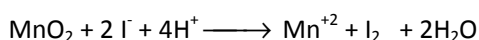
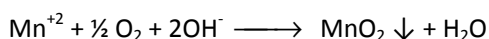
The amount of oxygen dissolved in sample of water as uncombined form is known as dissolved oxygen. The fresh water has 5 to 7 mg per liter of dissolved oxygen. This level of DO is essential for supporting aquatic lives including micro organisms. The aerobic decay of organic waste matters by micro organisms keeps the water in fresh and clean condition. If the DO decreases due to water pollution, then anaerobic decay may occur which forms bad odour and indicates the polluted water.

When the water is polluted with large amounts of organic matter, a lot of dissolved oxygen would be rapidly consumed in the biological degradation. The decrease in the DO affects the aquatic life and may completely damage the ecosystem of the water. DO is consumed by oxidation of organic substance in the presence of certain microorganisms or by reducing agent such as



Determination

Determination of DO plays a key role in the control of the water pollution. It can be determined by iodometric titration method. In this method, dissolved oxygen is allowed to react with I^- solution to form I_2 which is then titrated with standard $\text{Na}_2\text{S}_2\text{O}_3$ solution (hypo solution). It is carried by addition of Mn^{+2} salt in strongly alkaline medium. The basic reaction in the titration is,



From above, $2\text{mol of S}_2\text{O}_3^{-2} = 1\text{ mol I}_2 = \frac{1}{2}\text{ mol O}_2$

Air pollution

Air is polluted by addition of poisonous gases like CO, NO, NO_2 , SO_3 , SO_2 , O_3 , H_2S dust, smoke and unburnt hydrocarbons like CH_4 , C_2H_5 , CFC, etc. produced by either natural phenomena or human activities. These gases are continuously released to the atmosphere day by day. The air pollutants present in the atmosphere disturb the dynamic equilibrium in the atmosphere and thereby affect the earth inhabitants and their environment.

Sources of air pollution

There are several sources of air pollution which may be either natural process or manmade activities such as

1. Burning of coal, wood and Oils
2. Internal combustion of engines of car, buses, trucks, trains etc
3. Chemical industries: various poisonous gases like CO, NO, NO_2 , SO_3 , SO etc are released
4. Dust produced from heavy traffic and crowded population
5. Carbon monoxide by uncomplete combustion hydrocarbon, fuels etc.
6. volcanic Eruption, Wars, agricultural activities, scientific experiments, rocket launching etc

Effect of air pollution

1. Human being suffers from diseases like heart failure, lungs disease, and high blood pressure.
2. It increases tension makes fatigue and restless.
3. It may cause blindness, skin disease etc.
4. Man may become senseless,

Methods of control

The prevention of the production of air pollutants is the core of the control of air pollution. It can be control by the following methods

1. It can be minimize the production of by adding tetra ethylene lead in petrol.
2. It can be control by using alternative sources of energy instead of fossil fuels.
3. By planting green trees in rural as well urban areas.
4. It can be controlled by make awareness to air pollution
5. By banning the use of low quality gasoline
6. It can be controlled for long term by lunching international and national programs for protection of atmosphere.

Global warming and Climate Change

The over production of green house gases like CO₂, NO₂,CO,CFC water vapor, dust etc cover the earth atmosphere as a dense layer. The visible light and infra red rays pass this layer and heat the earth and its various objects. The hot earth and objects emit infra red rays which are absorbed by gaseous layer and causes the warming of earth atmosphere and its surface day by day and year by year continuously which is termed as global warming. The global warming is increasing mainly due to causes of human activities such as deforestation, industrialization, transportations, scientific search and wars etc. If people do not become alert to this, the temperature of the earth will increase too much which melt ice and causes glaciers floods, changes the biological activities and directly affect the living being in land and water.

The increase of temperature of earth and its atmosphere brings the change in water cycle, seasonal change and climate change which cause the complete alternation in biological activities of living being, breeding season, cropping pattern and harvesting periods. The change in climate brings the large scale decrease in crop production and badly affects the agriculture system. All the terrestrial animals, aquatic creatures and arboreal animals are equally affected by climate change and most of them may have short life period.

Effects of global warming:

- i) It increase the temperature of earth
- ii) It brings the change in climate
- iii) It melts the polar ice and brings glacier flood due to which level of ocean increases and low lying cities will sink in future
- iv) It decreases the breeding rate and fertility rate.
- v) It decreases the crop production due to change in climate
- vi) It invites various diseases due to growth of insects, mosquitoes etc.

Controls

It can be controlled by following methods

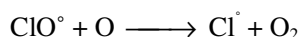
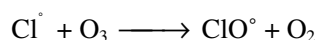
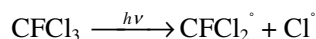
1. By afforestation of bare lands
2. By replacing use of gasoline with alternative sources of energy.
3. By banning of high fuel consuming engine.

Ozone layer depletion and CFC

Ozone layer serves as protective umbrella to save the living being on the earth from danger radiations like ultra violet rays, cosmic rays. Ozone layer is a natural gift for living creature offered by nature. But it is being

destroyed by the production of green house gases like CO₂, CO, NO, NO₂, SO₂, SO₃, CH₄, C₂H₆, CFC etc due to human activities such as industrialization, deforestation, combustion of coal, diesel, wood and scientific research. These gases diffuse from earth surface forming hazy layer to the stratosphere region where they react with ozone and makes hole in the ozone layer. The phenomenon formation of hole in the ozone layer by destroying it with green house gases like NO₂, SO₂, SO₃, CO₂, CO, NO, NO₂, CH₄, C₂H₆, CFC is known as ozone layer depletion.

In 1958, NASA scientists observed a hole in the ozone layer over Antarctica and it has been found that the ozone layer is depleting at an alarming rate. Although all green house gases are partially responsible for the depletion of ozone layer, but the main culprits are CFCs i.e. chlorofluorocarbon or Freon's which is extremely stable, non-corrosive and inert compounds. It is thought that one molecule of CFC has capability to destroy one lakh molecules of ozone (O₃). The probable mechanism of ozone layer depletion is;



The reaction goes on till the ability of destroying by ClO[•] ion is ceased.

Effect of Ozone layer depletion

The effects of ozone layer deflection are

1. UV rays directly reach to the earth and affect the living being on the earth.
2. It causes the global warming due to heating effect of UV light.
3. It destroys the green plants and small creatures.
4. It burns skin and causes blindness.
5. It decreases fertility rate and resists the growth.
6. It destroys the fertile land and decreases crops productions.

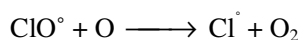
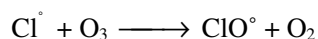
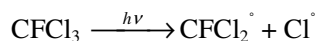
Controls

It can be controlled by

1. CFC producing refrigerator, spray can, air condenser should be prohibited
2. Combustion of fossil fuel, plastic and diesel should be diminished
3. Bombarding should be controlled.
4. People should be given knowledge ozone layer.

CFC

At the first time CFCs were considered as a miracle chemicals because of the non reactive, non toxic, non-inflammable and stable nature of CFCs. They were used as coolant in the refrigerators, air conditioners, spray can etc for long time. But later, it has been found that CFCs are the major culprit for the ozone depletion. Therefore, now a day, use of CFC is replacing by other molecules like ammonia as a coolant. CFCs are released by the operation of such refrigerants, aerosol can, burning of plastics, hydrocarbons and diffuses to the stratosphere. In the stratosphere, CFCs react with ozone molecules. Since CFCs are extremely stable and non reactive, they can persist for a long time and diffuse in to stratosphere where they get dissociated by ultra violet radiations. It is believed that one molecule of CFC can destroy one lakh molecules of O₃ continuous which forms hole in the ozone layer. The probable reaction is



The reaction goes on till the ability of destroying by ClO^\bullet ion is ceased

Effects of CFC

1. It depletes the ozone layer due to which UV rays reach to the earth.
2. It causes the global warming.
3. It invites the destruction of living being due to enter of U V rays.

Controls measures

1. CFCs must not be used in cooler, air condenser
2. Plastic should not be burnt but recycled.
3. CFC producing appliance must be banned.
4. It can controlled by making awareness about effect of CFC.

SOIL POLLUTION

The contamination of soil with acid rain, fertilizer, insecticide and pesticide's residue, metals like Pb from exhausted petrol, sulphate, nitrates etc is known as soil pollution. Soil is the acceptor of large quantities of waste products that may be domestic, human, animal, industrial and agricultural.

The combustion of sulphur containing fuels emits SO_2 and finally leaves sulphate on the soil. Fertilizers, pesticides, insecticides, herbicides applied to the crops are largely retained by the soil. Industrial products such as plastics, rubbers, glasses, tin and similarly toxic wastes like waste oil, lubricants, acid tars, lacquers etc are deposited on the soil. Such pollutants destroy the soil quality.

Sources of soil pollution

1. Industrial products: large percentage about 15.2% of pollutants includes from industrial productions like rubber, plastics, toxic substances, chemicals, sewage, glasses, dusts, waste oil, paints, decay row materials etc directly mix in to sources of water and spread over fertile land through irrigation
2. Agricultural: Residues of pesticides, herbicides and unconsumed fertilizers largely retained by the soil surface day by day due to their heavy use. After a certain year fertile lands are converted in to sterile and become bare land which cause land slide, flooding, soil erosion etc.
3. Domestic: It includes the garbage from houses and other premises such as undegrable domestic wastes like containers, pieces of bottles, plastics, glasses, gasoline, polythene etc. such domestic pollutants take a large part in pollution of soil in developing countries like Nepal. There are no safe and accessible dumping sites as well as strict rules-regulation by government. So, domestics' pollutants are not controlled and good managed in our country and as a result soil has been polluted rapidly. About 8.5% soil pollutants are from domestic and trade.
4. Volcanic eruption: Metallic oxides, sulphate residues and other tarry liquids, Solid tarry matters are spread over the soil surface and cover large area.

5. Mining and quarrying: It contains about 67% soil pollutants like rock particles, heap of wastes from quarries and tarry liquids like seam of coal, acid tars, waste oil etc from mining.
6. Toxic substances: tarry liquids, Pb containing gasoline sludge, water-kerosene mixture, acid tars, bases, sulphides and cyanide wastes, different aromatic hydrocarbon , Noxious organic solvent etc are toxic matters
7. Construction: Various construction works such as construction of roads, buildings, tunnels, bridges etc are the sources of the soil pollutants. Construction work consists about 2% pollutants.

Effects

1. It destroys the fertile land
2. It also affect the health of people through fruits ,vegetables and crops
3. It decreases the production rate of crops, grains.
4. It causes soil erosion and flooding.
5. It direct effect habitats of human, forest, grassy lands and hilly regions.

Controls

- 1.it can be controlled by replacing use of insecticides, fungicides by biological methods of control.
2. It can be controlled by advising and applying manure rather the use of chemical fertilizers.
3. By dumping domestic, industrial and chemicals.
4. By advising to apply lead free gasoline
5. By recycling the domestic materials.