ENVIRONMENTAL ENGINEERING

Chapter 7 : Hazardous Waste Management

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Chapter Description

- Topic
  - Definition and classification of hazard waste
  - Hazardous waste management
- Topic Outcomes
  - Quantify the wastes that fall in hazardous waste category
  - Relate the appropriate methods to manage the different types of hazardous wastes
- References

  - Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., Environmental Engineering, McGraw Hill, 1985.
  - Mackenze, I.D., Introduction to Environmental Engineering, 4th Edition, Davis A. Cornell, Mc Graw Hill, 2008.
  - Sawyer, C.N. Chemistry for Environmental Engineerin. 4th Edition, McGraw Hill, 1994.
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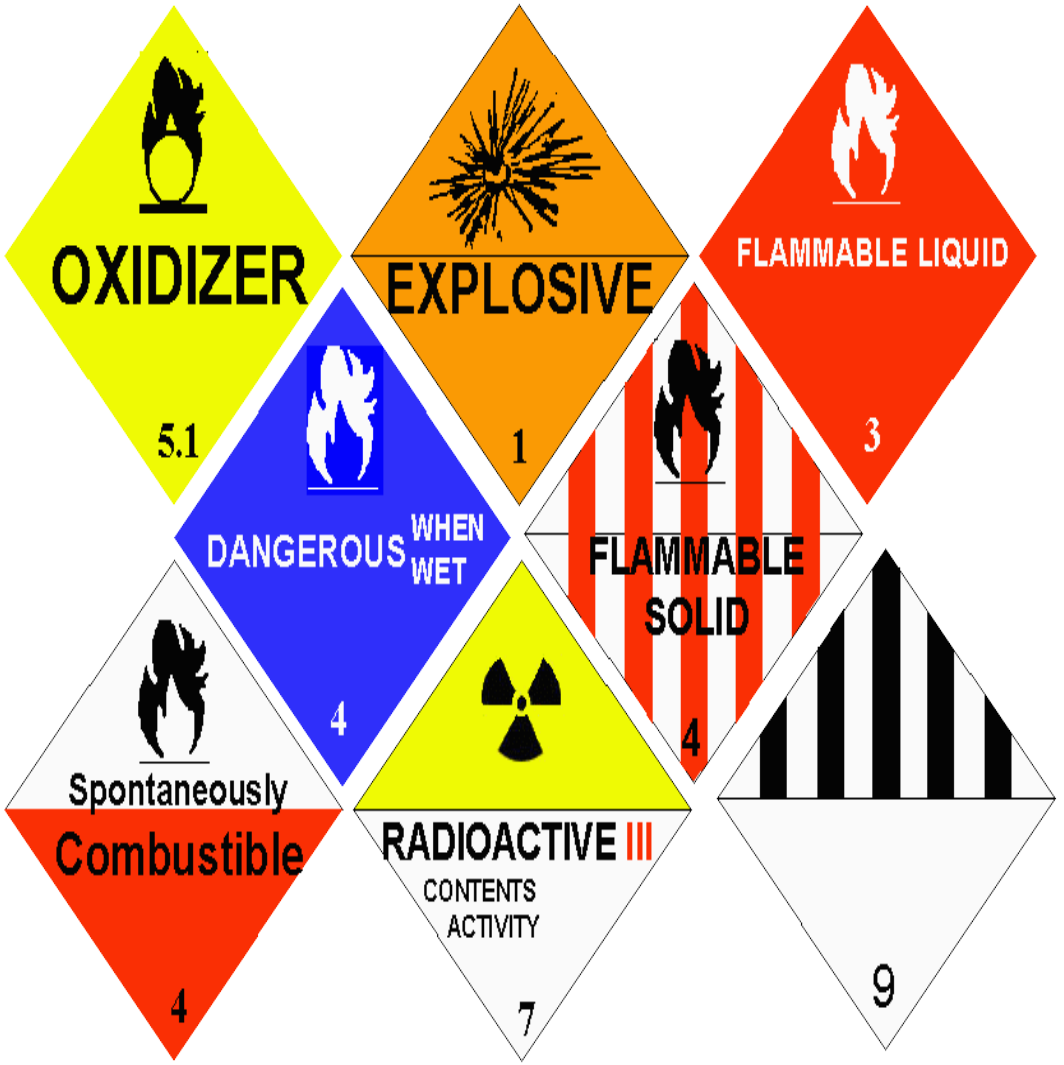
  - Environmental Quality Act 1974 (Subsidiary Legislation), International Law Book, Service June 2002.

HAZARDOUS WASTE

- Definition and classification
- Hazardous waste management
- Treatment technologies



Definition

Any waste/combination of waste that poses a substantial danger, now or in the future, to human, plant, or animal life and which cannot be handled or disposed without special precautions.

Characteristics

Ignitable

A substance that can explode, catch on fire or emit toxic fumes or gases into the environment

e.g.: fuels, some cleaning fluids, some furniture polishes.

Corrosive

- A highly acidic or base substance corrodes storage containers or damages human tissue if touched.
- Aqueous and has pH (≤2 or ≥12.5)

e.g.: battery acid, pool cleaner.

Reactive

- An unstable substance that react strongly (including explode) if explode to heat, shock, air or water.
- When mixed with water, generates toxic gases, vapors, fumes in a quantity sufficient to present danger (human health and environment)

Toxic

A substance that is potentially harmful to human health, can cause cancer or birth defects and can contaminate, harm and kill fish and wildlife.

e.g.: lead, mercury, pesticide

Hazardous waste management

- Waste minimization
  - Reduce the amount of waste generated.
  - Waste audit.
- Waste exchange
  - One's factory hazardous waste can become other's feedstock (acid/solvent waste from some industry can be utilized by others without processing).
- Recycle
  - Metals, energy contents and other useful resources contained in hazardous waste.

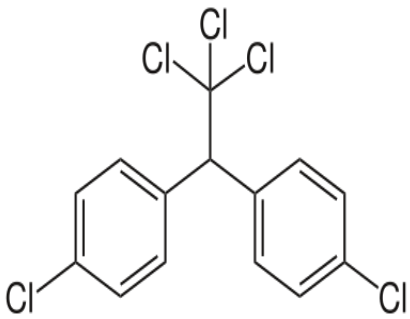
TREATMENT TECHNOLOGIES

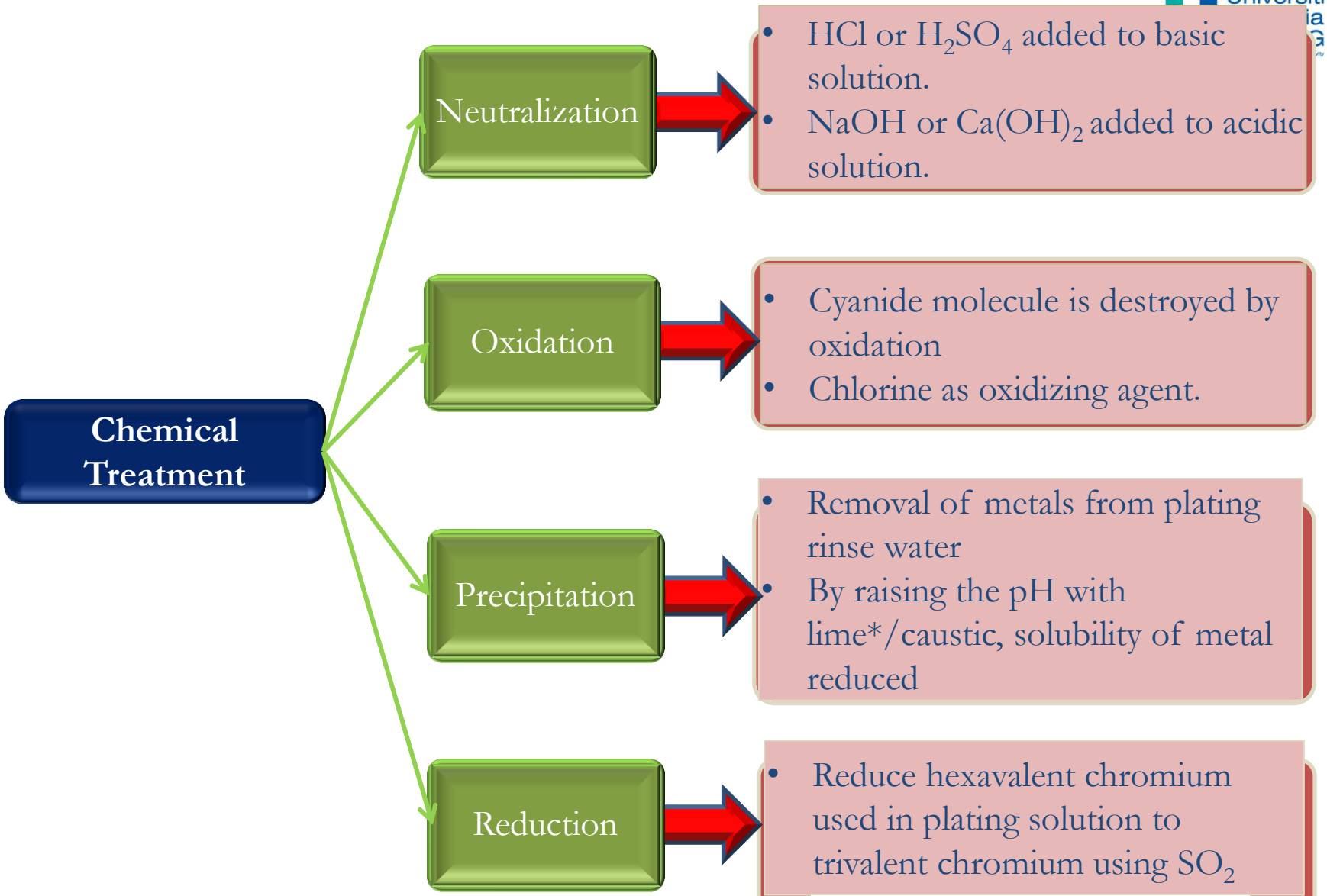
Biological treatment

- Reductive halogenation- microorganism accepts reduced organic compound and transfer them to halogenated compound.
- Activated sludge and trickling filters.

Example:

- DDT (*d*ichloro*d*iphenyl*t*richloroethane) – degraded by white rot fungus found on decaying tree.
- DDT is one of the most famous pesticides in the world, and it has been with us for quite a long time.





*Lime is a calcium-containing inorganic material in which carbonates, oxides and hydroxides predominate.

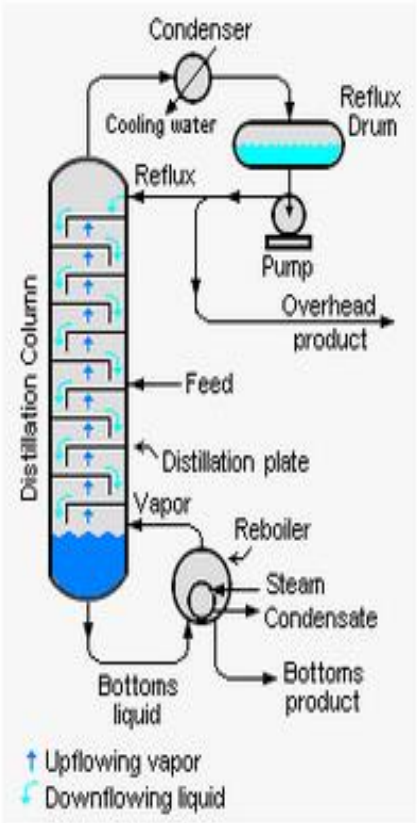
Physical/ chemical treatment

1- CARBON ADSORPTION

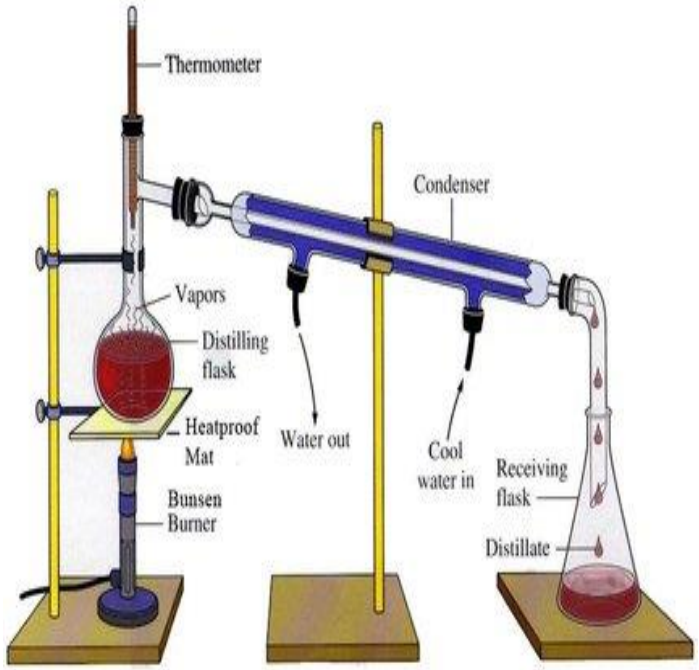
- Mass transfer process in which gas vapors/chemicals are held onto solid by intermolecular forces
- Common adsorbents: activated carbon, molecular sieves, silica gel.

2- DISTILLATION

- Separation process of more volatile material from less volatile materials.
- Types: batch, fractionation, steam stripping, thin film evaporation



Distillation column



Fractional distillation

3- ION EXCHANGE

- Waste stream containing the ion to be removed is passed thru a bed of resin
- H_2 or Na is exchanged for cations (metal).

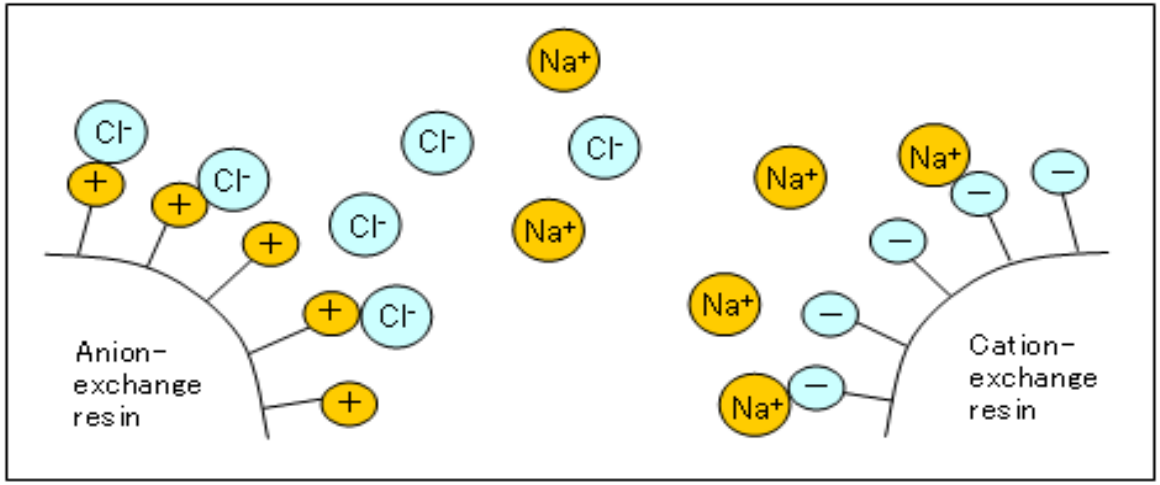
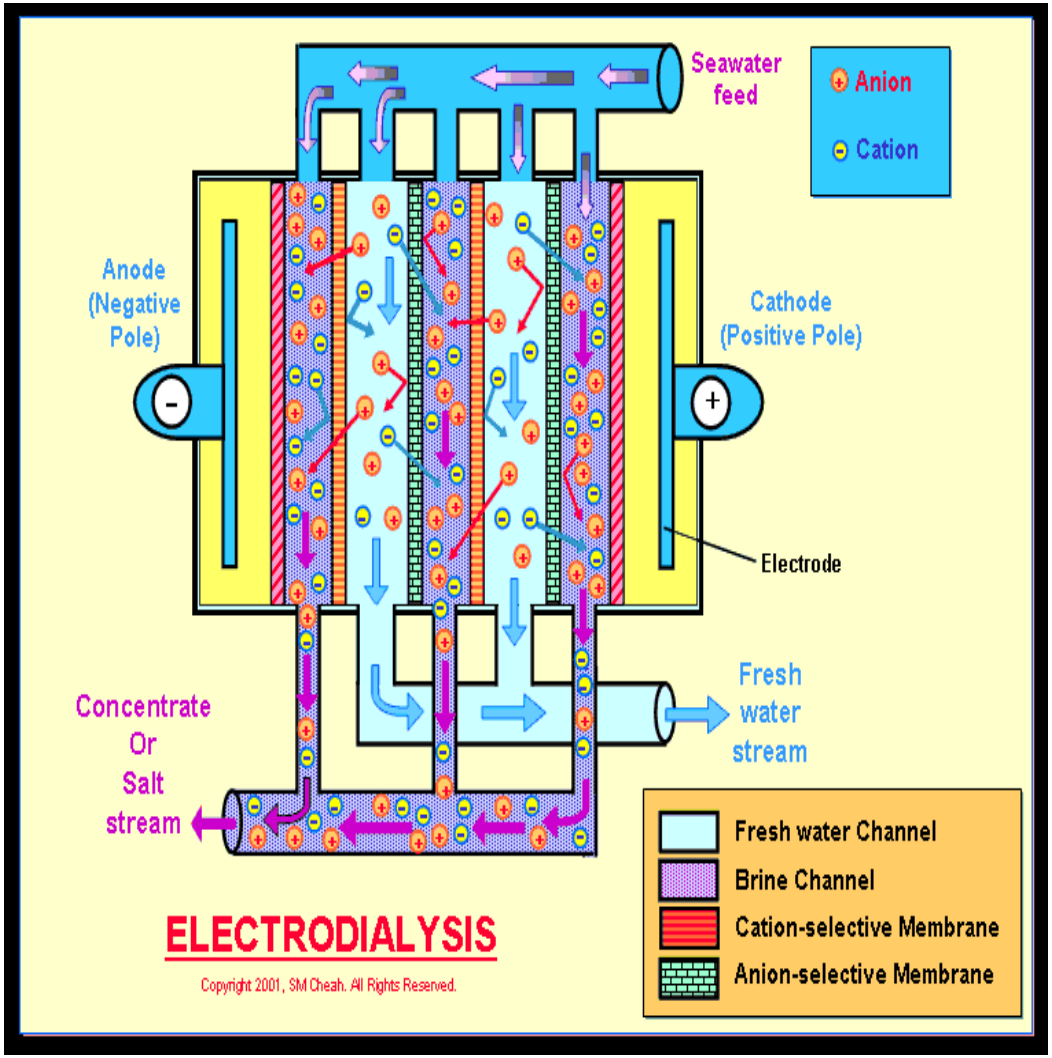


Figure 1. Pattern diagram illustrating ion exchange mode

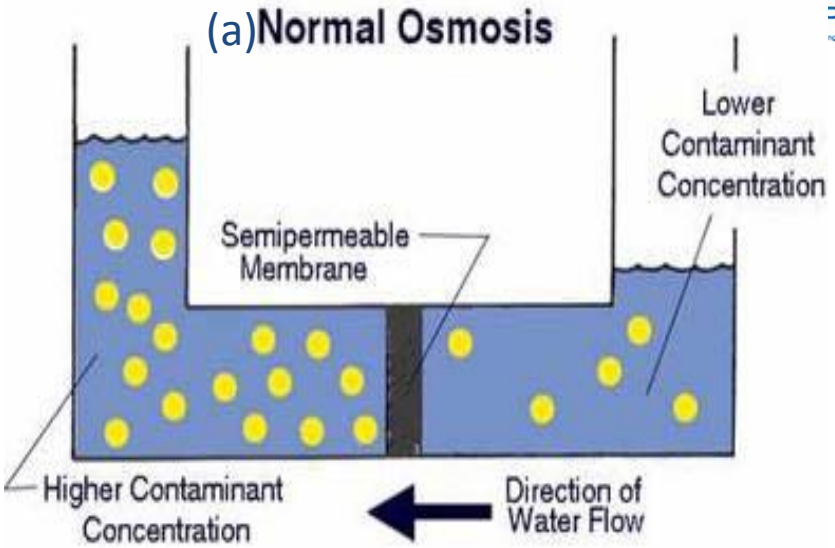
4- ELECTRODIALYSIS

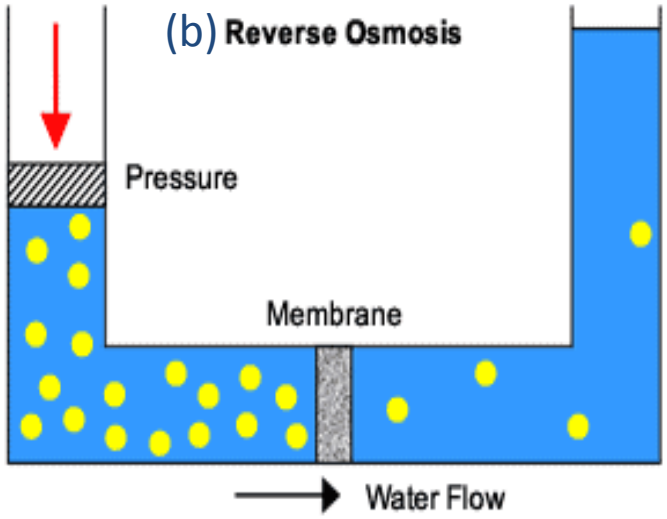
- Uses membrane to selectively retain or transmit specific molecules.
- Used in production of potable water from brackish water, de-ashing of sugar, recover waste developer in the photo processing industry.



5- REVERSE OSMOSIS

- Transport of solvent from dilute solvent to concentrated solvent across semipermeable membrane
- Solute in metal, solvent is pure water





The difference between (a) normal osmosis and (b) reverse osmosis

6- SOLVENT EXTRACTION

- Also known as liquid extraction.
- Contaminants is removed when the wastewater contacted with a solvent having a greater solubility from the contaminants.
- Used in food processing, pharmaceuticals, and petroleum industry.

Source:https://upload.wikimedia.org/wikipedia/commons/thumb/a/a4/Separatory_funnel_with_oil_and_colored_water.jpg/529px

7- INCINERATION

- Incineration is the waste treatment process that involve in the combustion of organic compounds contained in waste materials.
- Chemicals are decomposed by oxidation at high temperatures (800°C and greater).
- Primary product from combustion: CO2, water vapor and inert ash.
- Advantages:
  - Basic technology is available & well developed.
  - Applicable to most organic waste and can be scaled to handle large volumes of liquid waste.
  - Large & expensive land areas are not required.
- Disadvantages:
  - The equipment tend to be more costly and the process must meet regulatory requirement of air pollution control
  - Gaseous and particulate products of combustion maybe hazardous/ damaging properties

End of Chapter 7

Author Information

Credit to the author: Dr Norhanimah Hamidi