20.04.2022

# Oxygen demanding wastes

**Example : Animal manure, Plant debris**

- Organic wastes such as animal manure and plant debris that can be decomposed by aerobic bacteria.
- This degradation consumes dissolved oxygen in water. Dissolved oxygen is the amount of oxygen dissolved in a given quantity of water at particular pressure and temperature.

## Human sources

- Sewage
- Paper mills
- Food processing

## Effects

- Degrade the water quality by depleting dissolved oxygen of water.
- Oxygen consuming organisms, like fish die.

# What is biochemical oxygen demand (BOD)

- *Biochemical oxygen demand (BOD, also called biological oxygen demand)* is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period.

- The BOD value is commonly expressed in **mg of oxygen consumed per liter** of sample during 5 days of incubation at 20°C and is often used as a surrogate of the degree of organic pollution of water.

- The difference in dissolved oxygen between the initial measurement and the fifth day measurement represent the biochemical oxygen demand.

# What is it important?

- BOD test was first developed in 1930.

- The BOD is **an important parameter for assessing water quality**.

- Healthy water should generally have dissolved oxygen concentrations **above 6.5-8 mg/L .**

- It deals with the amount of oxygen consumption (mg $O_2$ $L^{-1}$) by aerobic biological organisms to oxidize organic compounds.

- Waste water release from domestic, commercial, municipal, institution are grouped as Sewage. (It contains carbohydrate, fats, biodegradable organic materials, polymer)

- Sewage with high BOD can cause a decrease in oxygen of receiving waters, which in turn can cause the death of some organism.

# Determination of DO (Winkler's method)

- Can be measured by either ***Winkler's method (Iodometric method).***
- **Titration:** The process of finding out the volume of one of the solutions required to react completely with the definite volume of the other solution is known as titration.
- Normality equation. It is expressed as, N1V1 = N2V2

- DO measurement is based on the fact that dissolved oxygen oxidizes KI and liberate $I_2$. The liberated iodine is titrated against thiosulphate solution using starch as an indicator.
- Since dissolved $O_2$ in water is in molecular state, it as such cannot oxidize the KI. Hence manganese hydroxide is used as an oxygen carrier.
- Manganese hydroxide in turn is obtained by the action of KOH on $MnSO_4$

**$MnSO_4 + 2KOH \longrightarrow Mn(OH)_2 + K_2SO_4$**

**$2Mn(OH)_2 + O_2 \longrightarrow 2MnO(OH)_2$** [dihydroxy(oxo)manganese]

- The brown precipitate dissolves on acidification liberates nascent oxygen

**$2MnO(OH)_2 + H_2SO_4 \longrightarrow MnSO_4 + 2H_2O + [O]$**

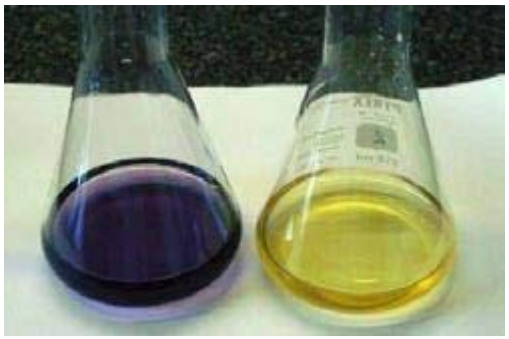
- When treated with KI, it liberates iodine $I_2$ which is equivalent to the initial DO.

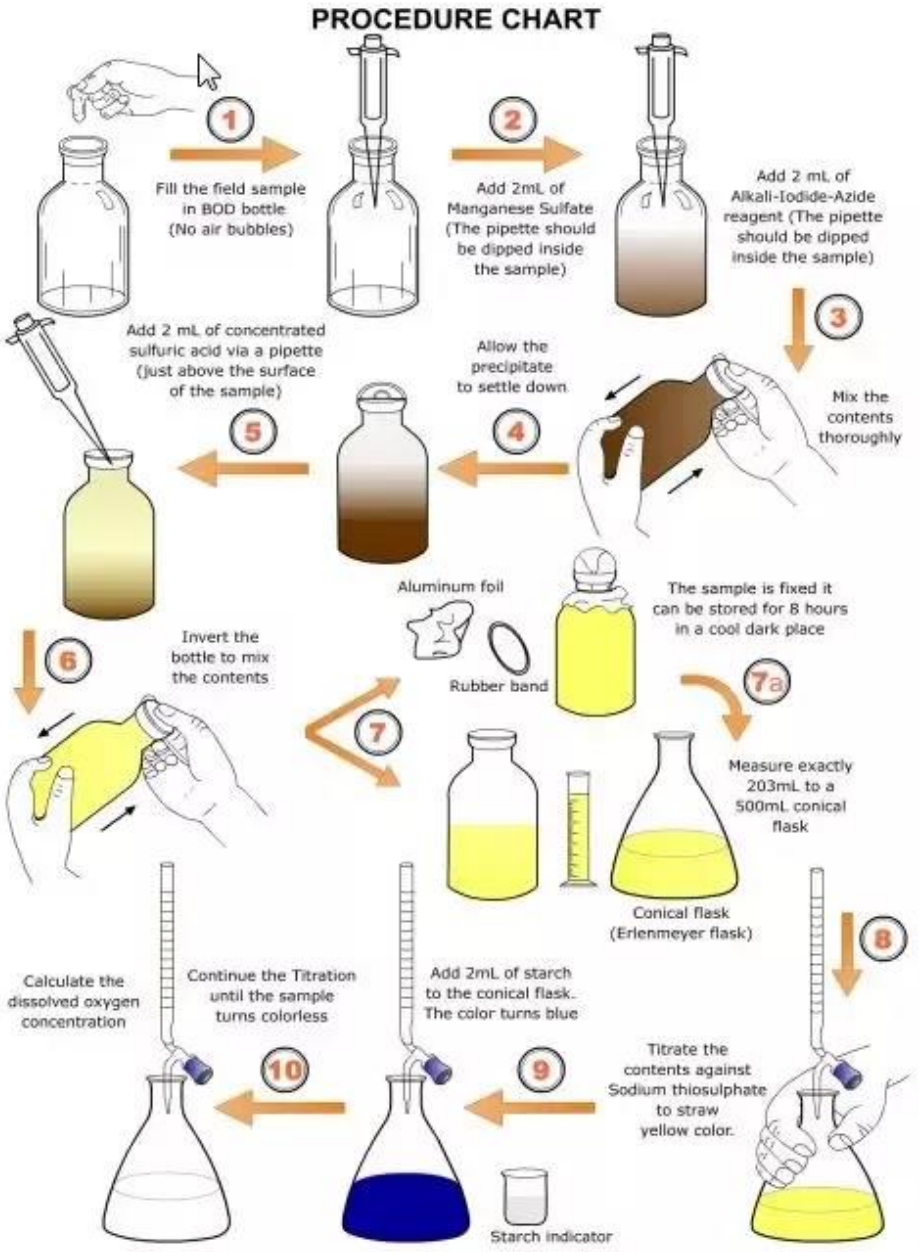
**$2KI + H_2SO_4 + [O] \longrightarrow K_2SO_4 + I_2 + H_2O$**

**Need starch indicator, which will react with $I_2$ and will form blue color.**

1 mol [O] liberated 1 mol $I_2$.
The liberated iodine is finally estimated by titration with sodium thiosulphate
**$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6$ (sodium tetrathionate) + 2NaI**

**Deep blue will transform to light yellow** when titrated with standardised thiosulfate solution. This indicates the end point of the titration.






So, we know the strength (N1) and volume (V1) of $Na_2S_2O_3$, and volume of water sample (V2).

N1 V1 = N2V2
N2 = M (N)
This means M(N) I2 or [O] is present in the solution.

i.e. 1000 mL solution M(N) * 8 gm [O] = x mg /L

The stoichiometric expression relating DO and sodium thiosulfate is given below

$$DO = \frac{Volume\ of\ Na_2S_2O_3\ X\ Strength\ of\ Na_2S_2O_3\ X\ 8\ X\ 1000}{Volue\ of\ Sample\ water}\ mg/\ lit$$

$$DO = \frac{Volume\ of\ Na_2S_2O_3\ X\ Strength\ of\ Na_2S_2O_3\ X\ 8\ X\ 1000}{100\ mL}$$

If 100 mL of sample water is used:

DO = Volume of 0.0125 N $Na_2S_2O_3$ mg/lit

# Determination of BOD

## Procedure

The test based upon the determination of dissolved oxygen prior to and following a 5 days incubation period at 20°C under aerobic conditions. A decrease in DO content after incubation is the measure of BOD and referred to $BOD_{5d}$ expressed in mg/liter

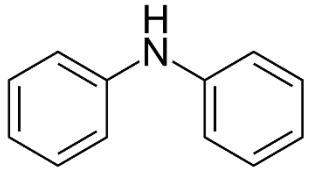
$$BOD_{5d} = DO_{initial} - DO_{after\ 5days\ of\ incubation}$$

# COD

- **Chemical oxygen demand** measures the amount of oxygen required for oxidation of organic compounds present in water by means of chemical reactions involving oxidizing substances such as $K_2Cr_2O_7$:
- Most of the organic matter decomposed and produces CO2 and H2O when boiled with a mixture of $K_2Cr_2O_7$ & $H_2SO_4$.
- A sample is refluxed with a known amount of $K_2Cr_2O_7$ in $H_2SO4$ medium and the excess of $Cr_2O_7$ (dichromate) is titrated against **ferrous Ammonium Sulfate [Fe(NH4)2(SO4)2] solution.**
- **The amount of dichromate consumed is proportional to the $O_2$ required to oxidize the organic matter.**

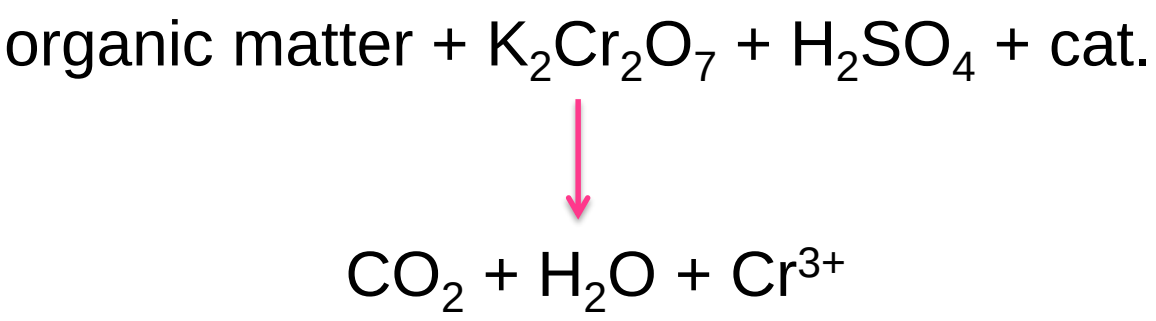
**Dichromatic titration**

➢ Diphenylamine use an indicator for this process.

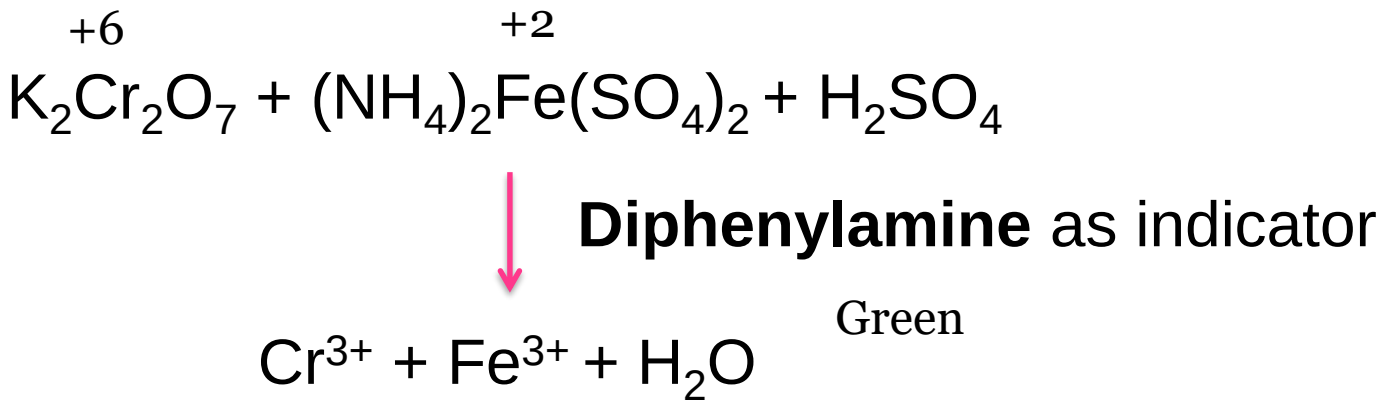


$$(NH_4)_2Fe(SO_4)_2 + K_2Cr_2O_7 + H_2SO_4 \rightarrow$$
$$(NH_4)Fe(SO_4)_2 + K_2SO_4 + Cr_2(SO_4)_3 + (NH_4)_2SO_4 + H_2O$$

**Color will change green to violet**



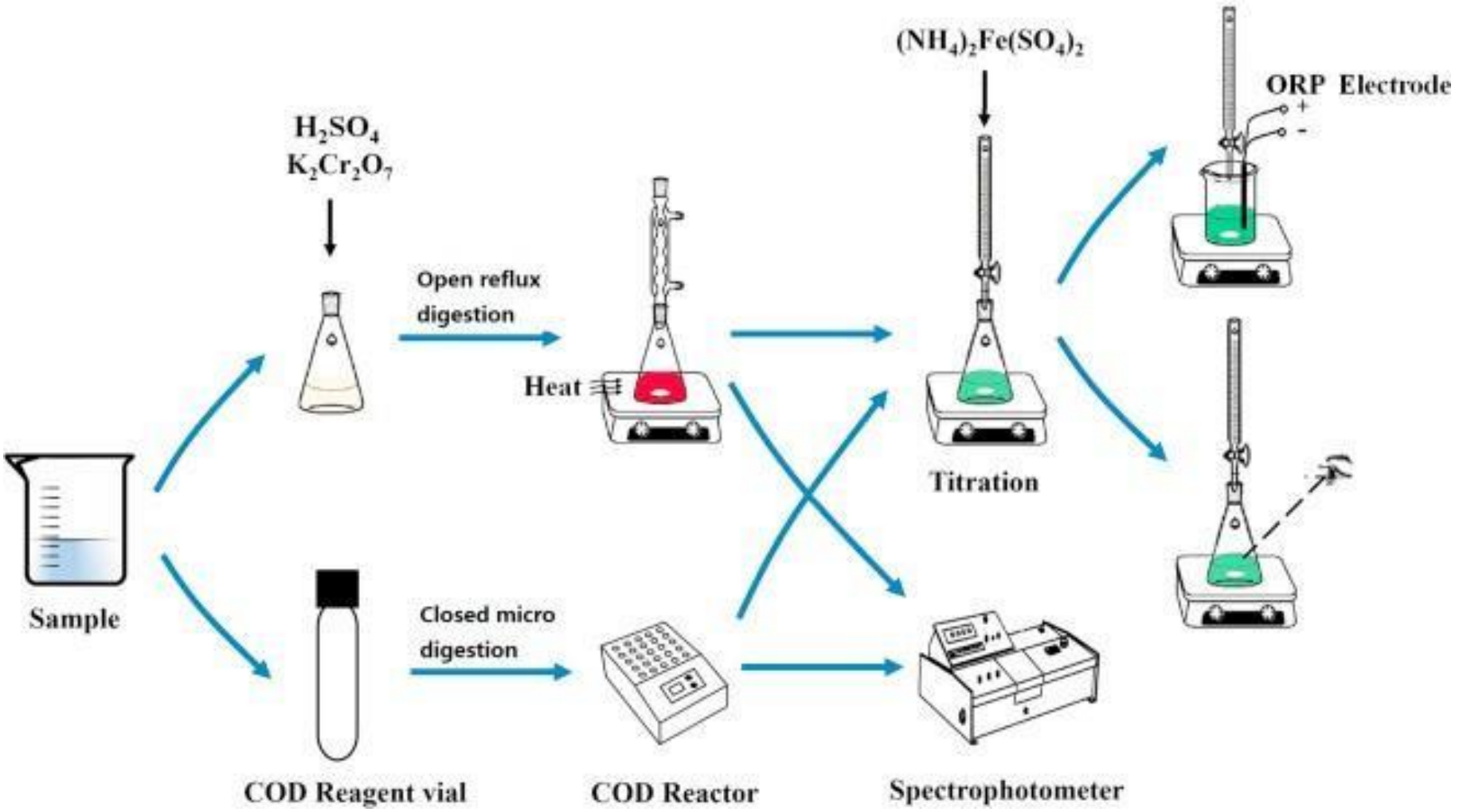

## Titration




Before the end point, colour of the solution is light green and at the end point, purple colour appears.

- **The amount of dichromate consumed is proportional to the O2 required to oxidize the organic matter.**

# COD test by K2Cr2O7




2h, 150 °C

$$K_2Cr_2O_7 + 4H_2SO_4 \rightarrow Cr_2(SO4)_3 + K_2SO_4 + 4H_2O + 3[O]$$

$$6FeSO_4 + 3H_2SO_4 + 3[O] \rightarrow 3Fe_2(SO_4)_3 + 3H_2O$$

---

$$K_2Cr_2O_7 + 7H_2SO_4 + 6FeSO_4 \rightarrow Cr_2(SO4)_3 + K_2SO_4 + 3Fe_2(SO_4)_3 + 7H_2O$$

Blank Titration: Distilled water → $V_1$ mL of $FeSO_4$

Back Titration: Sample water → $V_2$ mL of $FeSO_4$

$$COD = \frac{(V_1 - V_2)\ X\ Strength\ of\ FAS\ X\ 8\ X\ 1000}{Volue\ of\ Sample\ water}\ mg/\ lit$$

# What is it TDS

**Total Dissolved Solids (TDS)** in water are some organic and inorganic materials, which include minerals and ions that are dissolved in a particular quantity in water.

When water passes through stones, pipes or different surfaces, the particles are absorbed into the water.

TDS in water can come from different sources such as minerals in chemicals used for treating water, runoff from the road salts and chemicals or fertilizers from the farms. **Calcium, Magnesium, Sodium, and Potassium cations**, as well as Carbonate, Hydrogen Carbonate, Chloride, Sulfate, and Nitrate anions, are commonly the most prominent constituents. Contaminants that are larger than **2 microns** are termed as **total dissolved solids.**

# Drinking Water TDS Chart

**Acceptable level**

One of the important questions that many people have in their minds what is the acceptable **TDS level** in the water. To help you out, we are listing two tables which discuss the palatability quotient and acceptable TDS level.

ppm = milligrams per liter (mg/L)

| TDS Level in parts per million(ppm) | Palatability Quotient |
|---|---|
| Between 50-150 | Excellent for drinking |
| 150-250 | Good |
| 250-300 | Fair |
| 300-500 | Poor |
| Above 1200 | Unacceptable |

# Is low TDS water harmful to Human Body?

TDS present in water is not a measure of any single contaminant and so is generally not regulated as a health issue by many government agencies. A high TDS level, however, can affect the taste and odour of water. The Environmental Protection Agency in the US has set the **maximum recommended level** of 500 milligrams per litre (mg/L).

# Determination of trace metals

- Major industrial sources include surface treatment processes with elements such as Cd, Pb, Mn, Cu, Zn, Cr, Hg, As, Fe and Ni, as well as industrial products that, at the end of their life, are discharged in wastes.

- A variety of inorganic techniques can be used to measure trace elements in waste water

  **Atomic Absorption Spectrometry (AAS)**

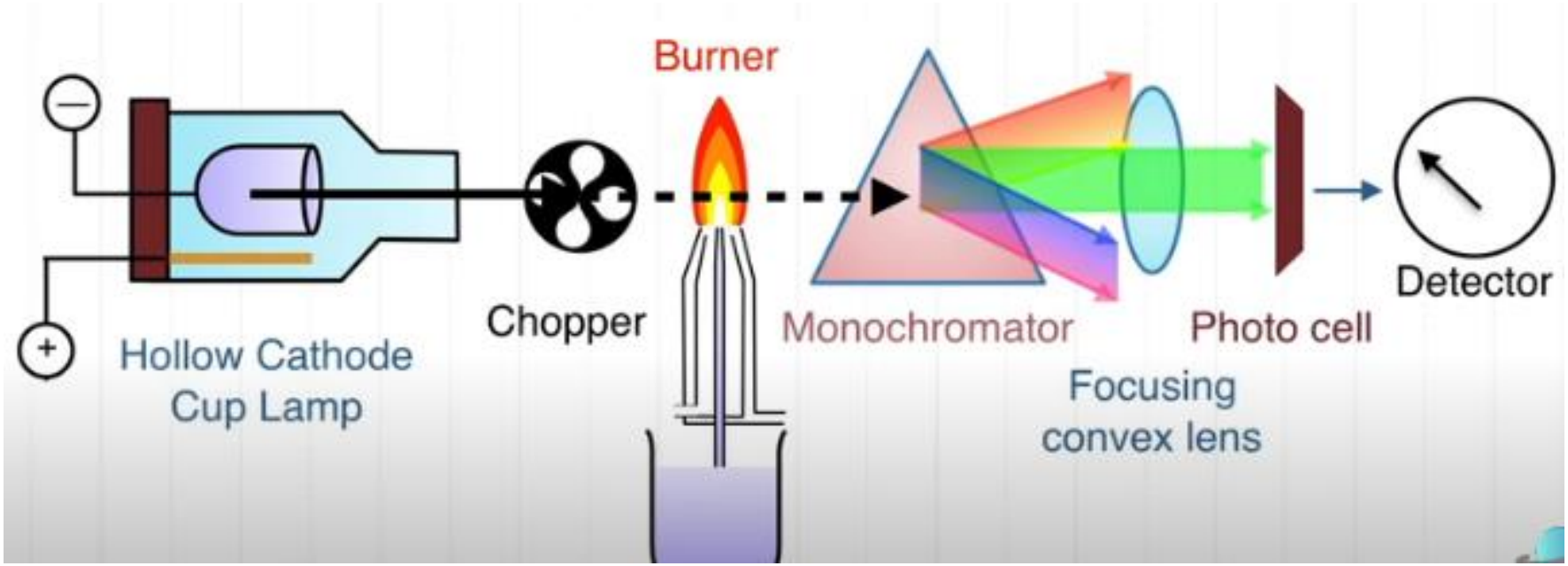
# What is atomic absorption spectrometry?

- Atomic absorption spectrometry (AAS) detects elements in either liquid or solid samples through the application of characteristic wavelengths of electromagnetic radiation from a light source.

- Individual elements will absorb wavelengths differently, and these absorbances are measured against standards.

- In effect, AAS takes advantage of the different radiation wavelengths that are absorbed by different atoms.

# Working Principle of (AAS)




Nebulizer

# Application of Atomic Absorption Spectrometry (AAS)

- Very low concentration which is 1 ppm or less than that can also be analysed accurately with the help of A.A.S.
- With the help of A.A.S. we can detect the toxic elements such as Cu, Ni, Zn present in the food products.
- How much amount of Pb present in the can also be found out with the help of A.A.S.
- Soil extracts plant materials fertilizer have been analysed for determination of Na, K, Cu, Mg, Mo and V etc.. Present.

# ENVIRONMENTAL POLLUTION

**28.04.2022**

# Soil Pollution

## Definition

The contamination of soil by human and natural activities, which may cause harmful effects to living things.

Human and animals activities generate many wastes that are discarded as useless. They are solid and generally termed as soil or land pollution.

## Composition of soil

Inorganic mineral-45%

Organic matter-5%

Soil water-25%

Soil air-25%

## Sources of soil pollution

- Industrial wastes
- Urban wastes
- Agricultural practices
- Radio active pollutants
- Acid rain
- Mining
- Biological agents

## Industrial Wastes

Disposal of industrial wastes such as ash, slag, corroded metal on land

**Sources**

- Pulp and paper mills
- Chemical industries, oil refineries, Sugar factories
- Manufacturing and construction industries
- Coal, Mining industries,
- Chemical, glass, cement and engineering industries
- Construction and demolishing wastes

**Effect**

- Alter the chemical and biological activities of soil
- Hazardous chemicals enter into the human and animal food chain.
- Disturb the biological process of living organisms.

# Urban wastes

## Source

Domestic and commercial refuse often termed as Municipal solid waste

## Constituents

- Garbage and rubbish material
- Remains of food, vegetables, Garden wastes
- Plastics, glasses, fibers, rubbers, fuel residues, abandoned vehicles

## Effect

- Air pollution
- Danger to plant growth
- Danger to aquatic life

# Agricultural practices

## Sources

Modern agricultural process pollute the soil

- Fertilizers, pesticides etc.
- Feedlots, Crop residues, Soil erosion
- Farm wastes

## Effects

- Kills important microorganisms in soil and aquatic life

# Radio active pollutants

## Sources

- Storage and disposal of radioactive materials
- Gets deposited on the surface and emits gamma radiation

## Effects

- Kills important microorganisms in soil and aquatic life


# Mining and Oil Spills

## Mining

- Huge holes are generated
- Waste are left on the site of mining in the form of spoil heaps
- Contain toxic and poisonous substances

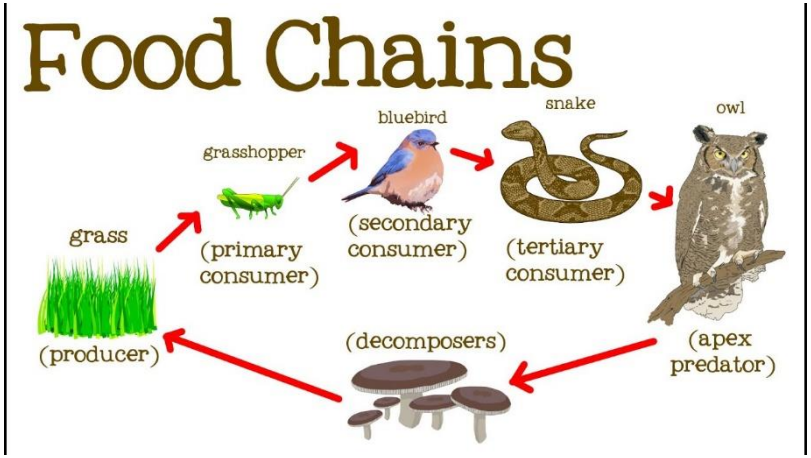
## Oil Spills

- Petroleum spills from containers or gas stations
- Examples: Benzene, Toluene, Xylene
- Cause poor growth of plants

## Effects on Microorganisms and Soil

### Loss of variety of microorganism due to:

- Change in composition of the soils which is needed for their growth
- Certain animal life die
- Loss the supply of food chain
- Imbalance in the food chain




### Soil:

- Reduces soil fertility
- Reduced the nutrients on the soil

## Proper dumping of unwanted materials

- Open dumping method should be changed
- Controlled tipping method should be followed

## Production of natural fertilizers

- Fertilizers and pesticides should not exceed the limit
- Bio fertilizers should be preferred over chemical fertilizers

Example : Animal's dung are used for composting manure

## Control measures of soil pollution

- **Agriculture activities**
  - Population growth
  - Urbanization

- **Control of soil erosion**

It is controlled by forestry and farm practices

Example

- Tree plantation on slopes
- Terracing and building diversion channel may be undertaken
- Reducing deforestation

## Control measures of soil pollution

**Public awareness**

- Public awareness programs should be conducted
- Problems of health hazards should be educated to the people.

**Recycling and reuse of wastes**

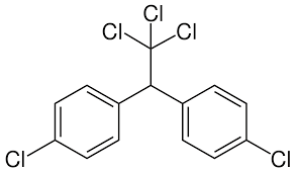
The waste paper, plastics, glasses, petroleum products and industrial effluents shouldbe re-used and re-cycled.

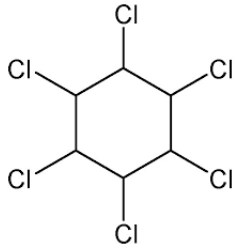
**Ban on toxic chemicals**

DDT, BHC pesticides should be banned

Improper disposal of radioactive wastes should be banned

Nuclear explosion should be banned.




**Dichlorodiphenyltrichloroethane** (DDT) Benzene hexachloride (BHC-gammaxene)

# Thermal pollution

## Definition

It is the entry of excess heat in the environment.

## Sources

- Thermal power plant, Industries, Cooking, etc..
- Deforestation due to developmental activities.

## Effects

- Addition of excess heat to water that makes it harmful to living things.
- Lowers the DO level in the water and disrupt the ecological balance.

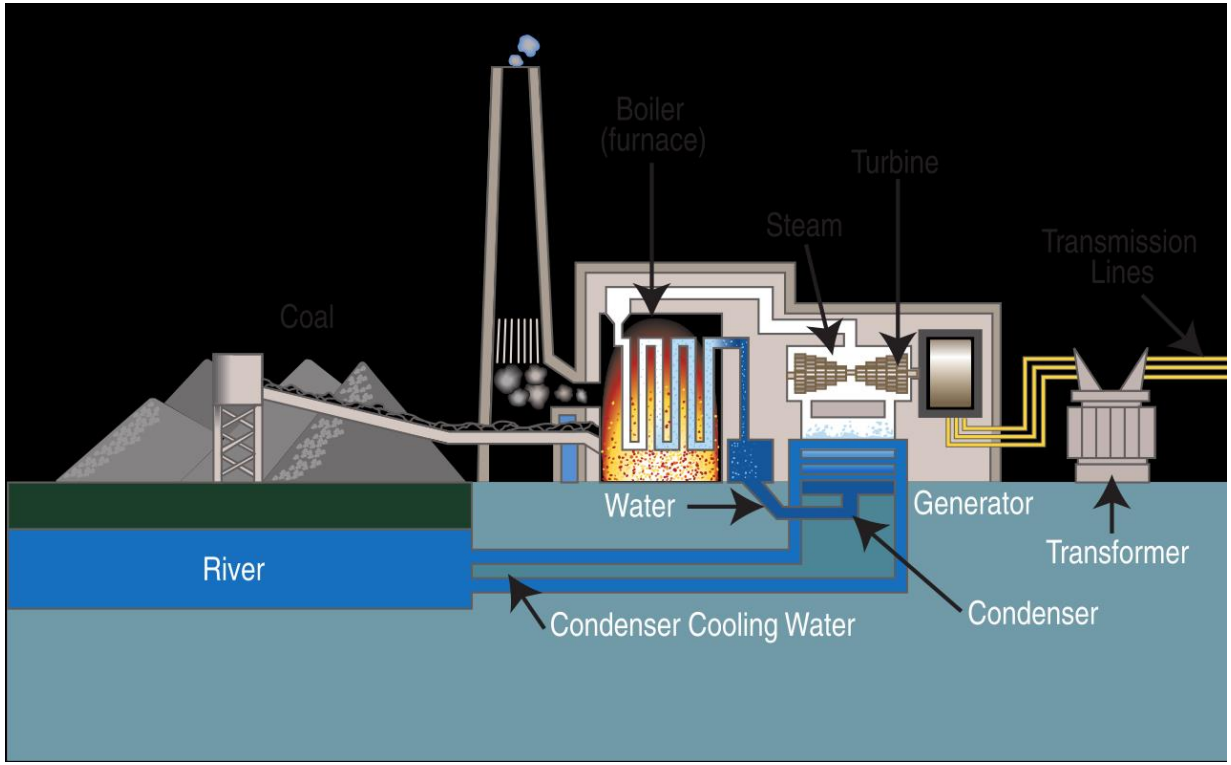
## Thermal power plants

- Nuclear explosions and experiments
- Emissions from power plant and nuclear reactor
- Heated effluents from power plants.

## Coal-fired power plants

- Condensers in the thermal power plants are cooled with water from river and lakes; discharge the hot water back to them increasing the temperature of the water bodies.
- The heated effluents decrease the dissolved oxygen content in water.
- It kills the fishes and other micro organisms

# Coal-fired power plants



# Thermal pollution

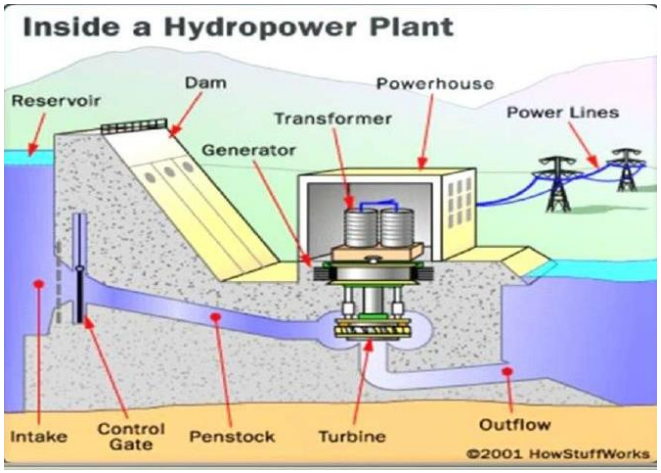
## Domestic sewage

These are discharged into river, lakes, and channels without treatment.

- The municipal sewage has high temperature
- The demand of dissolved oxygen increases.
- Water organisms will die.
- The offensive gases evolved

## Hydroelectric power

- Negative thermal loading takes place in water.



## Human activities

- Industries and power plants use water to cool are mixed with water bodies
- Cutting the trees and plants
- Soil erosion by construction
- Poor farming practices
- Use of refrigerator, AC..CFC

## Effects of thermal pollution

- **Global Warming:** melting of ice in the pole
- **Effect on aquatic life:** DO level decreases causing mass fish death
- **Interference with biological activities:** It controls the respiratory, digestive, excretion systems.
- **Food storage for fish:** upon killing the microorganism
- **Change in weather**: alters the seasonal variation which affect the food storage system of fishes.

# Control measures of thermal pollution

## Cooling towers

- Cooling towers are designed to reduce the temperature of water
- Cooling tower spread the heat from hot water to the surrounding by evaporation

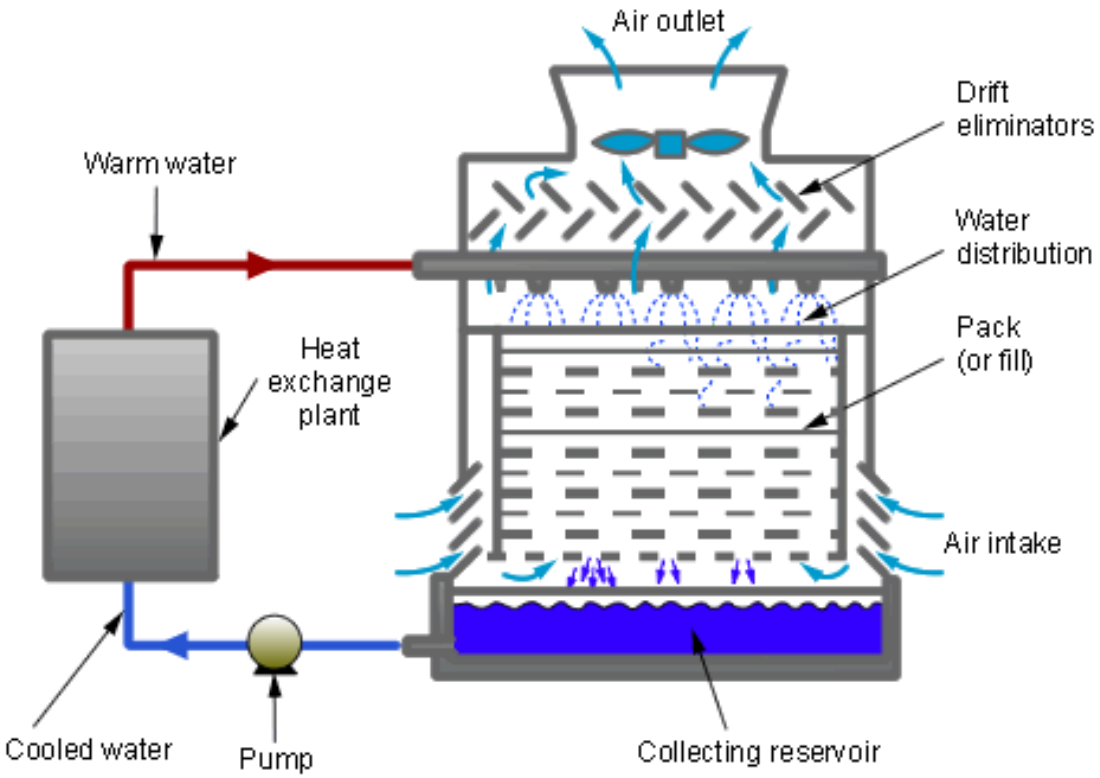
**Types**

a) Wet cooling tower

b) Dry cooling tower

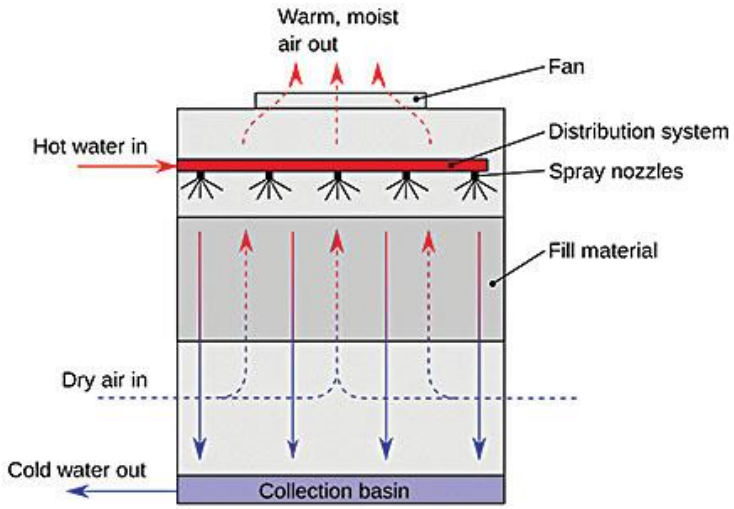
# Wet cooling tower

- Water coming out from the condenser is allowed to spray.
- Cool air with high velocity is passed from sides, which takes away the heat and cool the water.



# Dry cooling tower

- Hot water is allowed to travel in a spiral path.
- Cool air with help of fans is passed over this hot water
- Hot water is cooled and cool water can be recycled



## Cooling ponds

- It is a simplest method of cooling the thermal discharges
- Heated effluents transferred to cooling pond
- Water surface dissipate the heat to atmosphere

## Artificial lakes

- These are man made bodies of water
- The heated effluents can be discharged into lake at one end and cooling water withdrawn from other end.
- The heat is dissipated through evaporation

# Radiation Pollution

Radiation or radioactive pollution is emission of radiation from the radioactive substances (such as Uranium (U), Plutonium (Pu), Polonium (Po), Thorium (Th)) also from nuclear waste, contaminates air, water and soil and directly affects the human being.

# Types of Radioactive Pollution

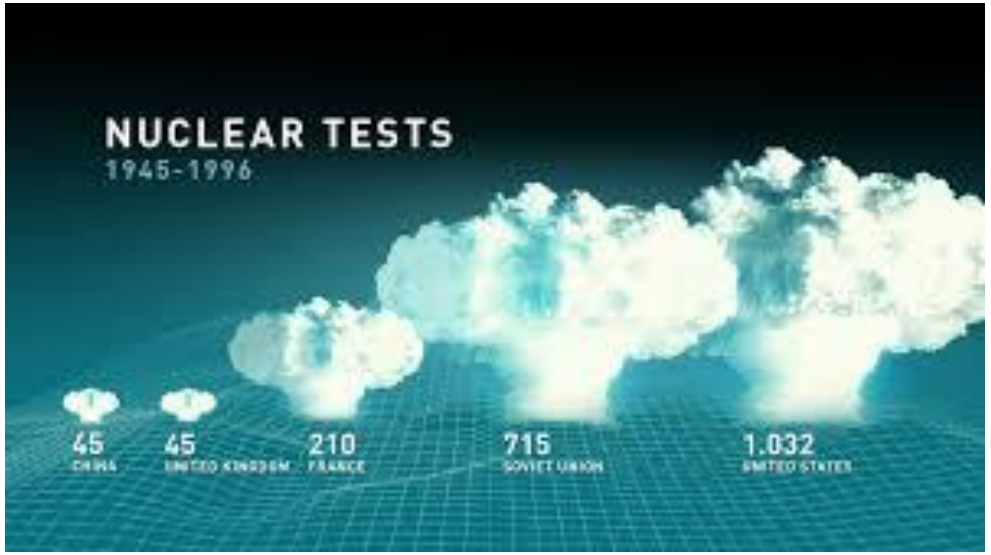
## Continuous Pollution

Continuous radioactive pollution is the type of pollution constantly coming from uranium mines, nuclear reactors, and test laboratories, where the radioactive contaminants are always present.

# Types of Radioactive Pollution

## Occasional Pollution

Occasional radioactive pollution is the type of pollution that occurs during nuclear tests or during experimental tests on radioactive substances.



# Types of Radioactive Pollution

## Accidental pollution

Accidental radioactive pollution is the type of pollution that occurs when certain experiments involving dangerous substances fail, and the substances used for experimentation get out of control.

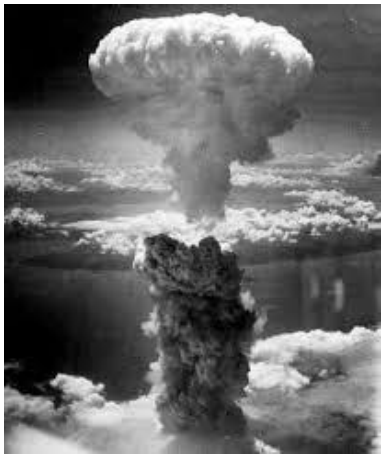
# Sources

**Any process that uses radio active elements.**

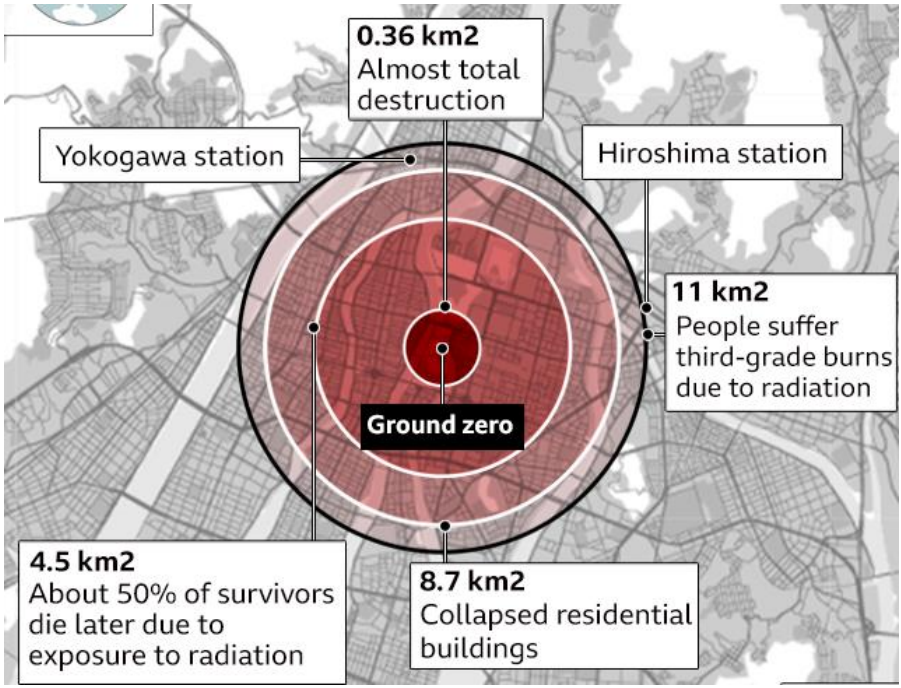
- **Nuclear power stations**

# Sources

- **Nuclear bomb, nuclear accident**

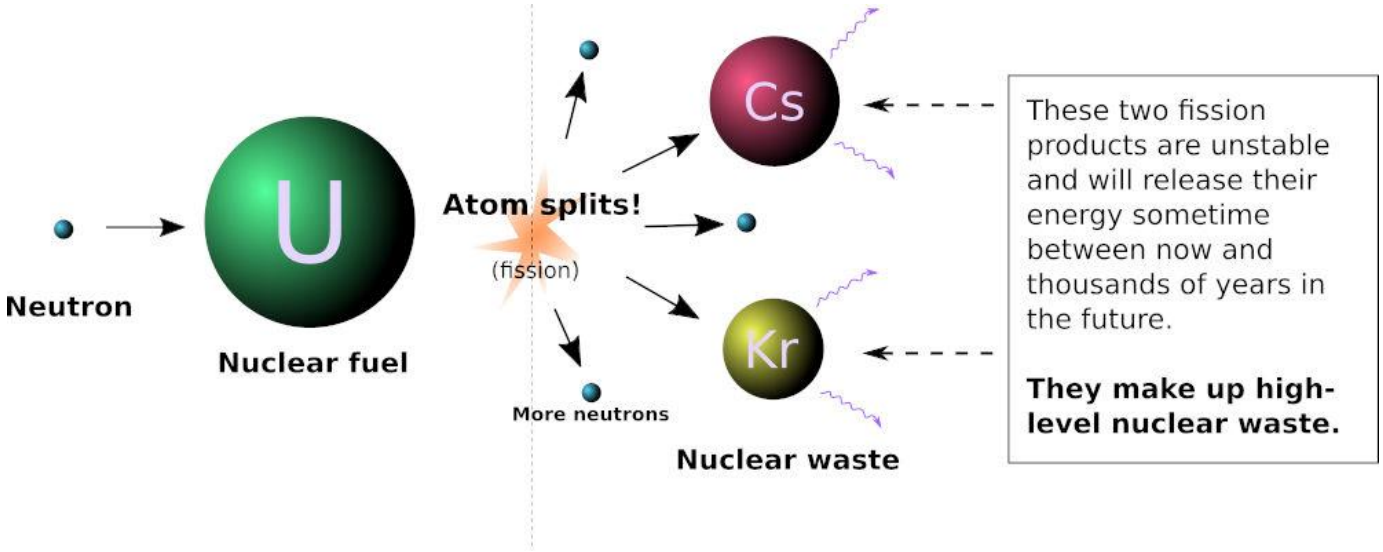


- **Heat wave**
- **Sound wave**
- **Radiation wave**



# Sources

- **Waste from nuclear power plants**



# Sources

## ❖ Mining

- During mining huge amount of radio active elements are disposed in to the soil.
- Radiations are emitted in to the environment

# Sources

- **X ray**

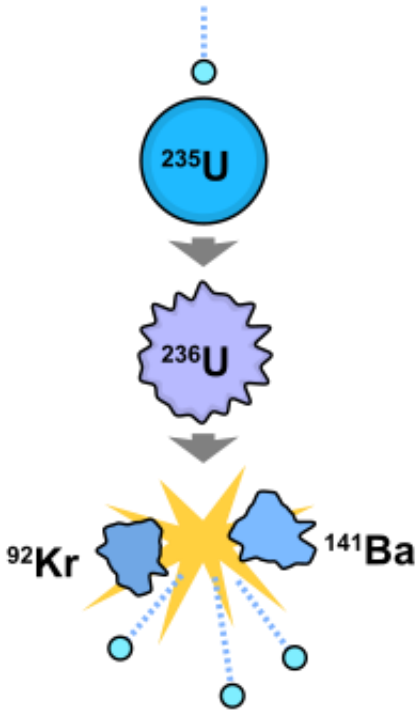
Very high power was used, which is
75 times stronger than the todays power

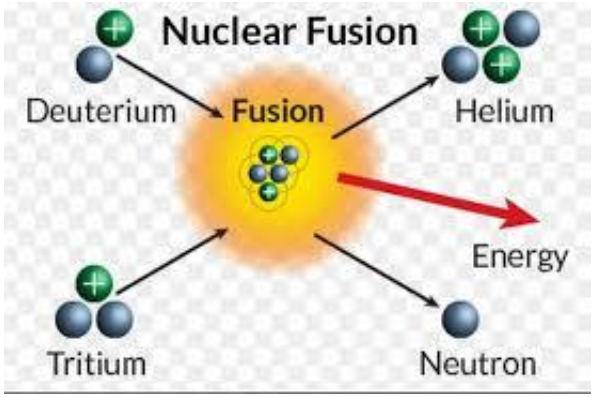
# Effects of Radioactive Pollution

- Brain and central nervous system affected and even lead to death
- Loss of sight in eyes
- Vomiting, bleeding and mouth ulcers
- Blood vessel damage and red spot on skin
- Infection of intestinal wall
- Brain damage, Brain tumor, mental retardation, affecting pregnancy
- EMR from cell phones have been linked to development of brain tumors, genetic damage
- Occupational health hazard, developing various type of cancer.

# Control measures of nuclear hazards

- Nuclear tests should not be in air rather in under ground
- Nuclear reactor should be covered by closed cycle coolant
- Production of radio isotopes should be minimized
- Nuclear installation should be controlled
- Fission reaction should be minimized.




# Dispose of Nuclear Hazards

## Decay-In-Storage

- Waste contaminated with certain short-lived radioisotopes can be stored.
- Duration must be for a minimum of 10 half-lives.
- Radioisotopes must have half-lives of less than 90 days.

# Dispose of Nuclear Hazards

## Dump to sanitary sewers

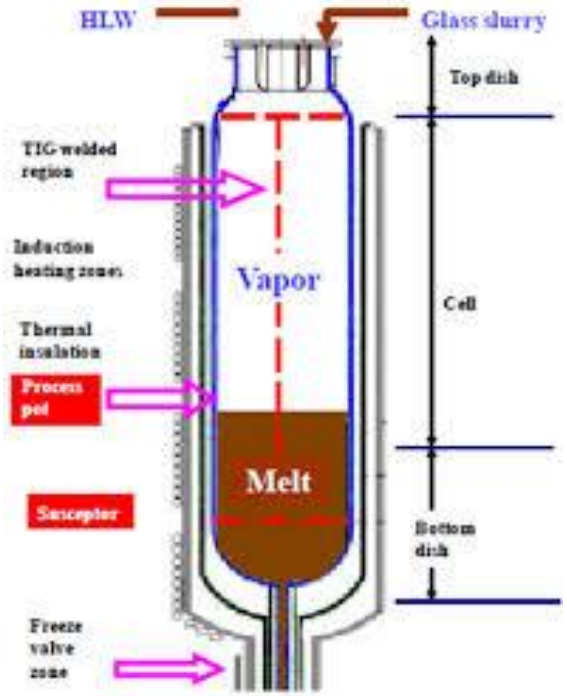
underground pipe or tunnel system for transporting sewage

# Dispose of Nuclear Hazards

## Vitrification

It is a process used to stabilize and encapsulate high-level radioactive waste

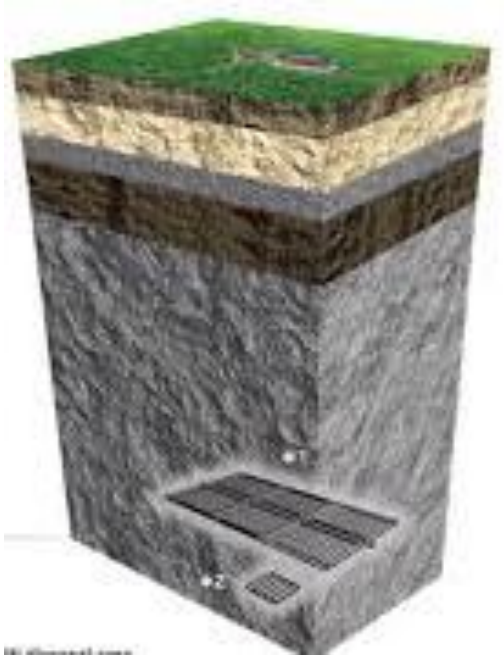
Radioactive waste is mixed with a substance that will crystallize when heated (e.g., sugar, sand) and then calcined.



# Dispose of Nuclear Hazards

## Geological Disposal

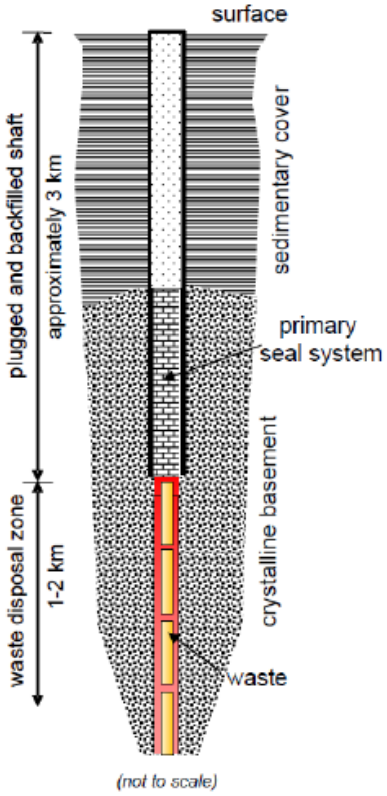
- Burrowing underground which is out of human reach.
- The waste is contained inside multiple barriers to provide protection over hundreds of thousands of years.
- The multiple barriers that provide safety for geological waste disposal are a combination of:
  - high level waste that arises initially as a liquid is converted into a durable, stable solid glass form before storage and disposal
  - the packaging of the waste
  - engineered barriers (buffer) that protect the waste packages
  - stable geological setting (rock) in which the facility is sited



# Dispose of Nuclear Hazards

## Deep Boreholes

- disposal seeks to place the waste as much as five kilometres beneath the surface of the Earth.
- safely isolate the waste from the biosphere for a very long period of time so that it should not pose a threat to humans



Thank you