Current status of hazardous waste disposal technology

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Abstract. Hazardous wastes refer to wastes with hazardous characteristics that are included in the national hazardous waste list or identified in accordance with the hazardous waste identification standards and identification methods prescribed by the state. Hazardous waste disposal methods are relatively mature including incineration treatment technology, plasma treatment technology, microwave treatment technology, pyrolysis vaporization, high temperature cooking, chemical method and landfill, etc. The final disposal achieves the effects of detoxification, reduction and stabilization.

1. Introduction
With the acceleration of the modernization process, China's economy is also developing at a high speed, but with it, China's resource consumption has increased, and more and more hazardous wastes have been brought. Hazardous wastes may not only destroy the beautiful living environment on which humans depend, but also have an adverse effect on human health and even endanger lives and restrict healthy and sustainable development. There are many types of hazardous wastes, complex components, toxic, corrosive, flammable and explosive, and their pollution is latent and lagging. It is one of the key and difficult problems of global environmental protection. Precisely because of the various types of hazardous waste and the complex composition, it is difficult to handle and can easily cause secondary pollution. Therefore, there must be a standardized disposal system.

2. Collection and transportation of hazardous waste
Due to the inherent properties of hazardous waste, including chemical reactivity, toxicity, flammability, corrosiveness or other characteristics, it can cause harm to human health or the environment[1]. Therefore, there are strict requirements on the reception, storage, transfer, and addition of hazardous waste. Prior to the disposal of hazardous wastes, processes such as incoming identification, classification, storage, and pretreatment must be carried out.

2.1 Temporary storage
In order to prevent hazardous waste from contacting with the outside world or being exposed to outside life during the entire process, there should be a fixed parking location provided by the production unit of the hazardous waste and a container for the storage of hazardous waste should be provided by the collection and transportation unit to make the hazardous waste generated. The waste is produced and processed in accordance with the standardized process. According to the time specified by each unit that produces hazardous wastes, and according to the chemical compatibility of the
hazardous wastes, the hazardous wastes classified by professionals are placed in the prescribed temporary storage sites for hazardous wastes. The hazardous wastes are then collected and transported regularly by enterprises that handle hazardous wastes for centralized processing[2].

Before analysis and identification, the hazardous wastes entering the plant are temporarily stored in the temporary dumping area of the plant, and the storage time of the wastes stored in the dumping area shall not exceed one day. The temporary storage area adopts corrosion-resistant hardened ground, set up light steel rainproof shed, and set up collection ditch and collection pool around. The temporary storage place of hazardous waste must be provided with reliable rain proof, moth proof, ventilation and other means, with eye-catching hazard warning signs, and more importantly, it needs to be managed by special personnel to avoid the accidental entry of irrelevant personnel; it is also necessary to facilitate the retrieval of hazardous waste collection containers and the traffic of transport vehicles.

2.2 Transportation system
According to the current relevant regulations, hazardous wastes are collected separately by various hazardous waste producing units and centralized harmless treatment at specialized treatment plants. Therefore, there is a link in the transfer of hazardous wastes from producing units to centralized harmless treatment plants. The transshipment of hazardous waste belongs to a special industry, and a professional transportation fleet needs to be set up to be transported in accordance with national and local regulations on hazardous waste transshipment[3].

2.3 Collection container
Hazardous waste contains a lot of toxic and harmful substances and is highly harmful. Therefore, it is required to place these hazardous wastes in special containers from the source of production to ensure the safety of storage, handling and transfer. With reference to relevant regulations, this project uses specially customized containers for hazardous waste collection. The special container and its mark shall meet the requirements of the "Hazardous Waste Storage Pollution Control Standard". According to the nature and form of hazardous waste, containers of different sizes and materials can be used for storage.[4] The hazardous waste containers can be steel drums, steel tanks or plastic products. According to the characteristics of hazardous wastes, the collected hazardous wastes shall be designed in accordance with relevant standards and regulations in special containers, packaging and packaging behavior.

(1) Liquid and semi-solid hazardous waste must be packed in packaging containers. Solid hazardous waste can be packed in packaging containers or bags and stored in temporary storage facilities that comply with this specification.

(2) The packaging container must be intact and free from corrosion, pollution, damage or other defects that can reduce its packaging efficiency. The packaging container that contains waste should be properly covered or sealed. The surface of the container should be kept clean and no hazardous waste should be attached.

(3) The same packaging container or packaging bag cannot contain more than two types of hazardous wastes of different properties or categories at the same time. The packaging container and packaging bag should be made of materials compatible with the contents. The packaging container must be strong, not easily broken, and have good impermeability.

(4) The hazardous waste packaging containers used in this project will not be cleaned in our factory, but will be sent to a unit with processing qualification and processing capacity for disposal.

3. Hazardous waste treatment process
The more mature disposal methods of hazardous waste include incineration treatment technology, plasma treatment technology, microwave treatment technology, pyrolysis vaporization, high temperature cooking, chemical method and landfill, etc., so that the final disposal can achieve detoxification, reduction, and stability[5].
3.1 Physical and chemical method
This method is to treat various liquid materials such as waste acid, waste alkali and waste liquid containing heavy metals. According to the treatment plan proposed by the laboratory according to the properties of different materials, the harmful substances in the solution can be decomposed or formed into precipitates and insoluble substances through neutralization, oxidation, reduction and other reactions. The precipitates are dehydrated by pressure filtration. The recovered filter cake is transported to the curing workshop for curing[6].

3.2 Biological treatment
Biological treatment mainly uses microorganisms to decompose the biodegradable organic matter of solid waste to achieve harmlessness or resource utilization. Treatment methods include biological treatment, anaerobic facultative anaerobic and aerobic treatment processes. Compared with chemical treatment, biological treatment is more economical and widely used, but this process takes a long time and the treatment efficiency is not stable enough.

3.3 Stabilization/curing method
Stabilization/solidification technology is an important means to deal with heavy metal waste and other non-metal hazardous waste[7]. The treatment objects in the solidification workshop are heavy metal sludge, industrial dust, asbestos, incineration ash, soot, cake filter, etc. After the hazardous waste is solidified, a barrier is established between the waste particles and the environment, so that the permeability and dissolution of the final product can be greatly reduced, can be safely transported, and can be conveniently finalized.

3.4 Incineration method
Disposal of hazardous waste by incineration has the advantages of high harmlessness, good volume reduction effect, high resource utilization rate, and small area[8]. It can completely kill harmful microorganisms and viruses in the waste. Most of the harmful compounds are decomposed into simple harmless substances (mainly CO₂ and H₂O), so that flammable substances are completely oxidized and reach a stable state. The most important and critical equipment in the incineration system is the incinerator. The design and selection of the incinerator should be comprehensively considered based on the type, quantity and investment of waste in the area. The one-time investment and operating costs of the incineration method are relatively high.

Its main advantages:
(1) After the waste is incinerated, the pathogens in it are completely eliminated. The harmful gases and smoke generated during the combustion process will meet the emission requirements and be harmless after treatment;
(2) After incineration, after the combustible components in the waste are decomposed by high temperature, it can generally be reduced by 80% and volume reduction by more than 90%. The reduction effect is good, which can save a lot of landfill area, and the incineration residue is a dense, Non-corrupted and sterile substances;
(3) The land occupation of the incineration plant is small;
(4) Conditional incineration equipment can also recover part of the energy.
(5) The incineration treatment can be operated around the clock and is not easily affected by the weather.

Its problems:
The incineration method requires well-trained technicians for operation and management: the incineration treatment also requires supporting safe landfills.

3.5 Plasma treatment technology
Plasma furnace is the core of plasma treatment technology. As the equipment of waste gasification, the waste in the plasma furnace goes through three stages of preheating, gasification and burning out in
turn to decompose the waste, which is the main place to realize waste reduction and harmless treatment[9].

Plasma technology, which is completely different from ordinary rotary kiln incineration equipment, is a high-temperature gasification technology. The plasma torch not only has the advantage of generating a high-intensity heat source, but also the plasma in the gasification furnace is a highly ionized or charged gas. Due to its high temperature and high thermal density, the plasma furnace can convert almost all the organic matter in the carbon-based waste into synthesis gas (mainly CO and H₂), while the inorganic matter can be turned into harmless ash (glass body). Due to the high temperature in the furnace, the formation of dioxins was avoided at the source. And a lot of research and engineering practice have proved that the leaching toxicity concentration of slag (glass body) generated by plasma is lower than the national standard, and it can be treated as general waste or developed and utilized.

3.6 Safe landfill
Safe landfill is the ultimate disposal method of hazardous waste[10]. Various countries have formulated design standards for safe landfill and technical requirements for landfill operations. The United States has required that all hazardous waste landfills must be equipped with double-layer liner system and leachate collection, drainage and treatment system. For new landfills, in addition to the above-mentioned systems, groundwater monitoring system and surface stabilization system must also be set up. The pollution control standard for hazardous waste landfill safety promulgated by China stipulates the requirements for site entry, site selection, design, construction, operation, site closure and environmental protection.

4. Summary and outlook
With the increase of hazardous waste, the disposal of hazardous waste has become a problem that people must pay attention to. Nowadays, the disposal of hazardous waste is mostly carried out by landfill and incineration, which has initially realized the reduction and harmlessness of hazardous waste. However, the incineration flue gas caused by the treatment of hazardous wastes by the incineration method requires a flue gas purification system to process. In recent years, plasma treatment technology has gradually matured and has been applied to practice. The application of plasma treatment technology has greatly reduced the pollutants in incineration flue gas. And with the continuous development of science and technology, the continuous improvement of hazardous waste treatment technology, reducing waste incineration, landfill disposal, and paving the way for the creation of a "waste-free city", so as to achieve effective protection of the ecological environment.

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