

Study on Management Policy of Waste Mercury Containing Fluorescent Tubes

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Abstract

China's policies on recycling, treatment and disposal of waste fluorescent tubes are still not perfect. The social source tubes are small and scattered, and the collection and transportation costs are high. The landfill and incineration of waste fluorescent tubes still occupy a certain position. This paper analyzes the management policy of waste fluorescent tubes and the current treatment and disposal status, and puts forward reasonable suggestions according to the current management, treatment and disposal of waste mercury containing fluorescent tubes, in order to provide a theoretical basis for the treatment and disposal of waste fluorescent tubes.

Keywords

Waste Fluorescent Tube; Mercury; Disposal.

1. Introduction

According to statistics, China has put into use more than 10 billion fluorescent lamps[1]. As the world's largest lamp producer, the annual output of fluorescent lamps exceeds 3 billion, the annual waste exceeds 1 billion, and 3000Kg of mercury and 4680 tons of rare earths can be recovered. , 25,000 tons of other powder, glass, guide wire, etc. can also be recycled, but the current recycling and disposal volume is less than 15% of the scrapped volume [2], there is a great recycling potential. Mercury is an essential material for fluorescent lamps. Broken fluorescent tubes will cause harm to the environment and human body[3-8]. Therefore, waste fluorescent tubes have been included in the "National Hazardous Waste List" [9,10].

With the emergence of fluorescent lamps, developed countries such as the European Union, the United States, and Japan have established relatively complete legislation and management systems for waste fluorescent tubes, clarifying the main responsibilities of all parties, and establishing a consumer-side collection network [11,12]. A series of policy documents have been issued in the areas of pollution control and recycling.

This article focuses on the research on the management policy of mercury-containing fluorescent tubes, and clarifies the current situation and problem gaps in the disposal and disposal of waste mercury-containing fluorescent tubes, in order to provide a reference for the treatment and disposal industry of mercury-containing fluorescent tubes.

2. Management Policy for Waste Fluorescent Tubes

China has issued a series of laws, regulations and policy documents on the prevention and control of environmental pollution by solid waste from waste fluorescent tubes. Promulgated in 1995, the latest revision of the "Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes" in 2020 stipulates the specific recycling behavior of waste fluorescent tubes [13]. Promulgated in 1998, and in the latest revision of the National Hazardous Waste List [14] in 2020, waste mercury-containing fluorescent lamps and other waste mercury-containing electric light sources generated during production, sales and use are included in the HW29 category of mercury-containing waste. Toxic, waste fluorescent tubes generated from household sources and not collected separately are included in the "Hazardous Waste Exemption Management List". The whole process may not be managed as hazardous waste, but after it is classified from domestic waste, it needs to be managed as hazardous waste. The "Hazardous Waste Pollution Prevention and Control Technology Policy", the "Management Measures for Hazardous Waste Operation Permits" and the "Management Measures for Hazardous Waste Transfer Forms" provide more detailed regulations on the management and supervision of hazardous wastes by the ecological environment management departments at all levels. The "Technical Specifications for the Recycling of Waste Fluorescent Lamps (GB/T 22908-2008)" introduces the technical specifications related to the recycling and treatment of fluorescent lamps [15]. In 2012, the "Twelfth Five-Year Plan for the Prevention and Control of Hazardous Waste Pollution" encouraged the promotion of cleaner production technologies such as solid mercury injection in the fluorescent lamp production industry, the implementation of the construction of mercury-containing waste utilization and disposal bases and the construction of the harmless disposal of waste mercury-containing lamps[16].

3. Current Status of Recycling and Management of Waste Fluorescent Tubes in Shanghai

3.1. Shanghai's Management Policy for Waste Fluorescent Tubes

In recent years, China has gradually promoted the recycling and treatment of waste fluorescent tubes through the implementation of household garbage classification management and the construction of waste-free cities. In 2009, Shanghai issued the "Shanghai Municipal Government's Implementation Plan for Local Subsidies for High-Efficiency Lighting Products". During the 12th Five-Year Plan period, the government implemented compact energy-saving lamps. The number of waste fluorescent tubes will be 4 million in 2020, and only 10% will be recycled. [9]. In 2019, Shanghai issued the "Regulations of Shanghai Municipality on the Management of Domestic Waste" to increase efforts to implement the classification and management of domestic waste. In that year, the recycling volume of waste fluorescent tubes in Shanghai increased by 25% compared with the previous year.

3.2. The Status Quo of the Treatment of Waste Fluorescent Tubes in Shanghai

The recycling and processing of waste fluorescent tubes in Shanghai started early, and a relatively standardized recycling and processing model has been formed. In 2012, it received subsidy support from the financial department. Government departments have issued regulations stating that professional sanitation teams should collect waste fluorescent tubes separately, and there are waste fluorescent tube disposal companies in the local area. In terms of industrial sources, industrial enterprises that produce waste fluorescent tubes entrust enterprises with hazardous waste transportation qualifications for recycling, and they must follow the hazardous waste management requirements in the solid waste management system. In terms of social sources, the domestic garbage is collected by the environmental sanitation department after classification, and transferred by a qualified transportation unit; the

sanitation department is commissioned to transport and handed over to the processing company, and the processing company provides collection boxes and turnover boxes. Professional recycling companies and processing companies in Shanghai only recycle and process undamaged fluorescent tubes containing mercury. In terms of treatment facilities, waste fluorescent tube treatment enterprises introduced Swedish MRT integrated equipment to crush and distill waste fluorescent tubes, and the mercury-containing waste gas produced was treated with multi-layer coconut shell activated carbon and discharged up to the standard. The treated cullet and metal powder are sold as waste resources to recycling companies, the recovered mercury is sent to mercury smelting companies for comprehensive utilization, and the collected dust containing waste phosphors is landfilled as hazardous waste. According to the survey, the current annual disposal volume of waste fluorescent tubes in Shanghai is more than 200 tons, and the annual waste volume in Shanghai is predicted to be 1500 tons [1], and the recycling rate is still less than 20%.

4. Collection and Disposal of Waste Fluorescent Tubes

4.1. The Social Source Recycling Model of Waste Fluorescent Tubes is not Perfect

The recycling objects of waste fluorescent tubes can be divided into two categories: industrial enterprise sources and social sources. Industrial enterprises have large source output and are easy to recycle. At present, about 95% of the recycled waste fluorescent tubes come from industrial enterprises[9], but the social sources are relatively scattered and the recovery rate is low. As the "Hazardous Waste Exemption Management List" stipulates that waste fluorescent lamps from unclassified household sources can not be disposed of as hazardous waste, and the classification of garbage in China is not yet fully popularized, the phenomenon of "first separation and then mixing" still exists in most areas. Residents are weak in environmental protection awareness, and the main body of recycling responsibility is not clear. Facing the small and scattered distribution characteristics, the collection and transportation costs are also high. Therefore, the contradiction in the recycling of waste fluorescent tubes generated by social sources is prominent [17].

Disused fluorescent tubes for household life in Taiwan are collected by sellers themselves. High-level cities such as Shanghai, Shenzhen, and Beijing can effectively separate and collect waste fluorescent tubes from domestic waste. However, the waste fluorescent tubes in most areas of the country are still mixed with domestic waste to be collected and transported to domestic waste landfills and incineration facilities for disposal. According to the survey, more than 70% of residents discarded waste fluorescent lamps unsorted, 69.42% of them were not sure about their hazards[18].

4.2. Problems in the Disposal and Utilization of Waste Fluorescent Tubes

The main treatment and disposal methods of waste mercury-containing fluorescent tubes include incineration, sulphur-added landfill and recycling. Among them, recycling is a relatively green and environmentally friendly way. According to research, 90% of the fluorescent lamp constituent materials can be recycled [18]. However, there are still many ways to dispose of waste lamps by incineration and landfill [12,19]. The incineration method is to directly incinerate waste fluorescent tubes, which is common in the process of mixing mercury-containing fluorescent tubes with domestic garbage for disposal. This method causes mercury to be heated and vaporized and carried away by the flue gas. If it is not effectively treated, it will cause mercury to be directly emitted. Sulfur-filled landfill method refers to the addition of sulfur during landfilling. Based on the "sulfur-friendly" characteristics of mercury, mercury and sulfur can react to form stable mercury sulfide at room temperature. The solubility product of

mercury sulfide in water is very high. Small, it is the most insoluble metal sulfide, which can fix free mercury and avoid environmental pollution. This method has a low processing cost and was initially widely used in the United States. However, the mercury content in the landfill leachate exceeds the standard, and there are potential environmental threats and the waste of valuable resources such as rare earths and glass [20].

4.3. Subject Responsibility is not Clear

However, in the actual recycling and treatment of waste fluorescent tubes, there are still unclear main responsibilities of producers, sellers, and consumers, difficult law enforcement supervision, lack of national and local recycling and disposal subsidies, and slow progress in the classification of domestic waste. Problems such as low recovery rate of waste fluorescent tubes.

5. Conclusions and Recommendations

5.1. Conclusion

With the gradual enhancement of society's awareness and supervision of hazardous wastes, the effective disposal of waste fluorescent lamps has gradually become a hot issue, and corresponding policies and regulations have begun to pay attention to all aspects of the life cycle of fluorescent lamps. The recycling situation of industrial enterprises is relatively good. However, except for developed provinces and cities, the recycling level of fluorescent lamps from social sources is still low in most areas, the relevant responsibility is not clearly defined, the recycling and disposal of garbage are not implemented, and the public's awareness of environmental protection is not strong. After collection, the number of processing and disposal companies is relatively small, and they rely on foreign technology. The most typical example is a complete set of processing equipment for MRT in Sweden. Although universities and scientific research institutions have carried out a series of studies in recent years, the number of papers and patents has shown a rapid growth trend, but most of them stay in the experimental verification stage, and the results are limited to a few pilot verification companies. There are problems of high cost and low feasibility. Large-scale use will take some time.

5.2. Suggestions

Based on the current situation, it is suggested that the recycling and treatment of waste fluorescent tubes in the future can be improved from the aspects of source reduction, process prevention and control, and technological upgrading. The first is reduction at the source, promoting the upgrading of low-mercury/non-mercury fluorescent lamps and the replacement of LED lighting. The second is to refine management and recycling policies and regulations, starting from large-scale users, and implementing the extended producer responsibility system in stages. Establish an effective recycling model based on the extended producer responsibility system, establish a waste fluorescent lamp foundation, a recycling database, record fluorescent lamps of different brands and models and their disposal methods, micro-manufacturing companies pay disposal funds, and implement a subsidy system for actual disposal companies. The third is to establish multiple recycling channels to solve the problem of effective recycling of waste fluorescent tubes from social sources. Borrow Internet+ and Internet of Things technology to update the recycling channel information in a timely manner. Home users use a combination of fixed-point collection and regular collection, and large-scale users such as universities and government departments can make appointments for on-site collection. Recycling points can be set up at sales outlets, maintenance outlets and fixed distribution points in public areas. Community property companies or neighborhood committees are responsible for the supervision and guidance of household sources and effective recycling. The fourth is to build public service projects for the recycling and utilization of waste fluorescent lamps to

support the diversified development of recycling enterprises. Led by the local government, enterprises cooperate to establish a centralized publicity and recycling platform to dissipate local waste fluorescent tubes and radiate nearby surrounding areas. Due to the unstable source of waste fluorescent tubes, recycling companies often face the situation of "eating hundreds of food" and high operating risks. It is recommended that they can cooperate with the government and third-party collection companies. At the same time, recycling companies should continuously improve their technical level, develop diversified businesses, and integrate Dispose of a variety of wastes containing mercury. Fifth, formulate targeted management policies for the recycling and treatment of waste fluorescent tubes, update and improve the technical standards for recycling and treatment, and develop and promote new treatment technologies. Develop new green treatment devices and auxiliary reagents for waste fluorescent tubes, such as renewable adsorbents, high-efficiency leaching liquids and extractants, etc., develop collaborative recovery technologies for rare earth metal elements in fluorescent tubes, and integrate new technologies in a "production-learning-research" model Marketing promotion.

References

- [1] Lu Shengpeng, Du Huanzheng. Discussion on the governance model of waste fluorescent tubes from social sources [J]. *Scientific Development*, 2020(6): 93-99.
- [2] Shen Chengyuan. The status quo and improvement measures of the recycling and disposal of discarded fluorescent lamps in China[J]. *Journal of Shanghai Institute of Ship and Transportation*, 2019, 42(2): 79-82.
- [3] Yang Wenjing, Sun Yue, Ye Dan, et al. Mercury pollution of discarded fluorescent lamps and its environmental health risk management countermeasures[J]. *Journal of Environment and Health*, 2017, 34(12): 1100-1102.
- [4] Zhang Jiaying, Chen Sha. Research and analysis on the disposal of fluorescent lamps in China[J]. *Sustainable Development*, 2016, 6(2): 103-109.
- [5] Xu Yan, Dong Qingyin, Yang Jianxin. Suggestions on the recycling management mechanism of multi-source waste fluorescent tubes under the situation of compulsory classification of domestic waste[J]. *China Environmental Management*, 2020, 12(5): 87-94.
- [6] Quanyin Tan, Jinhui Li. A study of waste fluorescent lamp generation in mainland China[J]. *Journal of Cleaner Production*, 2014, 81: 227-233.
- [7] Mohammad A. Al-Ghouti, Reem H. Abuqaoud, Mohammed H. Abu-Dieyeh. Detoxification of mercury pollutant leached from spent fluorescent lamps using bacterial strains[J]. *Waste Management*, 2016, 49: 238-244.
- [8] Amit Kumar, Vinoth Kumar Kuppasamy, Maria Holuszko, Shulei Song, Antonio Loschiavo. LED lamps waste in Canada: Generation and characterization[J]. *Resources, Conservation & Recycling*, 2019, 146: 329-336.
- [9] Chen Wei. Research on the Countermeasures for the Construction of the Waste Fluorescent Tube Recycling System in Shanghai[J]. *Environmental Science and Management*, 2014, 39(3): 76-79.
- [10] Shen Ning. Analysis of the disposal of waste energy-saving lamps under the rule of law[J]. *Knowledge Economy*, 2014(3): 48-49.
- [11] Yin Jie, example. Research on the management system and treatment status of waste fluorescent tubes at home and abroad [J]. *Environmental Impact Assessment*, 2016, 38(4): 81-87.
- [12] Liu Fang, Zheng Lixia, Tan Quanyin, et al. European Union waste fluorescent tube recycling management experience and its enlightenment to China[J]. *Environmental Science and Management*, 2018, 43(6): 6-10.
- [13] "Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes" [J]. *Environment*, 2021(7): 2.

- [14] National Hazardous Waste List (2021 edition) [J]. Bulletin of the State Council of the People's Republic of China, 2021(4): 18-46.
- [15] Lin Xiaowei, Xie Ming, Xiao Yong, et al. Exploration and suggestions on the management system of waste fluorescent tube recycling[J]. Guangdong Chemical Industry, 2017, 44(10): 119-121.
- [16] Ministry of Ecology and Environment of the People's Republic of China, "The Twelfth Five-Year Plan for the Prevention and Control of Hazardous Waste Pollution" [EB/OL]. [2012-10-08]. http://www.mee.gov.cn/gkml/hbb/bwj/201210/t20121023_240228.htm.
- [17] PenyPeng L, Wang Y, Chang C T. Recycling research on spent fluorescent lamps on the basis of extended producer responsibility in China[J]. J Air Waste Manag Assoc, 2014,64(11):1299-1308.
- [18] Liu Juan. Harmless and resource disposal of waste fluorescent lamps[J]. Optoelectronic Technology, 2009, 51(4): 33-35.
- [19] Misuzu A., Kazuki F, Shin-ichi S. Life-cycle flow of mercury and recycling scenario of fluorescent lamps in Japan[J]. Science of the Total Environment, 2008.(1): 1-10.
- [20] Wang Jingxian, Zheng Ji. Status and analysis of disposal of waste fluorescent tubes containing mercury[J]. China Environmental Protection Industry, 2010(10): 37-41.