A

Seminar report

On

HAZARDOUS WASTE MANAGMENT

Submitted in partial fulfillment of the requirement for the award of degree
Of Civil

SUBMITTED TO: **SUBMITTED BY:**

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Preface

I have made this report file on the topic **HAZARDOUS WASTE MANAGMENT;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

INTRODUCTION

A hazardous waste is any waste or combination of wastes that poses a substantial danger, now or in the future, to human, plant or animal life and which therefore cannot be handled or disposed of without special precautions.

The Hazards and Disasters can be classified into four categories viz., Natural events, Technological events, Man-made events and Region-wise events. The adverse impacts caused due to the indiscriminate disposal of Hazardous Wastes (HWs) come under the category of Environmental Disasters.

For example, in 1982, 2242 residents are evacuated after dioxin is found in soil in Missouri, U.S.A. In 1996-97, 265354 tonnes of soil and other dioxin-contaminated material from Times Beach (Missouri, U.S.A) and 26 other sites in eastern Missouri had been incinerated. Release of Methyl Isocyanate (MIC) gas in Bhopal (1984) caused a severe disaster in India. So there is a growing concern all over the world for the safe disposal of hazardous waste generated from anthropogenic sources.

CLASSIFICATION OF HAZARDOUS WASTE

US EPA has designated five categories considered as hazardous:
1. Specific type of wastes from nonspecific sources:
a. halogenated &non-halogenated solvents
b. electro-plating sludges
c. cyanide solutions from plating batches
2. Specific types of wastes from specific sources;
a. oven residue from production of chrome oxide green segments
b. brine purification muds from the mercury cell process in chlorine production
3. Specific substances identified as acute hazardous waste:
a. potassium silver cyanide,
b. toxaphene
c. arsenic oxide.
4. Specific substances identified as hazardous wastes
e.g. Xylene, DDT, carbon tetrachloride
5. Characteristic wastes:
Wastes not specifically identified elsewhere exhibiting properties of:
ignitability, corrosivity, reactivity, or toxicity

BASIC APPROACH IN HAZRDOUS WASTE MANAGEMENT

OBJECTIVES

A logical priority in managing hazardous waste would be to:
1. Reduce the amount of hazardous wastes generated in the first place.
2. Stimulate “waste exchange”:
• One factory’s hazardous wastes can become another’s feedstock; e.g. acid and solvent wastes from some industries can be utilized by others without processing.
3. Recycle metals, the energy content, and other useful resources contained in hazardous wastes.
4. Detoxify and neutralize liquid hazardous waste streams by chemical and biological treatment.
5. Destroy combustible hazardous wastes in special high-temperature incinerators equipped with proper pollution control and monitoring systems.
6. Dispose of remaining treated residues in specially designed landfills.
7. Treatment, storage, disposal facility(TSDF) requirements-
• Treatment: Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize it or render it nonhazardous or less hazardous; to recover it; make it safer to transport, store, or dispose of; or make it amenable for recovery, storage, or volume reduction.
• Storage: The holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed, or stored elsewhere.
• Disposal: The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters.

TREATMENT OF HAZARDOUS WASTE

Treatment when used in connection with an operation involved in hazardous waste management, means any method, technique, or process, including neutralization or incineration, designed to change the physical, chemical, or biological character or composition of a hazardous waste, so as to neutralize such waste or to render such waste less hazardous, safer for transport, amenable for recovery or reuse, amenable for storage, or reduced in volume.
Wastes remain after the implementation of waste minimisation must be treated to detoxify and neutralise them. There are large number of treatment technologies available.

Examples:

- Biological oxidation
- Chemical precipitation, oxidation-reduction
- Ion exchange
- Carbon adsorption
- Membrane separation
- Other/new technologies

BIOLOGICAL TREATMENT

Synthetic chemical compounds are relatively resistant to biodegradation. Microorganisms that are naturally present often cannot produce the enzymes necessary to degrade complex compounds and these compounds are toxic thus killing the biomass. Co-treatment of industrial and domestic waste with the addition of nutrients in biological systems is often a practical system that has been tested in India as a cheap and effective compared to chemical treatments. It consists of the introduction of food they consume, alter and detoxify the waste. This is what is called secondary processing. Table 2 demonstrates that members of almost every class of anthropogenic compound can be degraded by some microorganism the table also illustrates the wide variety of organisms that participate in environmental significant biodegradation.

Table 2- Examples of anthropogenic compounds and microorganisms that can degrade them

Compound	Organism
Aliphatic (nonhalogenated)	
Acrylonitrile	Mixed culture of yeast mold, protozoan bacteria
Aliphatic (halogenated)	
Trichloroethane, trichloroethylene, methyl chloride, methylene chloride	Marine bacteria, soil bacteria, sewage sludge
Aromatic compounds (nonhalogenated)	
Benzene, 2,6-dinitrotoluene, creosol, phenol	*Pseudomonas* sp, sewage sludge
Aromatic compounds (halogenated)	
1,2-; 2,3-; 1,4-Dichlorobenzene, hexachlorobenzene, trichlorobenzene	Sewage sludge
Pentachlorophenol	Soil microbes
Polycyclic aromatics (nonhalogenated)	
Benzo(a)pyrene, naphthalene	*Cunninghamells elegans*
Benzo(a)anthracene	*Pseudomonas*
Polycyclic aromatics (halogenated)	
PCBs	*Pseudomonas, Flavobacterium*
4-Chlorobiphenyl	Fungi
Pesticides	
Toxaphene	*Corynebacterium pyrogenes*
Dieldrin	Anacystic nidulans
DDT	Sewage sludge, soil bacteria
Kepone	Treatment lagoon sludge
Nitrosamines	
Dimethylnitrosamine	*Rhodopseudomonas*
Phthalate esters	Micrococcus 12B

Source: Extracted from Table 1 of H. Kobayashi and B. E. Rittmann, "Microbial Removal of Hazardous Organic Compounds," *Environmental Science and Technology*, vol. 16, p. 173A, 1982.

CHEMICAL TREATMENT

Chemical treatment of hazardous waste refers to the treatment methods that are used to effect the complete breakdown of hazardous waste into non-toxic gases or, more frequently, to modify the chemical properties of the waste, for example, through reduction of water solubility or neutralisation of acidity or alkalinity. Various chemical treatment methods are chemical oxidation-reduction, acid-base neutralisation, precipitation, hydrolysis, ion exchange, thermal treatment methods, wet air oxidation photolysis and biodegradation. 4.2.1 Oxidation-reduction Oxidation reduction methods provide another important chemical treatment alternative for hazardous wastes. One important chemical redox treatment involves the oxidation of cyanide wastes from metal finishing industry, using chlorine in alkali solution. In this reaction CN- is first converted to a less toxic cyanate. Further chlorination oxidises the cyanate to simple carbondioxide and nitrogen gas.

$$NaCN + Cl_2 + 2NaOH \rightarrow NaCNO + 2NaCl + H_2O$$

$$2NaCNO + 3Cl_2 + 4NaOH \rightarrow 2CO_2 + N_2 + 6NaCl + 2H_2O$$

Ozonolysis

Ozone is a very powerful oxidising agent. Although this process has not been demonstrated in any full-scale facility, its application to Tetrachlorodibenzodioxin(TCDD) and Polychlorinated biphenyl(PCB) is quite promising. With respect to TCDD it was demonstrated that if the dioxins were suspended as an aerosol combined with CCl4, 97% degradation of TCDD was possible. Ozone in conjunction with UV radiation has been shown effective for the destruction of polychlorinated phenols and pesticides. In both the cases the key requirements were to concentrate the TCDD in a medium where they were susceptible to attack and provide a free radical for reaction with dioxin molecule. 4.2.3. Acid-base neutralisation
Hazardous wastes are categorised as corrosive when their solution pH is less than 2 or more than 12.5. Such wastes can be chemically neutralised . Generally acidic wastes are neutralised with slaked lime [Ca(OH)2] in a continuoulsy stirred chemical reactor. The rate of addition of lime is controlled by feedback control system which
monitors pH during addition. Lime is least expensive and is widely used for treating acidic wastes. Since the solubility of lime in water is limited, solution of excess lime do not reach extremely high pH values.
Alkaline wastes may be neutralised by adding sulphuric acid. It is a relatively inexpensive acid. For some applications acetic acid is preferable since it is non-toxic and biodegradable. Alkaline wastes can also be neutralised by bubbling gaseous carbondioxide forming carbonic acid. The advantage of CO2 is that it is often readily available in the exhaust gas from any combustion process at the treatment site.

Chemical precipitation

This technique can be applied to almost any liquid waste stream containing a precipitable hazardous constituent. By properly adjusting pH, the solubility of toxic metals can be decreased, leading to the formation of a precipitate that can be removed by settling and filtration.
Quite often lime [Ca] or caustic soda is used for precipitation of the metal ions as metal

hydroxides. For example the following reaction suggests the use of lime to precipitate the metal as hydroxide.

$$M^{2+} + Ca(OH)_2 \rightleftarrows M(OH)_2 + Ca^{2+}$$

Chromium is precipitated as hydroxide.

$$Cr^{3+} + 3(OH^-) \rightarrow Cr(OH)_3$$

Ion exchange:

Ion exchange is judged to have some potential for the application of interest in situations where it is necessary to remove dissolved inorganic species. However other competing processes - precipitation, flocculation and sedimentation - are broadly applicable to mixed waste streams containing suspended solids and a spectrum of organic and inorganic species. These competing processes also usually are more economical. The use of ion exchange is therefore limited to situations where polishing step was required to remove an inorganic constituent that could not be reduced to satisfactory levels by preceding treatment processes.

CARBON ADSORPTION

The principal use of vapour phase activated carbon in the environmental field is for the removal of volatile organic compounds such as hydrocarbons, solvents, toxic gases and organic based odours. In addition, chemically impregnated activated carbons can be used to control certain inorganic pollutants such as hydrogen sulphide, mercury, or radon.

When properly applied, the adsorption process will remove pollutants for which it is designed, to virtually non detectable levels. In fact one of the first large- scale uses of activated carbon was in military gas masks where complete contaminant removal is essential. Carbon adsorption is equally effective on single component emissions as well as complex mixtures of pollutants.

In the industrial area, the most common applications of activated carbon are for process off-gases, tank vent emissions, work area air purification, and odour control, either within the plant or related to plant exhausts. Additionally, activated carbon is used in the hazardous waste remediation area to treat off-gases from air strippers and from soil vapour extraction remediation projects.

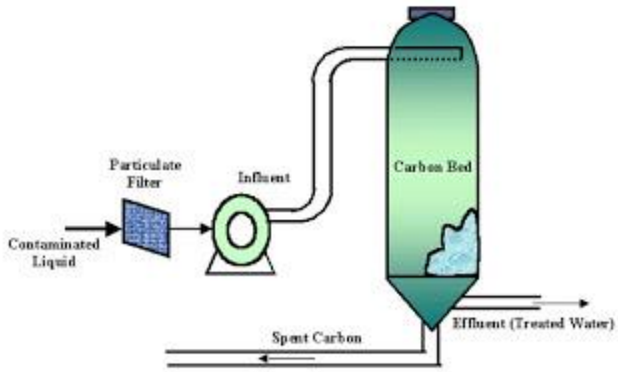

Fig.1. Typical fixed-bed carbon adsorption system

MEMBRANE SEPARATION: REVERSE OSMOSIS

Reverse osmosis separation technology is used to remove dissolved impurities from water through the use of a semi-permeable spiral wound membrane. Reverse osmosis involves the reversal of flow through a membrane from high salinity, or a concentrated solution to the high purity, or permeate, stream on the opposite side of the membrane. Your water pressure is used as the driving force for this separation. The applied pressure must be in excess of the osmotic pressure of the dissolved contaminants to allow flow across the membrane. Spiral wound membranes are tightly packed filter material sandwiched between mesh spacers and wrapped in a small diameter tube. The membrane's operating conditions are fine-tuned to balance the flux, or the amount of water which passes through the membrane, with the specific rejection rates of Drinking Water Contaminants up to 99.8%. Spiral wound membranes are cost-effective thin-film elements used to remove salts and separate organic material, by molecular weight or particle charge. The technology is also very effective at removing bacteria, pyrogens, and organic contaminants.

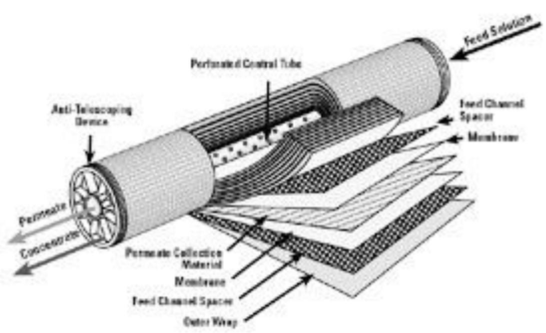

Fig 2. Spiral wound reverse osmosis

INCINERATION

An engineering process that employs thermal decomposition via thermal oxidation at high temperatures (800-1600 C) to convert a waste to a lower volume and non-hazardous material. Products from combustion of organic wastes are carbon dioxide, water vapour & inert ash. Other

products can be formed depending on waste composition.
Combustion Conditions of incineration are:

- Actual incineration conditions generally require excess oxygen to maximize the formation of products of complete combustion and minimize the formation of products of incomplete combustion.
- Temperature, residence time, and turbulence are optimized to increase destruction efficiencies. Typical residence times are 0.5 to 2 seconds.

Two types of technology dominate the incineration field (90% of all facilities):
1. Liquid injection and
2. Rotary kiln incinerators.

The majority of incinerators for hazardous waste inject liquid hazardous waste through an atomising nozzle into the combustion chamber. An auxiliary fuel such as natural gas or fuel oil is often used when the waste is not autogenous. Hydrochloric acid generated from chlorinated hydrocarbon wastes is neutralised by the lime in the kiln while slightly lowering the alkalinity of cement products. Cement kilns have been to be very efficient at destroying hazardous waste(Fig 3.).

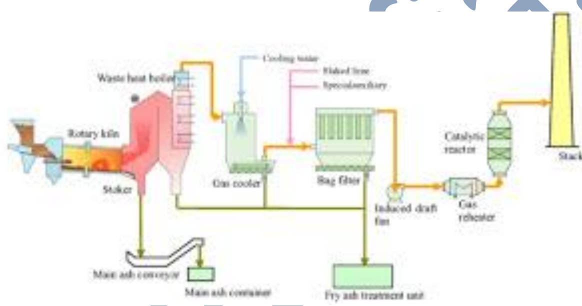

Fig 3. Rotary kiln incinerator

STORAGE OF HAZARDOUS WASTE

Storage is the holding of waste for a temporary period of time prior to the waste being treated, disposed, or stored elsewhere. Hazardous waste is commonly stored prior to treatment or disposal, and must be stored in containers, tanks, containment buildings, drip pads, waste piles, or surface impoundments that comply with the Resource Conservation and Recovery Act (RCRA) regulations.

CONTAINERS –

A hazardous waste container is any portable device in which a hazardous waste is stored, transported, treated, disposed, or otherwise handled. The most common hazardous waste container is the 55-gallon drum. Other examples of containers are tanker trucks, railroad cars, buckets, bags, and even test tubes.

Fig 4. Hazardous waste disposal container

TANKS –

Tanks are stationary devices constructed of non-earthen materials used to store or treat hazardous waste. Tanks can be open-topped or completely enclosed and are constructed of a wide variety of materials including steel, plastic, fiberglass, and concrete.

CONCLUSION

The industry driven economy of India's has resulted in hazardous waste problems, which are difficult to manage in an environmentally friendly manner. The lack of awareness, improper implementation of principles and laws, absence of proper infrastructure and centralized disposal facilities, and lack of technical and financial resources have led to the unscientific disposal of hazardous wastes posing serious threat to human, animal and plant life.

All studies related to this matter indicate that the hazardous wastes situation in India is fairly grim. Thus, there is an urgent need for formulating proper hazardous waste management strategies, implementation of hazardous wastes management regulations and establishment of proper hazardous waste treatment and disposal facilities for controlling the unscientific disposal of hazardous wastes .This is now being done in India, but needs more improvement with the aid of better technologies.

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