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Research on Classification and Recycling Technologies of Municipal Solid Wastes—A Case Study in Shanghai

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Abstract: *With the improvement of people's living standard in China, the amount of municipal solid wastes (MSW) has been increasing year by year, and resulted in serious environmental issues. Developing diverse classification and recycling technologies for treating municipal solid wastes is an effective solution to such problem, which can maximizes the utilization of wastes, reduces the amount of waste disposal and improves the living environment. This paper analyzes the Shanghai municipal wastes sorting programmed and concludes the following reasons for its first-stage success, including a well-designed recycling structure, a high-value food wastes reduction and recycling system, a low value-added wastes re-utilization system, various treatment technologies and the corresponding policy supports .*

Keywords: *Municipal solid wastes, classification and recycling technologies, Shanghai*

1. Introduction

China accounts for about one fifth of the world's population. In 2004, China became the world's largest waste producer with an annual amount of about 400 million tons, and it has been growing at an average annual growth rate of more than 10 percent. A large amount of waste is being buried and burned in improper ways which has led to 30 billion RMB direct economic losses per year. Therefore, waste management is a complicated issue related to environmental, economic, and social factors. It is also a major bottleneck that needs to be broken through in the process of China's urbanization process. It is essential to reduce the amount of waste disposal, minimize the disposal and re-utilization cost, improve the recycling rate of low-value wastes, and upgrade the information management platform. In this way, the green economy can be promoted, the environment can be protected and the economy can be developed in a sustainable way.

2. Difficulties of classifying and recycling MSW in Shanghai

2.1 The increasing amount of waste production

The social and economic background for promoting of MSW classification in Shanghai are different from those of metropolises in developed countries and regions. It shows that urban construction in Shanghai is still booming, the living standard and consumption capability are rapidly improving, and thus MSW is also growing continuously (Figure 1). The key driven power of slowing down the growth of waste output is the encourage of green lifestyle, which requires long-term efforts. Therefore, in the short run, the pressure of MSW reduction mainly lies on the capacity reduction in the transit process and the amount reduction in the re-utilization stage, which puts forward higher requirements for the relevant infrastructure and facilities management.

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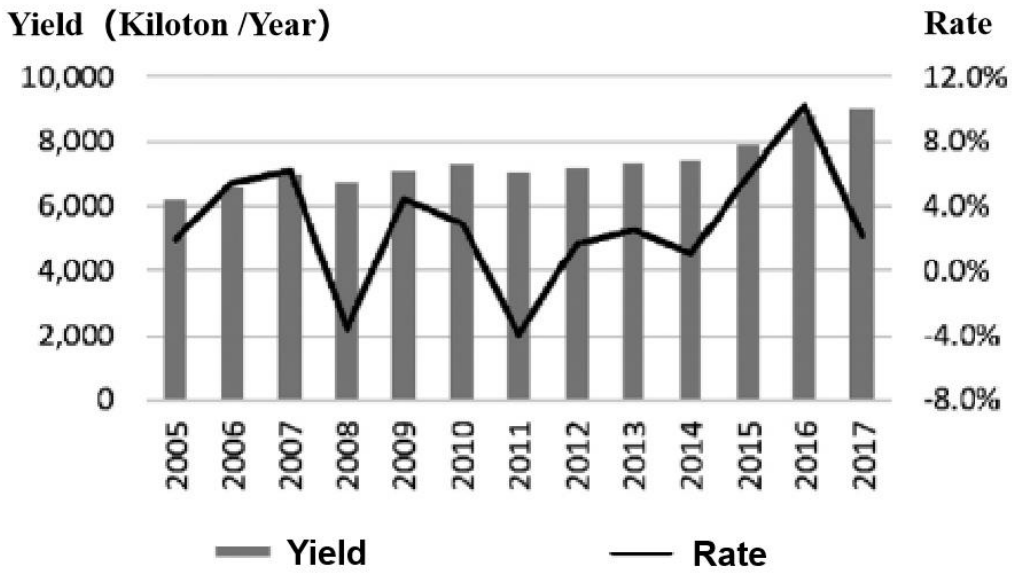

Figure 1: The growth of municipal solid wastes in shanghai

2.2 The weak classification management

The MSW management process is divided into three stages, including front stage (waste classification), middle stage (waste transportation) and end stage (waste recycling and treatment). It is not easy to promote the concept of waste classification for residents in the community, and it is difficult to determine the location of recycling or treatment enterprises. In the front stage, the garbage station renovation rate in the community is low, and the management heavily relies on the supervision and guidance of the volunteer team. In terms of the waste treatment facilities construction, the amount of waste they can deal with only meet the basic requirements. Currently, the main difficulty is to separate the food waste and low-value wastes from other wastes, and there are insufficient number of enterprises that are capable of dealing with low-value wastes. For those companies that are willing to locate in Shanghai are also in confront of problems such as high employment costs and land usage restrictions.

2.3 Lack of management details

The MSW management system is not detailed enough. It shows that the entire industrial chain, from the front stage to the end stage is not yet mature, the classification and recycling system has not been converged effectively, not all types of wastes have been considered comprehensively. In addition, the digital platform for MSW collection, storage and transportation is still developing, and not convenient for government supervision and decision-making.

3. The development of diverse classification and recycling technologies

It is proposed to enhance various technologies, together with developing policy supports and business models. First, improving the facilities and treatment technologies for food waste capacity reduction and high-value utilization. Second, enhancing the facilities and high-value recycling technologies for low-value recyclables such as glass and plastic wastes.

3.1 Complete set of equipment for food waste reduction and high-value utilization

First of all, the reduction of food waste is carried out through steps such as cleaning and deoiling, desalination, dehydration, magnetic iron absorbent, shredding and volume reduction, crushing and volume reduction, extrusion and dehydration. After the liquid enters the sewage treatment system, it is discharged or reused according to the standard. After the physical volume reduction, the oil content of the solid substance is less than 2%, and the reduction rate is more than or equal to 75%. Solid residue is used in black soldier fly breeding. The incubation temperature and humidity of the eggs were controlled at 25 ~ 33℃ and 60% ~ 80% respectively. Strong larvae are Incubated after 7 days. The larvae were quantified into quantified solids by the density method. Research is conducted on the

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development of fully automatic breeding equipment, including automatic feeding, unloading, breeding, quantitative and accurate feeding. Through the intelligent control system, it simulates the best growth environment for black soldier flies, and the production of insect dung and fresh insects can be automatically completed within 6 days (Figure 2). It is a good illustration of realizing the food waste reduction and high-value reutilization.

Figure 2: The system of black soldier fly breeding

3.2 High-value re-utilization for low-value recyclables

One the one hand, taking Shanghai Intco Industries Co., Ltd. as an example. It developed an EPS compressing equipment at the front stage of waste classification, which solved the key problem of reducing the capacity of plastic wastes and reduced the recycling cost. The technology of producing polystyrene micro-foamed co-extruded wood materials solves the re-utilization problems (Figure 3). In addition, the application of low value waste to the field of wood material is a new way to realize high-value recycling from the perspective of art design.

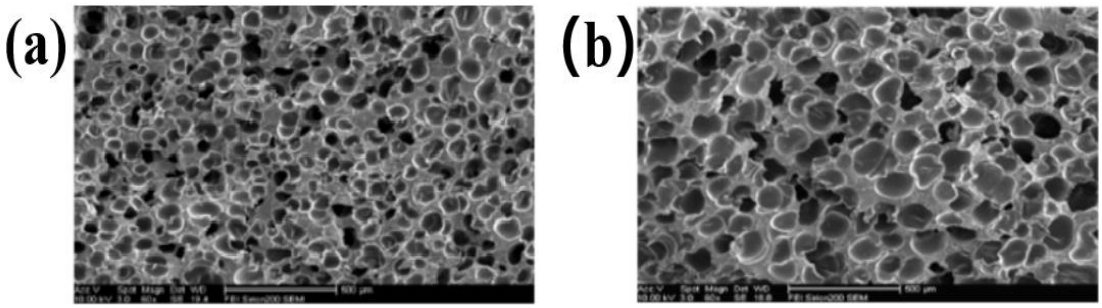

Figure 3: The tem of polystyrene micro-foamed co-extruded wood materials, (a) crosslinking, (b) raw material

On the other hand, Shanghai Yanlongji Environmental Protection Group Co., Ltd. has established the largest three-stage recycling system in the glass waste recycling industry. The self-developed intelligent light sorting technologies for glass wastes, including weighting, pre-treatment, sorting, and storage etc., combined with the "dry cleaning" sorting method, successfully solved the waste water treatment pollution problem during the traditional waste glass sorting process. Its processing capacity is the number one in the world (2 million tons annually).

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3.3 The integration of two networks and the development of big data platform

The integration of the two networks refers to the integration of the high-value and low-value waste collection and management networks. In May 2017, the Circular Economy Research Institute of Tongji University and Shanghai Tianqiang Environmental Protection Technology Co., Ltd. conducted the "two networks integration" pilot programmed in Feng Xian District, and summarized the "two networks integration" as "four synergy, four re-construction". That is, through the facility collaboration, promoting the facilities co-construction and space sharing of the two networks. Through personnel coordination, promoting the coordination and unity of management and personnel. Through data collaboration, a unified municipal waste data platform is constructed. Through regional cooperation, strengthening the facilities and system coordination of each district. Through the market mechanism, re-constructing a unified classification and recycling system. Through organizational re-structuring, the management division of different departments is re-divided. Through the mixture of traditional media and new media, innovating communication methods through various activities. Through assessment reconstruction, new indicators are introduced into the assessment system of governments at all levels.

So far, the data sharing degree between relevant parties is low. There are a number of data platforms in Shanghai, however, it is suggested to integrate them into one intelligent management system. With modern technologies such as big data, cloud computing and artificial intelligence, the level of data governance and intelligent governance can be improved. In this way, it ensures data security, deepens data interconnection, sharing and application, and forms a cross-departmental, cross-level and cross-regional operation system. A more scientific, refined and intelligent management system can help to improve the forecasting capability and problem-solving skills.

4. Conclusion

In order to improve the quality of urban environment in China, it is imperative to build a modern municipal solid waste management system. Based on the experience obtained from the waste sorting programme in Shanghai, four stages are necessary. The first is to conduct "two networks integration" with the systematic thinking approach and to define the main targets, principles, implementation paths. The second is to clarify the main components of constructing the municipal waste management system (e.g., operating system, organization, propaganda, and assessment etc.), and to realize the management coordination of personnels, facilities, data, and more. The third is to develop key technologies, equipments and business models for the high-value re-utilization of low-value recyclables. The last is to establish a big data platform for the entire waste sorting network.

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