

Hazardous Waste Management & Treatment (BCM)

8/09/24

- 1.) Industrial & Hazardous Waste Treatment - Nemrow N.L.
- 2.) Hazardous Waste Identification and classification Manual - Wanger TP
- 3.) Hazardous Waste Mgt - Lagrega M.D.
- 4.) Hazardous & Industrial Waste Treatment - Charles N.
- 5.) Hazardous Waste Incineration - Brunner C.R.
- 6.) Toxic and hazardous waste disposal - Vol I Processing for solidification / Stabilization - Pojasek Robert B.

Case Study of Indian Chemical Process Industry → Go through their website
What are the hazardous waste management practices and technology - Discuss

Slide 1-2 → Overview of Indian Industry. (Manpower, history, work)

Slide 3-8 → List of hazardous waste materials generated with a flow sheet
• List of hazardous wastes with quantity and permissible limit

Slide 9-14 → Treatment Method in details with diagram
(one)

common Treatment Methods used in the plant (slide 3-6)

Case Study (15 marks) → PPT in pdf form to TAs

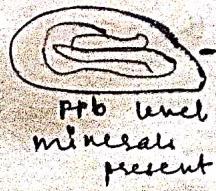
→ Teacher's assessment (5 marks)

Introduction :— Chemical process plant handles variety of chemicals raw material, immediate chemicals, and finished product and generates hazardous waste to convert them to industrially important useful products Due to rapid industrialisation hazardous waste disposal is becoming a serious problem and which can threat human health, animals, property as well as whole environment.

The inherent properties of many chemicals sometimes causes accident in chemical process industries due to following !—

- a.) insufficient inform abt. the chemical hazards
- b.) poor design equipment
- c.) inadequately trained personnel.

All pollutants are not hazardous.



when discharged / discarded
the pb level increases
to a dangerous level.

Hazardous residues obtained
as a byproduct of
side processes → crushing,
grinding etc.

→ Hazardous Waste (EPA definition) :-

Although the exact definition of hazardous waste is very complex, as per EPA, Hazardous waste can be defined as any waste that could pose a threat to human health and the environment if managed improperly.

EPA → Environment Protection Agency.

Ex. → methyl isocyanate → Bhopal Tragedy.

Workers → Contractor Staff → Least trained abt life threatening situation

EPA criteria for defining hazardous waste :-

In developing criteria for defining a hazardous waste, EPA had to take into account :-

- Toxicity, persistence and degradability in nature.
- Potential for accumulation in tissue. Ex. some sea fish accumulate mercury
- Other related factors such as flammability, corrosiveness, and other hazardous ~~waste~~ characteristics.

Household : - Rechargeable batteries, residual medicines, lithium ion batteries, electrical residues

Shortening of life period of people working in hazardous industries & hours per day working → chronic life threatening diseases

→ Def" of Hazardous Waste in RCRA :-

Hazardous waste means a solid waste which bcoz of its quantity, con, physical, chemical or infectious characteristics may :

- cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or
- pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

A waste is a hazardous waste, if it exhibits, any of the characteristics identified below :-

> Toxic waste (T)

> Acute Hazardous Waste (H) → produces illness. Ex - SO_2 , NH_3 bearing hazardous material

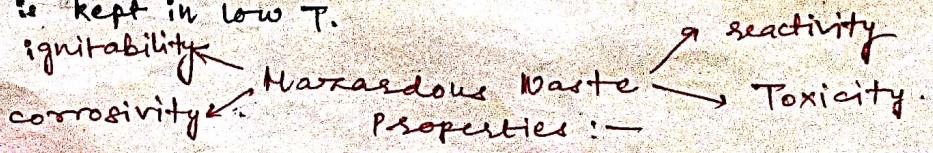
> Ignitable Waste (I) → burning tendency Ex. - C bearing compounds

> Corrosive Waste (C)

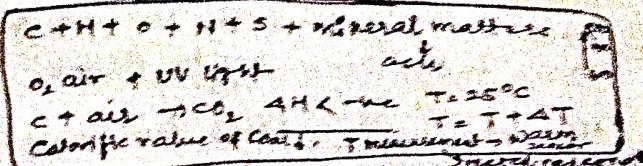
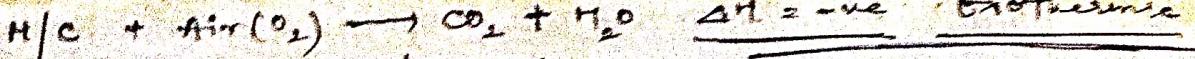
> Reactive Waste (R) → which may react with other waste or the container

* Bottle cap opens instead of screwdriver to open NH_3 bottle :

* The bottle is kept in low T.



- ① Ignitable → (Petrochemicals and refinery products). Ignitable chemicals (e.g. - lighter fluid, solvents, friction sensitive substances) can create fire under certain conditions. If $T >$ ignition temp. → burning of chemical → fire and explosion



lower explosion fl. Upper explosion fl.

For flammable materials, lower flammability fl. and upper flammability fl.

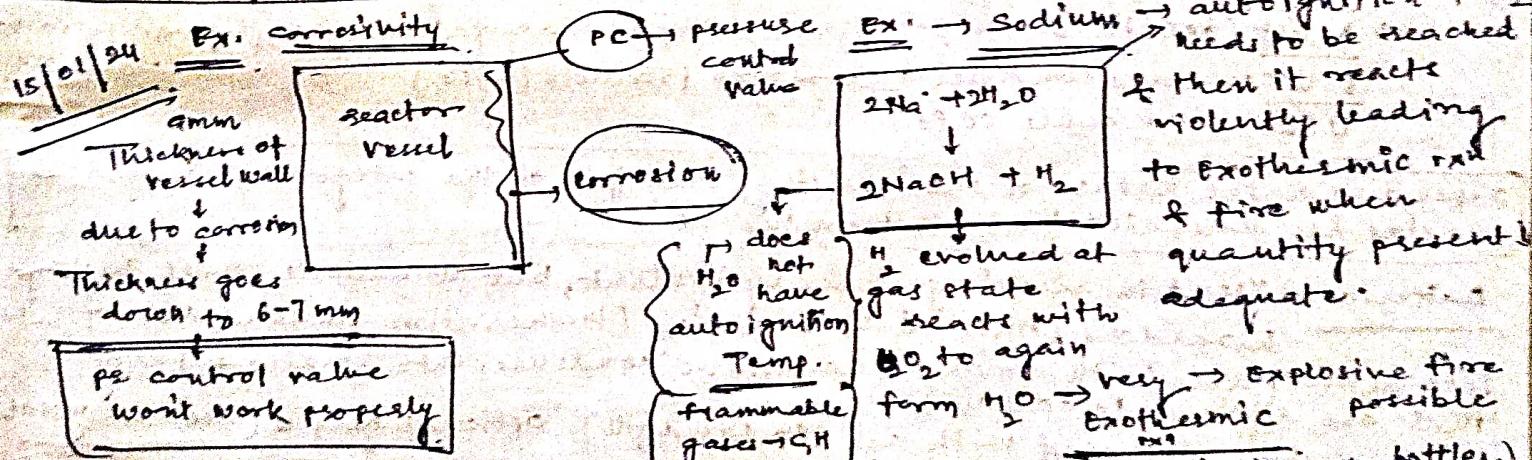
Sufficient vapour pr. needed for flames to form.

Petrol Tank \rightarrow Highly flammable. Explosion when enough vapours pr. Storing of ignitable materials is a sensitive matter because even a little spark can cause fire (spontaneous combustion \rightarrow explosion - open speed mixing with air)

② Corrosive \rightarrow (fertilizers, acid plant, Chloro-Alkali, Inorganic basic chemical industries) \rightarrow Corrosive wastes (e.g. battery wastes) causes a chemical action that eats away materials or living tissue. They are capable of corroding metal, such as tanks, containers, drums and barrels.

③ Reactive \rightarrow Material that can react violently or create toxic fumes. Reactive materials (e.g. sodium) are unstable under normal cond's. They can create explosions and/or toxic fumes, gases and vapors when mixed with water.

fire - water ex. in Petroleum refinery due to common fires \rightarrow spray the water outside the tank to control the fire \rightarrow in the surrounding tanks. bcoz if T keeps on \uparrow the other tanks might reach autoignition T leading to explosion. When the T in the burning tankers has come down, ice form to cut down the air supply & completely extinguish the fire.



④ Toxic \rightarrow (pesticides and paints) are harmful or fatal when injected or adsorbed. When they are disposed of on land, contaminated liq. may contain drain from the waste and pollute ground water. A selected group of eight (8) heavy metals, ten (10) pesticides and twenty two (22) organic chemicals are classified as hazardous due to their toxicity characteristic. Any detectable amt of these chemicals must be identified on the Hazardous Waste level.

Ex: Lethal doses (Medicine doses depend on body wt.)

Lethal Dose 1 (LD₅₀) (toxic) \rightarrow 50% of total species will die. if such chemicals are injected in bodies.
How many milligrams of toxic material per kg of body mass.
Some indicative acute illness will show up.

Hazardous Chemical Diseases and consequences:-

The effect of chemical hazardous materials on the human body and safety precautions to be followed are closely related. These materials enter the body in the following ways:-

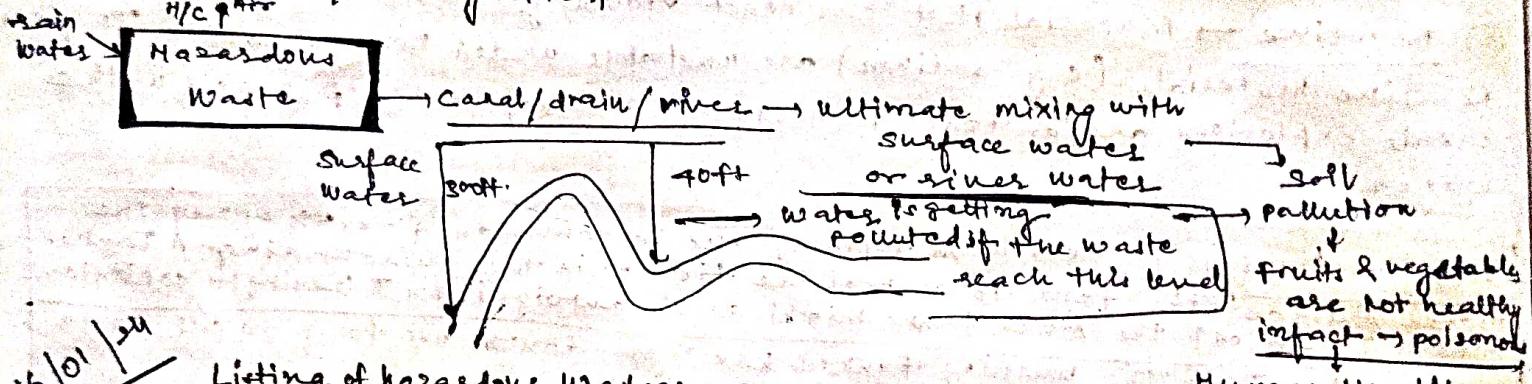
Ingestion! — mouth.

Inhalation! — nose \rightarrow vapour or gas phase materials \rightarrow get accumulated in lungs, carcinogenic materials.

Skin contact! — Liq. Chemicals, skin diseases \rightarrow may get absorbed inside body. occupational health and safety diseases.

Routes of migration:-

- groundwaters
- surface water
- air
- direct contact / soil ingestion



Listing of hazardous wastes!:-

- \rightarrow F List (non specific sources) \rightarrow solvents, electroplating, dioxins
- \rightarrow K List (specific sources) \rightarrow organic chemical manufacturing, explosives, petroleum
- \rightarrow P List \rightarrow acute commercial chemical products (CCPs)
- \rightarrow U List \rightarrow non acute CCPs.

Depending on the nature of the industry, only few of the categorical hazardous wastes are generated. (not all from the list)

Batteries \rightarrow trend in reducing mercury content, but all batteries still highly hazardous (HRI and 2) burning / incineration released heavy metals into atmosphere with smoke (cadmium condenses into smallest particles that are difficult to contain).

Heavy metals disposed with ash (to landfill) Options! Recycle (recovers metal) landfill (encapsulate)

- mercury chloride • potassium hydroxide • Sn • Zn • Zn Chloride
- rechargeable! -

- Cd • Ni • Carbon black • lead • ~~MnO₂~~ MnO₂ • Mercury

Dry Cell Wet Cell! -

- Pb • lead oxide • lead sulphate • sulphuric oxide • lead acid.

Mercury electrode in chlor-alkali industries used for electrolysis

Electronic! — computers (CPU, case, capacitors, PCB's); Cell phones;

Waste

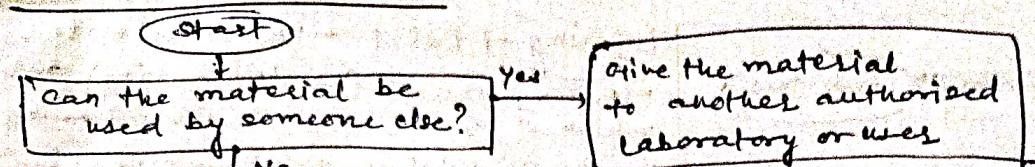
CRT (cathode ray tube); PCB's

Hazardous Waste Identification & Determination:-

Hazardous Waste Identific" :-

A liquid, solid, or aqueous waste which displays a 'hazardous characteristic' or is specifically listed as hazardous waste.

Waste determination :-

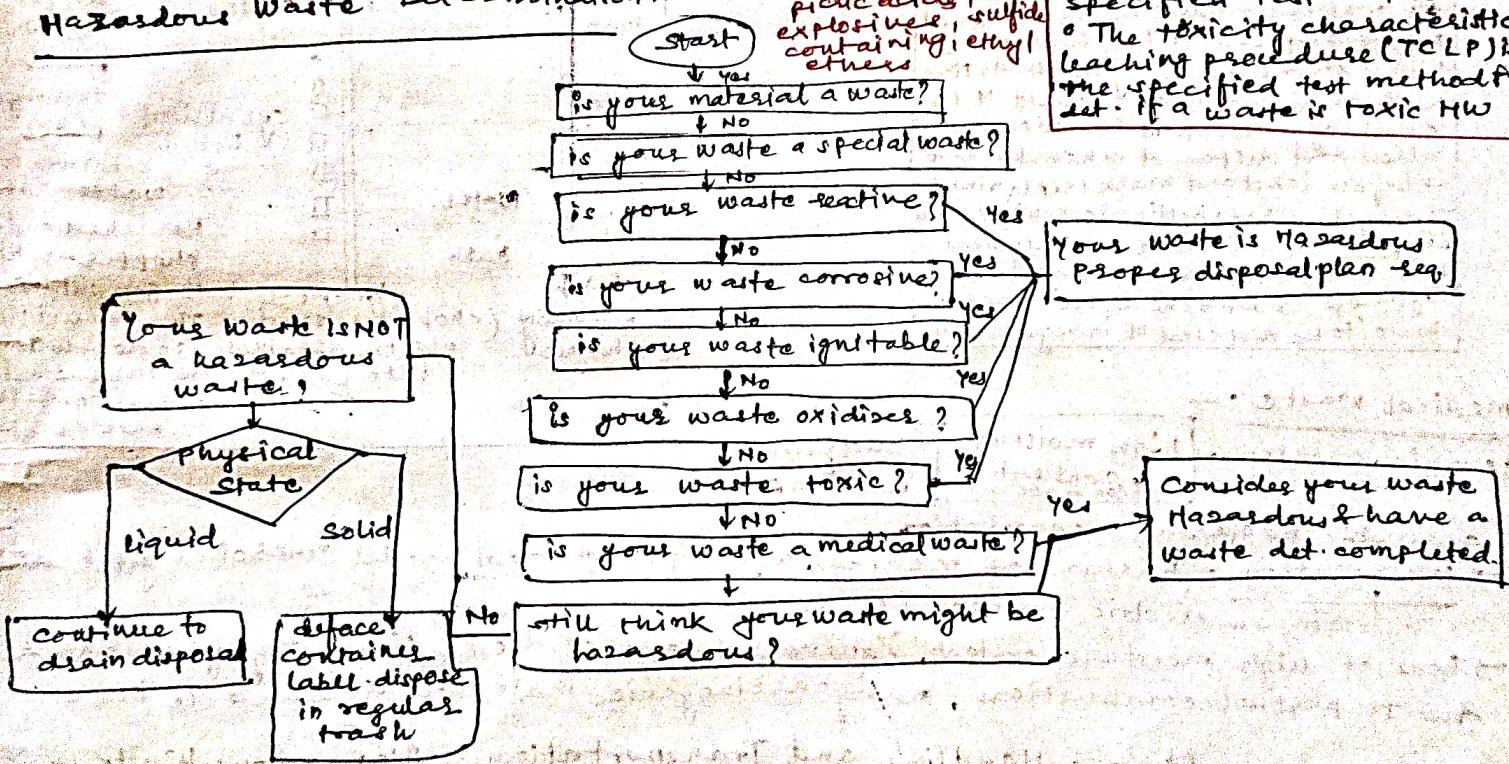


is the material intended to be discarded? (i.e. the material is "abandoned", "recycled" or inherently "waste like") EPA views old chemicals that have not been used by in years and which are unlikely to be used in the foreseeable future as waste

If Yes

material meets the definition of waste

Hazardous Waste Determination :-



Hazardous Waste

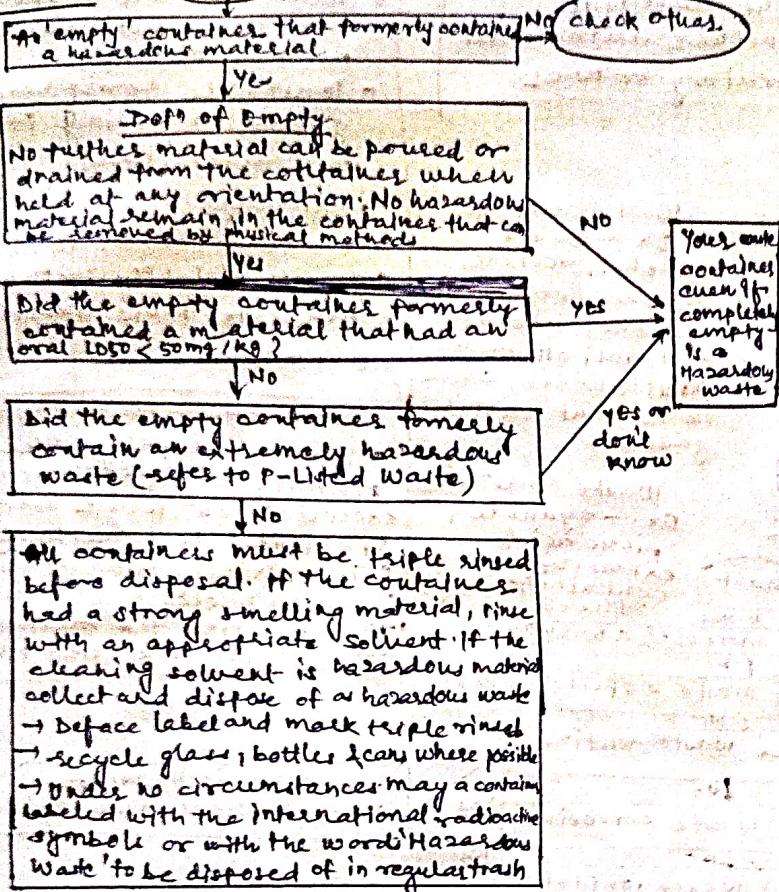
- radioactive waste
- paint waste
- empty containers
- waste oil & antifreeze
- used batteries
- reactivity
- corrosives
- oxidizing
- medical waste

Asbestos → Hazards → Asbestosis, lung cancer and mesothelioma (by breathing in asbestos fibres)

Empty containers of toxic materials consists of condensed paste form on walls (Insecticides / Pesticides)
Barrels → 55 gallons → Thick layer of polymeric/oxidised material formed at bottom of such barrels/containers lead to choking (oil barrels) when used in automobiles.
→ Aff. type of cleaning of empty containers needs to be done.

empty! —

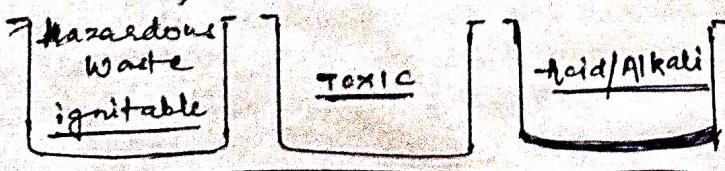
start



Medical Waste! —

- main problem → high moisture content (800 - 900%) → breeding of bacteria, bad smell, anaerobic bacterial degradation
- Incineration → (burning of medical wastes) most ideal → all microbes get killed → in an electric furnace / fuel
- bcoz of high moisture content, equivalent amt. of diesel / burning fuel is needed due to partial combustion, many carcinogenic materials released in the env.

Regulation on Storage, Handling and Transportation of Hazardous Waste! —



- Hazardous Waste is stored in designated containers.
- small in quantity generated in industries (maybe once in 6 months)
- Containment zones
- generator contains the hazardous waste, temporarily (wastes are removed)
- Recyclers → also stores of partial hardly non-renewable
- Transporter → moves the hazardous authorized waste to final disposal site (dump transport area) → All treatment & disposal processes done here

regulation governing generators of Hazardous Waste :-

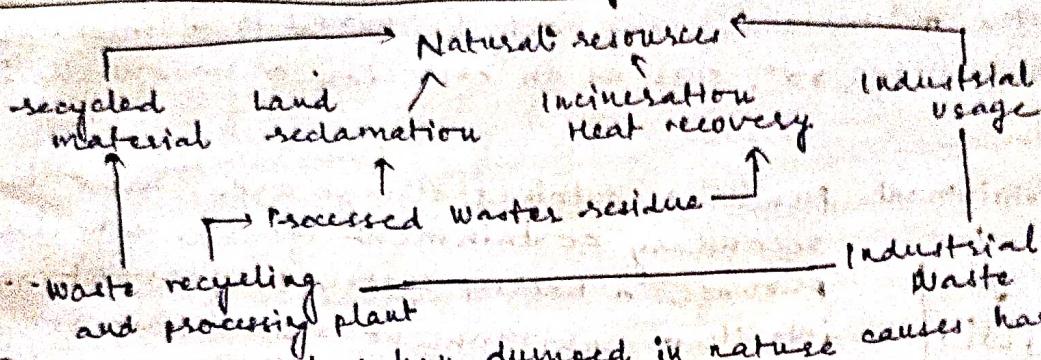
- Preparation for Transport

- Manifest requirements

- record keeping & reporting

Hazardous Waste disposal and recovery :-

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Hazardous constituents when dumped in nature causes harm to natural resources
(water, air, soil, etc.)

Hazardous Waste storage :-

It means holding hazardous waste for a temporary period at the end of which hazardous waste is treated, disposed of, or stored somewhere else. This is generally done in tanks, surface impoundments, or in containers, with the later used in most of the cases.

A container → portable device in which a material is stored, transported, treated or disposed or otherwise handled. Ex. → 55 gallon drum made from steel or plastic, large tanker truck, railroad car, small bucket or test tube

Containers

Containers represent one of the most commonly used and diverse forms of hazardous waste storage (max. wt. = 200 kg. but typically 30 - 30 kg & max 50kg) (e.g. waste containers 40 L - 50 L), 55 Gallon container in big industries to store primary & secondary

- As compared to tanks or surface impoundments, containers are less expensive and generally less difficult to manage.
- Containers are also mobile allowing an owner/operator to use only one unit for storage, transportation and disposal.
- Prior to regulation containers are frequently used mismanaged or abandoned. When the abandoned containers become weathered or corroded, the hazardous contents were released posing a ~~for~~ threat to human health and the environment. corrosion leads to leaking of oil from tin containers (drums)

How to check if there is any leakage in the test container.

- ① Visual inspection for deformity
- ② Radiation detection to check for cracks.
- ③ Ignitable light sources
- ④ Sound passing
- ⑤ Water filling.

cond' of containers:-

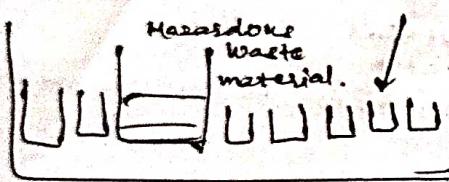
- Containers that are deteriorating (e.g. cracked or warped) or leaking must not be used. Waste stored in defective containers must be transferred to the containers in good cond' or handled in another way that satisfies the requirements.
- Containers used to store hazardous waste must be made of or lined with materials that will not react with and are otherwise compatible with the waste in the containers. In compatible wastes and materials must not be placed in the same container.

Compatibility with Waste:-

The term incompatible waste refers to a hazardous waste which is unsuitable for placement in a container bcoz it may cause corrosion or decay of the container or lines.

- Commingling with another waste or material under controlled conditions bcoz it might produce heat or pressure, fire or explosion, violent rxn, toxic dusts, mists, fumes, or gases, or flammable fumes or gases
- Incompatible wastes or materials can only be mixed in a manner that will not cause an adverse rxn, such as an explosion or uncontrolled flammable fumes

Containment:-



1° containment permitted containers storage areas must have a secondary containment sys. Sec containment provides a backup system to prevent release into the environment should primary containment (i.e. the container) fail. This usually consists of a poured concrete base or other impervious base with curbing to prevent releases of hazardous waste into the environment and to allow drainage of any accumulated liq. to a sump, tank, or other container.

(-5-7°) inclined surface of 2° containment (only a tray maybe) helps to prevent spills polymers sheets as 2° containment and jute bags as 1° containment in food industry (unheat grains)

Management of Containers:-

- Containers holding hazardous waste must always be closed during storage, except when waste is added or removed. In add', containers must not be handled, opened, or stored in a manner that may cause them to leak.
- Containers holding ignitable or reactive wastes must be located at least (150 feet) from the facility's property line. This req. is sometimes referred to as the buffer zone requirement, because it creates a zone of protection b/w waste storage and adjoining properties.

Sealing Hazardous Waste Containers:-

Hazardous waste containers must be sealed to prevent leakage or spillage. containers should be sealed with a screw-type lid or other appropriate device. Plastic wrap, aluminum foil, and other make-shift lids are unacceptable. A container holding hazardous waste must ALWAYS be closed during storage except when it is necessary to add or remove waste.

Labeling Hazardous Waste Containers :-

29/01/2022

- > Hazardous waste containers must be labeled with hazardous chemical waste tags as soon as the container is used to collect hazardous waste.
- > These tags "inform" including name, telephone no., building, room no., and exact contents of the container.
- > Include "inform" about the contents of the hazardous waste containers including pH and water content.
- > If a container is being used to collect hazardous waste intermittently, the tag should be filled out immediately upon use of the container, and must be edited as more waste is added. A separate tag must accompany each individual hazardous waste container. Old labels that do not accurately describe the contents of the waste container must be defaced.

Mixing Hazardous Wastes :-

- > Hazardous wastes should be kept separate whenever possible. Mixing a hazardous waste with a non-hazardous waste can ~~impose~~ increase the volume of hazardous waste for disposal and increase disposal costs due to difference in disposal options for certain hazardous wastes.
- > For instance, halogenated solvents such as methylene chloride and chloroform are more costly to dispose of than non-halogenated solvents such as hexane and styrene; thus, halogenated solvent wastes should be kept separate from non-halogenated solvent wastes.

Improper storage :-

- No tables, No sec. containment → storage in high traffic area.
- No segreg & containers covered with residue

proper storage
labeled
segregated by compatibility
sec. containment in isolated area.
sealing.

Quick facts abt. hazardous waste storage :-

- > Store hazardous waste in sealed, compatible containers.
- > Hazardous waste containers must be kept closed at all times except to add waste.
- > Label hazardous waste containers with U.S. chemical waste tags as soon as waste accumulation begins.
- > Store hazardous wastes with sec. containment.
- > Segregate incompatible hazardous wastes.
- > Never accumulate more than 55 gallons of HW or one quart of acute H10.
- > Ensure that lab personnel are trained on proper waste handling procedures.

Handling hazardous wastes safely :-

- > Shippers & carriers of hazardous wastes are also responsible for applying safety marks, such as labels, placards and signs on all containers, packages, tanks and cylinders, and on all vehicles containing hazardous wastes.
- > These special marks immediately identify the type of substance and nature of the hazard.
- > They also provide invaluable assistance to emergency response teams in case of an accident during the transport of hazardous waste.
- > The TDG regulations also include a requirement to train employees in the handling of hazardous wastes.

Hazardous Waste Labeling :-

- > All waste containers must be clearly labeled with the following :-

- The words "HAZARDOUS waste"
- The contents of the hazardous waste container (compos' of waste)
- Physical state of the waste (i.e. solid or liquid)
- The hazardous ~~waste~~ property of the waste (i.e. flammable, corrosive, reactive/toxic)
- The date the material became a waste or the date waste was first added to waste collection

Waste storage requirements :-

- Summary of state regulations pertaining to the accumulation of hazardous waste in work areas. Waste collection containers may be stored in work areas if the following requirements are met :-
- Waste is stored in a secure / locked work area at or near the area where it was generated and under the control of the person who generated it.
 - Storage containers are in good condⁿ (i.e. rust free & not leaking).
 - No more than 55 gallons of liquid waste, per wastestream, is stored in a work area.
 - Waste is stored in work area for more than 9 months.
 - Containers are kept closed except when waste is being added; all drums must be closed with a bung.
 - Incompatible chemicals are stored separately.
 - Full drums have atleast 4 inches of head space.
 - Spilled materials are properly cleaned up.
 - Solvents and flammable liquids are stored in fire resistant, covered containers.
 - Combustible materials (oily rags, combustible debris, etc.) are stored in covered metal containers.
 - Within 3 days of reaching the 55 gallon limit or the 9 month storage limit, the container must be labeled with the date the quantity limit was reached and the container has to be moved to the waste storage facility.

minimizⁿ approaches :-

- Redⁿ or eliminⁿ of toxic materials
 - replacing a material in the prodⁿ line
 - reformulating the product
 - installing new or modifying existing process equipment
- Closed loop (on-site) recycling
- Developing new technology that helps.

Main ideas for minimizⁿ of HW :-

- source redⁿ → eliminates hazardous waste at the step where it is created. reduces the HW to public health and environment with such products
- reuse
- recycling.

Emission redⁿ :- Redⁿ or eliminⁿ of Hazardous pollutants and not emitted into the environment.

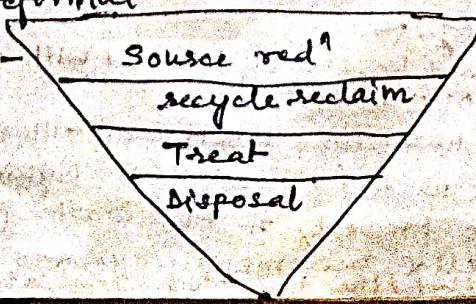
Reclamation :- Use of recovered chemical or HW material in some other industry.

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Toxic use reduction :- in-plant prodⁿ changes or raw materials that reduce, avoid, "eliminate the use or prodⁿ of toxic substances."

- involves substitution or product reformulⁿ

Pollution prevention Hierarchy :-



WASTE MINIMIZATION TECHNIQUES

SOURCE REDUCTION

PRODUCT CHANGES

- Product Substitution
- Product Conservation
- Change in Product Composition

SOURCE CONTROL

RECYCLING (ONSITE AND OFFSITE)

USE AND REUSE

- Return to Original Process
- Raw Material Substitute for Another Process

RECLAMATION

- Processed for Resource Recovery
- Processed as a By-Product

INPUT MATERIAL CHANGES

- Material Purification
- Material Substitution

TECHNOLOGY CHANGES

- Process Changes
- Equipment, Piping, or Layout Changes
- Additional Automation
- Changes In Operational Settings

GOOD OPERATING PRACTICES

- Procedural Measurement
- Loss Prevention
- Management Practices
- Waste Stream Segregation
- Material Handling Improvements
- Production Scheduling