Lecture Nine

MANAGEMENT OF HAZARDOUS WASTES

8.1 Introduction

Large volumes of hazardous wastes are being generated worldwide. These tones of wastes can cause death, illness or injury to people or destruction of the environment if improperly treated, stored, transported or discarded. However, a few can be used only with special precautions that decrease their risks. Therefore, their management is of utmost importance to reduce their dangerous impacts.

8.2 Management standards

The management of hazardous wastes is usually from generation to disposal. Overall, this involves collection, storage, treatment, disposal and re-use of the generated hazardous wastes. Hazardous waste management standards vary depending on whether one is a hazardous waste generator, transporter, or operator at treatment, storage and disposal facility (TSDF). All those who generate, transport, treat, store or dispose of hazardous waste are therefore subject to such waste management rules. In many cases, such rules requires that generators to take some or all of the following responsibilities.

- Identifying waste as hazardous
- Determining the volume of hazardous waste generated monthly
- Notifying the responsible agency of hazardous waste activities.
- Obtaining an identification (ID) number from the agency.
- Storing the hazardous waste properly on-site in accordance with the management standards applicable to generators accumulating hazardous waste on-site.
- Packing the hazardous waste for shipment off-site.
- Manifesting the shipment.
- Developing and maintaining a contingency plan

- Training employee who manage hazardous waste
- Preparing biennial reports and exception reports
- Minimizing the amount of hazardous waste generated
- Complying with land disposal restrictions
- Reducing the hazardous waste's toxicity.

8.3 Management Technologies

The management of hazardous wastes involves the following procedures (1) waste minimization or reduction (2) Treatment and (3) Disposal. These procedures are discussed below.

8.3.1 Waste minimization

In spite of numerals laws and regulations and extensive government and industry expenditures for treatment and disposal of wastes, unacceptable amount of dangerous and ecologically damaging chemicals have been and continue to be discharged into the environment. Therefore, the best way to eliminate the hazard waste is to generate it in the first place, although this is current not possible. Then we must strive toward advanced methods of production that generate less hazards waste than the current methods. For example improvement have been made in the production of integrated circuits in which the toxic chlorinated hydrocarbons (Hydrocarbon whose some or most hydrogen atoms have been replaced by chlorine atoms. Chemically and thermally stable, chlorinated hydrocarbons are used mainly in the manufacture of synthetic solvents and insecticides. Their danger to the environment comes from their toxicity, great stability) commonly used in the 1970s where replaced by less toxic glycol in the 1980s or by low toxicity esters and alcohols in the 1990s. (Also called ethylene glycol, ethylene alcohol. a colorless, sweet liquid, $C_2H_6O_2$, used chiefly as an automobile antifreeze and as a solvent).

Processes involved in the waste minimization are reduction of source includes treatment along with source reduction and recycling. Unfortunately, as with most definitions, the distinction between recycling and treatment blurs a bit when consider that many methods of recycling require that the waste be purified- treated in some way before recycling.

Waste minimization effectively reduces the amount of hazardous materials that permanently leaves the production process as a waste. It is therefore recommended that industry implement source reduction and recycling before resorting to treatment or disposal. The reduction of volume or hazardous nature of the waste usually provide significant economical, regulatory or other incentive to the companies or industries. Such economic incentives include reduced waste management costs, improved operation, reduced liability risks and increasing competitive advantages. However, until recently, this intent not been widely implemented.

8.3.2 Source Reduction

Source reduction is defined as either any action that causes a net reduction in the generation of hazardous waste and any action taken before the hazardous waste is generated those results in a lessening of the properties, which causes it to be classified as a hazardous waste. Source reduction, therefore is pollution prevention. It reduces the toxicity and/or quantity of hazardous material at the source.

Therefore, the volume reduction operation, if they simply reduce the total volume without reducing toxicity of a waste, do not qualify a source reduction. For example, the reduction of amount of water (dewatering) in heavy metals sludge waste through pressure filtration and drying does not reduce the number of molecules of toxic heavy metals in the sludge but actually increases the concentration of metals has been increased. Therefore, although dewatering is an important treatment method that reduces both the cost of handling and the capacity for migration of waste from the site of

deposition, it does not prevent waste generation or reduce the amount or toxicity of waste being generated.

Source reduction techniques vary greatly from one industry to another, many being quite process-specific. However, there are some elements common to all. Approaches to source reduction are often grouped in the following four major categories:

i. Good operating practices.
ii. Changes in technology.
iii. Changes in input or feedstock materials.
iv. Changes in product.

Good operating practices: Good operating practices include many procedural changes that can implemented in many areas of plants operation. Many effective operating practices can be implemented at low cost giving a good return on the investment in relatively short time.

The following specific aspects of good operating practices are considered important:

i. Waste management cost- accounting.
ii. Inventory management.
iii. Procedural scheduling.
iv. Material handling improvements and loss prevention.
v. Waste stream segregation.
vi. Personal education, communication and involvement.

Change in Technology:

Source reduction strategies involving change in technology tend to be industry and process specific and require a good understanding of the details of a facility's operation. Categories of technological changes to achieve source reduction include:

i. Process change
ii. Equipment, piping or layout changes

iii. Additional automation

Specific examples include countercurrent rinsing, which has been used successfully in the metal plating industries to reduce the amount of water used by up to 90%, which lessens solution carryover and contaminated water and sludge generation.

Changes in inputs materials:

This is an active and growing area of industrial research and development. Less toxic substitute products are being developed and tested. Procedures for increasing the purity of raw materials include:

i. Materials purification

ii. Materials substitution

Changes in product:

The amount of toxicity waste generated from the product end use may be reduced by:

i.Product substitution

ii.Product conservation

iii.Changes in product composition

Product substitution is exemplified by widely successful product substitutions plastic bumper for chrome bumpers on automobile and concrete utility poles for chemically treated wood ones. Product conservation refers to the way in which an end product is used. For example better maintenance of equipment and components by industry can be decrease the frequently of equipment component replacement, which in turn reduces waste generated by the used component. A change in product composition involves manufacturing a product with reduced or no hazardous components. For example a nonhalogenated solvent might be used in place of a halogenated one as the active ingredient in a chemical formulation.

8.4.3 Recycling

Recycling *is the use, reuse or reclamation of usable materials from a waste after it has been generated.* Through recycling and reuse hazardous waste is routed into a production process rather than being released to the environment as a waste. It is however difficult to delineated recycling and source reduction all together. Under some conditions, recycling/reuse may be considered to be source reduction. For example, the return of materials or their components, for reuse within the existing processes or operations, so as to reduce or eliminate the generation of hazardous waste is considered as a source reduction.

About 5% of hazardous waste in United State is recycled as solvents; a similar amount is recovered as metals. For example, approximately 15% of sulphuric acid is recycled in chemical manufacturing. In the past, most sulphur used for sulphuric acid production was mined, now the amount of sulphur recovered from smelters (Facilities that remove metals from ores) refineries (facilities that purify substances) and manufactures is more than double that produced by mining.

Recycling generally falls into two categories: **onsite** and **offsite.** *Onsite recycling* is the reuse of waste materials at the site of generation. It may be used in the same or another process. Example includes reuse of cleaning washes and of solvents in the production process (possibly in a process requiring less purity). This type of recycling reduces the cost of raw materials as well as the cost of waste disposal. *Offsite recycling* involves transporting the waste to a commercial recycler whom processes and returns the material to the generator to sells it. Common examples of this are battery recycling and used oil recycling- all very common practices in the automotive repair industry. Off recycling generally reduces disposal costs and may result in some savings on purchase of these materials.

8.4 Treatment of Hazardous Wastes

8.4.1 Incineration

Incineration has been used since human beings learned to control fire. It is the preferred method of handling infectious medical wastes. However, it should not be used for wastes that contain toxic heavy metals or chlorinated hydrocarbons. When burned, old paints surfaces can releases lead or arsenic into the air, whereas chlorinated hydrocarbons produce hydrocarbon acid and dioxins. Solids left over from incineration may have to be disposed of as hazardous waste.

8.4.2 Solidification

Solidification of waste the hazardous waste involves turning it into a glass through a process known as vitrification. Two types of vitrification are distinguished, standard vitrification and enhance vitrification with the latter type being associated with higher in site. Simple remedies methods involve building a barrier around the waste. This barrier can be plastic, steel, concrete, clay or even glass. This involves melting them and mixing them with a binder, a substance at eventually hardens the mix into an impenetrable mass.

8.4.3 Decomposition

Decomposition of hazardous wastes to produce less toxic or non-toxic substances usually utilizes heat, chemical or biological inputs. According to the detoxicication means used, three types of decomposition processes are distinguished (i) Thermal decomposition (ii) chemical decomposition and (iii) Biological decomposition.

Thermal decomposition: refers to such process which uses heat energy in detoxicating an hazardous waste material.

Chemical decomposition: includes all processes that use chemicals during the detoxication process.

Biological decomposition: removes toxic by microorganisms actions.

8.4.4 Encapsulation

Encapsulation is that technology which immobilizes the waste within a mineral matrix, surrounded by either glass or rock. Minerals encapsulation of hazardous waste provides more secure and longer lasting immobilization with other current technologies in addition to high waste loadings.. Macro and micro encapsulation are normally distinguished. The latter produces treated tiny particles or silica cells which are smaller in size (usually with diameters less than 100 microns) than soil particles while the former produces rather large solid particles. Micro-encapsulation consists of a two-stage process in which hydrocarbons, contaminants and various heavy metals are Micro encapsulated in an inert silica matrix.

8.4.5 Disposal of Hazardous Waste

The disposal of hazardous waste from various sources is either by (i) Landfill/surface impoundments. (ii) Waste piles. (iii) Underground injection wells.

8.4.5.1 Waste Piles

The waste piles are defined as any no containerized accumulation of solid wastes that is used for treatment or storage in which its closure shall not result in environmental contamination. By definition, waste piles not authorized by the relevant authorities are considered as open dumps and prohibited. The following three types of waste piles are usually authorized without a permit or license

- Construction and demolition waste piles at the site of generation

 Low hazard industrial waste piles under certain circumstances and disposal area that is not authorized by the authority.

 Contained piles.

8.4.5.2 Underground injection wells

Hazardous waste injection wells into which hazardous wastes are injected for disposing them with minimal environmental problems.