

Programme : Bachelor of Science (Third year)

Subject : Chemistry

Semester : V

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Course Title : Green Methods and Safety
Aspects in Chemistry
(Section B)

Title of the Unit : Waste Handling and Laboratory Equipment.

Module Name : Characterization of Waste, Collection and Storage and Consequences of Mixing Incompatibles

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Classification of waste

➤ Waste Is Classified into Four Categories:

- Ignitable
- Reactive
- Corrosive
- Toxic

Ignitability: A waste material is classified as Ignitable if it is

- A liquid (other than an aqueous solution containing less than 24% alcohol by volume) and has a flash point of less than 60°C.
- Not a liquid and is capable under STP of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, it burns vigorously and persistently that it creates a hazard.
- An ignitable compressed gas.
- An oxidizer.

Toxic waste

- Toxic materials pose a threat to groundwater, which can have long term effects to human health and the environment.
- Include common metals such as; As, Ba, Cd, Cr, Hg, Pb, Se, and Ag.
- Toxic solvents, and pesticides.

Corrosivity: A waste material is classified as Corrosive if

- It is aqueous and has a pH equal to or less than 2 or greater than or equal to 12.5.
- liquid substance that corrodes steel at a rate greater than 6.35 mm per year at a test temperature of 55 °C.
- Corrosive substances, such as hydrochloric acid, nitric acid, and sulfuric acid, have the ability to eat through containers, causing the leakage of harmful materials.
- Everyday example of corrosives include battery acid and rust removers.

**Reactivity: A waste material is classified as
Reactive if**

- It is normally unstable and readily undergoes violent change without detonation.
- It reacts violently with water. It generates toxic gases, vapors, or fumes when mixed with water.
- It is a cyanide or sulfide-bearing waste that generates toxic gases, vapors, or fumes at a pH between 2 and 12.5
- It is capable of detonating or exploding when it is subjected to a strong initiating course or if it is heated under confinement; or It is an explosive.

Waste: Collection and Storage: Before generating chemical waste, the researcher should determine how it will be collected and stored and obtain the necessary equipment (containers, labels) in advance.

- Chemical waste must be stored in compatible containers with closed and properly fitted caps.
- Waste containers must be labeled mentioning chemical compositions, the accumulation start date, and appropriate hazard warnings.
- Incompatible waste types should not be mixed and should be kept separate in order to avoid any reaction, heat generation, and gas evolution.
- Waste containers should be stored in secondary containers in a ventilated, cool, and dry area.

Lids

- Lids or caps must be securely in-place except when waste is being removed or added to the container.
- Lids or caps on waste containers must be tight.
- Containers picked up for waste collection must have leak proof lids.
- A funnel that screws onto and seals the opening with a lid that can be securely closed is acceptable, as long as it is only open when waste is being added.

Labels

- Hazardous waste containers must be labeled with hazardous chemical waste tags, these tags require the laboratory to provide specific information including name, telephone number, building, room number, and exact contents of the container. The date should be filled out when the container is full.
- Old labels that do not accurately describe the contents of the waste container (eg. the original label for a ethanol bottle now being used to store waste xylene) must be defaced.

Labels

- Containers too small to affix a waste label to may be boxed up or segregated and a single label applied to the whole group/container of small containers
- Examples of labels: “Acetone Waste”, “Waste Paint” and “Spent Solvent Waste”.
- label or mark must indicate that the material is a hazardous waste and not a raw material.
- Inaccurate labels leads to a reaction when the waste is mixed and a results in incident and risk to the personnel handling the waste

Leaks

- Glass containers holding liquid hazardous waste kept on the floor must be provided with secondary in order to minimize the potential for breakage and to minimize the consequences in the event of breakage.
- In general, secondary containment is to be used as a means of preventing incompatibles from interacting in the event of breakage and/or spillage.
- Hazardous waste are to be segregated by hazard class and stored in separate cabinets, trays, or pans.
- Leaking containers must be replaced.

Location

- Isolated portion of laboratory should be designated as a hazardous waste storage area.
- The Satellite Accumulation Area must be located at or near any point of generation where wastes initially accumulate.
- Transfer waste when the lab has accumulated 5 gallons of a specific waste.
- Containers must be moved to either a designated Hazardous Waste Storage Area on-site or shipped off-site for disposal.
- Laboratories should try to minimize storage of hazardous waste.

Containers

- Hazardous waste must be stored in containers made of materials that are compatible with the waste.
- Containers must be in good condition and free of leaks
- The best container for storing hazardous waste is the original chemical container.
- The hazardous waste containers must be sealed with screw type lid.
- The hazardous waste container must always be closed during storage except when it is necessary to add or remove waste.

Consequences of Mixing Incompatibles

- Many wastes, when mixed with other waste or materials at a hazardous waste facility, can produce effects which are harmful to human health and the environment, such as
 - Heat or Pressure,
 - Fire or Explosion,
 - Violent Reaction,
 - Toxic Dusts, Mists, Fumes, or Gases
 - Flammable Fumes or Gases.

Incompatible chemicals are combinations of substances, usually in concentrated form, that react with each other to produce very exothermic reactions that can be violent and explosive and/or can release toxic substances, usually as gases.

- Most chemical reactions that are exothermic will be either acid–base reactions or oxidation–reduction reactions.
- When flammable or oxidising chemicals are stored next to toxic and corrosive substances, a fire in the area could cause the rapid dispersal of toxic gases and corrosives.

Acid–Base Incompatibles.

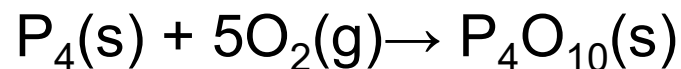
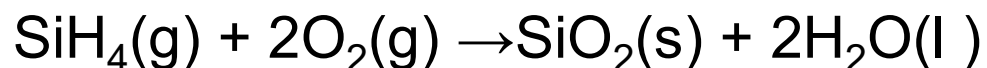
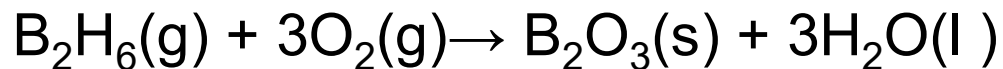
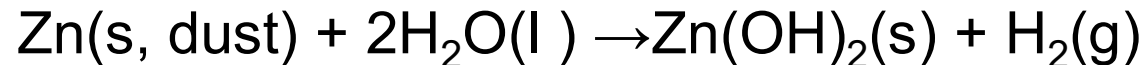
- Mixing strong acid and bases results in a very violent, uncontrolled reaction.
- Mixing soluble cyanide salt with strong acid results in toxic HCN gas: $\text{NaCN(aq)} + \text{HCl(aq)} \rightarrow \text{NaCl(aq)} + \text{HCN(g)}$
- Mixing soluble azide salt with any strong acid results in toxic and explosive hydrogen azide gas:
$$\text{NaN}_3(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{HN}_3(\text{g})$$
- Mixing soluble sulfide salt + any strong acid results in toxic H_2S gas: $\text{Na}_2\text{S(aq)} + 2\text{HCl(aq)} \rightarrow 2\text{NaCl(aq)} + \text{H}_2\text{S(g)}$

Strong Oxidants and Reductants

- Perchloric acid, HClO_4 is a strong and very strong oxidizing agent. Hot solutions are powerful oxidizers and pure perchloric acid explodes upon contact with organic compounds and materials (such a cloth, wood, and rubber).
- Perchlorate salts are shock-sensitive and may easily detonate.
- Permanganate and Hydrogen peroxide has explosion hazards when mixed with organic and inorganic compounds.

Pyrophorics

Finely divided metal powders can be pyrophoric, as well as reactive metal alloys, metal hydrides, and some metal salts. Calcium, zirconium, uranium, and magnesium powders are examples of pyrophoric metals.



NITRIC ACID

- Do not mix with Organic Solvents or Organic Acids.
- Do not mix Nitric Acid Waste with:
Acetic Acid; Acetic Anhydride; Acetone; Acetonitrile;
Acrylonitrile; Alcohols; Aldehydes; Alkali Metals;
Ammonia; Cyanides;
- Powdered Metals; other Organic Substances

Water-Reactives

- Alkali metals
- Organometallics
- Acyl chlorides

References

- Robert H. Hill, David C Finster, Laboratory Safety for Chemistry students, Wiley, July, 2010.