

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. The nitrogenous 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.

❧❧❧

## 38. Air Pollution

*Air pollution refers to the undesirable change occurring in air causing harmful effects on man and domesticated species.*

### Air Pollutants

The common air pollutants are the following :

- |   |                         |
|---|-------------------------|
| 1. Dust                                 | 9. Hydrogen fluoride    |
| 2. Smoke                                | 10. Chlorines           |
| 3. Carbon monoxide (CO)                 | 11. Phosgenes           |
| 4. Ammonia (NH <sub>3</sub> )           | 12. Arsines             |
| 5. Sulphur di-oxide (SO <sub>2</sub> )  | 13. Aldehydes           |
| 6. Hydrogen sulphide (H <sub>2</sub> S) | 14. Ozone               |
| 7. Nitrogen di-oxide (NO <sub>2</sub> ) | 15. Ionizing radiations |
| 8. Hydrogen cyanide                     | 16. CO <sub>2</sub>     |

Air pollutants are of two types. They are *primary air pollutants* and *secondary air pollutants*.

#### 1. Primary Air Pollutants

Air is polluted by poisonous gases and undesirable substances. They are released by burning fossil fuels. These substances are called *primary air pollutants*. The primary air pollutants are the following:

1. Soot released from unburned fuel
2. SO<sub>2</sub> (sulphur di-oxide)
3. Benzopyrene (hydrocarbon) released from cigarette smoke.
4. NH<sub>3</sub>
5. Oxides of nitrogen
6. CO (carbon monoxide)
7. Lead

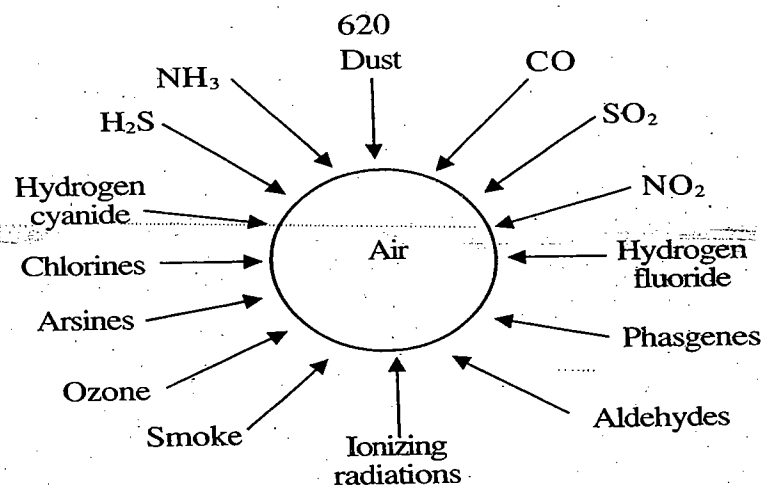


Fig.38.1: Factors causing air pollution.

### Secondary Air Pollutants

Secondary air pollutants are poisonous substances formed from primary air pollutants. In bright sun light, nitrogen, nitrogen oxides, hydrocarbons and  $O_2$  interact to produce more powerful photochemical oxidants like Ozone ( $O_3$ ), Peroxy Acetyl Nitrate (PAN), aldehydes, sulphuric acid, peroxides, etc. All these constitute **photochemical smog**.

### Causes of Air Pollution

#### 1. Agriculture

Hydrocarbons released by plants, pollen grains, insecticides, etc. cause air pollution.

#### 2. Dust

Dust in the air is increased by dust storms, wind, volcanoes, automobiles, etc.



Fig.38.2: Brick industry releasing smoke.

#### 3. Industries

Combustion of fossil fuels like coal, petroleum, etc. in industries is the main source of air pollution.

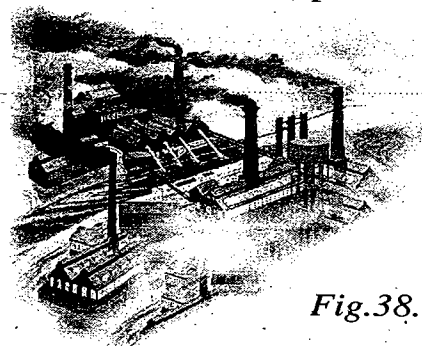


Fig.38.3: Industries.

#### 4. Automobiles

The combustion of petrol and diesel in automobiles releases harmful gases into the air. They also produce dust.



Fig.38.4: Train with smoke.

#### 5. Ionizing Radiations

Ionizing radiations include **alpha particles**, **beta particles** and **gamma rays**. They are released into the air from testing atomic weapons and atomic explosions.

#### 6. Freons

Use of freons and other chloro-flouro-carbons as refrigerants, coolants and as filling agents in aerosol packages cause pollution.

#### 7. Aerosols

Aerosols are small particles of solid or liquid substances suspended in the air. They block the stomata of plants and prevent

the gaseous exchange between plants and atmosphere. They may also change the climate of an area.

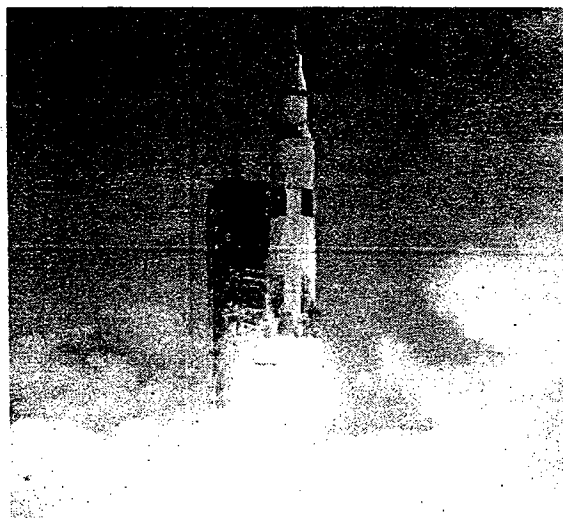


Fig.38.5: A rocket releasing enormous smoke.

### ✓ Ecological Effects of Air Pollution

#### 1. Death

When air is polluted with poisonous gases, death comes as a result immediately. **Bhopal episode** is a good example.

**Bhopal Episode :** On 2<sup>nd</sup> December 1984 about 3000 human beings died, about 5000 paralyzed and thousands of cattles, birds, dogs and cats died in one night at **Bhopal**. This mass death is due to the leakage of **methyl isocyanate** (toxic gas) into the air from an insecticide plant managed by Union Carbide.

#### ✓ 2. Chlorosis

The disappearance of chlorophyll is called **chlorosis**. It is caused by  $\text{SO}_2$  and fluorides present in the air.

#### 3. Necrosis

The breakdown of cell is called **necrosis**. It is caused by  $\text{SO}_2$ , nitrogen di-oxide, ozone and fluorides.

#### 4. Green House Effect

$\text{CO}_2$  is released into the air by the combustion of fuels. It is estimated that  $\text{CO}_2$  content of the air is increasing at the rate of 0.4% per annum. This will result in an appreciable warming up of the Earth. This is called **green house effect**. It is very likely that this will cause the melting of polar ice caps resulting in a rise of nearly 60 feet on the sea level. Coastal regions and low lying areas all over the World will be go under water (Fig.38.15).

#### 5. Crop losses

Heavy loss of crop plants is caused by **smog**. Smog denotes a combination of **smoke** and **fog**. The important components of **smog** are **ozone** and **PAN** (Peroxy Acetyl Nitrate). They damage leafy vegetables, cereals, textile crops, ornamental plants, fruits and forest trees.

#### 6. Respiratory Disorders

Excessive ethylene **accelerates respiration** causing premature **senescence** (old age) and **abscission** (accumulation of yellow fluid (pus) in the body). Aldehydes irritate nasal and respiratory tracts. Chlorine and phosgenes (carbonyl chloride) cause **pulmonary oedema**.

#### 7. Nausea

$\text{H}_2\text{S}$  smells like rotten eggs and causes **nausea**.

#### 8. Vomiting

$\text{SO}_2$  causes vomiting.

#### 9. Jaundice

Arsines induce RBC breakdown and jaundice.

#### 10. Oxygen Carrying Capacity

$\text{CO}$  reduces  $\text{O}_2$  carrying capacity of RBC by its permanent combination with haemoglobin.

#### 11. Coughing

Coughing is induced by phosgenes (carbonyl chloride).

### 4. Headache

$\text{SO}_2$  causes headache.

### 5. Cancer

Cancer is caused by air pollutants like ash, soot, smoke, chromium, nickel and radioactive elements.

### 6. Mutation

Radioactive elements produce mutation. Ozone produces chromosomal aberrations.

### 7. Cardiac Diseases

Cadmium causes high blood pressure and heart diseases.

### 8. Pneumonia

Pneumonia is caused by breathing in too much of manganese particles.

### 9. Depletion of Ozone Umbrella

In the atmosphere, about 30 km above the surface of the Earth, the ozone molecules ( $\text{O}_3$ ) form an umbrella. It prevents the penetration of harmful ultra violet radiation from the Sun and thus protects the life of the Earth. It is now feared that there is danger of appearing holes on the ozone umbrella. This is caused by the use of *freons* and other *chloro-fluoro-carbons* as

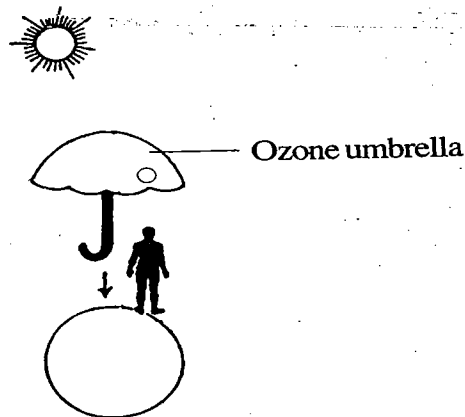


Fig.38.6: Depletion of Ozone umbrella.

refrigerants, coolants in domestic refrigerators and other cold storage facilities and as filling agents in foam plastics and in aerosol packages. Reaching the ozone umbrella, they destroy ozone molecules as a result of photochemical reactions.

Over the past 16 years, the density of the ozone layer has been diminishing at an average rate of 3%. It is calculated that the depletion of ozone layer by 1% results in an increase in the incidence of skin cancer by 5 to 7%.

### 10. Acid Rains

The rain water having pH as low as 5.6 is called *acid rain*. This lowering of pH is due to the dissolution of acids in the rain water. *Precipitation of oxides of sulphur and nitrogen with rain* is termed as *acid rain*.

Acid rain is caused by air pollution. When atmospheric air contains *sulphur di-oxide* ( $\text{SO}_2$ ) and oxides of nitrogen such as *nitrous oxide* ( $\text{N}_2\text{O}$ ) and *nitric oxide* ( $\text{NO}$ ), they dissolve in rain water forming *sulphuric acid* and *nitric acid*. The rain water falls as *acid rain*.



Fig.38.7: Acid rain.

The main source of oxides of sulphur and nitrogen is the burning of fossil fuels in power plants based on coal and oil contribute more than 60% of all sulphur oxides and 25 to 30% of nitrogen oxides in the atmosphere. Automobiles make a substantial contribution in large cities. Ozone is now recognized as a major factor in the formation of acid rain.

Acid rain affects both materials and organisms. It attacks building materials mainly sandstone, limestone, marble, steel and nickel. In plants, it leads to *chlorosis* (gradual yellowing in which the chlorophyll making mechanism is impeded) or depigmentation of leaves.

Acid rain increases the acidity of lakes and rivers. Vast tracts of forests and lakes in Europe and North America have been destroyed by acid rain. Acidity kills fish, bacteria and algae and the aquatic ecosystem collapses into sterility leaving a crystal clear but ultimately a dead lake.

### ✓ Control of Air Pollution

1. The emission of exhaust from automobiles can be reduced by devices such as *positive crankcase ventilation valve* and *catalytic converter*.

2. *Electrostatic precipitators* can reduce smoke and dust from industries.

3. Gaseous pollutants arising from industries can be removed by *differential solubility* of gases in water.

4. A fine spray of water in the device called *scrubber* can separate many gases like  $\text{NH}_3$ ,  $\text{SO}_2$ , etc. from the emitted exhaust.

5. Certain gases can be removed by *filtration* or *absorption* through activated carbon.

6. Certain gases can be made chemically inert by *chemical conversion*.

7. At the Government level pollution can be controlled by framing *legislations*.

### Separation of Air Pollutants

Air pollutants are separated by the following methods:

#### 1. Adsorption

The solid pollutants are collected by an *adsorbant*. The pollutant is attached on the surface of adsorbant. The adsorbants commonly used are activated *carbon*, activated *alumina*, *silica gel*, etc.

#### 2. Absorption

In absorption, the pollutant air is passed through a liquid. The liquid absorbs the pollutant gas.

### 3. Condensation

The pollutant vapour is *cooled* to become a liquid. The liquid is separated.

### 4. Combustion

The air pollutants are burned to release harmless substances. For example *carbon monoxide* can be burned to *carbondioxide*.

Similarly *hydrogen sulphide* can be burned to sulphur dioxide.

### 5. Gravity Settlers

Particulate air pollutants are removed by gravity settlers. It is a funnel like device. The pollutant air is passed into the chamber. The particulate pollutants are pulled down by gravity. The clean air comes out.

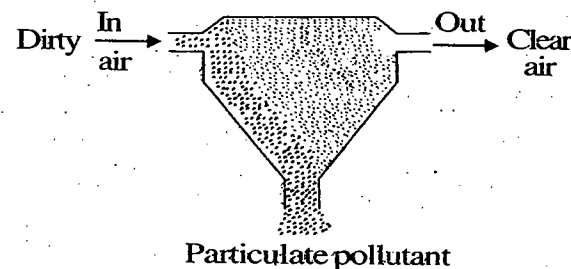


Fig.38.8: Schematic representation of gravity settler.

### 6. Cyclones

Cyclone is a cylindrical chamber. Polluted air is passed in. Centrifugal force is applied. The particles are collected in a cone.

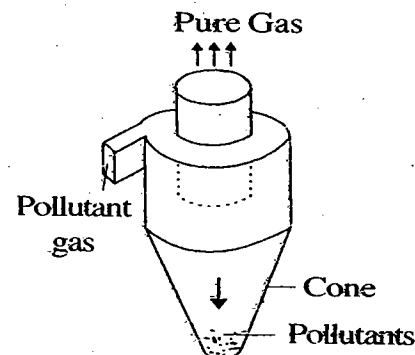


Fig.38.9: Schematic representation of cyclone.

are harmful to plants, animals and human beings. Hence a sufficient amount of ozone must be present in the atmosphere.

✱ Ozone itself is a pollutant. When the amount of ozone decreases it also causes ill effects.

✱ The following are the harmful effects of ozone depletion:

1. Production of *skin cancer* in human beings. The skin cancers may be carcinoma, melanoma, etc.
2. Aging of the skin.
3. The *immune system* is weakened.
4. *Breast cancer*
5. *Sun-burn*
6. *Leukaemia*-Blood cancer.
7. *Cataract*
8. *Lung edema* (Swelling).
9. *Lung haemorrhage* (Bleeding in the lungs).
10. *Bronchitis* (Disease affecting respiratory tube).
11. *Asthma*
12. *DNA breakage*
13. *Cell death*
14. *Death of phytoplankton*. This leads to starvation of plankton, fishes and marine animals.
15. Decrease in *fruits* and *vegetable* yield.
16. Reduction in *photosynthesis*.
17. Transpiration is increased on the surface of the leaves.
18. It produces green house effect.
19. Global warming is increased.
20. Paintings fade.
21. Fabrics are damaged.

#### Control of Ozone Depletion

1. The chloro-fluoro-carbons should be substituted with harmless chemicals. The chloro-fluoro-carbon can be substituted by *hydro-chloro-fluoro-carbon*.
2. HFC-134 can be used in place of freon.
3. September 16, 1995 was celebrated as *international ozone day*. It provides awareness.

□□□□

## 39. Water Pollution

*Water is the soul of nature; its pollution will perish the World.*

*Water pollution* refers to the undesirable change occurring in water which may harmfully affect the life activities of man and domesticated species.

### Water Pollutants

The common water pollutants are as follows :

- |                                |                                     |
|--------------------------------|-------------------------------------|
| 1. <i>Domestic sewage</i>      | 7. <i>Plankton blooms</i>           |
| 2. <i>Industrial effluents</i> | 8. <i>Heavy metals like mercury</i> |
| 3. <i>Pesticides</i>           | 9. <i>Temperature</i>               |
| 4. <i>Herbicides</i>           | 10. <i>Silt</i>                     |
| 5. <i>Fertilizers</i>          | 11. <i>Radioactivity</i>            |
| 6. <i>Bacteria and viruses</i> | 12. <i>Oils, etc.</i>               |

### Causes of Water Pollution

#### 1. Domestic Sewage

The city sewage is released into the river.

Domestic sewage consists of human faeces, urine and the dirty used-up water in houses. It contains a large number of pathogenic bacteria and virus.

#### 2. Industrial Effluents

All industrial plants produce some organic and inorganic chemical wastes. Those non-usable chemicals are dumped in water as a means of getting rid of them. The industrial wastes include heavy metals (Hg, Cu, lead, zinc, etc.), detergents, petroleum, acids, alkalies, phenols, carbonates, alcohol, cyanides, arsenic, chlorine, etc.

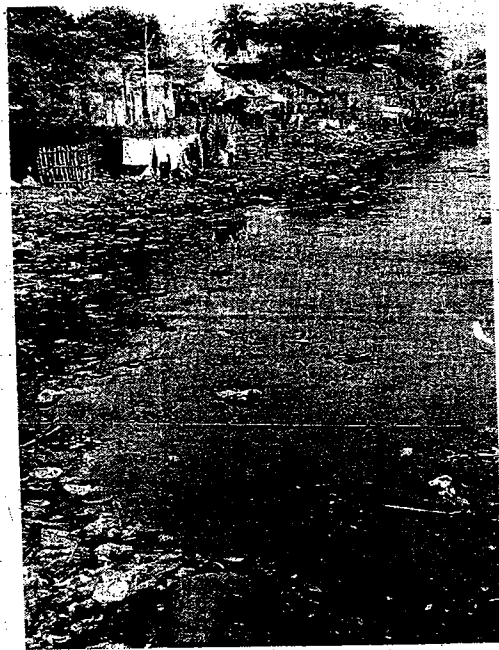


Fig.39.1: A sewage channel.

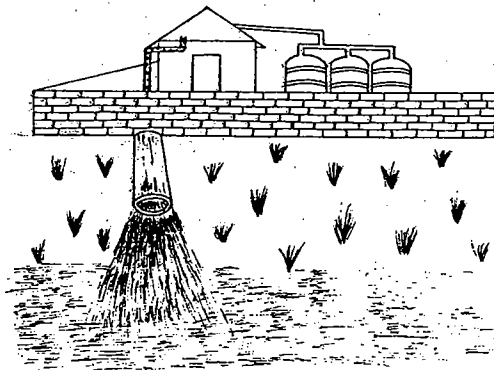


Fig.39.2: Industrial effluents released into the Ganga river.

### 3. Thermal Pollution

Many industries use water for cooling. The resultant warm water is discharged into rivers. This brings about thermal pollution.

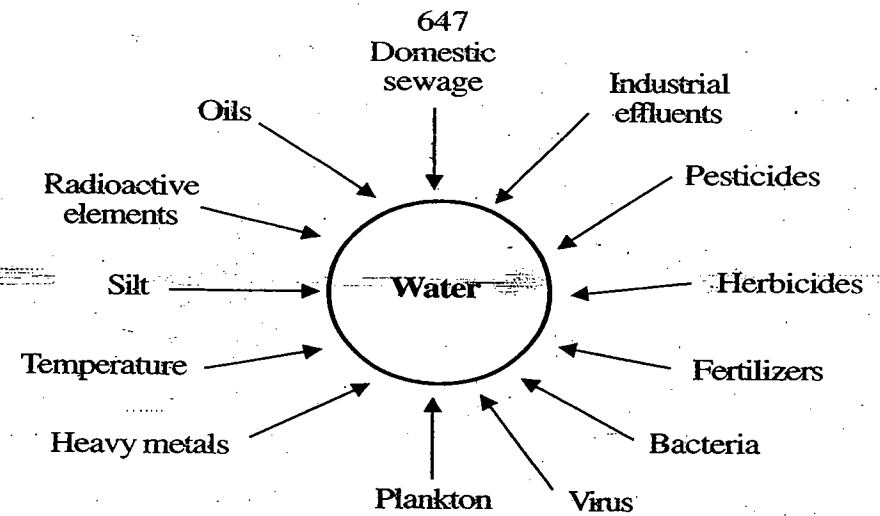


Fig.39.3: Factors causing water pollution.

### 4. Fertilizers

The fertilizers used for crops are washed into ponds and rivers.

### 5. Pesticides

Pesticides are used to control pests in fields and houses. They include DDT, BHC, endrin, etc.

### 6. Radioactive Wastes

Liquid radioactive wastes are released into the sea around nuclear installations. The oceanic currents carry the radioactive contaminants everywhere.

### 7. Oil Pollution

Oil is a source of pollution in sea-water. Oil pollution is due to ship accidents, loading and discharging of oil at the harbour, oil refineries and off-shore oil production.

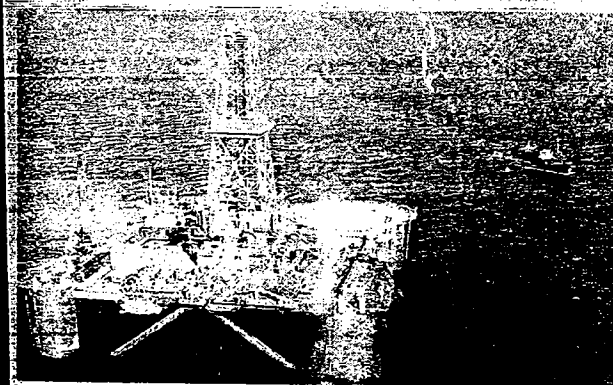


Fig.39.4: An oil rig in the North Sea.

### 3. Retting

The process of decaying coconut husk to get fibre for making coir is called **retting**. Retting releases  $H_2S$ . It makes water polluted.

### ✓ Ecological Effects of Water Pollution

#### 1. Minamata Disease

This disease is caused by **mercury poisoning**. It is characterized by crippling and death. This disease appeared in a coastal town, **Minamata**, in Japan.

The primary cause for this disease was a plastic industry which was started on the sea coast of Japan in 1905. From this factory a by-product called **mercury** was disposed into the sea. This mercury accumulated in marine animals.

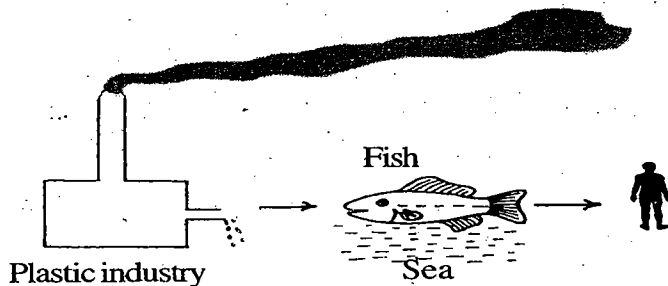


Fig.39.5: Minamata disease.

Later birds, cats, dogs and men receive mercury when they eat marine fishes and animals. The accumulation of mercury leads to crippling and death. Their initial symptoms of minamata disease includes the numbness of limbs, lips and tongue, impairment of motor control deafness and blurring of vision.

Finally it affects and destroys the brain. As a result of the attack of minamata disease about 17 persons died and 23 became permanently disabled in the year 1953, in Japan.

#### 2. Diarrhoea

It is caused by mercury, cadmium and cobalt.

#### 3. Mortality of Plankton and Fish

Chlorine which is added to water to control the growth of algae and bacteria in the cooling system of power stations may persist in streams to cause the mortality of plankton and fish.

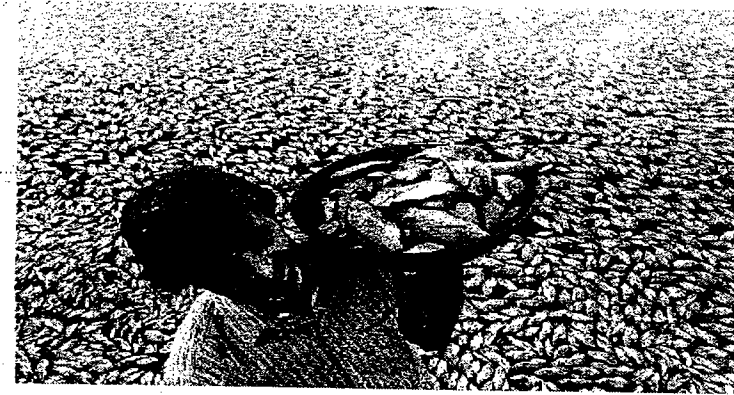


Fig.39.6: Water pollution causing the death of thousands of fishes in a lake.

#### 4. Reduction in Productivity

Intensive agriculture increases the amount of silt in lakes and rivers. Silt prevents the penetration of light to depths and thus reduces primary production.

#### 5. Siltation

Siltation is a phenomenon by which the gills of fishes are deposited with silt. This causes heavy mortality among fishes.

#### 6. Poor Oxygenation

Oil present on the surface of water prevents water oxygenation. This reduces respiration and metabolism in aquatic organisms.

#### 7. Poor Photosynthesis

Oil pollution prevents photosynthesis in phytoplankton.

#### 8. Red Tide

When coastal waters are enriched with nutrients of sewage, dinoflagellates multiply rapidly and form **bloom**. These blooming dinoflagellates liberate into the water, produce toxic metabolic by-products which can result in a large scale death of marine fishes. This is called **red tide**.

#### 9. Biochemical Oxygen Demand

Sewage enriches the water with nutrients. This causes rapid growth of plankton and algae. This leads to oxygen depletion in water. The oxygen depletion causes the death of algae. The decay and decomposition of algae consume more oxygen from water.

**Biochemical Oxygen Demand** or **Biological Oxygen Demand** (BOD) is the amount of oxygen required by the micro-organisms in water. BOD is higher in polluted water (sewage) and lesser in drinking water. Increased BOD lowers the contents of dissolved  $O_2$  in water causing the suffocation and death of aquatic flora and fauna.

#### 10. Water-borne Diseases

Diseases like jaundice, cholera, typhoid, diarrhoea, etc. are transmitted through water contaminated with sewage.

#### 11. Methaemoglobinemia

The nitrate used in fertilizers enters the intestine of man through drinking water. In the intestine, it is converted into *nitrite*.

Nitrite is absorbed into the blood where it combines with haemoglobin to form *methaemoglobin*. Methaemoglobin cannot transport oxygen. This leads to suffocation and breathing troubles, especially in infants. This disease is called *methaemoglobinemia*.

#### 12. Eutrophication

Domestic sewage and fertilizers add large quantities of nutrients such as nitrates and phosphates to the freshwater ecosystems. The rich supply of these nutrients make blue green algae, green algae and other phytoplankton to grow abundantly. This increased productivity of lakes and ponds brought about by nutrient enrichment is known as *eutrophication*.

As the algae use  $O_2$  of the water for respiration, the  $O_2$  is depleted from the water. The rapid growth also consumes all the nutrients of the water. The depletion of  $O_2$  and nutrients lead to the death of algae and other phytoplankton.

As other organisms, such as zooplankton and fishes of the water, depend on the blue green algae and phytoplankton for their food, they also die. Thus eutrophication leads to the complete depletion of the fauna from the ecosystem.

### Control of Water Pollution

#### 1. Sewage Treatment

Water pollution can be controlled by sewage treatment includes the following steps:

1. Sedimentation
2. Dilution and
3. Storage.

**1. Sedimentation** : When sewage is allowed to stand, the suspended particles settle at the bottom. So by sedimentation the suspended particles are removed from sewage.

**2. Dilution** : The sewage can be diluted with water. This increases the  $O_2$  contents and reduces BOD and  $CO_2$ .

**3. Storage** : The diluted sewage is stored in a pond. This facilitates the growth of micro-organisms. This renders further oxidation of sewage.

#### 2. Waste Stabilization Pond or Oxidation Pond

The National Environmental Engineering Research Institute (NEERI) at Nagpur has devised a very economical method for the treatment of industrial and domestic effluents. Domestic and industrial wastes are stored in a dilute condition in shallow ponds called *waste stabilization pond* or *oxidation ponds*. After a few days micro-organisms and algae flourish. The micro-organisms decompose the organic wastes by *oxidation* and the water is purified. This water is rich in nitrogen, phosphorus, potassium and other nutrients. This water can be used for fish culture, agriculture, etc.

#### 3. Recycling

Pollution can be prevented to a certain extent by reutilizing the wastes. This is called *recycling*. Eg. a. The dung of cows and buffaloes can be used for the production of *gobar gas*. b. Sewage can be used for irrigation and fish culture after treatment in *oxidation pond*.

Certain pollutants from industrial effluents can be removed by *filtration* and *selective absorption*.

Excessive use of *pesticides* and *herbicides* should be avoided.

At the Government level, legislations should be framed to control water pollution.

### 1. Minamata Disease

*Minamata disease* is a disease of the nervous system caused by mercury poison.

It appeared suddenly as an epidemic in the coastal town *Minamata*, Japan and hence the name.

It is a case of *water pollution*, *marine pollution*, *heavy metal pollution*, *mercury pollution* and *industrial pollution*.

## 42. Noise Pollution

The word noise has a *Latin* origin *Nausea* meaning, a *ting of sickness at the stomach with an urge to vomit*. Noise is defined as *unwanted sound or sound without value*. Noise pollution is *the unwanted sound dumped into the environment*.

Noise is measured by the unit *decibel* (dB). One decibel is equal to the faintest sound that can be heard by the human ear. The permissible noise level is **125 decibel**.

Some people feel discomfort with the sound of **85 dB**. More people do not feel discomfort with the sound of **115 dB**. Pain is usually felt at **145 dB**.

### Causes of Noise Pollution

Scooters	Ships
Motor bikes	Loud speakers
Cars	Loud popmusic
Tempos	Social gatherings
Vans	Factories
Buses	Mills
Trucks	Industries
Tractors	Kitchen appliances
Aircrafts	Fire crackers
Supersonic aircrafts	Generators
Motor boats	Workshops

### Ecological Effects of Noise Pollution

1. Noise diminishes the power of hearing.
2. It gives pain to the ear.

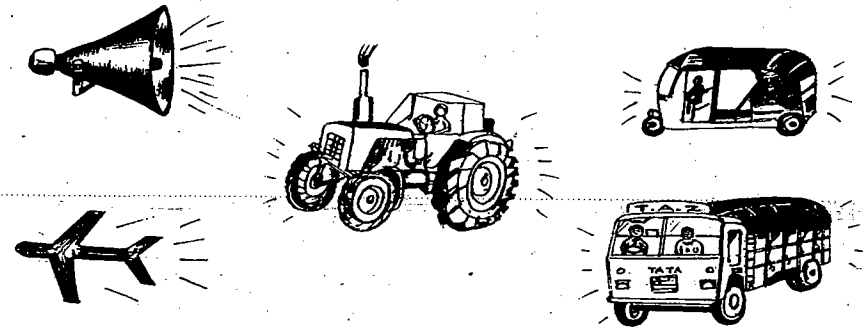


Fig.42.1: Causes of noise pollution.

3. It interferes with communication systems.
4. It causes stress.
5. Noise increases the secretion of *adrenaline*, the hormone of *flight and fright*.
6. It causes fright.
7. It increases the rate of heart beat.
8. It causes the constriction of blood vessels.
9. It increases *blood pressure*.
10. It causes *headache*.
11. It causes the *dilation* of *pupil* of the eye.
12. It causes *emotional upsets*.
13. It causes *deafness*.
14. Noise causes physical or mental fatigue and *lack of concentration*.
15. In industrial situations, this effect results in lowered efficiency, reduced work rate and higher chances for accident.
16. Noise disturbs *sleep*.
17. High frequency or ultrasonic sound can affect the semicircular canals of the internal ear and cause *nausea* and *dizziness*.

### Control of Noise Pollution

Noise pollution can be controlled in the following ways:

1. Legislations should be framed.
2. The sources that generate unwanted sound should be reduced.

3. Noisy automobiles should be condemned.
4. Wheels of automobiles should be oiled properly.
5. Industrialists must take up necessary steps to control noise.
6. Loudspeakers should be set at a low sound.
7. Trees absorb noise and thus reduce noise pollution. So thick vegetation must be grown around industries, cities and on the sides of roads.
8. Noise producing machines should be placed in closed rooms.
9. Residential houses should be constructed far away from industries, factories and airports.

□□□□

## 43. Thermal Pollution

*Thermal pollution* refers to the release of warm water into the water body.

It is the *undesirable change in the temperature* of the water body.

### Sources of Thermal Pollution

- |                           |                    |
|---------------------------|--------------------|
| 1. Thermal power stations | 6. Oil refineries  |
| 2. Atomic power stations  | 7. Steel factories |
| 3. Water power stations   | 8. Industries      |
| 4. Coal fired plants      | 9. Factories       |
| 5. Oil field generators   |                    |

The heat producing industries use fuels to heat water. Steam is produced to run turbines and for many other purposes.

Water is also used as a coolant.

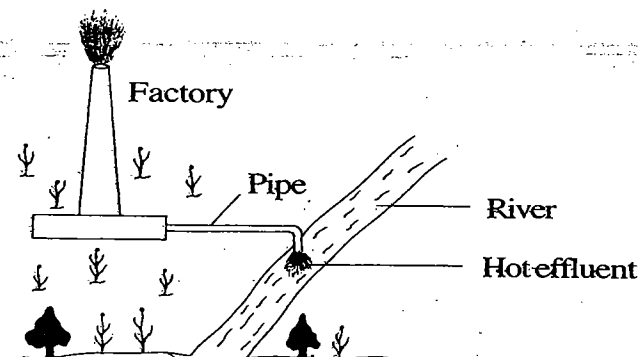


Fig.43.1: Hot effluent, from an industry, is released into a river.

### 1. Solar Energy

Sunlight is the solar energy. It forms the major energy source for the plants. Plants synthesize starch with the help of Sunlight. All animals in the World depend on the energy stored by the plants.

The solar energy is also used for *solar cooker, solar heater, solar calculator*, etc.

The solar energy contains tremendous electric energy. Technologies must be developed to exploit the Sunlight.

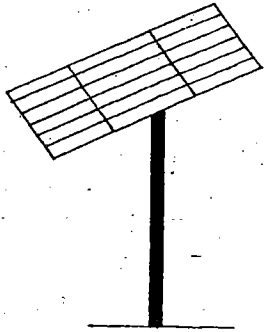


Fig.35.23: Solar cell.

**Solar cells** generate electricity using Sunlight. They are pollution free.

In solar cells, two layers of *silicon* are used.

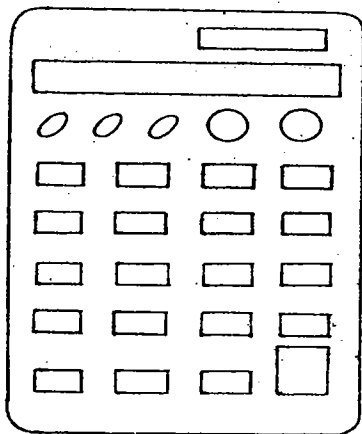


Fig.35.24: A solar calculator.

Solar cells are used for-

*Calculators*

*Radios*

*Electric lights*

*Street lights*

*Electric appliances*

*Water pumping*

*Weather stations*

*Cars.*

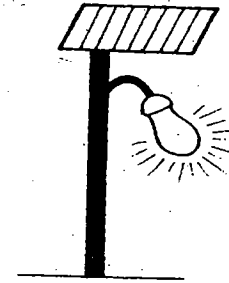


Fig.35.25: A solar cell with street light.

Soon, Man is going to fly in air without any air crafts.

A day will come on which men fly individually in air.

Man can fly in air by two methods:

1. By attaching a solar cell on his body.

2. By neutralizing the gravitational force around him.

When the gravitational force is neutralized, man can fly in the air like a hydrogen balloon.

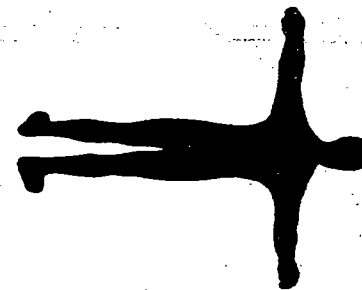


Fig.35.26: A man flying using solar energy.

### 2. Fossil Fuels

Fossil fuels are coal, oil and natural gas formed over geological time under the Earth. They are **organic compounds**. They are **nonrenewable** energy resources.

The waste warm water is disposed into the natural water body such as rivers, ponds, lakes, sea, etc. This increases the temperature of the natural water body causing thermal pollution.

### III Effects of Thermal Pollution

1. Oxygen content decreases in warm water.
2. Warm water prevents the penetration of oxygen into deep cold waters.
3. The *toxicity* of pesticides and detergents increases with increase in temperature.
4. Metabolic activities of organisms increase in warm water; but warm water contains less oxygen. Hence organisms are affected.
5. Warm water disturbs spawning of animals.
6. Young fishes are killed by warm water.
7. Fish migration is affected by warm water.
8. *Blue green algae* dominate in water bodies due to thermal pollution.
9. Decrease of *zooplankton*.
10. Fishes move away from areas polluted by warm water.
11. Sponges, molluscs and crustaceans are eliminated at temperatures above  $37^{\circ}\text{C}$ . This results in a change in the *biodiversity*.

### Control of Thermal Pollution

Thermal pollution is controlled by three methods.

1. *Cooling ponds*
2. *Cooling towers*
3. *Spray ponds*

#### 1. Cooling Ponds

The hot water, emerging from industries is stored in ponds. Here natural evaporation cools the water. After cooling, the water is drained into natural water bodies.

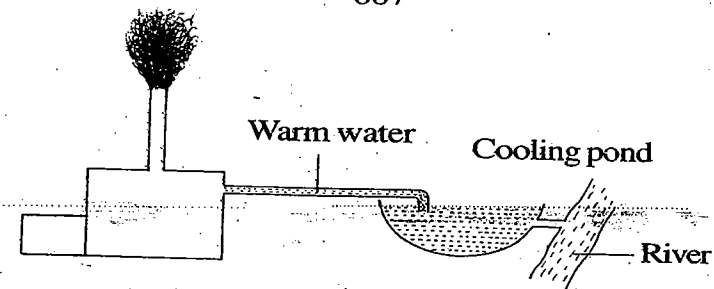


Fig.43.2: A cooling pond.

#### 2. Cooling Towers

The hot water is passed through a system of coiled pipes kept in a tower. The hot water is allowed to flow downwards from the top of the tower. Cool air is allowed to flow over the pipes upwards from the bottom of the tower.

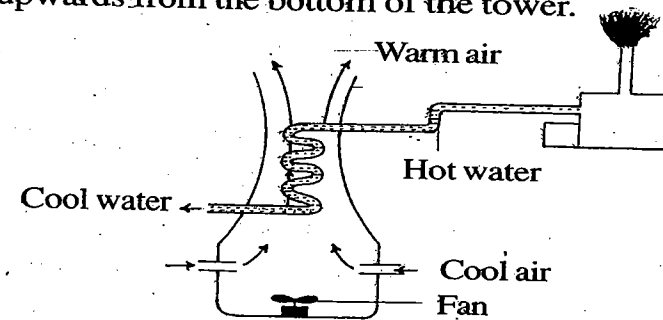


Fig.43.3: A cooling tower.

#### 3. Spray Ponds

The hot water from the industries are sprayed through nozzles (sprayers) into fine water droplets. Heat is dissipated from these droplets and the water is collected in spray ponds.

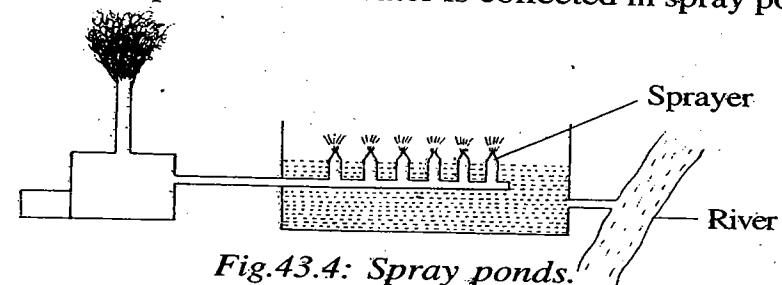


Fig.43.4: Spray ponds.

### Infant Mortality

A study from Punjab revealed high levels of DDT and  $\text{PCDD}$  in breast milk samples. High infant mortalities have been reported from places where high residues of DDT were found in human milk.

### Death

In 1957, in Kerala pesticide poisoning caused the death of 102 people.

In Indore, 5 persons died by Malathion poisoning during 1967-68.

In 1984, at Bhopal 2500 people died due to Methyl isocyanate poison leaked out from an insecticide plant Union Carbide.

In this accident, several thousand peoples are suffering from serious diseases of eye, skin, lung, etc. A large number of cattles and birds also died.

### Control of Pesticide Pollution

The following methods must be followed in using pesticides:

1. The persistent pesticides such as DDT must be prohibited.
2. Only selective pesticides must be used.
3. Pesticides must be used in small quantity.
4. Repeated pesticide application should be stopped.
5. Less toxic and less persistent organophosphates must be used instead of persistent organochlorine.
6. Ecofriendly *biopesticides* must be used.
7. *Biological control* must be encouraged.
8. Pesticide education should be given to public and farmers.
9. Scientific research should be carried out to know the effects of pesticides.



## 45. Nuclear Hazards (Radioactive Pollution)

• *Nuclear hazard is an environmental pollution caused by ionizing radiations.*

• *Atom bomb explosion, nuclear power plant accident, etc. are nuclear hazards.*

• *It is a radioactive pollution.*

• *It is caused by radioactive substances called **radioactive isotopes** or **radionuclides**. Eg. Uranium.*

• *A radioactive isotope is an **element**. It is made up of many **atoms**. Each atom has a **nucleus** and a set of **electrons** revolving around.*

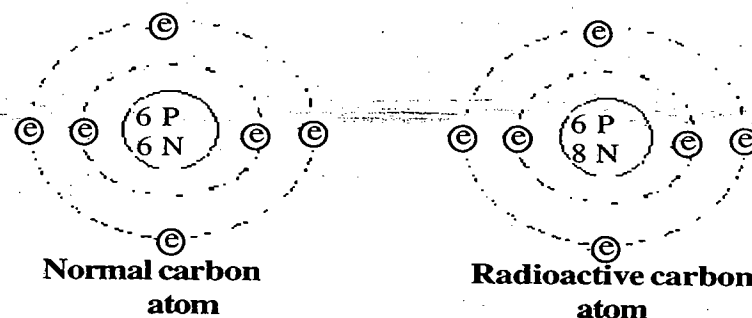


Fig.45.1: Atoms.

- The nucleus is formed of **protons** and **neutrons**.
- In the normal atoms, the number of protons is equal to the number of neutrons. But the radioactive atoms have **extra number of neutrons**. For example, normal carbon atom has 6 protons and 6 neutrons; but radioactive carbon has 6 protons and 8 neutrons.

• The nucleus of a radioactive isotope is **unstable**. Hence it undergoes spontaneous decomposition. During decomposition the nucleus throws out a stream of protons. The throwing of protons by an atomic nucleus is called **radioactive decay**.

• During radioactive decay the protons, neutrons and electrons are released in the form of **radiations**.

• These radiations include **alpha particles, beta particles and gamma radiations**.

• According to penetrating power, the radiations are arranged in the following order:

Alpha particles	-	Blocked by paper
Beta particles	-	Blocked by wood
Gamma rays	-	Blocked by concrete wall

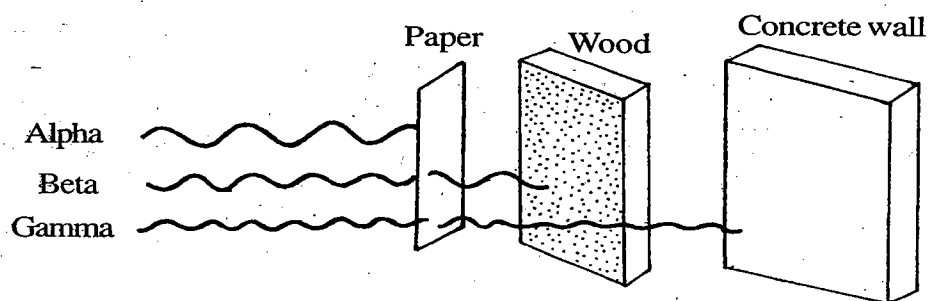


Fig.45.2: Penetration power of ionisation radiations emitted by radioisotopes.

• They are high **energy radiations** with deep **penetrating** power. They are **ionizing radiations**. They attack other atoms and cause ionization.

• The radioactive pollution or nuclear hazard is caused by **natural radiations** and **artificial radiations**.

• The natural radiations include **cosmic rays** and **lightning**. Cosmic rays come from other planets.

• The artificial radiations include X-rays, alpha particles, beta particles and gamma rays.

• The artificial radiations are the main cause for **nuclear hazard** or radioactive pollution.

• They are released in

1. Atom bomb explosion
2. Atom bomb testing
3. Atomic power stations
4. Atomic power accidents

### Atom Bomb

Atom bomb is a nuclear bomb made up of radioactive isotopes. It is a lethal weapon.

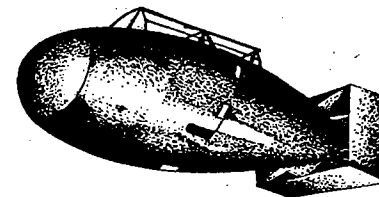


Fig.45.3: Atom bomb.

In bomb explosion, there is **nuclear fission**. The nucleus of the atom releases electrons. The electrons strike other atoms to produce more and more electrons. Thus a **chain of reactions** (fissions) is produced.

The bomb blast releases enormous **heat, alpha particles, beta particles** and **gamma rays**.

An atom bomb releases enormous amount of heat of several million degrees. It creates a large **fire ball**. Even stones and metals melt. The animals and plants are burnt.



Fig.45.4: Atom bomb explosion.

The alpha particles, beta particles and gamma rays are carried by wind and are deposited on the Earth as **radioactive out** or **radioactive rain**. They remain on the Earth for hundreds of years and cause ill effects to man, domestic animals and crops.

The first atom bomb called **Little boy** was dropped in **Hiroshima** during II World war in 1945.

The second atom bomb, called **Fat man** was dropped on **Nagasaki**.

About 3 lakhs and 40,000 people were killed during these atom bomb explosions.

### Atomic Power Plants

Atomic power plants use radioactive isotopes and produce electric current. Eg. **Kudankulam, Chernobyl**, etc.

In these plants, uranium is used as the **fuel**. It releases enormous heat. It is used to produce steam which in turn rotates the turbines to produce electricity.

In **Chernobyl**, Russia, the reactor of the atomic power plant exploded in 1986. It caused the death of about 2000 people.

### III Effects of Radioactive Pollution (Nuclear Hazards)

1. Radioactive pollution causes **holocaust**. It is the mass extermination of human beings by fire. It is a **nuclear hazard**.

In Hiroshima and Nagasaki, 3 lakhs and 40,000 people were killed during these two atom bomb explosions.

Atom bomb explosion liberates enormous heat due to **nuclear fission** reactions. This heat melts even stones and metals. Man, animals and plants are burnt to death.

The **Chernobyl atomic power plant** accident caused the death of 2000 people.

2. Radiations cause **gene mutations** and **chromosomal aberrations**. This leads to genetical defects in future generation.

3. **Stillbirths** - Birth of dead babies.

4. **Congenital deformities** - Defects in new born babies.

5. **Microcephaly** - Abnormal small head in babies.

6. Destruction of cities.

7. Destruction of animals and plants.

8. Ionizing radiations penetrate into the body and cause **ionization** of molecules in cells. These cells cannot function normally and die.

9. It causes **radiation sickness**. It is characterized by **reddened and ulcerated skin, loss of hair, nausea, anaemia**, etc.

10. Continuous exposure of a person with radiation may lead to **cumulative radiation damage** and **death**.

11. **Cataract** in the eye.

12. Damage to liver, spleen, thyroid, etc.

13. Reduced fertility.

14. Carcinoma (cancer).

15. Leukaemia (Blood cancer).

16. Tissue **necrosis**.

17. General malaise (discomfort).

18. Nausea

19. Vomiting

20. Inhibition of **mitosis** (cell division).

21. **Leucopenia** (diminished level of lymphocytes and granulocytes).

22. Septicemia - Blood poisoning due to the presence and persistence of pathogenic micro-organisms or their toxins in the blood.

23. **Anaemia**

24. **Inhibition of enzyme** secretion.

25. Mental retardation.

26. Population and ecosystem are destroyed.

27. **Pine tree forests** are destroyed by gamma radiations of Cobalt or Cesium.

28. Thyroid cancer.

29. Bone cancer.

### Control of Radioactive Pollution

Radioactive pollution can be controlled by the following methods:

### 1. Glass Spectacles

Use of glass spectacles will protect the eyes from ultraviolet light because UVL cannot penetrate the glass.

### 2. Exposure to Visible Light

Visible light neutralizes UV damage considerably. Therefore exposing the UV radiation affected persons to sunlight can treat him.

### 3. Insulation of Reactors

Radioactive isotopes are used as fuels in the atomic power plants. So the reactors must be enclosed in broad concrete walls to prevent the radiations to come out. The water, used in the reactor as a coolant, also must be kept in safe concrete walls.

### 4. Waste Disposal

Radioactive wastes must be stored in underground tanks where they gradually decay in a harmless manner.

### 5. Protective Garments

Workers in atomic power plant and other industries using radioactive materials should wear protective garments and should be screened from radioactive materials by radiation resistant walls or cases.

### 6. Radiation Indicators

The workers, should wear radiation indicators to know the total amount of radiation to which they have been exposed.

### 7. Atomic bomb explosion must be stopped.

## 1. Hiroshima-Nagasaki Episode

Hiroshima and Nagasaki are two cities of Japan attacked by atom bombs during the II World War in 1945.

During World War II, *Germany*, under the leadership of *Hitler*, invaded and captured many countries. On one occasion, it destroyed the ship of America, which remained so far as the silent observer of war. Hence America joined with Britain and Russia, attacked Germany, Italy and Japan.

Germany and Italy surrendered. But Japan continued war. America warned Japan to surrender, otherwise Japan had to face heavy destruction. As Japan refused, America dropped atom bombs on Hiroshima and Nagasaki and finally Japan surrendered.



Fig.45.5: Explosion of bomb. Created a ball of fire with dust.  
**Hiroshima**

*Hiroshima* is an industrial city. It has an area of 72.7 sq.km and 2.45 lakhs human beings. It is an *army head quarter*, a *port* and a *manufacturing centre* of weapons in Japan. Hence it was selected to bomb.

The bomb used was called *Little Boy*. It was 3 metre long and 0.7 metre broad weighing 4,100 kg. It contained inside 22 kg of radioactive *Uranium*<sup>235</sup>.

The bomb was dropped in 1945, August 6 at 8.15a.m. It was burst about 580 metre above the city. The explosion created a great ball of fire. The heat produced was 3,00,000°C. 80,000 people were burnt to death. 70,000 injured. Of these 60,000 died in the next year. The trees became ashes. Even the stones and tiles melted on the heat produced by the bomb.

Again the bomb created a wind force to a speed of 15,000 km. Hence the stones, tiles and glass pieces ran fast like missiles in the city. About 13 sq.km area of Hiroshima was destroyed.

