

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.

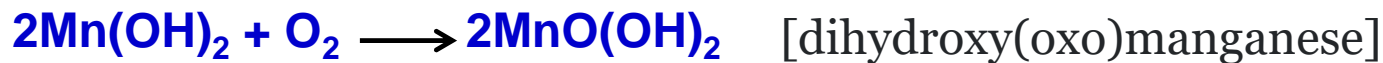
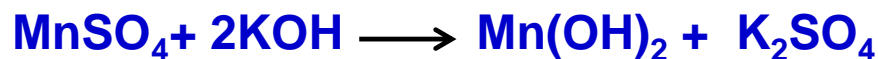
# What is it important?

- 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 ( $\text{mg O}_2 \text{ L}^{-1}$ ) 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.

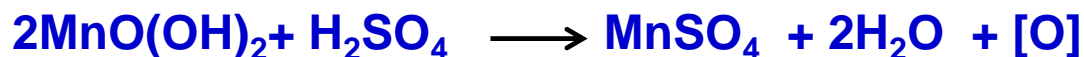
# Determination of DO (Winkler's method)

- 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,  $N_1V_1 = N_2V_2$

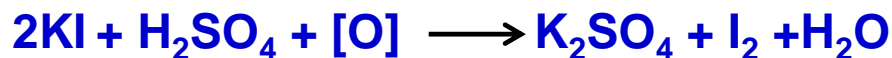
- ❑ DO measurement is based on the fact that dissolved oxygen oxidizes KI and liberate  $I_2$ . The liberated iodine is titrated against thiosulphate solution using starch as an indicator.
- ❑ Since dissolved  $O_2$  in water is in molecular state, it as such cannot oxidize the KI. Hence manganese hydroxide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



- ❑ The brown precipitate dissolves on acidification liberates nascent oxygen



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



**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



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



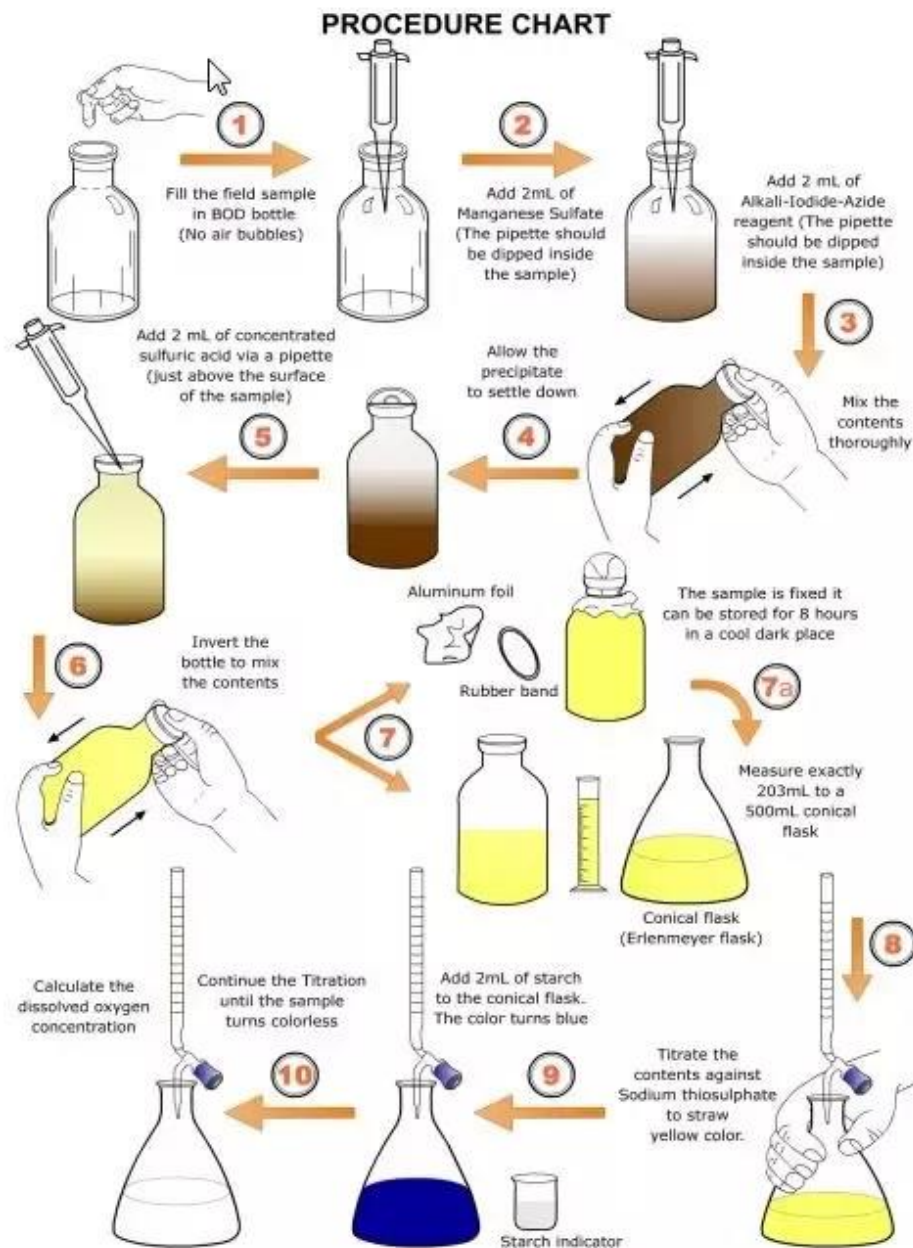
So, we know the strength ( $N_1$ ) and volume ( $V_1$ ) of  $\text{Na}_2\text{S}_2\text{O}_3$ , and volume of water sample ( $V_2$ ).

$$N_1 V_1 = N_2 V_2$$

$$N_2 = M(N)$$

This means  $M(N)$   $\text{I}_2$  or  $[\text{O}]$  is present in the solution.

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



The stoichiometric expression relating DO and sodium thiosulfate is given below

$$\text{DO} = \frac{\text{Volume of Na}_2\text{S}_2\text{O}_3 \times \text{Strength of Na}_2\text{S}_2\text{O}_3 \times 8 \times 1000}{\text{Volume of Sample water}} \text{ mg/ lit}$$

$$\text{DO} = \frac{\text{Volume of Na}_2\text{S}_2\text{O}_3 \times \text{Strength of Na}_2\text{S}_2\text{O}_3 \times 8 \times 1000}{100 \text{ mL}}$$

If 100 mL of sample water is used:

$$\text{DO} = \text{Volume of 0.0125 N Na}_2\text{S}_2\text{O}_3 \text{ mg/lit}$$



# 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<sub>5d</sub>** expressed in mg/liter

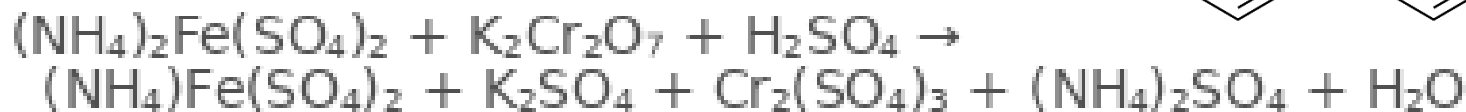
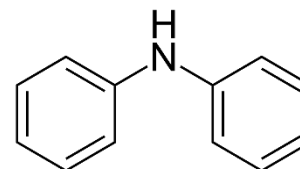
$$\text{BOD}_{5d} = \text{DO}_{\text{initial}} - \text{DO}_{\text{after 5days of incubation}}$$

# 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  $CO_2$  and  $H_2O$  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  $H_2SO_4$  medium and the excess of  $Cr_2O_7$  (dichromate) is titrated against **ferrous Ammonium Sulfate  $[Fe(NH_4)_2(SO_4)_2]$  solution.**
- **The amount of dichromate consumed is proportional to the  $O_2$  required to oxidize the organic matter.**

➤ Diphenylamine use an indicator for this process.

Dichromatic titration



**Color will change green to violet**

organic matter +  $\text{K}_2\text{Cr}_2\text{O}_7$  +  $\text{H}_2\text{SO}_4$  + cat.



$\text{CO}_2$  +  $\text{H}_2\text{O}$  +  $\text{Cr}^{3+}$

## Titration

$\overset{+6}{\text{K}_2\text{Cr}_2\text{O}_7} + (\text{NH}_4)_2\overset{+2}{\text{Fe}}(\text{SO}_4)_2 + \text{H}_2\text{SO}_4$



**Diphenylamine** as indicator  
Green

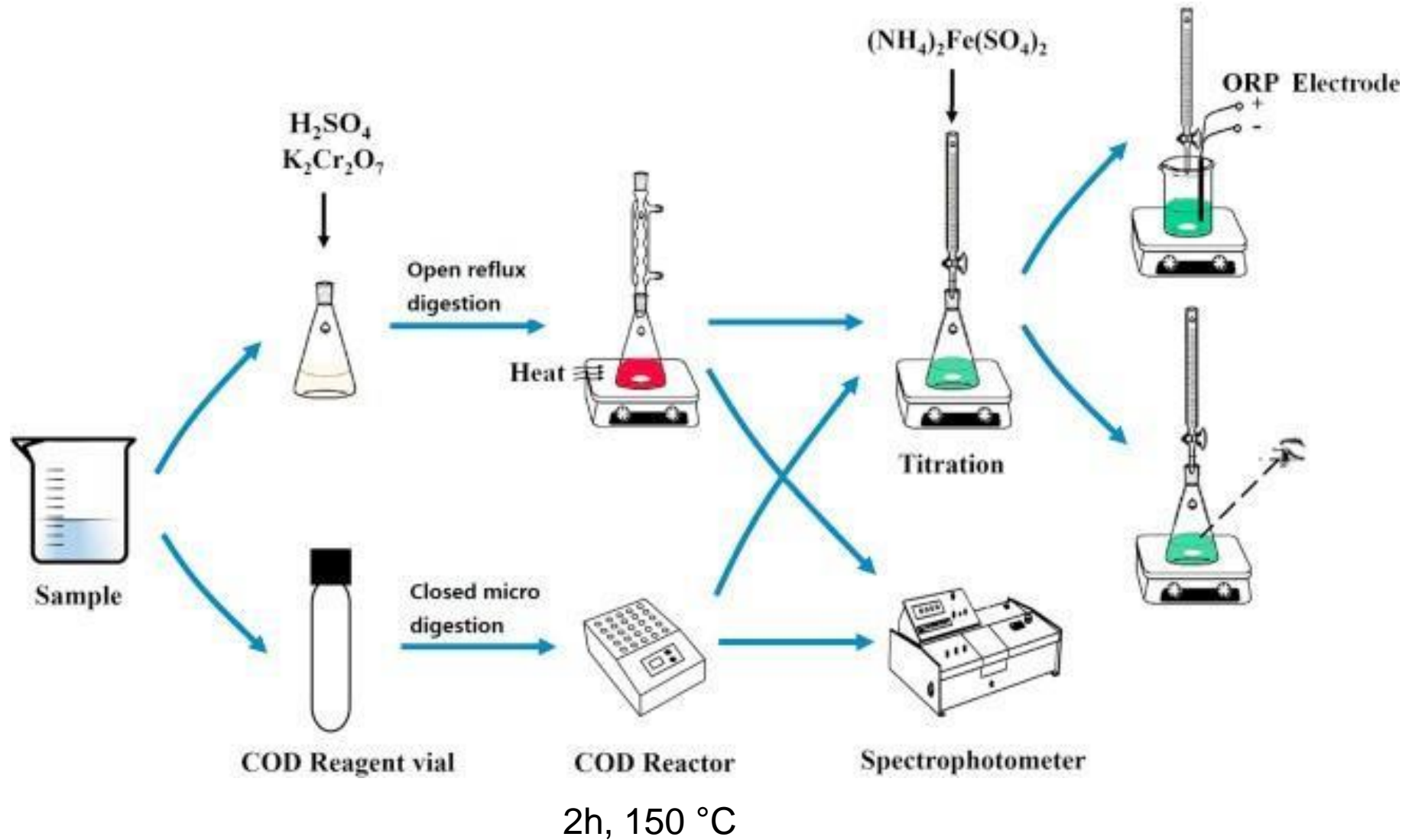
$\text{Cr}^{3+}$  +  $\text{Fe}^{3+}$  +  $\text{H}_2\text{O}$

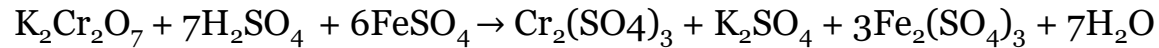
Violet /Wine red

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  $\text{O}_2$  required to oxidize the organic matter.

# COD test by $K_2Cr_2O_7$





Blank Titration: Distilled water  $\rightarrow$   $V_1$  mL of  $\text{FeSO}_4$

Back Titration: Sample water  $\rightarrow$   $V_2$  mL of  $\text{FeSO}_4$

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

# 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

- **AAS (Atomic Absorption Spectrometry)**
- **ICP-AES (Inductively Coupled Plasma atomic Emission spectroscopy)**



## 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

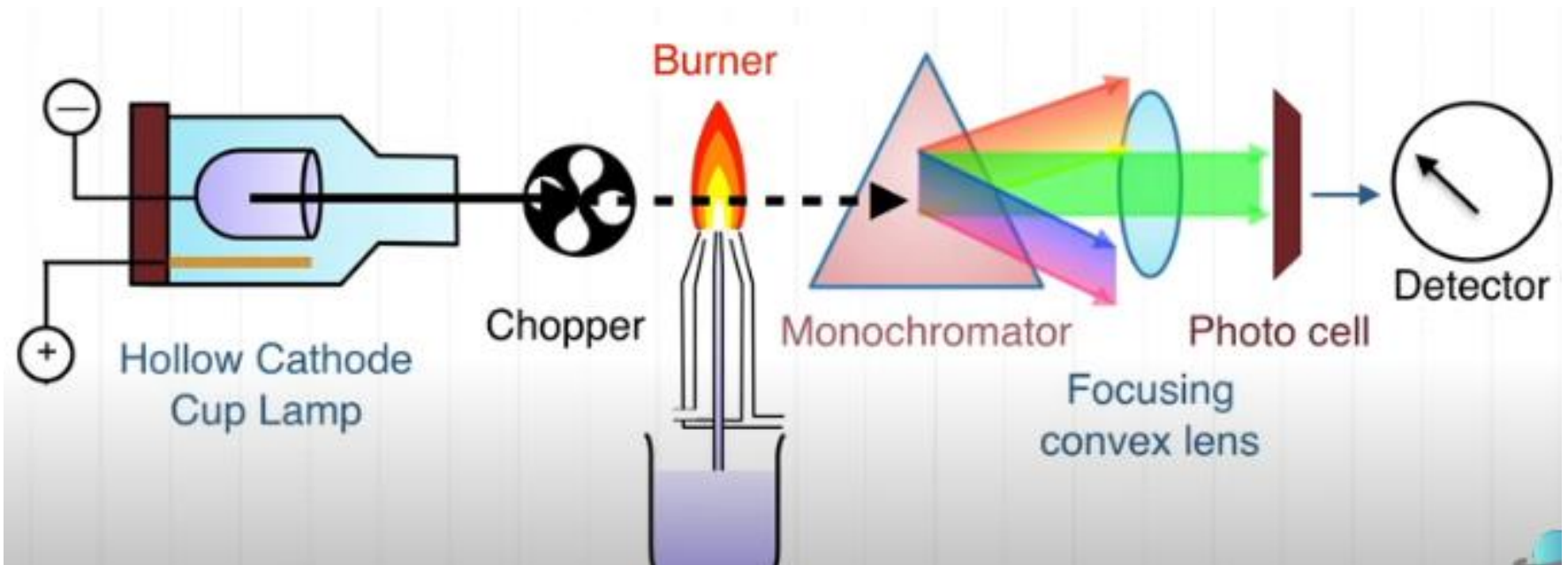
### 1. Atomic Absorption Spectrometry (AAS)

### 2. Inductively Coupled Plasma (ICP).

## 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.

Thank you