The Study about the Solid Waste Automatic Sorting System at the Source
——Take Beijing for Example

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Abstract. The paper provides a novel waste disposal mode that builds a semi-automatic sorting system in the resident area to achieve the goal of waste sorting at the source. The paper mainly introduce the facilities and the workflow of the system and analyze its economic benefit. As it turns out, the system is economical and sustainable.

Introduction

The scale and pace of China's urbanization promise to continue at an unprecedented rate. With the city development and improvement of standard of people living, municipal solid waste is increasing day by day, which imposes enormous demands on the environment. In China, about 2/3 of cities are surrounded by garbage, 1/4 of which is difficult to select refuse landfill sites. The problems of Besieged by garbage、Pollution transfer and diffusion、NIMBY(not in my back yard) of waste incineration gradually emerged. The MSW (Municipal Solid Waste) delivering quantity of important cities in China is shown in table 1.

Table 1 MSW delivering quantity of important cities in China

Year City	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Beijing	491.0	454.6	538.2	600.9	656.6	656.1	633.0	634.4	648.3	671.7
Tianjin	181.6	144.8	155.2	165.0	173.8	188.4	183.7	189.9	185.8	200.0
Shanghai	609.7	622.3	658.3	690.7	676.0	710.0	732.0	704.0	716.0	735.0
Chongqing	237.2	237.6	243.9	200.5	225.2	224.3	256.7	281.6	335.3	349.8

To solve the garbage disposal problem, I propose an idea of solid waste semi-automatic sorting system.The system is installed in the residential areawhich has compact structural, small floor space and low investment of equipment. The paper introduce the model of the system and the economy and ecology benefit it brings.

The Model of the Solid Waste Automatic Sorting System

The work flow chart of the solid waste automatic sorting system is shown as figure 1.

The Feedstock. Weighed by weighbridge, the garbage is poured into the feed hopper of the sorting system. The garbage is stirred there, coordinating by the feeding balancer and the plate

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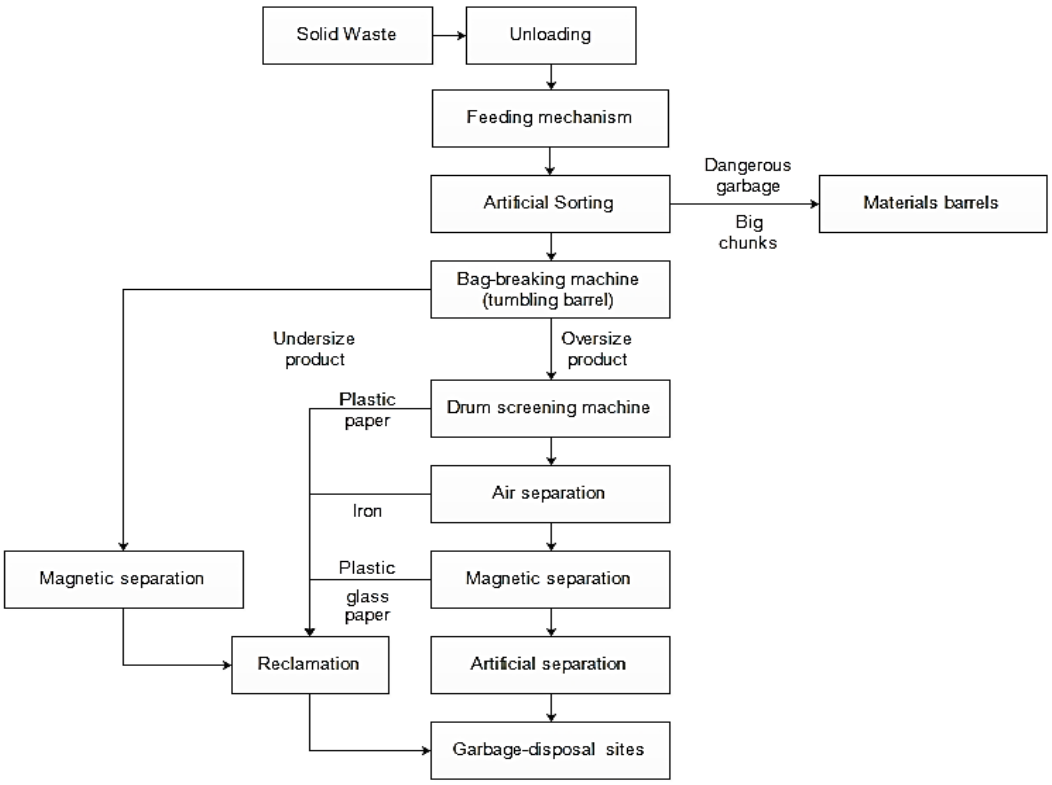
feeder. The feed rate is controled by adjusting the speed of the feeding balancer and the distance between the plate feeders.

The ArtificialSorting Platform. The artificial sorting platform is set at the middle of the plate feeder, which used to separate the fragile glass battle, big chunks that would block the channels and those able to damage the blade of bag-breaking machine.

The Bag-breaking Machine.



The bag-breaking machine applies multistep procedures to ensure the effiency; The garbage bags are broken with blade at the feed inlet roughly. Then the garbage bags are broken many times in the drum bag-breaking machine. The blade is installed in the drum bag-breaking machine. When the garbage bags enter the machine, they will rotate with the roller to certain height and fall on the blade below and so on. The garbage bag is broken at the same time as garbage transfer.

The Deodorant Sprinkler. The garbage is easy to send out dust and bad smell. In this way, the deodorant sprinkler is installed at the inlet and the outlet of the roller. The device should spray evenly and has large coverage. The selection of the chemicals is depend on the category of garbage.

The Drum Screening Machine.

The screening machine screening out the muck and the small garbage. The inside of the screening machine is assembled with the blade, breaking the garbage bags at second time.

The Garbage Sorting Procedures

The Garbage Sorting Procedures are composed by automatic sorting procedures and artificial sorting procedures. The iron is separated by magnetic separator automatically. The artificial sorting is completed on the artifical platform, all kinds of useful material in the garbage, such as paper, plastic, glass and cloth, are separated artificially.

The Recovered Materials Packaging

The recovered material passed into the material barrels in categories is transported to the packaging device, preparing to transport outside.

Disposal of the Leftover

The leftover of the garbage after screening is transported to the nearest waste dump to further disposal.

Economic Benefit

Cost of Traditional Waste Disposal Model

Collection and Transportation Cost. According to Feng Sijing's study, the transportation cost increase to 120% with the rise of prices. The cost of waste collection and transportation in Beijing is shown as Table 2.

Table 2 Transportation Cost

Link	Cost $(yuan/t)$
Collection Cost	120
Transportation Cost	141

Disposal Cost in Waste Disposal Station. According to related survey data and Studies, the cost of a ton of waste is shown in Table 3.

Table 3 Cost of life waste disposal

Waste disposal device	Investment cost $(yuan/t)$	Running cost $(yuan/t)$	Total cost $(yuan/t)$
Sanitary landfills	43.4	78.7	122.1
Composting Plants	86.3	123	219.3
Incineration Plants	87.3	157	244.3

Data is from The Reports about Operation of Municipal Waste Disposal Facilities in Beijing in 2008.

The Total Cost. The total cost of a ton of waste disposal is,

$$U = U_1 + U_2 + \sum_{i=1}^{3} P_i \times Q_i$$

Where the U_1 is collection cost, the U_2 is transport cost, P_i is the proportion of each waste disposal device in Table 3, and Q_i is the corresponding cost.Plug the data in Table 3, the cost is 402.16 yuan.

The Cost of Building a Solid Waste Semi-automatic Sorting System

This part of funds is mainly used for land auction, factory construction, purchase of the car in initial period, which provides with some necessary equipments for operation of the station.The cost of equipment is shown in Table 4.

Table 4 The cost of the equipments

Equipment	Specifications	Unit price (yuan)	Total price ($\times 10^4$yuan)
Weighbridge	1t	1650	17.24
Bag-breaking machine	Yseries(closed)	600	
Comprehensive sort device	complex	135000	
Waste dehydrator		2300	
Waste compressor	Semi-automatic	21000	
Transfer belt	Linked belt type（Containing the motor and automatic lifting device0.5m × 23m）	11850	

The construction cost and the renovation cost is total 1500 ($\mathrm{yuan/m^2}$). The first floor of station is a workshop, the second station is a control room. The total gross area is $160\mathrm{m}^2$. So the total cost of construction is 24$\times 10^4$yuan.

Analysis

The cost of transportation is 141$\mathrm{yuan/t}$. The amount of the waste that need to transport reduces by 60%. In this way, the waste that need to transport is 40%. The MSW delivering quantity of Beijing in 2013 is $671.69 \times 10^4\mathrm{t}$. The saving of a ton of waste disposal is,

$$\mathrm{S} = 0.6 \times 141 \times 671.69 \times 10^4 = 5.68 \times 10^8(\mathrm{yuan})$$

And the cost of building a waste disposal station is the sum of cost of the equipment and construction,

$$\mathrm{T} = (17.4 + 24) \times 10^8 = 41.24 \times 10^8(\mathrm{yuan})$$

An equivalent calculation is done,

$$\mathrm{N} = \frac{\mathrm{S}}{\mathrm{T}} = \frac{5.68 \times 10^8}{4.124 \times 10^6} = 138$$

The equation shows that the saving money by building local waste disposal station can build 138 new local waste disposal. Not only could the local disposal facility bring big economic benefits, but also it is sustainable.

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