Characteristics of Hazardous Waste and Recovery

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Abstract. Hazardous waste accounts for a small proportion of the total waste, but this waste poses the greatest harm to human health and the living environment. Hazardous waste greatly impacts the whole waste classification and treatment work and has special requirements for putting in and disposal. To understand the current situation of daily disposal of hazardous waste, to clarify the existing problems in the process of hazardous waste disposal and to improve the disposal capacity of hazardous waste, this paper will analyze the characteristics and common recycling methods of three typical hazardous wastes. Each hazardous waste recycling method has a certain negative impact on the environment. The disposal of waste products is easy to cause secondary pollution. Through the analysis of the cost and impact of these treatments, a more complete recovery system is worth promoting. Improving the recycling process helps reduce the negative impact of hazardous waste in the treatment project.

Keywords: Hazardous waste, electronic waste, waste pesticide, medical waste, recovery.

1. Introduction

With the development of the economy and society, the consumption level has been greatly improved, and more and more waste with complex types has been produced. The continuous deepening of garbage classification has led to a rapid increase in the amount of hazardous garbage collected in domestic garbage. Hazardous waste refers to domestic waste that causes direct or potential harm to human health or the natural environment. Although the output of hazardous waste in life is small, its harm is the greatest. With the classified management of domestic waste, there is also a complete system for the treatment of hazardous waste. This paper mainly analyzes the characteristics and recovery of three kinds of hazardous waste, namely electronic waste, waste pesticide and medical waste. Firstly, the problems caused by electronic waste include heavy metal pollution, waste plastic pollution, and chemical pollution. There are currently two main ways to handle it. First, electronic waste is disassembled into fragments according to classification, and then heavy metals are further extracted through smelting or dissolution [1]. The process of disassembly mainly brings about the pollution of semi-volatile organic compounds and persistent organic compounds. Subsequent smelting and dissolution will cause heavy metals to be lost to the environment. These pollutants are harmful to the surrounding environment and human health, as well as to regional atmospheric ozone and PM2 Pollution also has a significant impact [2-3]. Therefore, there are still environmental problems to be solved in the recycling and treatment of electronic waste. In addition, the proportion of waste pesticides in hazardous waste is relatively large. Many pesticides expire and cannot be circulated to the market for cultivation. The content of toxic substances in waste pesticides will soar, so such pesticides need to be centrally disposed of. These waste pesticides are generally collected in a centralized manner for incineration or landfill [4]. To reduce the harm of this treatment method, waste pesticides are generally diluted before treatment. In recent years, the amount of medical waste has also been increasing. Due to the possibility of exposure to viruses and bacteria, this type of waste is more likely to directly cause harm to the environment or people. Currently, there are two main types of disposal methods for medical waste: incineration and non-incineration [5]. Incineration-type treatment methods can generate harmful substances, which can enter the air, water, and soil as the exhaust gas is discharged, causing pollution to the environment. However, medical waste that has undergone non-incineration and disinfection treatment will still be sent to landfills or incineration plants, which can also cause pollution, but the degree of pollution will be reduced [6].

This article mainly introduces two methods to treat medical waste: high-temperature steam and chemical disinfection. The treatment of these three types of hazardous waste has always been relatively complex. The characteristics of electronic waste, waste pesticide and medical waste, in detail, as well as various measures for further recycling and treatment will be introduced.

2. Electronic waste

2.1. Characteristics of electronic waste

Electronic waste refers to abandoned electronic equipment devices, mainly from daily life, such as obsolete TVs, refrigerators, washing machines, air conditioners and other electronic products. These electronic wastes generally contain a large number of heavy metals, such as copper, nickel, lead, etc. These heavy metals are easy to leak and accumulate in water or soil during the process of disposal, which will cause great harm to the environment. Electronic waste contains a variety of substances harmful to the environment and human body and there are six main components, namely, lead, cadmium, mercury, hexavalent chromium, PVC plastic and brominated flame retardant [7]. Lead mainly damages the hematopoietic system and nervous system of bone marrow, and also has certain damage to male reproductive glands. Cadmium will be enriched in the organism and enter the human body through the food chain, causing harm. Mercury is also toxic to humans. If exposed in large quantities, the main hazards include acute mercury poisoning and chronic mercury poisoning. Skin contact with hexavalent chromium may cause sensitivity and genetic defects. It has persistent risks to the environment. The persistence of PVC is very long. This accumulated poison can diffuse into the air and soil, affect nearby animals and plants, and be biomagnified. Brominated flame retardant, as a common pollutant, has strong durability and is easy to accumulate, which will harm the human body. These main pollutants are very harmful to the environment and people, so the treatment of electronic waste has always been a topic of concern.

2.2. Recovery of electronic waste

2.2.1 Disassembly

The first step in electronic waste disposal is usually disassembly, usually completed manually or mechanically. Due to their complex structures, which are usually composed of different materials, they need to be decomposed to facilitate subsequent processing. E-waste is disassembled depending on the physical characteristics of its parts. For example, the picture tubes of TVs and monitors containing glass can be recycled in large quantities; some coils made of copper can be recycled. After the decomposition of these components can be subsequently recycled, the specific process includes disassembly, crushing and sorting. The materials after recovery can be recycled into metal, plastic, glass and other raw materials. This treatment method is a common recycling method because of its low cost and simple operation. But there are also some problems. However, the disassembly process is usually carried out at high temperatures to ensure the efficiency of it. High-temperature environments are also more prone to the release of harmful substances. The disassembly, disassembly, and recycling process of electronic waste has increased the content of heavy metals, semi-volatile organic compounds, and persistent organic pollutants in the air, water, and soil [8-9]. Once these toxic substances accumulate with organisms and enter the biosphere, they are difficult to remove. Human exposure to toxic heavy metals or organic pollutants may cause damage to body functions and organs, and even endanger life.

2.2.2 Dissolution

The dissolution step usually occurs after the decomposition of electronic waste. Dissolved liquids include strong acids, strong bases, and organic solvents. Currently, there are three main techniques in factories for the secondary treatment of electronic waste, namely, hydrometallurgy, chemical extraction, and ion exchange. After disassembly and crushing, electronic waste will undergo eddy current separation, flotation, magnetic separation, etc., to separate components other than electrode

materials. The resulting substance can meet the requirements for dissolution and recovery. This mature recycling method has a high recovery rate and can greatly recover the heavy metal materials in electronic waste. However, this recovery method has a high cost, and the dissolved reaction can produce harmful substances, further causing environmental pollution. Although it is widely used, the chemical solvents used may cause secondary pollution to the environment. A large amount of bromodiphenyl ether has been detected in the electronic waste treatment plant in Shantou City, Guangdong Province [10]. This substance is discharged into the environment along with wastewater during the treatment process. It is prone to bioaccumulation and endangers human health. Therefore, these chemical reagents used to treat electronic waste pose significant environmental hazards.

3. Waste pesticide

3.1. Characteristics of waste pesticide

Waste pesticides refer to pesticides that have not been used up and have exceeded their shelf life. Pesticides that deteriorate, fail, or have reduced efficacy during storage, or whose labels fall off and cannot be identified, are also referred to as waste pesticides. Most of these pesticides are persistent organic compounds that are difficult to degrade, have strong persistence, and accumulate continuously in the biosphere. Due to excessive storage time or environmental conditions, pesticides become stale and cannot be used. Pesticides are randomly discarded before they are used up, resulting in harmful effects from their residual liquid and waste packaging. Pesticides leaked from nonapplication sites can enter soil or groundwater, causing environmental pollution and endangering human health. Waste pesticides are stable, difficult to degrade and transform in the environment or biology, and have certain toxicity. Pesticides such as DDT, have long persistence and high residue levels. Waste pesticides and their degradation products can pollute the atmosphere, water, and soil, affecting the ecological environment and sustainable agricultural development [11]. They can cause acute or chronic poisoning in humans, animals, and plants. Common waste pesticides include organochlorine pesticides, organophosphorus pesticides, and organonitrogen pesticides.

3.2. Recovery of waste pesticide

3.2.1 Landfill

Waste pesticides are generally disposed of by landfilling. When landfilling non-water-soluble solid pesticide formulations, including powders, wettable powders, granules, suspending agents, etc., the waste pesticides are placed in the pit, crushed into packaging containers, filled and compacted, and paved. After digging the pit, it is not allowed to add padding to the pit. When handling liquid or soluble pesticides, a lime layer and a sawdust layer should be placed after digging the pit to prevent infiltration. After the crushed waste pesticide is landfilled, a layer of lime shall be paved and compacted, and finally, the soil shall be filled and compacted for pavement. The site for landfill waste pesticides should be located in remote areas far from living areas and with deep groundwater levels. High-toxic pesticides are specifically treated and they should be kept away from residential areas and water sources. Metal cans and barrels containing pesticide waste should be cleaned, exploded, and then buried. Glass containers should be broken and buried. Although this method is simple to operate and low in cost, it is relatively harmful. Because the components of waste pesticides are highly toxic chemicals, they can easily pollute the environment once they penetrate soil and groundwater.

3.2.2 Incineration

Waste pesticides can be treated at high temperatures through an incinerator. However, it is not advisable to incinerate at will, which poses a significant pollution risk to the ecological environment [12]. Mature incineration systems are widely used. The waste pesticide is mixed with combustion air and combusted at high temperatures in an incinerator for decomposition. The generated flue gas is then removed from the acidic gas through the absorption system and discharged up to standard. During the incineration process of salty waste liquid containing salts such as sodium carbonate,

sodium sulfate, and sodium chloride, the organic matter is completely decomposed. To recover usable resources, heat and reusable organic matter can be recovered after incineration. In order to recover resources and reduce operating costs, a waste heat recovery step is added to the incineration system. The high-temperature flue gas generated by the incinerator is passed into a new type of quench cooler to cool down and emit heat. The flue gas discharged after incineration will contain HCl, SO2, etc., which can cause air pollution. But when emissions meet standards, these pollutants are controllable.

4. Medical waste

4.1. Characteristics of medical waste

Medical waste refers to waste generated by medical institutions in medical, preventive, health care, and other related activities that have direct or indirect toxicity, and other hazards [13], such as used cotton balls, needles, gauze, adhesive tape, disposable medical devices, postoperative waste, expired drugs, and so on. During the COVID-19 epidemic, the sanitary waste generated at all temporary isolation points and key sites is also typical hazardous waste. Due to the possibility of contact with viral bacteria, the bacterial and viral content on the surface of such waste should not be underestimated. They may harbor some deadly viruses and bacteria, and the degree of harm is unimaginable. Due to the particularity of medical waste, their treatment and recycling methods also require mature systems. Improper disposal of medical waste is not only harmful to the environment but also causes diseases that endanger human health [6]. Therefore, in order to minimize the pollution of medical waste, advanced recovery and treatment methods are very important.

4.2. Recovery of medical waste

4.2.1 High-temperature steam

High-temperature steam sterilization is a method of inactivating viral bacteria by using steam to place medical waste in an airtight pressure sterilization pot. By heating, a large amount of steam is generated in the sterilization pot. Wait until the water vapor rapidly exhausts the cold air in the pot from the exhaust valve, and then the exhaust valve is closed. At this time, due to the inability of the steam to escape, the pressure in the sterilizer increases, resulting in an increase in the boiling point and a temperature higher than 100 ℃, resulting in the coagulation and denaturation of the protein of the diseased bacteria in the medical waste to achieve the purpose of sterilization. This sterilization condition requires a vapor pressure of 220 kPa, a temperature of over 132 ℃, and a duration of over 45 minutes [14]. However, due to high temperatures, this treatment and recovery method can generate many harmful gases, such as hydrogen sulfide, which is prone to cause secondary pollution to the environment. However, high-temperature steam sterilization cannot be used to treat pathological waste, pharmaceutical waste, and chemical waste. In addition, when the amount of medical waste is large, the treatment efficiency of this method will be greatly reduced due to the penetration ability of steam [15].

4.2.2 Chemical disinfection

The chemical disinfection and sterilization method uses chemicals to penetrate the body of bacteria, destroy their physiological functions, inhibit bacterial metabolic growth, and thus play a disinfection role. Conventional chemical disinfectants such as lime powder, chlorine dioxide, sodium hypochlorite, calcium hypochlorite, etc [16]. Germs in a medical waste can be removed through immersion, wiping, fumigation, and other methods. This method consumes a large amount of chemical reagents, costs a lot, and the technology is not mature enough, so it is not widely used. In addition, the process of decomposing organic substances by chemical reagents can cause the generation of harmful gases, causing significant environmental damage.

5. Conclusion

This article has described the characteristics and treatment methods of three types of hazardous waste. There are relatively mature processes for the recycling and treatment of three types of hazardous waste: electronic waste, waste pesticides, and medical waste. However, these recycling methods can also some harm to the environment. In order to improve processing efficiency and reduce the possibility of secondary pollution, some technical improvements and policy support are also needed. Hazardous waste is an important component of domestic waste. All localities should establish and improve hazardous waste collection, transportation, and disposal models, effectively dispose of hazardous waste, and eliminate potential environmental risks. The classification of hazardous waste must also be ensured, and their transportation and treatment processes need to be kept away from densely populated areas. Professional personnel is also indispensable for inspection and inspection. They should guide residents to properly place hazardous wastes and avoid mixing them with other wastes. The storage, transportation, and recycling of hazardous waste must be managed in a unified manner in accordance with laws and regulations, and a mature, professional, and complete management system must be established. The municipal management department should coordinate with various competent departments and strengthen cooperation in professional jurisdiction.

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