Hazardous Waste Management

Hazardous Waste

In addition to releasing gases and particles into the atmosphere, humans produce waste that is dumped on the environment. Often, this waste is hazardous and dangerous to both nature and human life. The levels of dangerous wastes continue to grow Industries and individuals continues to be largely unware of this environmental problems.

According to US Federal Resources Conservation and Recovery Act 1976, hazardous waste is defined as 'corrosive, ignitable, reactive or toxic or capable of posing substantial threat to the human health and environment and have to be treated separately from all over other waste'.

Chemical waste is considered hazardous waste if it is either listed as such, or if it exhibits one of the following hazardous characteristics

Ignitability It catches fire easily. Ignitable wastes are solid wastes that exhibit any of the following properties as defined at **40 CFR 261.21**. Ignitable wastes can creates fires under certain condition are spontaneously combustible, or have a flash point less than 60°C.

Reactivity It can react strongly with water and other chemically. Corrosive wastes are acids or bases that are capable of corroding metal containers, such as drums, and barrels.

Corrosiveness It can be corrosive and damages other material. Reactive wastes are unstable under 'normal' conditions. They can cause explosions, toxic fumes, gases or vapours when heated, compressed or mixed with wastes.

Toxicity These are toxic to the living system and produce symptoms like metabolic disorders, poisoning, disease, cancer and mutation. To identify toxic compound in the waste, TCLP (Toxicity Characteristic Leaching Procedure) is employed.

Radioactivity These may release harmful ionising radiation. Radioactive solid wastes containing radioisotopes with half-lives greater than 120 days are collected in white polypropylene pails lined with heavy yellow liners.

Carcinogenecity Substances which attacks on the normal cells of the body and causes cancerous growth of normal cells are called **carcinogens**.

Sources of Hazardous Waste

Some sources of hizardous wastes are as follows

Coal Industry Coal ash contains hazardous metals like copper, zinc, chromium, nickel, selenium, barium, antimony, mercury, arsenic, thallium and cadmium.

Petroleum Industry During extraction of petroleum natural gas, petroleum refining.

Metallurgical Industry During mining and benefication of ores extraction of metals from ores.

Electroplating Industry During manufacturing of mirrors and metal finishing operations.

Chemical Industry During the production of primary and inorganic chemical, pesticides, drugs, detergents and other chemicals.

Paints Industry During the production of inks, varnish, paints and glues.

Leather Industry Tanning of leather dyes and dye intermediates produce hazardous waste.

Textile Industry Laundering, bleaching and cloth dyeing.

Automobile Industry During servicing and repair of automobile engines, hazardous waste is produced.

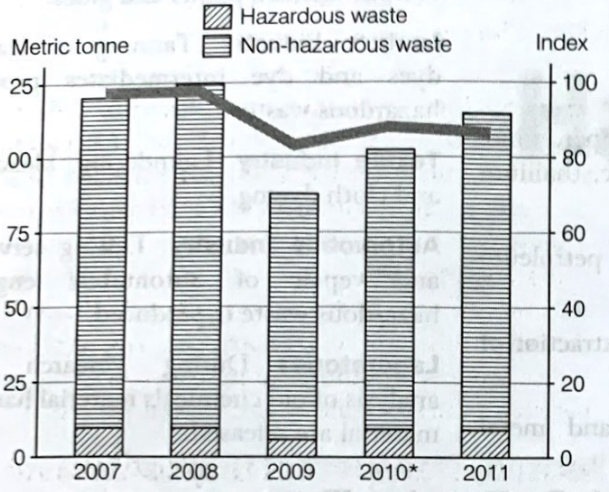
Laboratories During research and analysis of old chemicals material harmful material are released.

Categories of Hazardous Wastes As Per Hazardous Waste Management Handling Rules, 1989 (HOEF)

Waste Category Numbers	Type of Wastes	Regulatory Quantities
1.	Cynide wastes.	1 k/yr calculated as cyanide.
2.	Metal finishing wastes.	10 k/yr the sum of the specified substance calculated as pure metal.
3.	Waste containing water soluble chemical compounds of lead, copper, zinc, chromium and antimony.	10 k/yr the sum of the specified substance calculated as pure metal.
4.	Mercury, arsenic, thallium and cadmium bearing wastes.	5 k/yr the sum of the specified substance calculated as pure metal.
5.	Non-halogenated hydrocarbons including solvents.	200 k/yr calculated as non-halogenated hydrocarbons
6.	Halogenated hydrocarbon including solvents.	50 k/yr calculated as oil or oil emulsions.
7.	Wastes from paints, pigments, glue, varnish and printing ink.	250 k/yr calculated as oil or oil emulsions.
8.	Wastes from dyes and dye intermediate containing inorganic chemical compounds.	200 k/yr calculated as inorganic chemicals.
9.	Wastes from dyes and dye intermediate containing organic chemical compounds.	50 k/yr calculated as organic chemicals.
10.	Waste oil and oil emulsions.	1000 k/yr calculated as oil and oil emulsions.
11.	Tarry wastes from refining and tar residues from distillation or prolytic treatment.	200 k/yr calculated as tar.
12.	Sludgesarising from treatment of waste containing heavy metals, toxic organics, oils emulsions and spend chemical and inceneration ash.	Irrespective of any quantity.
13.	Phenols.	5 k/yr calculated as phenols.
14.	Asbestos.	200 k/yr calculated as asbestos.
15.	Wastes from manufacturing of pesticides and herbicides and residues from pesticides and herbicides formulation units.	5 k/yr calculated as pesticides and their intermediate products.
16.	Acid/alkaline/slurry.	200 k/yr calculated as acids/alkalies.
17.	Off-specification and discarded products.	Irrespective of any quantity.
18.	Discarded containers and containers linears of hazardous and toxic wastes.	Irrespective of any quantity.

Hazardous Waste Management

A well known British practices can be adopted to manage hazardous waste. These are BPEEO (Best Possible Environmental and Economic Option) and BATNEC (Best Available Technique Not Entailing Excessive Cost).



Total hazardous waste generated during 2007-2011

Hazardous waste can be managed in following ways

Minimising the Quantity of Waste

Utilisation of raw material should be optimised and generation of hazardous waste could be reduced, *e.g.,* In zinc electroplating chloride compound changes sulphate salt to eliminate cyanide. Waste could be concentrated using evaporation, precipitation or decapitation techniques.

Pretreatment of Waste before Disposal

Physical Treatment

It includes phase separation like lagooning, prolonged storage in tanks, sludge drying in beds. Particulate pollutants could be separated by it.

Commonly used physical processes are

1. Screening and sedimentation
2. Floatation
3. Filtration
4. Centrifugation
5. Dialysis
6. Electrodialysis
7. Reverse osmosis
8. Ultrafiltration
9. Distillation

Chemical Treatment

It facilitates the complete breakdown of waste through oxidation, chemical reduction, heavy metal precipitation, etc.

Commonly used physical processes are

Neutralisation It is used to reduce acidity and alkalinity of waste.

Precipitation It is a process of removing soluble compounds.

Dechlorination It is the process of stripping chlorine atoms from chlorinated compounds.

Oxidation It is a reduction process.

Solidification

This method is employed to convert liquid waste into an insoluble material, which could be used for landfilling. Hazardous components are immobilised.

Incineration

It is the process of destruction of highly toxic waste by burning the waste at very high temperature. At 1200°C all kinds of organic matter is mineralised into basic non-toxic components. Incineration serves the dual purpose of reduction of toxicity and the volume of waste. Dioxins, furans are the toxic compounds released during incineration.

Guidelines laid down by Ministry of Environment and Forest Government of India for the standards to be followed during incineration of toxic cation compounds are

(a) Combustion efficiency should be at least 99%

It is defined as $CE = \frac{\%\ CO_2}{\%\ CO_2 + \%\ CO} \times 100$

(b) Temperature in primary chamber of incinerator must be 750-800°C.

(c) Gas respond time in secondary chamber of incinerator must be 1s at 1000-1100°C with minimum 3% O_2.

(d) *Emission standards have been prescribed as follows*

Parameter	Concentration mg/nm^3 (12% CO_2 concentration)
Particulate matter	150
NO_x	450
HCl	50

(e) Volatile organic compounds in ash shall not be more than 0.01%.

(f) Minimum stack height shall be 30m above the ground.

(g) Chlorinated disinfectants should not be used for chemical treatment.

(h) Toxic metals in the incineration shall be present within regulatory quantities under hazardous waste management and handling rules, 1989.

(i) Low sulphur fuel must be used for incineration.

(j) Effluent generated from the hospitals must be within permission limits.

Parameter	Permissible Limits
pH	6.5-9.6
Suspended solid	100 mg/L
Oil and grease	10 mg/L
BOD	30 mg/L
COD	250 mg/L
Bio-assay test	90% survival of fish after 96 h in 100% effluent

Autoclaving Waste

It is subjected to wet heat sterilisation. It is applicable to treat biomedical waste. It is subjected to 121°C and pressure of 15 pounds per square inch (psi) for an autoclave and residence time not less than 60 minutes operational parameters, *which should be checked during the entire autoclave cycle are*

Validation Test Biological indicator for autoclave is *Bacillus stearothermophilus* spores strips. The autoclave should completely kill the biological indicator.

Routine Test A chemical strip or an indicator, which change its colour at certain temperature can be employed to check that specific temperature have been reached.

Characteristics of Hazardouss Wastes

Hazardous Characteristics	Potential Hazards on Living Animals/Environment
Flammable/ explosive	This type of waste may cause damage to the surroundings by producing harmful gases at high temperature and pressure or by causing fire hazards.
Oxidising	Type of wastes that may yield oxygen and thereby cause or contribute to the combustion of other materials.
Poisonous (acute)	These wastes have high potential to cause death, serious injury or to harm health if swallowed, inhaled or by skin contact.
Infectious substances	Hazardous wastes containing micro- organisms and their toxins and responsible for diseases in animals or humans.
Corrosives	These wastes are chemically active and may cause severe damage to the flora and fauna or to the other materials by direct contact with them.
Eco-toxic	These wastes may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.
Toxic (delayed or chronic)	These wastes, if inhaled or ingested or if they penetrate the skin, may cause delayed or chronic effects, including carcinogenicity.
Organic peroxides	These are organic waste containing bivalent—O—O— structure and may undergo exothermic self-accelerating decomposition.

Recycling of Hazardous Waste

There are various technologies recommended by the hazardous waste (Management and Handling) amendment rules, 2003. *Environmentally sound technologies include*

(i) Vacuum distillation with clay treatment.

(ii) Vacuum distillation with hydrotreating.

(iii) Thin film evaporation process.

(iv) Oil-refining uses combination of heat and pressure to remove the contaminants. Interline Resources Corporation USA has claimed for the patent for solvent extraction system without extensive heat and pressure. In this technology oil is mixed with solvent. This solvent has capacity of rejecting heavy metals and contaminants from the used oil and shows high selectivity for the hydrocarbon solvent is removed from the oil with help of solvent stripper. The remaining oil is distilled in a vacuum column to produce high quality base oil, tube stock diesel and bottom products.

Collection, Transport of Disposal Waste

The collection of hazardous waste from a source or in EPA terms, a 'generator' is also regulated. Before a transporter can move hazardous waste to a facility for treatment, recycling or disposal, the entity or individual must obtain an EPA identification number and comply with all laws regulating the transport of such materials.

Legislations and Regulations of Hazardous Waste

(i) Ministry of Environment and Forest (MOEF) is the nodal agency for environmental matters in India. It control over the import and export of hazardous waste under the hazardous waste rules. Hazardous Substances Management Division (HSMD) of MOEF (Ministry of Environment and Forest) deals with the management of both indigenous and imported hazardous chemical and major chemical accidents.

(ii) There are 36 types of industrial process listed in hazardous waste amendment rule, 2003. As per rule no. 11, import of hazardous waste from any country to India shall not be permitted for dumping. It is allowed on for processing or reuse as raw material.

(iii) 29 categories of hazardous waste is prohibited for import and export for each category OECD and basel number are mentioned.

(iv) Any person importing hazardous waste shall maintain the records of the hazardous waste imported as specified in form 2A and records are inspected by MOEF/CPCB/SPCB/PCC or officer regulated by these regulatory bodies.

(v) Country, which wants to export hazardous waste to India must apply to MOEF. To get permission for the preposed transboundary movement of hazardous waste.

(vi) SPCB and PCB (Pollution Control Board) grant autherisation to the actual user for handling, transport, treatment, storage or disposal of hazardous waste in India under the hazardous waste management and handling rules.

(vii) Basel convention deals with the trans boundary movement and disposal of hazardous waste as well as other. Chemical waste by regulating and controlling the movement of hazardous waste from OECD countries to non OECD countries.

Biomedical Waste

It includes human anatomical wastes discarded medicines, toxic drugs, blood, pus, liquid and chemical waste associated with medical operations treatment, pathological investigations, etc. Microbiological and biotechnological waste also comes under biomedical waste. It could be defined as any solid or liquid waste including its intermediate products and storage containers, which are generated during, diagnosis, treatment immunisation of human being/animals in production and testing of biologicals. Any institution like hospital, nursing home, clinic, dispensaries blood banks, pathological laboratories, etc., must ensure proper handling and management of biomedical waste according to the guidelines laid down by Ministry of Environment and Forest, Government of India, July 27, 1998 notification.

Biomedical Wastes and Recommended Treatment Options

Class	Waste Description	Treatment Method
Human anatomical wastes and body fluids	Wastes consisting of anatomical human tissues, organs, waste body parts, body fluids, blood and blood products and items saturated or dripping with blood, body fluids removed during/after treatment, surgery or autopsy or other medical procedures.	Incineration
Animal waste	Waste consisting of animal tissues, organs, body parts, caracasses, bleeding, fluid blood and blood products, items contaminated with blood and fluids, wastes from surgery treatment and autopsy and wastes of experimental animals used in research, waste generated by veterinary hospitals, colleges animal houses and livestock farms.	Incineration
Microbiological wastes	Wastes from laboratory culture stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, waste from production of biological dishes and devices used for transfer of cultures.	Incineration
Waste sharps	Wastes consisting of sharps, such as needles, scalpel, blades, etc., which include both used and unused sharps.	Chemical disinfection/ autoclaving followed by shredding.
Highly infectious wastes	Wastes containing highly infectious living and non-lining pathogens.	Incineration
Isolated wastes	Biological wastes from discarded material contaminated with blood exertion exudates or secretion from human and animals isolated due to communicable disease.	Incineration
Discarded medicines	Waste comprising expired contaminated and discarded medicines.	To be send back to the manufacturers for safe disposal.
Discarded glasswares	Wastes generated from glass wares and glass equipment used.	Chemical disinfection/autoclaving followed by shredding.
Soiled wastes	Waste generated from soiled cotton, dressing, beddings, etc.	Incineration
Disposable (PVC plastics, cardboard and thermocol)	Waste generated from disposable items other than the waste sharps.	Chemical disinfection/autoclaving followed by shredding.
Biotechnology wastes	Wastes generated from activities involving genetically engineered organisms or products and their cultures not declared to be safe.	Incineration
Incineration wastes	Ash generation from incineration of any biomedical waste.	Secured landfill as per Hazardous Waste (Management and Handling) Rules, 1989.
Liquid wastes	Wastes generated from laboratory and washing, cleaning, kitchen house keeping and disinfection of the premises.	Effluent treatment prior to disposal.

Categories of Containers and Recommended Colour Codings

Waste Class	Type of Containers	Colour Coding	Treatment Method
Human anatomical waste, blood and body fluids, animal waste, microbiological waste, highly infectious waste, isolated waste, soiled waste and biotechnology waste.	Single use containers/ polytene holdings bags	Red	Incineration
Waste sharp	Reusable sturdy polythene/metal	Blue	Disinfection/autoclaving followed by shredding /crushing
Discarded glasswares	Reusable sturdy polythene/metal	White	Disinfection/autoclaving followed by shredding/crushing
Disposable (PVC/plastics, cardboards and thermocol)	Reusable sturdy polythene/metal	Green	Disinfection/autoclaving followed by shredding/crushing
Incineration waste	Reusable sturdy polythene/metal	Black	Landfilling in secured landfill

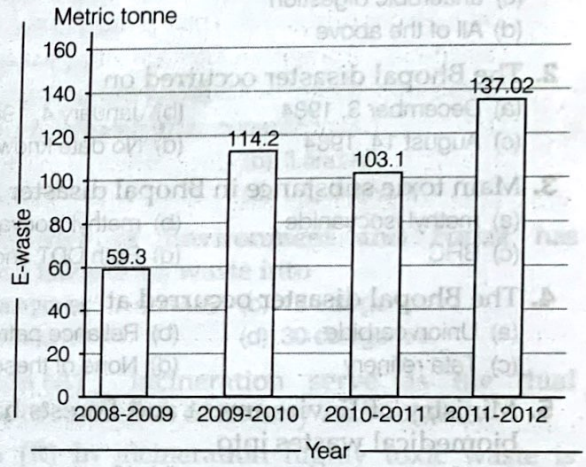
Electronic Waste

With an increased use of electronic products there is an increased generation of electronic waste. As per study report of EPA, USA, electronic waste constitutes 1% of the municipal solid waste. Main components of electronic waste or E-waste are Colour Cathode Ray Tubules (CCRTs). CRT monitors, it contains various hazardous substances like lead, mercury, chromium, etc. Electronic waste are made up of plastics, which contain bromine as flame retardant. At present there is no legislation for the disposal of E-waste in India. Central Pollution Control Board is working on the formulation of E-waste in India.

Recycling of E-waste

Leading computer companies/manufactures like Dell and Hp are offering recycling services. The waste and its constituent parts are sent to the specialist, which can recover the reusable material. CRTs, LCDs, printed circuit boards, power supplies and batteries are processed individually to ensure that materials are handled safely.

Through Dell Irish customers have recycled over 22 tonnes of computer equipments in 2004. Reusing and recyling the raw materials from E-products could help in conserving natural resources and reducing greenhouse gas emission. Electronic items could be denoted to the schools, NGO's, lower income families, which cannot afford new purchase. USA provides tax incentives for computer donations.



Bhopal Gas Tragedy

It occurred in Union Carbide Company at Bhopal, MP India in night of December 3, 1984. Methyl isocyanate (MIC) gas (CH_3NCO) was leaked from Union carbide factory. MIC is the starting material for production of carbaril. It is stored underground in low temperature as a liquid with help of liquid nitrogen. It is fatal to human beings as it converts haemoglobin to N-methyl carbamoyl haemoglobin. Nearly 2000 people were killed and thousands have lost eyesight partially or fully.

At union carbide factory water entered inside the tank and reaction started increasing the temperature. Temperature converted MIC from liquid to gas and pressure was built up. Pressure burst the steel tank and scrubber valve were broken and 40 tons of gas was released in $1\frac{1}{2}$ hour.