Hazardous Wastes

Hazardous waste is defined as the waste likely to cause danger to health and/or environment by itself or in combination with other substances. The Environment (Protection) Act, 1986 defines a hazardous substance as "any substance or preparation which, by reason of its chemical or physico-chemical properties of handling, is liable to cause harm to human beings, other living creatures, plant, microorganism, property or the environment".

Waste is classified by the USEPA as hazardous waste if it exhibits any of the following characteristics—corrosivity, ignitability, reactivity, toxicity. Other characteristics such as carcinogenicity, mutagenecity, bioaccumulation, or phytotoxicity etc. are also classified as hazardous.

Corrosivity. Wastes are corrosive if it has a pH less than or equal to 2 or greater than or equal to 12.5. Any waste that corrodes steel at a rate greater than 6.35 mm per year at a test temperature of 55°C is classified as hazardous.

Ignitability. Waste causing fire through friction, absorption of moisture, or by spontaneous chemical change are classified as hazardous. Such wastes when ignited burn vigorously and persistently. It also include flammable gases, and liquids as described below:

(*i*) Flammable gases; chemicals which in the gaseous state at normal temperature and pressure and when in contact with air become flammable.

(*ii*) Highly flammable liquids; chemicals which have a flash point lower than 23° C and the boiling point of which at normal pressure is above 20° C.

(*iii*) Flammable liquids; chemicals which have a flash point lower than 65° C- and which remain liquids under pressure. Under certain processing conditions, such as high pressure and high temperature, there may create major accident hazards.

Chemicals which explode under the effect of flame, heat or photo-chemical conditions or are sensitive to shocks or friction are also categorized as hazardous.

Reactivity. Reactivity is the process whereby a material is normally unstable but undergoes violent changes or reacts violently with water.

Toxicity. Any waste that has poisonous effects upon human beings or any other living organisms is categorized as hazardous waste. Toxicity can be acute or chronic depending upon the type of substance and length of exposure of the living beings to it. Toxicity Characteristic Leaching Procedure (TCLP) test is used to identify toxic constituent of wastes.

Carcinogenicity. Wastes which can cause cancer are considered as highly hazardous. Such substances attack the normal cells of body and may induce cancerous growth over a period of time.

Hazard identification is required to determine a relationship, if any, between a pollutant and its potential for causing injury to human health or environment. Such injuries may include neurological disorders or cancer, fish kills, habitat destruction or any other environmental deterioration. Risk to humans includes kidney and lever damage, skin infections, hair loss, eye disease, neurological disorders and significant increase in the risk of cancer. Risk assessment techniques involve clinical studies, epidemiological studies, animal studies, and laboratory studies.

It is necessary to identify the initial or background concentration of the chemicals in the environment before commencing any project. Any increase in concentration due to a new project provides an index of the likely exposure. It is often difficult to determine the initial concentration of chemicals since most of the epidemiological studies are carried out after the symptoms of disease manifest when the amount or duration of exposure has changed. Maintenance of detailed records and continuous monitoring of public health and environment can help in accurate assessment of exposure. Environmental consequences of some categories of hazardous wastes are presented in Table next page.

Management of Hazardous Wastes

The main sources of hazardous wastes are the industrial units. Law requires that industries dispose off their hazardous wastes, only after proper treatment. Unfortunately it is seldom heeded in practice especially in developing countries. As a result most hazardous wastes are commingled with the municipal wastes. Ultimately hazardous waste reaches the landfills and is leached to the ground water with grave impact on the human health.

Environmental Consequences of Various Categories of Wastes.

Waste Category	*Material / Wastes*	*Environmental Consequences*
Cyanide wastes	Spent mixed acid, acid sludge, solvents	Generation of toxic hydrogen cyanide gas
Metal bearing waste	Acetylene sludge, alkaline caustic liquids, spent caustic, spent mixed acid, acid sludge, solvents	Fire of explosion, generation of flammable gas
Non halogenated hydrocarbon including solvents	Aluminum, beryllium, calcium, lithium, magnesium, sodium, zinc powder and other reactive metals and metal hybrids	
Waste oil and emulsion	Asbestos waste & other toxic wastes, beryllium wastes, unrinsed pesticide containers, waste pesticides	Release of toxic substances in case of fire or explosion
Phenols	Oxidizing minerals acids, spent mixed acid, acid sludge	Heat generation, fire
Asbestos	Cleaning solvents, obsolete explosives, petroleum waste, retrograde explosives, waste oil & other flammable and explosive wastes	Release of toxic substances in case of fire or explosion
Waste pesticides	Cleaning solvents, obsolete explosives, petroleum waste, retrograde explosives, waste oil & other flammable and explosive wastes	Release of toxic substances in case of fire or explosion
Acid slurry	Acetylene sludge, alkaline caustic liquids, spent caustic	Heat generation, violent reaction
Alkaline slurry	Spent mixed acid, acid sludge, solvents	Heat generation, violent reaction

Many chemicals are bioaccumulative. Studies on aquatic life in contaminated water have revealed huge bioaccumulation - magnifying hundreds of times the original concentration of chemicals rising through various levels of the food chain. For instance, water containing 0.02 parts per million (PPM) of DDD (an organochlorine pesticide namely Dichloro-diphennyl-dichloroethane) will grow plankton containing 5.3 PPM of DDD. Small fish living on it may be contaminated with about 10 PPM of this chemical, and large predatory fish feeding on this small fish may, in turn, have DDD concentrations of as much as 1700 PPM. This amounts to a magnification of 85000 times the original concentration of 0.02 PPM in the water.

Many chemicals are synergistic, *i.e.*, they do not pose a major danger by themselves, but in combination with even a small amount of certain other chemicals, these transform into a major, sometimes fatal, health risk. Important consideration in the management of hazardous wastes are given in below Table.

Important Considerations in Handling/Disposal of Hazardous Wastes.

Environmental Aspect	*Considerations*
Air Quality	• Existing air quality, various sources of air pollution and their cumulative impact on air quality • Volume, physical and chemical characteristics of wastes, including potential for volatilization and dispersion • Health risk due to human exposure • Potential for damage to wildlife, crops, vegetation, buildings etc • Persistence and permanence of the potential adverse effects
Surface Water Quality	• Hydrogeological features of the area, including topography • Details of surface water bodies in the region • Quantity, quality and direction of groundwater flow • Patterns of rainfall in the region • Proximity of waste facility to surface water • Existing quality of surface water, including other sources of contamination and their cumulative impact on surface water • Volume, physical & chemical characteristics of wastes, including potential for volatilization and dispersion • Health risk due to human exposure • Potential for damage to wildlife, crops, vegetation, buildings etc • Persistence and permanence of the potential adverse effects
Groundwater Quality	• Geological and hydrological characteristics of the area • Quantity, quality, and direction of groundwater flow • Patterns of landuse in the region • Potential for migration of waste constituents or leachate into subsurface physical structure • Potential for migration of waste constituents or leachate into root zone of food-chain crops and other vegetation • Volume, physical & chemical characteristics of wastes, including potential for volatilization and dispersion • Health risk due to human exposure • Potential for damage to wildlife, crops, vegetation, buildings etc • Persistence and permanence of the potential adverse effects

Hazardous waste treatment and disposal strategies are usually industry-specific and are best implemented on the basis of an environmental audit of each industrial unit. An environmental audit is a systematic, documented, periodic and objective review of operations and practices in the industrial unit. It ensures compliance with rules and regulations. It can also detect any risk of breakdown leading to environmental problems. Further, the audit can also examine the possibility of minimization of waste streams.

Apart from audits, other management strategies for hazardous waste management include life cycle analysis, volume reduction, toxicity reduction, recycling and reuse, avoiding waste mixing, and good housekeeping practices.

The well known British practices *e.g.* BPEEO (Best Possible Environmental and Economic Option) and BATNEEC (Best Available Technique Not Entailing Excessive Cost) can be adopted for deciding upon the management strategy for hazardous wastes.

Treatment and disposal techniques for hazardous wastes include Chemical Oxidation, Vitrification, Incineration, Pyrolysis, and Land disposal.

RECYCLING OF WASTE MATERIAL

Resource extraction hurts the environment—manufacturing of products pollutes the air and water. Wastes continue the pollution cycle to the detriment of public health and environment. People now realize that mass-production, mass-consumption, mass-disposal systems must be designed for environmental protection and sustainable development.

The recycling of MSW components is universally accepted to be an excellent strategy for controlling the solid waste pollution problems. It also conserves the natural resources and landfill space. Over a third of Western Europe's municipal rubbish is recycled, reused or used to provide energy. Almost every State in USA has passed laws establishing recycling or reduction targets aimed at reducing their wastes volume through recovery/recycling by 20-70 % of the volumes generated. Germany has introduced specific legislation on waste management and recycles more than two-thirds of its paper; Japan recycles more than half of paper and plastics. The Government of India vide its Municipal Wastes (Management & Handling) Rules, 2000 requires municipal authorities to organize awareness programs for segregation of wastes to encourage recycling/reuse of segregated components.

Recyclable Components in MSW

Several components of MSW *e.g.* aluminum cans, paper, cardboard, plastics, glass, iron and steel are usually recycled. Where it is not carried out officially, private ragpickers are actively engaged in this process. Valuable products are made out of the recycled items such as: Videotape, telephone cards, photographic films and plastic bottles. All these recycled items can be converted into polyester fibers, which can be used to manufacture carpets etc. Japan probably is the leader in such techniques. Glass bottles are pulverized into fragments or powder and then mixed with clay. The mixture is then used for manufacturing of various household items. Kitchen scraps are converted into fertilizers for farmers. Waste paper is used for making various decorative items. Waste cooking oil is used for making soaps.

It is a general perception that recycled means that the end product is inferior in quality. However products are made from recycled materials are less costly and of good quality provided the

manufacturing methods are suitably selected. The Negoro Sangyo Co. Ltd., one of the companies in Japan dealing with recycled products, follows a 'cradle to grave' approach to products. It started making its own raw material from old plastics, and uses this material to make new products e.g. carpet tiles.

Recycling of glass metals is carried out in many ways. It can be cleansed and reused, or it can be crushed and melted to make new products. Glass must often be separated by color for reuse.

Crystal Clay Co. of Tokyo has developed a process to fuse glass particles to clay. The company manufactures a new type of ceramic tile block that can be used to pave sidewalks and as sidings on buildings. These 'Crystal Clay Blocks' (named after the company) offer numerous benefits. They contain fragments of waste glass of different colors. The blocks contain 70% glass, reducing the amount of clay used, thereby protecting a valuable natural resource. Under a new manufacturing process, the blocks are fired at 1000 °C, which is 200 °C lower than the earlier system. Apart from saving energy it also reduces the carbon dioxide emission by 26%.

The recyclable components of MSW in Delhi constitutes to about 12% of total volume. The market value of recyclable materials recovered from municipal solid wastes runs into millions of rupees. It makes economic sense to recover these materials for reuse. Such recovery will also result in safeguarding the environment, saving the energy, conservation of natural resources, and reduction in the final residuals for landfills.