Industrial and Hazard Waste Management

TREATMENT OF AZARDOUS WASTES

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Introduction

The Waste Management Hierarchy

- In deciding on the best method for managing any waste there is a hierarchy for decision making which addresses issues such as sustainability, cleaner production, health, safety, and environmental protection.
- It is applied to existing or proposed practices, examining and testing these at each level, starting at the top of the hierarchy.
- For hazardous waste the hierarchy is as follows:
  - Eliminate the production of hazardous waste
  - Where elimination is not possible apply methods to reduce the quantity or hazard involved minimize amount of waste for disposal by recycling, reuse and/or recovery. This includes the recovery of energy which may be available from the waste.

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Introduction

- Treat waste to stabilise, immobilise, contain or destroy hazardous properties.
- Dispose of residues with a minimum of environmental impact.
- Appropriately contain, isolate and store hazardous waste for which no acceptable treatment or disposal option is currently available.

Cleaner Production

- Cleaner production refers to a precautionary approach which includes the goal of preventing the generation of hazardous waste.
- Minimizing the amount of hazardous waste produced would be one of the objectives of a cleaner production program.
- In many cases the introduction of cleaner production measures brings economic benefits in addition to savings in waste disposal costs.

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Introduction

Practice	Industry	Activity
Substitution	Leather production	Replacement of ammonium salts by carbon dioxide in dehairing operations
Process Change	Manufacture of plastic containers	Labels moulded into lids eliminating need for glues containing organic solvents
Reduction of Waste Quantity by Recycling/ Recovery and Reuse	Wire manufacturing	Recycling by sulfuric acid use for pickling mild steel
	Timber treatment	Recover of copper, chromium and arsenic and/or boron from sludges and reuse in wood treatment process
	Dry cleaning	Improved recovery of perchlorethylene
	Vehicle servicing	Recovery of used lubricating oils for -refining and reuse -use as a supplementary source of fuel in cement kilns

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Treatment of HWs

- The purpose of treating hazardous waste is to convert it into nonhazardous substances or to stabilize or encapsulate the waste so that it will not migrate and present a hazard when released into the environment.
- Stabilization or encapsulating techniques are particularly necessary for inorganic wastes such as those containing toxic heavy metals.
- Treatment technologies exist for most if not all hazardous wastes
- Treatment methods can be generally classified as chemical, physical and/or biological.

Chemical Methods

Neutralisation

Waste acid with an alkali e.g. sulfuric acid with sodium carbonate:

$$H_2SO_4 + CO_3^{2-} \rightarrow SO_4^{2-} + CO_2 + H_2O$$

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Chemical Methods

Oxidation

Using common oxidising substances such as hydrogen peroxide or calcium hypochlorite e.g. cyanide waste with calcium hypochlorite:

$$CN^- + OCl^- \rightarrow OCN^- + Cl^-$$
$$OCN^- + H_3O^+ \rightarrow CO_2 + NH_3$$

Reduction

Used to convert inorganic substances to a less mobile and toxic form e.g. reducing Cr(VI) to Cr(III) by the use of ferrous sulphate:

$$14H^+ + Cr_2O_7^{2-} + 6Fe^{2+} \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

Hydrolysis

Decomposition of hazardous organic substances e.g. decomposing certain organophosphorus pesticides with sodium hydroxide.

Precipitation

Particularly useful for converting hazardous heavy metals to a less mobile, insoluble form prior to disposal to a landfill e.g. precipitation of cadmium as its hydroxide by the use of sodium hydroxide:

$$Cd^{2+}(aq) + 2OH^- \rightarrow Cd(OH)_2(s)$$

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Physical Methods

Encapsulation

Immobilising hazardous materials by stabilisation and incorporation within a solid matrix such as cement concrete or proprietary organic polymers prior to andfilling. e.g. encapsulating beryllium in concrete

Filtration/Centrifuging/Separation

Physically separating phases containing hazardous substances from other nonhazardous constituents e.g. separation of oils from ship bilge waters.

Biological Methods

These involve the use of microorganisms under optimised conditions to mineralise hazardous organic substances e.g. the use of pseudomonas under aerobic conditions break down phenols.

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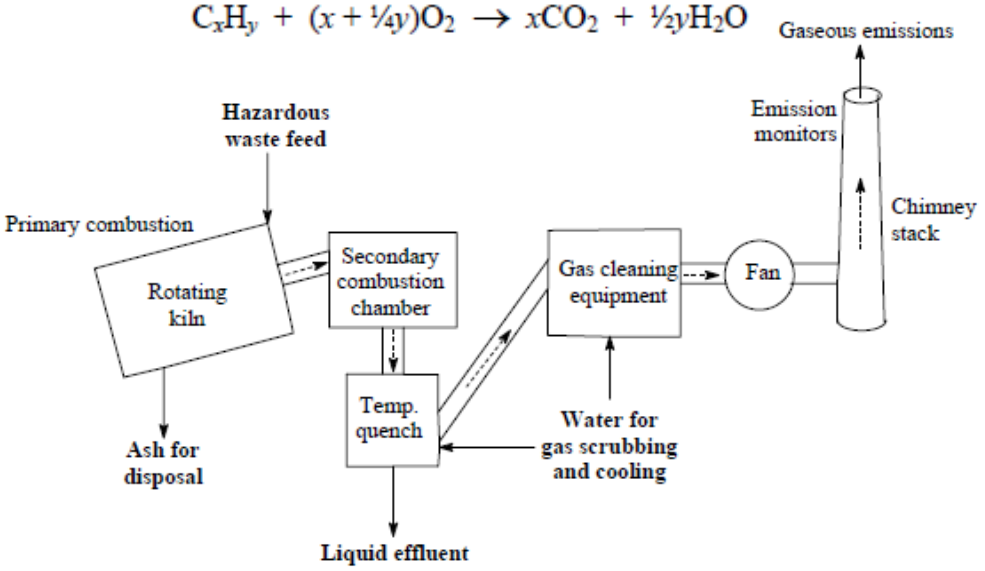
Thermal Methods

These are the treatment processes which involve the application of heat to convert the waste into less hazardous forms. It also reduces the volume and allows opportunities for the recovery of energy from the waste.

High Temperature Incineration

$$C_xH_y + (x + \tfrac{1}{4}y)O_2 \rightarrow xCO_2 + \tfrac{1}{2}yH_2O$$



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Thermal Methods

Use of Cement Kilns

- Kilns used for the production of cement clinker in the manufacturing of Portland cements are designed and operated in a manner that achieves the required parameters for the destruction of hazardous waste, such as time at high temperatures,
- Such wastes include PCBs, and waste chlorofluorocarbons (CFCs).
- An additional advantage from the use of cement clinker kilns is that the alkaline particulates involved act to neutralise acidic combustion products.

Plasma Arc

- A thermal process developed for commercial application uses the very high temperatures, in excess of 10,000K, which can be attained in arcs formed across high voltage electrodes.
- This is particularly useful for the destruction of difficult hazardous liquids and gases such as some of the halogenated organics.
- This process is particularly applicable for the destruction of waste halons and CFCs.

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Landfills as a Disposal Method

- some of the treatment processes discussed above result in residues that themselves require disposal.
- This disposal is best carried out in properly designed and operated landfills.
- Most refuse dumps or landfills can be classified into two categories according to the manner in which they have been designed, sited and installed, particularly with regard to leachate management: dilute and disperse, and containment landfills

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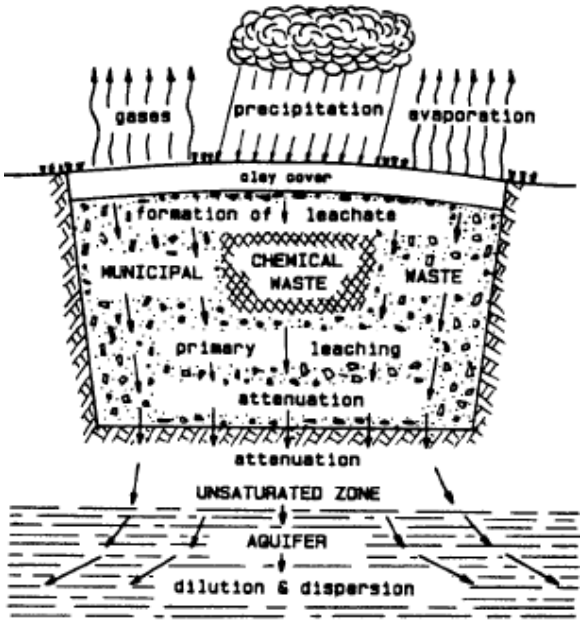
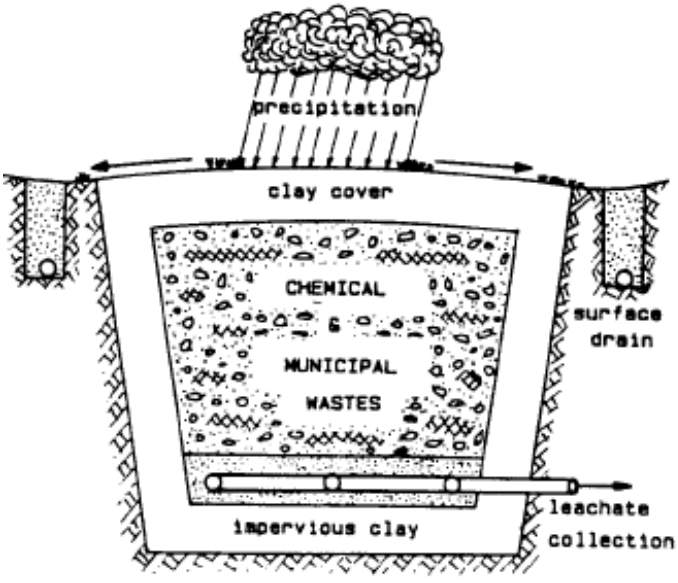
Landfills as a Disposal Method





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Landfills as a Disposal Method

Classification of Hazardous Wastes for Landfilling.

The CAE Report (1992) recommended that hazardous wastes be classified as follows in respect to acceptability for disposal by landfilling:

Type A. Those wastes unsuitable for landfilling in any quantity or in any type of landfill.

Type B. Wastes which could be suitable for placement in dedicated landfills. See, however, comments above relating to dedicated landfills.

Type C. Those wastes which may be appropriate for codisposal with normal municipal refuse under carefully managed conditions.