

WATER POLLUTION



Water Pollution

- ❖ Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.



- ❖ It is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels.

Effects of Wastewater

Water pollutants may be broadly classified into two groups:

- ❖ Substances which are directly poisonous/toxic themselves like
 - ❖ Suspended matter
 - ❖ Organic or inorganic poisons such as cyanides
 - ❖ Pollutants that degrade the waterbodies aesthetically
- ❖ Organic matter which undergo biological actions or oxidation and degrade into toxic substances or leads to depletion of dissolved oxygen.

Types of Water Pollution

❖ Physical Pollution

This is due to temperature, turbidity, suspended matter, colors, foam and froth and radioactivity.

❖ Chemical Pollution

This can be due to inorganic and organic chemicals. Inorganic chemicals include acids, alkalies, soluble salts, or heavy metals.

❖ Physiological Pollution

Taste and odour constitute physiological pollution. Water pollution by industrial wastes containing taste producing substances damage the values of fisheries.

❖ Biological Pollution

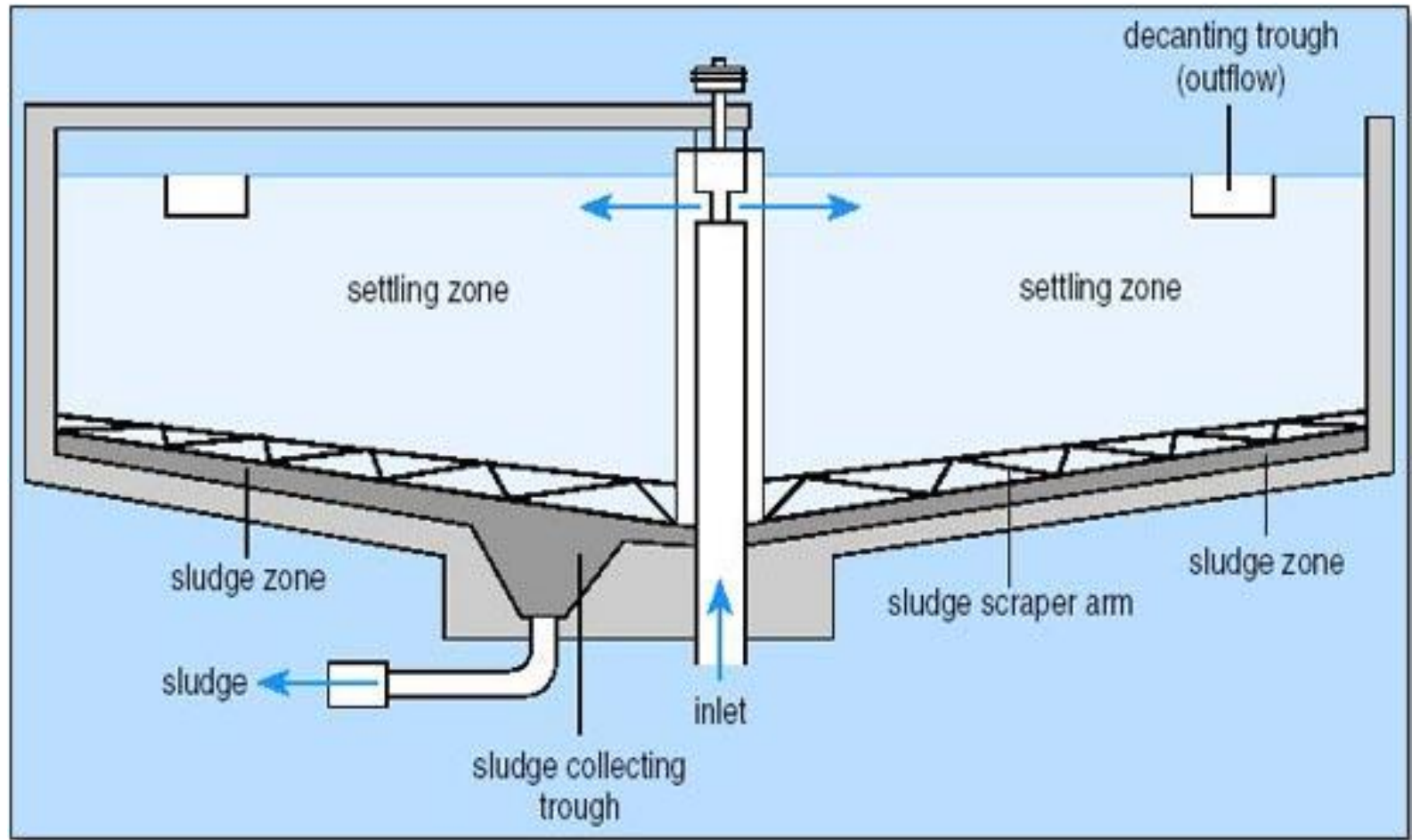
Biological pollution is a result of discharge of wastewaters containing pathogenic forms of bacteria, fungi, algae, viruses, protozoa and helminthic parasites.

Control of Water Pollution in Petroleum Refineries

❖ Primary Treatment methods

Stage1: Oil removal is done in small ponds or basin where major portion of oil is removed by using baffling, flotation and skimming methods.

Stage2: Oil removal is done by American Petroleum Institute separators or other gravity separators.

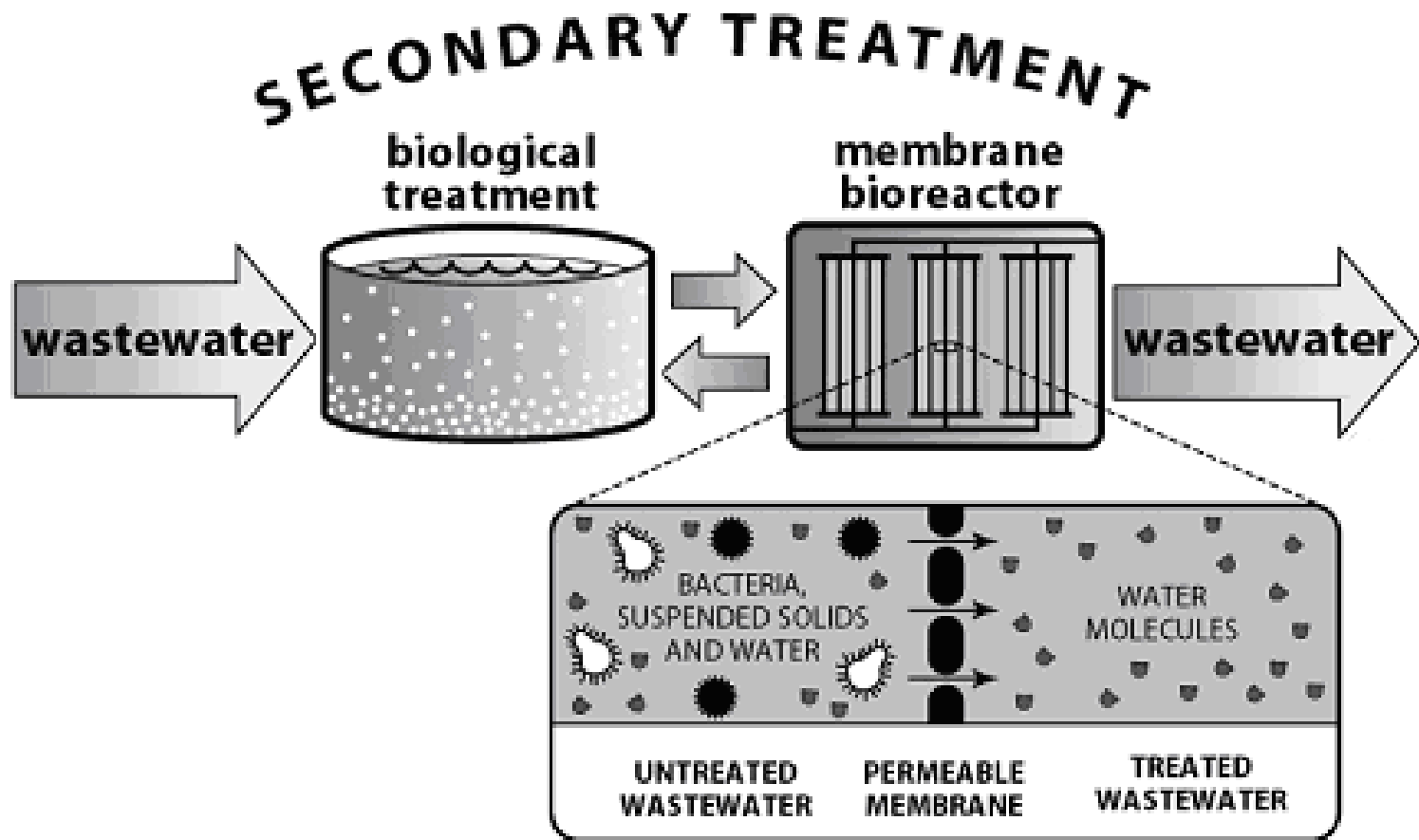


Settling: An example of primary treatment of was

❖ Secondary treatment methods

Chemical method: The main purpose of this method is to remove emulsified oil, suspended solids, toxic substances with addition of flocculating agents.

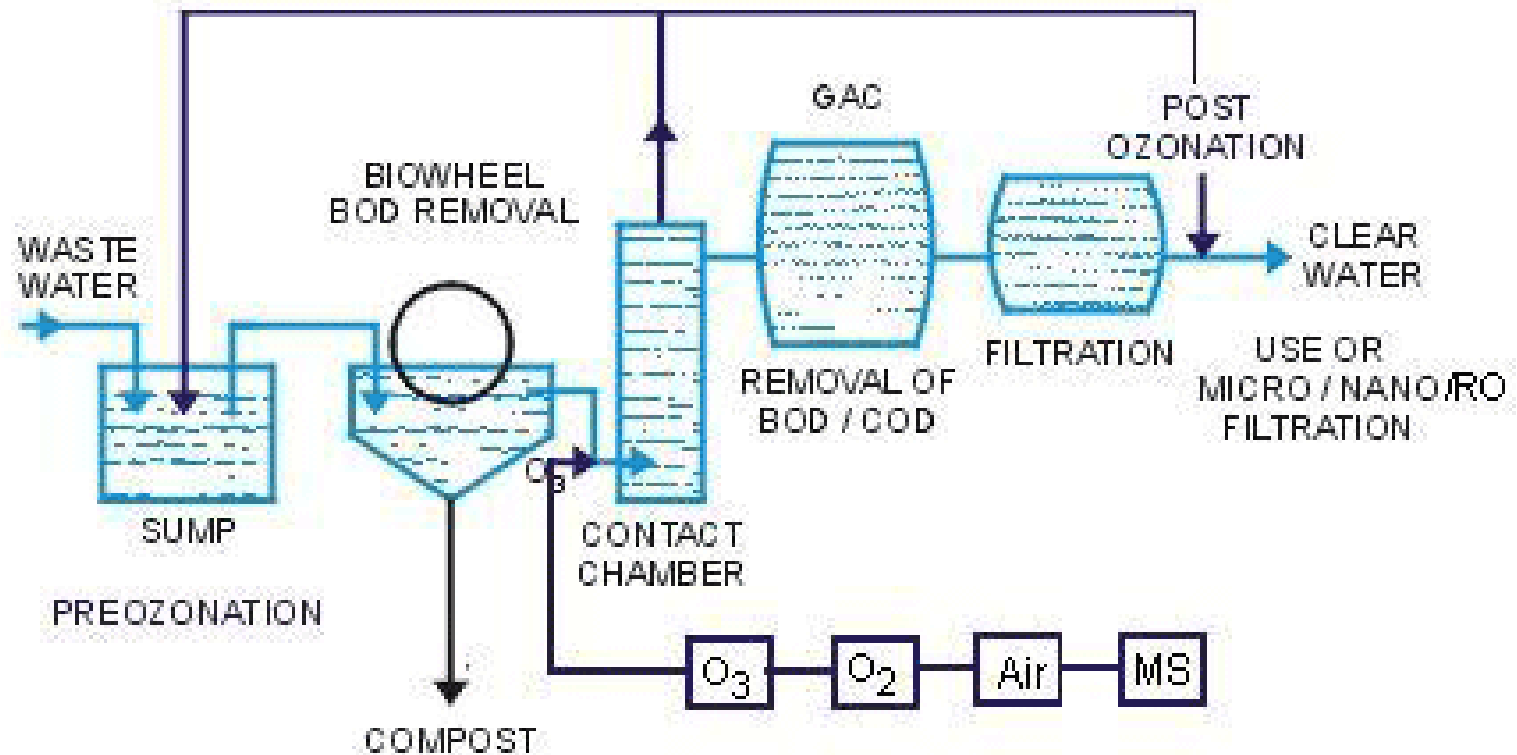
Biological method: This treatment aims at the removal of all oxidizable and organic matter from the wastewater by using activated sludge process, trickling filters, aerated lagoons and oxidation ponds.



Bio-chemical reactors: Secondary treatment

❖ Tertiary treatment methods

This treatment has been limited to activated carbon filtration process and ozonation which are effective in removal of the taste and odour and organics from biologically treated waste waters.



Ozonation and Filtration: Examples of Tertiary Treatment process

Control through reduction of hydrocarbon losses

- ❖ Careful draining from storage tanks while draining water.
- ❖ Periodic checking of cooling water for oil leaks to avoid operation of leaky coolers.
- ❖ Improved maintenance practices for pump gland packing.
- ❖ Inter-connection of gas blanketed tanks where fuel gas is used for gas

Standards for Discharge of Effluent Water

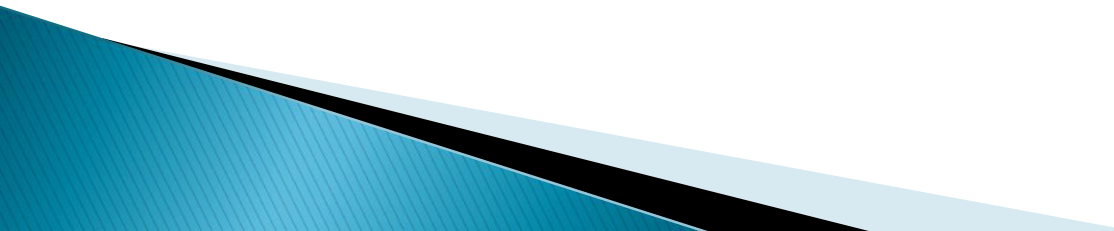
SL No.	Effluent characteristics	Tolerance limits					
		For inland surface waters subject to pollution		For effluents discharged on land for irrigation (IS : 3307-1977)	For effluents discharged into public sewers (IS : 3306-1974)	For effluents discharged into inland surface waters	For effluents discharged into marine coastal areas (IS : 7968-1976)
		For public water supply & for bathing ghats (IS : 2296-1974)	For irrigation (IS : 2296-1974)				
1.	TSS, mg/l, Max.	—	—	—	600	100	100
2.	Particle size of TSS, micron, Max.	—	—	—	—	850	3000 (floatable solids) 850 (settleable solids)
3.	TDS, mg/l, Max.	—	2100	2100	2100	—	—
4.	Temperature, °C, Max.	—	—	—	45	40	45
5.	p ^H	6.0-9.0	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
6.	BOD, mg/l, Max.	3.0	—	500	500	30	100
7.	COD, mg/l, Max.	—	—	—	—	250	250
8.	Dissolved oxygen, mg/l, Min.	3.0	—	—	—	—	—

9.	Oils and grease, mg/l, Max.	0.1	—	10	100	10	20
10.	Ammoniacal nitrogen (as N), mg/l, Max.	—	—	—	50	50	50
11.	Free ammonia (as NH ₃), mg/l, Max.	—	—	—	—	—	—
12.	Nitrates (as NO ₃), mg/l, Max.	50	—	—	—	—	—
13.	Sulphates (as SO ₄), mg/l, Max.	—	1000	1000	1000	—	—
14.	Phosphates (as P), mg/l, Max.	—	—	—	—	15	—
15.	Sulphides (as S), mg/l, Max.	—	—	—	—	2.0	5
16.	Fluorides (as F), mg/l, Max.	1.5	—	—	—	2.0	15
17.	Chlorides (as Cl), mg/l, Max.	600	600	600	600	—	—
18.	Cyanides (as CN), mg/l, Max.	0.01	—	—	2	0.2	0.2
19.	Lead (as Pb), mg/l, Max.	0.1	—	—	1	0.1	1.0
20.	Selenium (as Se), mg/l, Max.	0.05	—	—	—	0.05	0.05
21.	Zinc (as Zn), mg/l, Max.	—	—	—	1.5	5	5.0
22.	Copper (as Cu), mg/l, Max.	—	—	—	3	3.0	3.0
23.	Nickel (as Ni), mg/l, Max.	—	—	—	2	3.0	5.0
24.	Cadmium (as Cd), mg/l, Max.	—	—	—	—	2.0	2.0
25.	Hexavalent chromium (as Cr ⁶⁺), mg/l, Max.	0.05	—	—	2	0.1	1.0
26.	Mercury (as Hg), mg/l, Max.	—	—	—	—	0.01	0.01
27.	Arsenic (as As), mg/l, Max.	0.2	—	—	—	0.2	0.2
28.	Sodium (as Na), percent, Max.	—	60	60	60	—	—
29.	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max.	0.005	—	—	5	1.0	5.0
30.	Residual chlorine (as Cl), mg/l, Max.	—	—	—	—	1	1

SLUDGE TREATMENT AND DISPOSAL



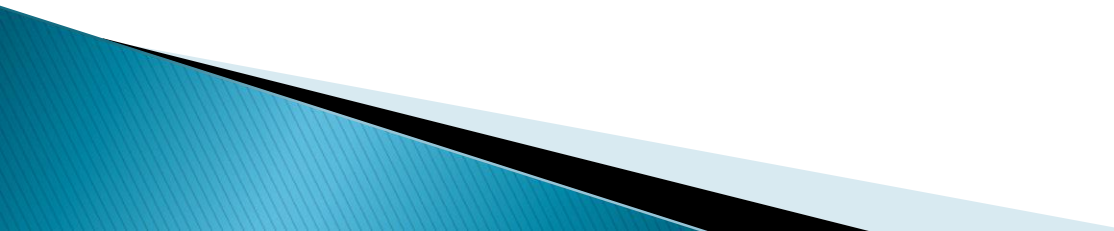
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 - ▶ SLUDGE TREATMENT PROCESS
 - ▶ SLUDGE CHARACTERISTICS
 - ▶ SLUDGE DISPOSAL
 - ▶ METHODS FOR SLUDGE DISPOSAL
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INTRODUCTION

- ▶ It is the suspension of solids in process waters and aqueous wastes
- ▶ Sludge from petroleum refineries contains:
 - crude tank bottoms
 - slop oil emulsion sludge
 - cooling tower sludge
 - lube oil filter cake
 - heat exchanger bundle cleaning sludge
 - FCC catalyst fines

SLUDGE TREATMENT

- ▶ The sludge is treated before its disposal in the following steps :
 1. Sludge conditioning
 2. Sludge thickening
 3. Dewatering of sludge
 4. Oil and hazardous waste separation
 - ▶ Sludge disposal
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CHARACTERISTICS OF SLUDGE

- ▶ Sludge is characterised by its
 - pathogenicity
 - toxicity
 - rheological properties
 - corrosivity
 - irritancy
 - flammability
 - explosivity
 - combustibility
 - filterability

SLUDGE CONDITIONING

- ▶ To increase solids concentrations, improve recovery and reduce thickening time sludge conditioning is done. It is achieved either by chemical addition or thermal treatment.
- ▶ **Chemical conditioning** – It involves use of either inorganic (lime, ferrous and ferric sulphates, ferric chloride and alum) or organic (polyelectrolytes/ polymers) chemicals.
Organic chemicals are preferred over inorganic ones due to reduction in handling, storage and equipment problems.

- ▶ **Thermal conditioning** – It improves the dewaterability of the sludge.

The advantages of this process are:

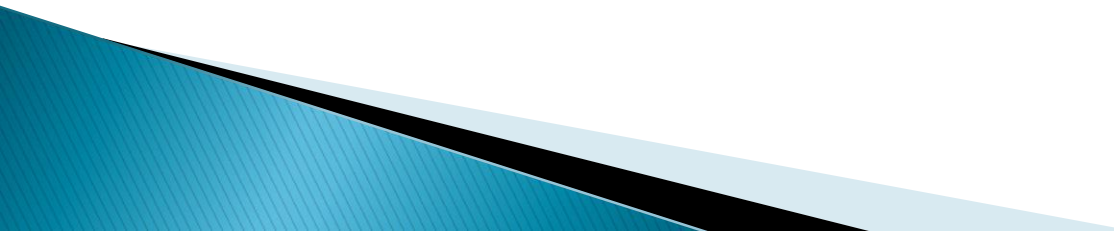
reduced solids quantity, low filtration resistance, sterilization, enhanced activated sludge digestion

The disadvantages are:

Complex equipment arrangements, potential for corrosion, high energy requirements, odour problems, production of side stream waste

- **Lime stabilization** – Lime is added to sludge to raise its pH to more than 12 to reduce microorganisms and control odour.

SLUDGE THICKENING

- ▶ The thickening of sludges remove excess water to reduce the volume of sludge.
 - ▶ The thickening methods used are :
 1. Gravity thickening
 2. Floatation thickening
 3. Centrifugal thickening
 4. Gravity belt thickening
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DEWATERING OF SLUDGES

- ▶ For efficient handling the thickened sludge is dewatered.
- ▶ The selection of dewatering equipment depends on the requirements for subsequent treatment or disposal.
- ▶ The processes for dewatering are :
 1. Non-mechanical systems : sludge drying beds and drying lagoons
 2. Centrifugation : solid-bowl decanter , imperforate basket
 3. Filtration system : belt filter , plate pressure filter , vacuum filter
 4. Heat drying

OIL AND HAZARDOUS WASTE SEPARATION

- ▶ Sludge is mainly produced by the oil content of the effluent.
- ▶ The free and emulsified oil can be recovered by
 1. Deemulsification
 2. Gravity separation
 3. Air floatation
 4. Flocculation
 5. Coagulation
- ▶ But the remaining oil which is not removed by these processes is recovered using special techniques :
 1. Three phase high speed separator
 2. Microwave radiation
 3. Low temperature thermal treatment process
 4. Solvent extraction process

▶ **THREE PHASE HIGH SPEED SEPARATOR :**

The sludge is heated to lower its viscosity and is fed through a perforated metal plate to a three phase high speed centrifuge.

Oil-based or water-based demulsifiers are added to remove oil.

□ **MICROWAVE RADIATION :**

Oil is recovered by heating through microwave radiation of 915– 2450 MHz. Due to this the viscosity reduces and coagulation becomes easier resulting in faster oil separation.

▶ **LOW TEMPERATURE THERMAL TREATMENT :**

In this process an indirectly heated rotary dryer is used to volatilize water and dust formation. An inert carrier gas transports the volatilized components to a gas treatment train which removes entrained solid particles with a scrubber.

▣ **SOLVENT EXTRACTION PROCESS :**

This is the most efficient process for removing oil. Chloroform is added to recover the oil.

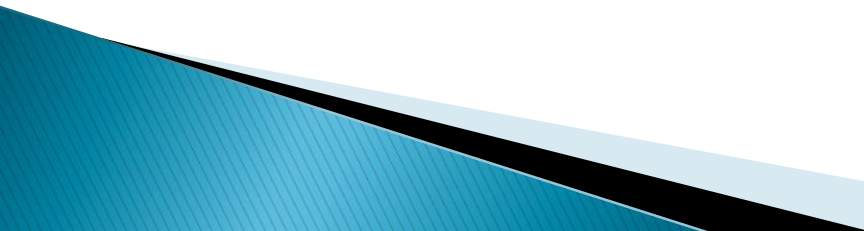
Triethyl amine is a commonly used solvent.

SLUDGE DISPOSAL

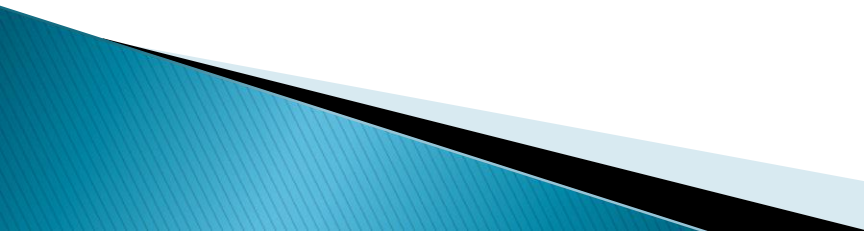
- ▶ The methods of disposal of the treated sludge are :
 1. Incineration
 2. Pyrolysis
 3. Direct disposal

INCINERATION

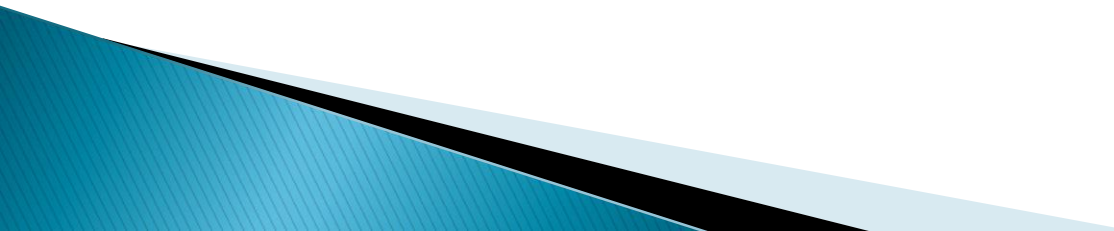
- ▶ It is the combustion of a material in presence of a stoichiometric quantity of air.
- ▶ The products from incineration are carbon dioxide , water and ash.
- ▶ The benefits of using incineration are :
- ▶ Reduced waste volume , complete elimination of bacterial and viral constituents , destruction of toxic organic compounds
- ▶ For incineration the sludge must contain significant organic component.
- ▶ An incinerator consists of a waste storage and feeder, a combustor, energy–recovery system, gas cleaning equipment, ash handling equipment and discharge system of the cleaned gas

- ▶ The types of incinerators used are:
 1. Multiple hearth furnace
 2. Fluidized bed incinerator
 3. Liquid waste incinerator
 4. Direct flame incinerator
 5. Rotary kiln
 6. Wet air oxidation
 - ▶ The multiple hearth furnace and fluidized bed incinerator are most commonly used.
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PYROLYSIS

- ▶ The carbonaceous materials are thermally decomposed into fuels by indirect heat transfer.
 - ▶ The mixture of gases that are produced as a result of pyrolysis can be used as fuels or for the synthesis of other fuels.
 - ▶ The conventional methods of pyrolysis do not provide good burnout of solid material hence the residue contains high carbon content which is again a disposal problem.
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DIRECT DISPOSAL

- ▶ Sludge contains majority of essential nutrients for plant growth and hence are used as fertilizer supplements.
 - ▶ The sludge is directly disposed on agricultural systems and forests.
 - ▶ But the presence of high concentration of heavy metals in some sludges poses a problem to the crop.
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THANK YOU

