

## STUDY ON THE CURRENT SITUATIONS OF MUNICIPAL SOLID WASTE MANAGEMENT IN CHINA

Wang Wei\*, Jiang Jianguo, Cao Qiyong, Su Xiao

Department of Environmental Science and Engineering,  
Tsinghua University, Beijing 100084, P.R.China

### ABSTRACT

Owing to insufficient regulations and investment in China for a long time, a great amount of municipal garbage was directly deposited or disposed in simple landfills or open dumps outskirts, therefore, the garbage occupied a lot of cropland which results in the situation of municipal garbage encircling the city, at the same time, the air, groundwater, surface water and soil around the landfills or dumps were seriously contaminated because of the imperfect measures of environment protection during MSW treatment process. To solve the MSW pollution problems, the authors tried to explain the current situations of MSW treatment and disposal in China by analyzing the treatment rate of MSW harmless disposal and treatment facilities, the construction investment and operation cost of these facilities and the investment capacity of the central and local government. From the analysis, the authors concluded that we still have a long way to go to solve the MSW pollution problems thoroughly. But it can be solved much quicker if enough investment can be used to improve the MSW management technologies and to expedite the construction of MSW treatment facilities in China.

**Key Words :** municipal solid waste management, MSW treatment facilities

In China, the Environment and Sanitary Bureau of local government which is belonged to the Construction Ministry takes to the collection, transportation, transfer, treatment and disposal of municipal garbage. For a long time, a great amount of municipal garbage was directly deposited or disposed in simple landfills or open dumps outskirts because of insufficient regulations and investment. Therefore, the garbage occupied a lot of cropland which results in the situation of municipal garbage encircling the city, at the same time, the air, groundwater, surface water and soil around the landfills were seriously polluted because of the imperfect measures of environment protection during its treatment process.

In 1984, according to the analysis of the basic situations such as economy, science and technol-

ogy, city and MSW composition, the Construction Ministry put forward a treatment policy that the main MSW treatments in China are sanitary landfills and high temperature composting, some regions can develop incineration technology, and it was advocated to collect the garbage by classifying and integrated management, centralized collection and incineration for special MSW such as the garbage from hospitals. In 1992, the Notice on some Suggestions about how to Solve the MSW Problems in China issued by the State Government put forward that the current work should focus on sanitary landfills and high temperature composting, and incineration technology can be used in some cities by strict environment monitoring to improve the harmless treatment quality. In 1990's, the central and local government improved the investment and imported the advanced technology and fund from other countries, so the

\*教授, 精華大学环境科学工学部

construction for the city's environment and sanitary facilities was improved greatly. The MSW management was improved from ordinary collection and transportation to the process of comprehensive management including harmless, reduction and resourcification. In this article, the authors tried to explain the current situations of MSW treatment and disposal in China by analyzing the treatment rate of MSW harmless disposal and treatment facilities, the construction investment and operation cost of these facilities and the investment capacity of the central and local government.

### TREATMENT AND DISPOSAL FACILITIES AND THE RATE OF MSW HARMLESS DISPOSAL

The changing of MSW treatment and disposal situations in China was shown in Figure 1 in the last ten years. It can be seen from the data that the rate of MSW harmless disposal which was very low all along increased rapidly in 1990's. Till 1996, 874 MSW treatment and disposal facilities were built in China with a treatment capacity of 234791tons, and the rate of MSW harmless disposal reached 49.1%.(Fig.1)

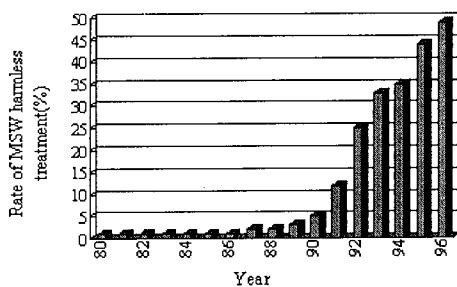


Fig.1 Rate of harmless disposal of MSW in China

According to the technical policy of MSW treatment and disposal in China, the most common ways of disposal are sanitary landfill, incineration

and composting. Thereinto, landfill holds 79.2% of the total treatment amount, composting holds 18.8% and incineration holds 2%. The contrast of MSW treatment and disposal methods for China, USA, Germany and Japan was shown in Figure 2.

It needs to be pointed out that a set of relatively comprehensive system for waste reclaim and reuse has been established from 1950's in China (see Figure3), the usable materials from household wastes were reclaimed before its entering the garbage, and usable materials which mixed in the garbage were classified and collected in transfer stations and deposit sites. According to the statistics, the total income of retrieved materials in China in 1995 was 29billion RMB yuan, the workers in this system was about 0.8 million, and there were 5000 enterprises, 0.16 million waste materials collection depot and 2500 regeneration factories involved there. The retrieved waste materials was over 0.3 million tons in 1991 in Beijing, that equaled to 8% of the total garbage generation in Beijing, and the retrieved waste materials in 1986 in Tianjin equaled to 13% of the total garbage generation in the city. (Fig.2)

Large numbers of MSW treatment and disposal facilities were built in China in the last ten years. They included sanitary landfills, composting factories and incinerators. The main MSW sanitary landfills and composting facilities were listed in Table 1 and Table 2 respectively.

Till now, only one large incineration facility was built and been operating in Shenzhen city with the treatment capacity of 450 tons per day. In the recent years, with the rapid development of MSW generation and the improvement of MSW calorific value, the situations that the land is insufficient for landfills were appeared in some of the big and middle cities, so it was considered to transfer from directly land filling to landfill after incineration in most of the local environment departments. Big MSW incineration plants are planed to be built in big cities such as Beijing, Shanghai and Guangzhou.

But it's still a difficult thing for most of the middle and small cities to import the incineration facilities from foreign countries directly because of its high investment, so it puts forward the request to develop China-made incinerators. Owing to the request of the incinerator market, some incinerator factories are established in China in recent years, and some middle and small incineration facilities are constructed (see Table 3). But

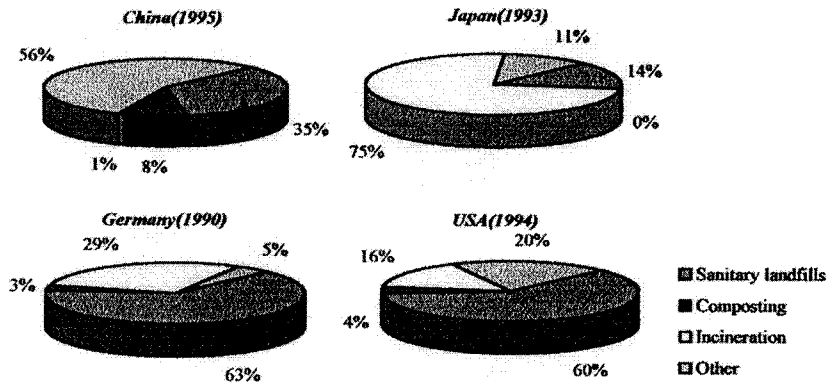


Fig.2 Treatment methods for garbage in various countries

Tab.1 The situations of MSW sanitary landfills in China

Landfills	Volume (10 <sup>4</sup> m <sup>3</sup> )	Treatment capacity(t/d)	Lifetime	Costs(million RMB yuan)
Tianzilin in Hangzhou	600	1000	19912014	2700
Old Harbor in Shanghai	1200	3000	1989	104
Li Chun in Guangzhou	180	1200	19901997	16
Datianshan in Guangzhou	1700	2000	19921999	
Jiangcungou in Xi'an	4900		19952045	37
Xiaping in Shenzhen	1400(5000)	1800	1997	300(1000)
Qingshan in Baotou	200	200	19902010	3
Ashuwei in Beijing	1070	2000	19952005	110

Tab.2 The situations of MSW composting facilities in China

Composting facilities	Treatment capacity(t/d)	Maximum Temperature(°)	Operation cost(RMB yuan/t)	Fermentation cycle(day)	
				First fermentation	Second fermentation
Wuxi	100	65	18	10	10
Hangzhou	15	70	816	3	15
Wuhan	100	65	7	10	60
Shanghai	300	70	13	30	
Tianjin	50	70	13	8	25

the current technology for China-made incinerators needs to be improved, and the gas treatment facilities are imperfect, so some technologies such as the manufacture, installation and operation of national-made incinerators and the technical standards such as secondary pollution control need to be solved.

## CONSTRUCTION INVESTMENTS AND OPERATION COSTS

The construction investment of the fundamental facilities for MSW harmless treatment and disposal is relatively high, and it's one of the important reasons to cause the MSW uncontrolled discharge. According to the analysis on the investment of some construction projects in China in recent years, the construction costs for some harmless treatment and disposal facilities are listed in Table 4. The data is estimated with a design lifetime of 20 years and treatment capacity of 100 tons per day. Thereinto, the compacted density of the garbage in the landfills is calculated as  $0.8t/m^3$ , moreover, the costs for the disposal of the cinder from composting and incineration are not included there.

During the operation of the facilities, the compacted density of the garbage in the sanitary landfills always can't meet  $0.8t/m^3$ , most of the landfills will be closed before their designed service lifetime, so the actual construction cost for one volume will be higher. Moreover, the construction costs for composting and incineration will be far more than the estimated costs to consider the extra costs such as the garbage classification, disposal of the cinder in landfills and the gas purification treatment.

Not only the construction costs for MSW treatment and disposal facilities are relatively high, but the operation and management costs of these facilities are rather expensive to meet the better harmless efficiency. For examples, the operation and management cost for the Asuwei sanitary landfill in Beijing was 71 RMB yuan per ton waste in 1994, thereinto, the transportation fee not including the collection fee from the generator to the transfer station was 51 RMB yuan per ton, and the cost for sanitary disposal in landfill was 20

RMB yuan per ton. The estimated cost for sanitary disposal in Xiaping landfill in Shenzhen will be over 30 RMB yuan per ton waste. The treatment fee per ton garbage in Shenzhen incineration plant in 1995 was also over 100 RMB yuan. The treatment capacity is 400 ton garbage per day in the Beihai MSW harmless disposal plant in Guangxi including sanitary landfill and incineration, and the estimated cost of sanitary disposal in landfill will be 70 RMB yuan per ton garbage and the cost of incineration will be 150 RMB yuan per ton garbage including transportation fees.

It can be seen from the current situation of urbanization and MSW generation in China that large amounts of MSW harmless treatment and disposal facilities need to be constructed to utterly eliminate the environment pollution caused by the municipal garbage, and this needs more investments. But the environment and sanitary industries are regarded as public utilities for a long time, its investment needs to be allocated by the central and local government, and the investment is far less than its actual needs. (see Table 5), and most of the allocation can be used only for garbage collection.

Although the Implementation Measures of Present Industrial Policy on Municipal Environment and Sanitary issued by Construction Ministry in 1991 put forward a principle of financial allocation integrated with service charge, the Notice on some Suggestions about how to Solve the MSW Problems in China in 1992 issued by the State Government put forward policies such as adopting different ways to solve the construction and operation costs of MSW harmless disposal facilities and advocating MSW treatment charge actively, it's still quite difficult to maintain the operation of these facilities with the collect fees, and it can be only supported financially by the state and local government to construct the MSW treatment and disposal facilities. The total operation cost was 9.36 million RMB yuan in the MSW incineration plant in Shenzhen, and it was all allocated by the city finance, and the treatment capacity of this incineration plant is basically determined by how much financial allocation can be got from the government, thus the treatment capacity can't be fully used. The main conditions that limit the implementation of the MSW treatment and disposal facilities construction is investments including the fund sources, fund using and its supporting ability.

**Tab.3** The situations of construction of China-made incinerators

Incinerators	Finished date	Capability	Style	Manufacture factory	Construction cost(10 <sup>4</sup> RMB)
Changzhou, Jiangsu	1997	50t/d	Chain grid	Changzhou E & S Eng. Design Institute	265
Yanhua, Beijing	1997	120t/d	Chain grid	Chongqing Environment Protection Eng. Liaision Corp	800
Luzhuo, Sichun	1994	80t/d	Chain grid	Chongqing Environment Protection Eng. Liaision Corp	1870
Loushan, Sichun	1988	20t/d2	Stationary bed	Southeast municipal design institute	
Changping, Beijing	1997	100t/d5	Chain grid	Contemporary garbage consumption corp	4800
Haidian, Beijing	1997	100t/d	Fluidized bed	Thermo-physics research institute of CSSA	700
Shunde, guangdong	1997	75t/d2	Oil pressure grate	Wuling boiler factory	1700
Zhongshan, Guangdong	1997	50t/d2	oil pressure grate	Xuzhou Greenland environment engineering corp	300

**Tab.4** The construction costs for the MSW harmless disposal facilities

Disposal methods Costs	Unit10 <sup>4</sup> RMB yuan					
	Sanitary landfill		Composting		Incineration	
China-made	800	1000	500	800	500	1000
Import partly or totally	1200	1600	3500	4500	3000	8000

**Tab.5** Statistic table for environment and sanitary costs

Year City	Unit10 <sup>4</sup> RMB yuan			
	1986	1991	1993	1995
Total	107719	206776.3	363825.1	575785.7
Beijing	12443	19048.0	32734.0	72275
Tianjin	5082	7277.0	13131.0	20673
Shanghai	19356	38855.0	73379.0	116298.0
Chongqing	923	2584.3	1110.0	3162.0
Harbin	2507	4322.0	6752.0	10052.0
Shenyang	4655	8765.0	1129.0	13852.0
Xi'an	370	1700.0	1276.0	1295.0
Dalian	1464	2996.4	4966.0	6675.0
Nanjing	1324	2308.6	3934.8	5278.9
Wuhan	1816	3226.1	8996.0	12658.0
Guangzhou	3281	7853.0	18819.5	31194.0

## ANALYSIS ON THE INVESTMENT ABILITY

Till now, the construction fund for MSW harmless disposal facilities was mainly supported by the regional city maintenance and construction tax. The income of the city maintenance and construction tax is limited and it needs to pay for the construction and management costs of different infrastructures, so the investment for the MSW treatment projects is rather low.

From a long-term point of view, the construction fund source of garbage infrastructure in principle is supported by the state, local government and the beneficiary. But the financial capacity of the state and the local government is rather limited, to invest a lot of money is impossible. Moreover the investment from the beneficiary needs to be accumulated step by step and a large amount of fund can't be collected in a short time. Therefore, the different measures needing to be carried out at the moment are as following:

- Self collected in region. The garbage treatment volume fee and municipal garbage disposal fee can be collected except the financial allocation from the city maintenance and construction fees.
- State loan. The central government can provide a special loan of favorable terms to the cities which are difficult to raise funds by themselves.
- Foreign loan. To use foreign loan is still a good way to collect fund recently. In recent years, the construction projects in most of the environment areas such as water supply, wastewater treatment, coal gas, heating and municipal garbage used some of the foreign loan including World Bank, Asian Bank, OECF and the government loan from Europe and USA. The main usage of the foreign loan is to purchase the advanced facilities that can't be manufactured in China, at the same time it can make up the deficit of construction funds, thus the speed of the project implementation can be improved. But the cost of the same type of foreign facilities is 4 to 6 times or more of China-made facilities, and it will be increased after customs duty and the

appreciation tax. It should be considered to decrease the customs duty and the appreciation tax because of the social benefit of MSW treatment and disposal.

- Fund raising in society. It can be tried to open joint-stock waste company if it's possible.
- BOT construction method. BOT construction method is a way to overcome the shortage of construction funds. There's no successful construction cases in environment area in China at the moment.

## Conclusion

Because of insufficient regulations and investment in China for a long time, a large amount of municipal solid waste was directly deposited or disposed in simple landfills or open dumps outskirts, therefore, the garbage occupied a lot of cropland which results in the situation of municipal garbage encircling the cities, at the same time, the air, groundwater, surface water and soil around the landfills or dumps were seriously contaminated because of the imperfect measures of environment protection during MSW treatment process. To solve the MSW pollution problems, the authors explained the current situations of MSW treatment and disposal in China by analyzing the treatment rate of MSW harmless disposal and treatment facilities, the construction investment and operation cost of different facilities and the investment capacity of the central and local government. From the analysis, the authors think that we still have a long way to go to solve the MSW pollution problems thoroughly. But it can be solved much quicker if enough investment can be used to improve the MSW management technologies and to expedite the construction of MSW treatment facilities in China.

## REFERENCES

- George Tchobanoglous, Hilary Theisen et al. *Integrated Solid Waste Management*. USA: McGraw-Hill, Inc., 1993

J. Vehlow. Municipal Solid Waste Management in Germany. Waste Management, vol.16, nos 5/6, pp. 367-374, 1996

Shin-ichi Sakai. Municipal Solid Waste Management in Japan. Waste Management, vol.16, nos5/6, pp. 395-405,1996

T.Taylor Eighmy, David S. Kosson. U.S.A. National Overview on Waste Management. Waste Management, vol.16, nos5/6, pp. 361-366, 1996

Wang Wei, Yuan Guangyu. The Status and Development of Solid Waste Treatment and Disposal in China. Environmental Science, 1997, 18(2):8790

Yita, Mashahiro Suto. 17th National Municipal Environment & Sanitary Conference. Japan: Chemical Industry Daily Press, 1996

