WASTE MANAGEMENT – 23ETC 15F

Industrial Solid Wastes Management

Industrial waste is the waste produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, mills, and mining operations.

Classification of industrial solid waste

Industrial solid waste is classified into 2 categories depending on the generation rate.

1. Non-hazardous solid waste
2. Hazardous solid waste

1. **Non-hazardous solid waste:** Non-hazardous solid waste refers to industrial waste that is not considered dangerous or toxic. It includes waste or debris that will not contaminate a property but do take up space, such as desks, chairs, sheet metals, PVC pipes, and papers. Non-hazardous solid waste further classified into following categories,
   a. **Biodegradable waste:** Those industrial waste materials which can be broken down or decomposed to non-toxic substances in nature with time by the action of micro-organisms such as certain bacteria are called biodegradable industrial waste.

      In short, we can say that a biodegradable waste decomposes naturally and becomes harmless or non-toxic after some time. Common biodegradable industrial waste examples are cattle dung and compost, animal bones, tea leaves, wool, paper, leather, etc.

      Many industrial wastes are biodegradable, but some are not. Thus, all the biodegradable industrial wastes should be treated to make them harmless before disposing of them in soil or water.

   b. **Non-biodegradable waste:** The industrial waste materials which cannot be broken down or decomposed into non-toxic or harmless substances in nature are called non-biodegradable industrial waste.

      Since these wastes cannot be decomposed easily by micro-organisms like bacteria; hence they are major pollutants to the environment. These non-biodegradable substances accumulate in the ecosystem and finally get absorbed by the plants and animals. The chemicals absorbed are retained in our bodies. They can enter into the living organisms through respiration, intake of food or drink, or even by direct absorption through the skin.

2. **Hazardous solid waste:** "Any solid waste, other than radioactive wastes, which by reasons of physical and/or chemical or reactive or toxic, explosive, corrosive or other characteristics causing danger or likely to cause danger to health or environment whether alone or when coming in contact with other waste or environment."

Characteristics of Hazardous Waste

Unlike listed wastes, these characteristic wastes follow the identification process depending on the characteristics they display. Below are the four characteristics that are identified with wastes.

1. Ignitability: Any waste that is flammable and can create fires. Examples of this include liquids with flashpoints below 140 °F, nonliquids with the potential to ignite via specific conditions and compressed gases.

2. Corrosivity: Any waste (typically acids and bases) that can rust and decompose and has the ability to melt through steel materials. Examples of this include aqueous wastes with an acidity level of equal to or less than 2 pH or equal to or greater than 12.5 pH.

3. Reactivity: Any waste that is explosive, unstable under normal conditions. Examples of this include any waste capable of explosion and detonation that may produce toxic gases.

4. Toxicity: Any waste that is fatally poisonous when ingested or absorbed. Examples of this include lithium-Sulphur batteries and other materials that can cause death when swallowed.

Occupier's responsibilities in hazardous waste management

1. For the management of hazardous and other wastes, an occupier shall follow the following steps, namely: -

- Prevention
- Waste Minimization
- Reuse
- Recycling
- Recovery
- Safe Disposal

2. A safe and environmentally sustainable disposal of hazardous or other waste shall be the responsibility of the occupier.
3. The hazardous and other waste created by an occupier's establishment shall be either transmitted or sold to an authorized actual user, or disposed of at an approved disposal facility.

4. The hazardous waste and other waste shall be moved, in compliance with the provisions of those rules, from an occupying facility to an authorized service provider or an authorized disposal facility.
5. The occupier shall take all the steps while managing hazardous and other wastes to- (a) contain contaminants and prevent accidents and limit their consequences on human beings and the environment; and (b) provide persons working in the site with appropriate training, equipment and the information necessary to ensure their safety.

Storage of hazardous and other wastes

The occupiers of facilities may store the hazardous and other wastes for a period not exceeding ninety days and shall maintain a record of sale, transfer, storage, recycling, recovery, pre-processing, co-processing and utilisation of such wastes and make these records available for inspection: Provided that the State Pollution Control Board (SPCB) may extend the said period of ninety days in following cases, namely:-

i. small generators (up to ten tonnes per annum) up to one hundred and eighty days of their annual capacity;
ii. actual users and disposal facility operators up to one hundred and eighty days of their annual capacity,
iii. occupiers who do not have access to any treatment, storage, disposal facility in the concerned State; or
iv. the waste which needs to be specifically stored for development of a process for its recycling, recovery, pre-processing, co-processing or utilisation;
v. in any other case, on justifiable grounds up to one hundred and eighty days

Labelling of hazardous waste

Figure: Labelling of hazardous waste.

Storage site selection and its requirements

Rules and regulations governing the hazardous waste (HW)

Regulations governing generators of HW

1. Preparation of report
2. Manifest requirement
3. Record keeping and monitoring

Regulations governing transporters of HW

1. Notification prior to transport
2. manifest requirement

Waste minimisation

The 4Rs of waste management are reducing, reusing, recycling, and refusing waste. The 4Rs are the most effective and sustainable approach to manage waste.

1. Reducing Waste: Reducing waste involves minimizing the generation of waste by using fewer resources and reducing consumption. This can be achieved by adopting eco-friendly practices such as using energy-efficient appliances, reducing packaging, and choosing reusable products.
2. Reusing Waste: Reusing waste involves using waste materials again for the same or a different purpose. This can be achieved by repairing and refurbishing products, donating or selling unwanted items, and using reusable containers.
3. Recycling Waste: Recycling waste involves processing waste materials to create new products. Recycling helps conserve natural resources and reduces the amount of waste sent to landfills. Recycling can be done at the household level or through centralized recycling facilities.
4. Refusing Waste: Refusing waste involves avoiding the use of products that are not essential or have a significant environmental impact. This can be achieved by choosing products with eco-friendly certifications, avoiding single-use plastics, and using renewable energy sources.

Treatment methods

There are three types of treatment methods

1. Physical treatment
2. Chemical treatment
3. Biological treatment

1. Physical treatment

The physical processes that are commonly used in waste treatment operations are as follows:

- Screening is a process for removing particles from waste streams, and it is used to protect downstream pre-treatment processes.
- Sedimentation is a process for removing suspended solid particles from a waste stream. Sedimentation is usually accomplished by providing sufficient time and space in special tanks or holding ponds for settling. Chemical coagulating agents are often added to encourage the settling of fine particles.
- Flotation is a process for removing solids from liquids by floating the particles to the surface by using tiny air bubbles. Flotation is useful for removing particles too small to be removed by sedimentation.
- Reverse osmosis separates components in a liquid stream by applying external pressure to one side of a membrane so that solvent will flow in the opposite direction.

2. Chemical treatment

- Neutralisation is a process for reducing the acidity or alkalinity of a waste stream by mixing acids and bases to produce a neutral solution. This has proven to be a viable waste management process.
- Oxidation-reduction is a process for detoxifying toxic wastes in which the chemical bonds are broken by the passage of electronics from one reactant to another.

3. Biological Treatment

- Biological waste treatment is a generic term applied to processes that use micro-organisms to decompose organic wastes either into water, carbon dioxide, and simple inorganic substances, or into simpler organic substances, such as aldehydes and acids.
- Typically, the micro-organisms used in a biological process are present in the incoming waste. In some instances, micro-organisms that were developed to attack specific compounds are injected into a waste stream.

Disposal methods

1. Incineration

Incineration serves as a robust method to not only minimize the volume of waste but also to neutralize many hazardous compounds. During incineration, waste is burned at extremely high temperatures, turning most solids into ash, water vapor, and a mixture of gases. This process is highly efficient at breaking down many hazardous compounds.

However, the combustion process can also produce harmful emissions. Modern incinerators are equipped with advanced air pollution control devices to mitigate this. These systems capture particulates, neutralize acidic gases, and remove other pollutants, ensuring that emissions are within environmentally safe limits.

1. Time: In order to completely destroy a VOC, the compound needs to stay in the combustion chamber for a specific amount of time, usually 0.5-1 second, with more time needed for complex, hard to burn hydrocarbons like those found in pesticides.
2. Turbulence: Turbulence, the third element of combustion, is used to define the proper air flow needed to mix oxygen with hydrocarbons. While oxygen content is an important factor (ranging from as little as 2% to over 21% of the volume), the proper mixture of hydrocarbon and oxygen is just as important. This is where turbulence comes into play.
3. Temperature: Temperature is the second element of combustion, and refers to the chamber/furnace temperature (as opposed to stack temperature). Often, the temperature required to destroy a hydrocarbon in a thermal oxidizer ranges from 1,400-1,600 Degrees Fahrenheit

2. Chemical Stabilization

Chemical stabilization is a technique where specific chemicals are added to hazardous waste to alter its properties, making it safer for disposal. The main goal is to reduce waste's solubility, reactivity, or toxicity. Doing so diminishes the waste's potential to harm the environment or human health. Once stabilized, the waste can be disposed of in landfills without posing as significant a risk as originally. The type and amount of chemicals used for stabilization depend on the characteristics of the waste.