

The Status, Problems and Solutions of Urban Waste Treatment in China

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Abstract: With the continuous development of cities, municipal waste is also growing, which has a serious impact on the development of cities. How to solve the problem of urban waste has become a major problem necessarily solved as quickly as possible in urban development. The main conspicuous contradiction in Chinese current urban waste treatment is that, waste is growing faster than the capacity of its treatment, waste treatment technologies are simple, and waste management system is unreasonable. Hence, it is necessary to accelerate innovation in waste collection, removal and treatment system, promote waste treatment technology innovation and implement standardized and legalized waste treatment, especially to achieve industrialization and marketization in waste treatment and strengthen environmental awareness education of citizens.

Keywords: municipal solid waste, waste reduction, waste recycling, harmless treatment

INTRODUCTION

With the significantly accelerating of urbanization, the continuous expansion of city size, the improving standards of living and the rapid expansion of urban population, municipal solid waste (MSW) is also increasing, which restricts the further development of economic society. As one of world's biggest developing countries, China's gross domestic product (GDP) has reached 9.4 trillion dollars in 2013 and become the second largest economy. At the same time, there are 490 million tons of garbage each year in the world, but the 150 million tons of municipal waste are from China.

Statistics data show that the accumulation volume of China's municipal solid waste has reached 70 million tons, which covers about 800,000 acres, growing at an annual rate of 4.8% in recent years. By the end of 2012, municipal solid waste generation quantity is as high as 170 million tons in 661 cities, 2/3 of which are besieged by garbage, and 1/4 of which even can't find a fit place to pile up garbage, resulting in the deterioration of environment in urban and rural areas to endanger Chinese sustainable development in the 21st century [1].

In recent years, frequent garbage pollution issues have wreaked havoc with the balance of urban environmental system. Municipal life waste not only pollutes the environment and destructs the urban landscape, but also spreads disease and threats to human health. Hence, waste pollution has become one of today's global environmental hazards. Especially due to the lack of separate collection of garbage in most cities, a lot of old batteries and heavy metals directly

are thrown into the garbage dump, leading to the heavy metal pollution in city landfill and harmful gases overflowing through long time accumulation[2-3]. In addition, the leachate in garbage decomposition will generate large amounts of harmful substances that will alter the soil properties and contaminate soil, as they will be washed off by the rain into river without pre-treatment, which causes great pollution of the water environment [4].

On the other hand, some cities treat rubbish only by a simple classification into organic fertilizers to sell it to farmers and growers. Their heavy metals and other hazardous materials can not only interfere with plant growth and development, but also accumulate in plants to endanger human health through the food chain, which poses a serious threat for urban residents [5]. Therefore, how to deal with urban waste has become one of the major environmental issues in urban development which is needed to be resolved urgently.

This paper is based on China's current status of urban solid waste, respectively from the technical structure, waste treatment levels and other aspects to discuss the current situation and problems of waste treatment. Finally, related countermeasures and suggestions are proposed to provide for future planning and development of China's cities.

CURRENT STATUS OF MUNICIPAL SOLID WASTE

Municipal life waste generation quantity and treatment rate

In 2012, municipal life waste generation quantity reaches 171 million tons in 661 cities in China, garbage harmless treatment rate was 84.8%. With the continuous development of urbanization , the amount of

garbage subsequently increases, which forces the scale of waste treatment industry to expand and treatment rate to increase year by year (see Fig 1).

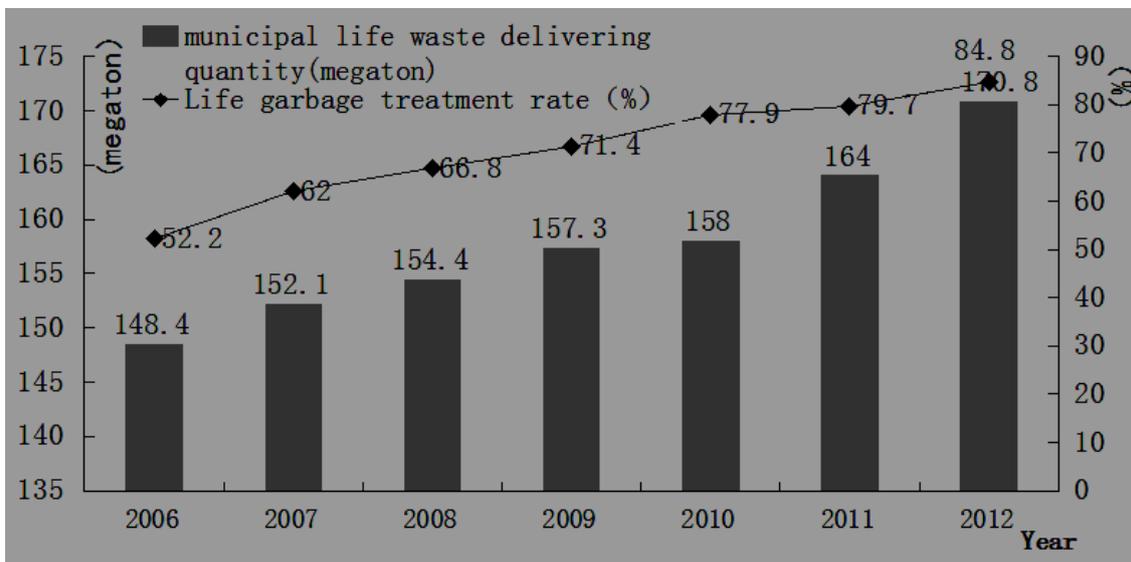


Fig-1: 2006-2012 municipal life waste delivering quantity and treatment rate

Urban waste treatment technologies

In China, the current waste treatment technologies include three ways of sanitary landfill, incineration and composting. With the continuous evolution of processing techniques to a further increase in garbage incineration, composting treatment is shrinking, but sanitary landfill and processing capabilities are growing. In 2012, there were 701 harmless treatment facilities, the processing capacity was 446,000 tons every day, the quantity of garbage harmless treatment was about 145 million tons every year. Among them, the number of sanitary landfill harmless treatment plants was 540, while the processing capacity is 311,000 tons every day and the actual processing capacity is 105 million tons every year. China has built 138 municipal solid waste into incinerators, and the processing capacity is 123,000 tons a day and the actual

handling capacity is 35.84 million tons a year. Municipal solid waste composting plants (including integrated treatment) has 23, the processing capacity was 13,000 tons a day, and the actual processing capacity is 3.93 million tons a year (see Fig 2).

According to waste generation quantity data in 2012, the proportion of sanitary landfill, composting and incineration was 61.5%, 2.3% (including a comprehensive treatment plant data) and 21.0%, respectively, while the remaining 15.2% was stacking and simple landfill (see Fig. 3). The main way was landfill, followed by burning, and a small amount of municipal waste piling up in urban fringe areas. As the harmless treatment facilities and technologies are not perfect, along with extensive management, so the whole harmless treatment rate is not high.

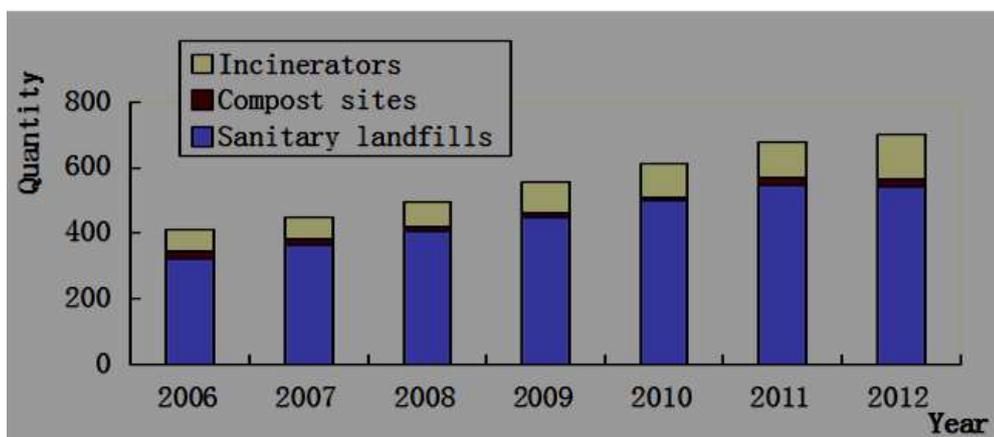


Fig-2: 2006-2012 harmless treatment plants statistics

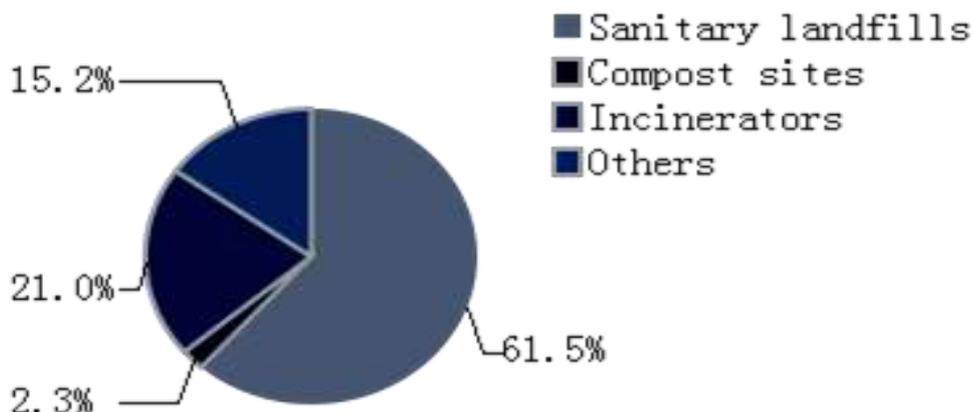


Fig-3: The ratios of different municipal life waste treatment in 2012.

The use of sanitation landfill technology

In the view of China's real conditions, the landfill disposals save costs and operate simply, which is easily adopted by policy-makers to become the preferred waste disposal method. In United States, about 84% of total waste was disposed by landfill before 1990. But after the 1990s, the United States has implemented relevant regulations to reduce garbage landfill disposal. According to the U.S. Environmental Protection Agency (EPA) data, the number of landfills in U.S. declined from 3300 in 1993 to 2300 in 2000 and the proportion is only 64.1%. further, it was reduced to 1200 in 2010 [6].

Compared with other countries, China's waste treatment with landfills accounts for about 60% of total garbage disposal. In recent years, China has built a number of relatively completed waste sanitary landfills and has a set of appropriate treatment facilities for seepage-prevention, leachate collection and treatment, landfill gas guide line and so on, but the limitation of technology need still to be improved. In addition, with the constraints of landfill capacity, when the old landfill is closed, it is very difficult to select new landfill site for it is resisted by rural residents.

The use of composting technology for urban waste treatment

Compared with the landfill, composting needs higher investment costs, so the current urban waste composting technology in China is relatively shrinking. However, it has been proved that the composts produced by a mixed collection of municipal waste easily pollute soil because of excessive levels of heavy metals and glass, which is also inefficiency and contains many impurities at high costs and is not conducive to agricultural production. Many foreign countries don't blindly take the garbage composting technology, but they adopt it on the basis of the separation and recycling of garbage so that it can protect the soil and at the same time realize the value of waste to reduces costs and improve the quality of compost. However, the separate collection of organic

waste is a key factor to find an efficient way to develop urban waste composting technology.

Application of waste incineration technology

Incineration is a new hot technology, which has been applied in many countries. About 30% of municipal waste in United States is burned for power generation. Heat generated by the incineration process is used to produce electricity to realize energy regeneration of the garbage, this technology has been taken in many developed countries [7]. Compared with developed countries, burn treatment rate in China is only about 15%. Municipal solid waste incineration technology has just started and thereby can't meet the growing needs. The huge market potentials have attracted many companies to invest in the development of incineration equipment.

Some relative economic developed cities in China are actively preparing for building urban waste incineration plants, but most technology and equipment for the construction are imported from abroad, while the existing ones are still at a low level of waste incinerator built by domestic technology and equipment in most cities. It is difficult to achieve normal operation and pollution control standards. Due to a mixed collection of municipal solid waste in most of places, organic contents in waste are up to 60%, and high moisture contents result in lower calorific value of garbage, falling to reach incineration requirements. In addition, the domestic incinerator and purification equipment can't resolve the problems of dioxins and other hazardous substances produced in burning [8-9].

Resource recovery and use of MSW

At present, as the recycling use of urban waste resources in China run mainly under the guidance of the laws of its own cost covering system such as preferential tax policy, so it is completely separate from the costs of waste treatment. Some recycling of municipal waste (e.g., old batteries) are not profitable, even at a loss, if these urban waste flow into the municipal waste system, then it has to pay higher costs and sometimes it can not eliminate harmful effects on

the environment even at a greater cost. Hence, urban waste treatment and waste recycling systems should be organically combined to treat the city's garbage toward the direction of sustainable development [10].

Waste management costs

In 2012, a total investment of 825.346 billion yuan for environmental pollution management has been achieved, having an increase of 16% compared with 2011. The national environmental sanitation spent 39.864 billion yuan for the cities to maintain the city appearance and environmental sanitation. Since 2009, the government has dramatically increased investment in municipal solid waste treatment, directly from the previous over ten billion to forty billion. With the increasing investment, the construction standards and units of investment in waste disposal facilities have significantly improved, and urban waste disposal capacity has increased nearly 32,572,000 tons from 2009 to 2012. However, due to many historical debts, the lack of investment in fixed assets is still a major restrained factor in life garbage processing. China has a late start at waste disposal levy fees, yet most cities have not still taken any actions on levying garbage fees, the collection tax is also very low in fees cities. Because collected garbage fees are insufficient to cover the costs of waste disposal and is far from forming a waste disposal operation mechanism in line with the requirements of the market economy, it is difficult to attract social funds to invest in waste industry.

PROBLEMS IN CHINA'S URBAN WASTE TREATMENT

With the expansion of the size of urban population, the contradiction between the growing municipal waste in China and low levels of urban waste disposal capacity become increasingly obvious.

In recent years, government departments have gradually paid more attention to urban waste treatment problems, so they have invested a lot of manpower, material and financial resources on urban sanitation recycling collection, transportation and disposal of municipal waste at all levels, which makes great progress in China's sanitation development. However, there is a big difference in the composition of municipal waste because of China's urban unclassified waste and imperfect processing technologies and management tools, resulting in a low real effective rate of waste treatment capacity far behind the rapid development of economy and society.

Currently, the overall levels of national municipal waste treatment are still in a relatively backward state, and many cities have deficiencies in waste classification, funding, management system, treatment facilities, etc., so it's far to meet the needs of urban construction, environmental protection, resource utilization.

Unreasonable waste collection system

The main urban waste is formed by people's daily production and living. At present, the collection and transportation of municipal waste has adopted the mixed mode, only small regions to classify waste, but the effect is not obvious. Garbage is collected from the streets, towns or household, uniformly transported and handled by the environment sanitary management center, but due to the lack of necessary technologies and equipments, its ultimately removal process is still mixed [11].

Chinese current urban waste's collection and transportation are still in a relatively backward stage. Not classified waste increases not only the number of municipal solid waste, and consumes more resources including human, physical, financial resources, but also increases technical difficulties, investment and operating cost in waste processing, which is not conducive to the reduction and recycling of municipal life waste.

Single waste treatment method

At present, most of cities use only landfills as the most important way to deal with waste with a single form and low resource recycling levels. With the increasing amount of waste, many landfills are already overloaded after encroaching on valuable land resources and limiting the use of land. It is not easy to decompose for waste, which cause the impact of reality and potential hazards on atmosphere, soil, surface and groundwater [12-13]. At the same time, due to the lack of classification and collection measures, it results in the loss and waste of garbage resources, which leads to a series of problems such as the odor overflow, a new selection landfill and interest coordination issues with surrounding occupants. Because landfills are limited by space, so it can't reduce waste pollution for water and soil and can not turn waste into treasure and be recycled.

Unreasonable Waste management system

There are many problems in our current waste management system. To begin with, the administration department of sanitation only passively aims at garbage removal, lacks of systematic consideration in reduction, recycling and reuse, without unified long-term plan. Secondly, a single source of funding, the major costs of garbage removal management as a public welfare is still paid by the government. With the increasing amount of waste and environmental requirements, the government needs to spend more and more money to build a sufficient number of harmless treatment facilities to reach a good intended target of harmless treatment rate. Once it lacks of government investment, there are no guarantee to construction and operation of treatment facilities.

China is in a "all out without in" situation in government fiscal expenditure for garbage treatment,

which becomes a heavy burden to the current government. It is extremely difficult to normal plant operation as a result of lack of finance. While the corresponding garbage fee system has not been established, governance lack revenues to disposal of waste. Garbage fee system has been implemented in many countries around the world, and achieved good results to become a new form of economic income. Because MSW management has not taken a standardized charging system so that the public and businesses stand by, which not only increases the difficulty of garbage management, but also lays heavy economic burdens on the country [14].

Furthermore, the current city garbage processing is low productivity and technical content, which is still a labor-intensive industries. Because of the lack of technical appraisal and construction quality review system for waste disposal project, appropriate industrial policies and technical standards are not perfect.

Finally, China's current urban sanitation system performs completely in accordance with the mode of planned economy, the management system and operational mechanism are incompatible with the market economy. The sanitation departments in many cities perform their supervision functions while they organize the specific garbage removal and disposal, and thus it is typical of the integration of government administration with enterprise, which can't form an effective oversight and competition mechanism.

Problem of waste reduction and recycling use

With the rapid development of modern society and transformation of residents' convenient consumption attitude, it promotes the development of the packaging industry to grow. It's easy to find out more and more goods in diverse forms of packages, the number of type and quantity increases quickly. In addition, the increase in disposable consumption goods, not only raises the amount of waste, but also brings a tremendous waste of resources. However, China has not taken action on municipal solid waste reduction, while there is only one step for disposable goods ranging from consumption goods to trash. Excessive product packaging and extensive use of disposable products bring great pressure on the environment. Many developed countries have imposed high taxes to make people unwilling to pay the extra money for using garbage bags, which reduces the white pollution.

Municipal solid waste does not mean useless stuffs, and can be back into use through certain recycling [15]. Through such a manner, it can achieve waste reduction and effective allocation of resources. However, industrialization development of recycling is still low, the existing recycling network is not enough for the normal operation because of the lack of large-scale utilization of corporate compliance with the requirements of environmental protection. The existing

recycling companies are weak and small-scale, the levels and the technologies of total waste utilization are urgently needed to be improved.

Unsound regulations and low awareness of environmental protection

Because environmental health monitoring system has not been established, there are hidden dangers in the waste disposal process. Although a lot of regulations have been promulgated on the prevention of urban environment pollution, it is difficult to be practiced in accordance with the law because of the lack of appropriate implementing detailed rules. If China studies foreign residents who have already taken classification of waste as a part of their lives, then it will not only save time in recycling, but also ensure environment clean and tidy. People's awareness of environmental health is a critical factor in handling urban waste problems. Only in a community with good universal sense of environmental health, the management regulations and preventive measures can be successfully implemented [16].

SOLUTIONS

From the perspective of sustainable development, urban waste pollution has become a major obstacle for further social and economic development. The transition should be made from the old way of a focus on quantity but low recycling ratio to the new waste management goals, forming a separation and recovery process management system. A simple mode of collection, transportation, treatment should turn to waste reduction and recycling, until it finally realize the transformation of sanitary treatment [17].

To promote waste reduction, classified collection and recycling use

If China want to promote cleaner production and ways of life to strengthen source management, then it is necessary to reduce the generation of municipal solid waste from the source to minimize the disposable goods such as using glass instead of plastic cups, ceramic tableware instead of paper tableware and minimizing the use of plastic packaging to achieve waste reduction. At the same time, China should strengthen the separate collection of municipal waste to promote the recycling and use of waste, and advocate residents willingly to classify garbage at home. All places should set up containers for separate collection of garbage in schools, factories, stations and other places, and especially for waste plastic, waste paper and scrap metal. Sub-bag can be used to separate different recyclable and non-recovery materials in the waste. Recycling the classified collection provide the reliable sources of waste for the recovered processing enterprises, and facilitate solo-disposal of hazardous waste, too.

Broaden the existing range of waste material recycling, China should also attach importance to the recycling of old batteries while pursuing high economic

goals at scrap metal, paper, material recycling. China may establish comprehensive recovery sector of old home appliances and a sound e-waste recycling management system to form an efficient recycling network, which can reduce the phenomenon that a large amount of e-waste was landfilled as ordinary trash.

To strengthen the development and research of waste treatment technologies

Because of the complicated composition in urban waste, China should take a different approach to separate collection of garbage with comprehensive utilization of composting, sanitary landfill and incineration and other methods to treat the waste in the direction of diversification [16]. China can import new technologies such as pyrolysis and gasification from advanced countries [3] to use waste newspaper and other waste to produce fuel to achieve renewable energy[18].

Due to the current relatively backward levels of technology, processing equipment, production process, the government should increase investment in technology, and actively introduce foreign advanced technology. Research institutes should strive to develop solid waste disposal and utilization technology. According to local conditions to establish urban waste disposal technology system, the city should take comprehensive and balanced urban garbage disposal system strategies and technical methods in the development affected by the different natural environment and socio-economic level, not pandering to a single technology. A variety of the technical suitability must be adjusted to the region's preferences, preferably based on the degree of reduction and harmless disposal, or the amount of capital investment, which may achieve the greatest reduction and harmless disposal with a minimum investment to meet the demands of actual development.

To establish waste disposal fee system and realize the industrialization of waste treatment

The innovation of treatment should be based on the market-oriented principle instead of external management. A basic concept called the polluter pays principle will be taken to charge comprehensive waste disposal fees. Formulating scientific methods of billing are to strengthen the management. The country can unify imposed standards for water supply, sewage and garbage disposal fees, or a combined levy with water, electricity, housing costs and gas charges to improve the leviable rate of city garbage fee and lower fees costs. Gradually to raise fees to compensate for the costs of garbage collection, transportation and disposal that waste disposal companies can make a reasonable profit.

Municipal waste treatment must gradually move towards firms supported by the government to become the economic entities of self-financing and self-

management. China should gradually realize the industrialization and marketization of waste disposal. Companies or enterprises can be set up through open tender to implement enterprise-style management of the whole process of municipal solid waste collection, transportation, recycling and health treatment. To take economic policies such as government subsidies and appropriate garbage disposal fees from individuals or units to make up for the expenses of waste disposal facilities.

At the same time, China should encourage the foreign investors to participate in municipal solid waste disposal industry, and qualified enterprises can participate in fair garbage rights' competition, which can not only improve the efficiency of waste disposal and utilization and reduce costs but also promote the development of waste treatment technologies. To establish a classification, collection, transportation and processing "chain" to increase the level of junk industrial scale and efficiency.

To formulate an unified standard for waste treatment and improve relevant laws and regulations

China should improve relevant laws and standards system for municipal solid waste pollution prevention with unambiguous details, and manage in accordance with the law. China has recommend an unified law principle both in solid waste pollution prevention and comprehensive utilization of resources that the disposal of municipal waste should take recycling as a means to achieve urban waste resources and reduction, but it is necessary to promulgate relevant details, including garbage pollution prevention law, the garbage disposal industrial management, pollution control and treatment technology standards.

To strengthen publicity and education to raise environmental awareness of people

Publicity and education can strengthen the people's environmental awareness, and encourage citizens to actively participate in waste separation and recycling activities of resources to realize sustainable development strategy. Waste disposal knowledge and laws should be promoted between different social sectors through a variety of medias to gradually improve the quality of civic environmental protection. In addition, waste recycling and environmental protection knowledge should be added in primary and secondary education so that the students were trained to develop a strong awareness of environmental protection [19].

CONCLUSIONS

Urban waste treatment involves many issues, which is a systematic project and must be resolved from many different aspects. Firstly, China should control waste generation from the source, that is, to minimize it, which is the most basic measure. Secondly, China must

complete the separation, recycling and resource re-utilization of city waste. Of course, urban waste treatment and resource re-use should be according to local conditions, based on the characteristics and situation of different urban waste to classify and implement. Finally, the safe treatment of waste can actively learn from foreign advanced technology and experience, combined with the actual situation in the region to choose the most appropriate treatment technology and achieve the true harmless treatment of waste.

The key to solving the urban waste problem is to improve the existing waste management system, perfect relevant laws and regulations, and actively promote the marketization of waste disposal industry. To this end, China should step up publicity efforts to improve people's awareness of environment protection, to achieve municipal waste reduction, recycling and harmless as soon as possible to realize sustainable development of cities.

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