

Management of Hazardous Wastes Disposal: An Innovative Approach

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Abstract

A waste can be characterized as hazardous if it possesses any one of the following four characteristics as ignitability, corrosivity, reactivity or toxicity. Hazardous waste management is a major challenge in urban areas throughout the world. Without an effective and efficient waste management program, the hazardous waste generated from various human activities, both industrial and research, can result in health hazards and have a negative impact on the environment. In this study an attempt has been made to capture impacts on society of hazardous wastes. The treatment and disposal methods commonly used are discussed along with design criteria to be taken when designing a hazardous waste management system. Hazardous and other Wastes(Management and Transboundary Movement) Rules 2016 have to be followed for ensuring safe handling, generation, processing, treatment, package, storage, transportation, use, reprocessing, collection, conversion, and offering for sale, destruction and disposal of Hazardous Wastes.

Keywords: Hazardous waste, Corrosivity, Landfill design, TSDF, Manifest system, incineration.

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Introduction

Hazardous-waste management involves collection, transportation, treatment, and disposal of hazardous waste. when improperly handled, it can cause substantial harm to human health and safety or to the environment. Hazardous wastes can take the form of solids, liquids, sludges, or contained gases, and they are generated primarily by chemical research, production, manufacturing, and other industrial activities. They may cause damage during inadequate storage, transportation, treatment, or disposal operations. Improper hazardous-waste storage or disposal frequently contaminates surface water and groundwater supplies as harmful water pollution and can also be a source of dangerous land pollution. In an effort to remedy existing problems and to prevent future harm from hazardous wastes, we need to closely follow government's regulation of hazardous waste management. Hazardous wastes are classified on the basis of their chemical, and physical properties. These properties generate materials that are either toxic, reactive, ignitable and corrosive.. Toxic wastes are poisons, even in very small or trace amounts. They may have acute effects, causing death or violent illness, or they may have chronic effects, slowly causing irreparable harm. Some are carcinogenic, causing cancer after many years of exposure. Others are mutagenic, causing major biological changes in the offspring of exposed humans and wildlife. Reactive wastes are chemically unstable and react violently with air or water. They cause explosions or form toxic vapours. Ignitable wastes burn at relatively low temperatures and may cause an immediate fire hazard. Corrosive wastes include strong acidic or alkaline substances. They destroy solid material and living tissue upon contact, by chemical reaction. The hazardous waste management problem has now become an unavoidable problem of the world mainly as a result of high industrial and technological developments. Even though the new trend in the world is not to produce hazardous wastes, by waste minimization or by using replaceable materials, still huge amounts of hazardous wastes which have to be managed somehow are being produced each day. Unfortunately much of the produced hazardous wastes are disposed off in a manner that does not meet basic standards of environmental safety in the world. The objective of the hazardous waste management problem is to ensure safe, efficient and cost effective collection, transportation ,treatment and disposal of waste¹.

Aim of Study

The aim of the study is to provide the new approach for the hazardous waste management as per The hazardous and other wastes(Management and Transboundary movement) Rules,2016. Following steps have to be followed for the proper management of hazardous wastes disposal.

Responsibilities of The Occupier For Management of Hazardous Wastes

1. Hazardous waste shall be sent to the State Pollution Control Board authorised disposal facility for disposal.
2. Environmentally sound and safe hazardous waste management shall be the responsibility of the occupier.
3. Transportation of hazardous waste from an occupier establishment to an authorised disposal facility shall be done as per the provision of rules.
4. Occupier shall take necessary steps for the containment of contaminants and prevention of the accidents. and limit their effect on humans and the environment.
5. Occupier shall provide equipment and necessary training to the persons working in the facility for their safety.²

Grant of authorisation for managing hazardous wastes

Occupier of the facility engaged in generation, handling, collection, storage, packaging, transportation, use, treatment, processing, recovery, utilisation, transfer or disposal of hazardous waste shall be required to obtain an authorisation from State Pollution Control Board, Application in Form 1 shall be submitted along with a copy of following two documents. (a) Consent to establish under the water (Prevention and control of Pollution) Act, 1974 (25 of 74) and or Air (Prevention and control of Pollution) Act 1981 (21 of 81) granted by State Pollution Control Board. (b) Consent to operate under the water (Prevention and control of Pollution) Act, 1974 (25 of 74) and or Air (Prevention and control of Pollution) Act 1981 (21 of 81) granted by State Pollution Control Board.³

Storage of hazardous waste

The occupiers of facilities shall maintain a record of transfer, storage, recycling and recovery of hazardous waste and the period of storage should not exceed ninety days.⁴

Treatment, storage and disposal facility for hazardous waste

1. Occupier of captive facility, operator of common facility and State Government shall be responsible for the identification and establishing the facility for treatment, storage and disposal of the hazardous waste in the state.
2. Occupier of captive facility or operator of common facility shall set up the treatment, storage and disposal facility as per the Central Pollution Control Board guideline and obtain its approval from State Pollution Control Board.
3. Occupier of captive facility or operator of common facility shall maintain records of hazardous wastes in Form 3 and file an annual return in Form 4.
4. Generator of hazardous wastes shall be responsible for managing waste before being sent to the TSDF (Treatment, storage and disposal facility) for further treatment and disposal. Generators responsibilities are as follows. (i) Waste characterization, waste minimisation, maximum reuse of waste before sending it to TSDF (Treatment, storage and disposal facility) for disposal. (ii) Segregation of hazardous and non hazardous wastes to reduce the quantity of hazardous waste for disposal at TSDF (Treatment, storage and disposal facility).⁵

Packaging and Labelling of hazardous waste

Operator of the treatment, storage and disposal facility and occupier handling hazardous waste shall ensure that hazardous waste are properly packed in a manner suitable for safe handling, storage and transport according to Central Pollution Control Board guideline. The label shall be visible, weather proof and it is done as per Form 8. Hazardous waste container shall be labeled with the world Hazardous wastes and Handle with care. The label is filled with details of the code number of waste, type of waste, incompatible wastes and substances, senders and receivers name and address along with telephone number, Fax number and E-mail id. The name of the contact person also to be provided for the emergency case.⁶

Transportation of hazardous waste

1. Transportation is an important step for the handling of hazardous waste. Hazardous wastes are toxic, flammable, explosive and corrosive in nature, so transportation is done in such a way that it does not cause danger to health and waste and operator of a facility for treatment and disposal. The following points to be followed before providing hazardous waste to the transporter.
2. Transport of the hazardous waste shall be in accordance with the provision of The Hazardous and other wastes (Management and Transboundary Movement) Rules 2016 and the rules made by Central Government under the Motor vehicles act, 1988.

3. Occupier shall provide the transporter with the relevant information in Form 9 regarding the characteristic of hazardous waste, procedure to be followed in case of spillage/ accident/ explosion.
4. Transporter shall have the required copies of the certificate (Authorisation from State Pollution Control Board for transportation of hazardous waste by the waste generator or operator of the facility) for transportation of hazardous wastes. Transporter move hazardous wastes from one site to another by highway, rail, water or air. Since road vehicles have good access to most industrial sites and approved TSDFs(Treatment, storage and disposal facilities) hence highway shipment is common for the transportation of hazardous wastes. Transportation of hazardous waste to the TSDFs (Treatment, storage and disposal facilities) is a collective responsibility of the transporter and generator of the waste.[2,3]

Manifest System

1. It is a moment document for hazardous waste. This system is used for identifying the quantity, composition, origin and destination of hazardous waste during its transportation from generation point to Storage, treatment or disposal points. Disposal of the hazardous waste is the responsibility of the generator and they must provide the manifest along with hazardous waste to a State Pollution Control Board authorised transporter. The sender of the hazardous waste shall prepare seven copies of the manifest in Form 10(with colour code) as explained below. Sender shall sign all the seven copies of the manifest.
2. Copy 1(White) : To be forwarded to the State Pollution Control Board by the sender.
3. Copy 2(Yellow) : To be retained by the sender after taking signature of the transporter on it and the remaining five copies to be carried by the transporter.
4. Copy 3(Pink) : To be retained by the receiver after receiving the waste and remaining four copies to be signed by receiver.
5. Copy 4(Orange) : To be given to the transporter by the receiver after accepting waste.
6. Copy 5(Green) : To be sent by the receiver to the State Pollution Control Board.
7. Copy 6(Blue) : To be sent by the receiver to the sender.
8. Copy 7(Grey) : To be sent by the receiver to the State Pollution Control Board of the sender in case the sender is in another state.[2]

Treatment storage and disposal

The hazardous waste can be disposed at captive treatment facilities or at common TSDFs (Treatment, storage and disposal facilities). Disposal methods of recycling and reduction are used during the management of hazardous wastes. Even after applying these methods of disposal there will always be some leftover hazardous waste which requires treatment and storage. Treatment, surface storage, land fill storage and deep well injection methods are mainly employed for management of hazardous wastes.[1,4,5,6]

Treatment of hazardous wastes

Physical, chemical, thermal, biological, solidification and stabilisation methods are employed for the treatment of hazardous wastes. These methods detoxify and remove the dangerous parts of the hazardous wastes or totally destroys it. Treatment processes are as follows.[1,4]

Physical Treatment Methods

(I) Screening is a process for removing particles from hazardous wastes , (II) Sedimentation is a process for removing suspended solid particles from hazardous wastes , (III) Flotation is a process for removing solids from liquids. (IV) Filtration is a process for separating liquids and solids by using various types of porous materials.(V) Centrifugation is a process for separating solid and liquid components of a hazardous wastes.(VI) Reverse osmosis separates components in a liquid hazardous wastes, (VII) Distillation is a process for separating liquids with different boiling points.(VIII) Evaporation is a process for concentrating non-volatile solids in a solution by boiling off the liquid portion of the hazardous wastes..(IX) Adsorption is a process for removing low concentrations of organic materials on the surface of a porous material.

Chemical Treatment Methods	Chemical treatment produces less hazardous material. The chemical treatment operations commonly used in treating hazardous wastes are as follows: (I) Neutralisation is a process for reducing the acidity or alkalinity of a hazardous wastes by mixing acids and bases to produce a neutral solution.(II) Precipitation, In this process soluble substance is converted in to insoluble form either by a chemical reaction or by change in the composition of the solvent.(III) Ion exchange is used to remove from solution ions derived from inorganic materials.(IV) De-chlorination is a process for stripping chlorine atoms from chlorinated compounds.(V) Process of oxidation-reduction is used for detoxification of toxic wastes When electrons are removed from an ion, atom or molecule the substance is oxidised and when electrons are added to a substance it is reduced
Thermal treatment methods	Two types of Thermal treatment methods are employed for the hazardous waste. (I) Incineration: If the hazardous wastes are heated in the presence of oxygen, combustion occurs, and the process is known as incineration.(II) Pyrolysis: If the hazardous wastes are heated at higher temperature in the absence of oxygen, the process is known as Pyrolysis. pyrolysis and Incineration methods of treatment reduce the volume or toxicity of organic hazardous wastes by heating them to high temperatures 430-1700°C, Hazardous waste incineration and pyrolysis systems include single-chamber liquid systems, rotary kilns, and fluidised-bed incineration systems.
Biological Treatment Methods	Hazardous waste treatment which use micro-organisms to decompose hazardous organic wastes are known as biological treatment. Biological hazardous waste treatment is typically used on waste from the oil and gas industry. Land farming is the most common biological treatment method. Land farming involves the use of genetically engineered microbes to stabilize the waste.
Solidification and stabilisation	Solidification and stabilisation are treatment processes for the improvement in the waste handling and physical characteristics, decrease surface area across which pollutants can transfer or leach, limit the solubility or detoxify.
Disposal of hazardous wastes	Disposal of hazardous waste is the final stage of hazardous waste management system. Hazardous waste disposal methods are as follows.[1,4,5,6,7]
Surface storage	Surface or land storage, is the storage solution for residual hazardous wastes. Surface storage solutions include waste piles, ponds, and lagoons that are carefully constructed to eliminate the chance of leakage or erosion. Precautions are used to protect groundwater,
Secure Land Fill	A secure land fill is a disposal facility where hazardous wastes are placed into and stored in the soil. It is designed and constructed as a secured facility to contain hazardous waste material and any leachate which is formed by the entrapped moisture or by infiltration of rainfall. Various barriers/liners are used to achieve above objectives and include clay and synthetic liners. The landfill should be at least 10 feet above underlying bedrock or ground water tables. A groundwater monitoring system should be installed at a secure land fill to ensure all precautionary methods are working.
Deep well disposal	Deep well injection is a hazardous liquid waste disposal method. It involves injecting liquid waste through steel casings placed in limestone or sandstone. High pressure is applied to force the liquid into the pores and fissures of the rock, where it is to be permanently stored. These disposal wells are hundreds to thousands of meter deep, far removed from the surface and below the regional water table

Summary and Suggestion

As a summary and suggestion to the solution of the Hazardous waste management, several practical recommendations are suggested as per The hazardous and other wastes(Management and Transboundary movement) Rules,2016.[2]

1. Every occupier of the facility who is engaged in handling, generation, collection, storage, packaging, transportation, use, treatment, processing, recycling, recovery, pre-processing, co-processing, utilisation, offering for sale, transfer or disposal of the hazardous wastes shall be required to make an application in Form-1 and obtain an authorisation from the State Pollution Control Board.
2. Every occupier authorised under The hazardous and other wastes(Management and Transboundary movement)Rules, 2016, shall maintain a record of hazardous waste managed by him in Form 3 and prepare and submit to the State Pollution Control Board, an annual return containing the details specified in Form 4.
3. The occupiers of the facilities may store the hazardous waste 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.
4. The utilisation of hazardous wastes as a resource or after pre-processing either for co-processing or for any other use., including within the premises of the generator(if it is not part of process),shall be carried out only after obtaining authorisation from the State Pollution Control Board.
5. The operator of the common facility or occupier of a captive facility, shall design and set up the treatment, storage and disposal facility as per technical guidelines issued by Central Pollution Control Board and take the approval from the State Pollution Control Board.
6. Any occupier handling hazardous wastes shall insure that the hazardous wastes are packaged in a manner suitable for safe handling, storage and transport as per the guidelines by Central Pollution Control Board. The labeling shall be done as per Form 8.
7. The occupier shall provide the transporter with the relevant information in Form 9 regarding the hazardous nature of the wastes and measures to be taken in case of an emergency.
8. The sender of the waste shall prepare seven copies of the manifest in Form 10 comprising of colour code and all seven copies shall be signed by the sender. The sender shall forward copy 1(white copy).to the State Pollution Control Board and copy2(Yellow) to be retained by sender. Copies 3 to 7shall be given to the transporter for providing it to receiver. Receiver will provide copy 4(orange) to the transporter after receiving waste and send copy 5(Green)to the State Pollution Control Board. and send copy 6(Blue) to the sender and the copy 3(Pink) will be retained by the receiver. The copy 7(Grey) shall only be sent to the State Pollution Control Board of the sender, if the sender is in another state.
9. The occupier handling hazardous wastes and operator of disposal facility shall maintain records of such operations in Form 3 and shall send annual returns to the State Pollution Control Board in Form 4.
10. Hazardous waste should be managed in such a way that adverse effects to the welfare of the people should be minimised.
11. Processes of recycling and reuse can be employed for the minimisation of the hazardous waste volume.
12. Hazardous wastes should be treated before disposal. This can be done using physical, chemical, thermal and biological methods of treatment.
13. Disposal of the hazardous wastes is the final stage of the hazardous waste management and it should be done into a properly operated secure land fill of Treatment Storage and disposal facility authorised by the State Pollution Control Board.

Conclusion

In this study, the focus was on the management of hazardous waste. We have discussed the functional elements involved in hazardous waste management (i.e. generation, storage and collection, transfer and transport, processing and disposal). Subsequently we explained how hazardous waste could be treated through the physical, chemical, thermal, and biological methods to reduce their impact on public health and the environment. We then discussed some of the techniques for hazardous waste minimisation and pollution prevention. Provision of a hazardous waste management planning and monitoring system is a prerequisite issue for effective reduction of hazardous waste associated risks.

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