

Change in MSW characteristics under recent management strategies in Taiwan

Yu-Min Chang*, Chien-Chung Liu, Chao-Yang Hung, Allen Hu, Shiao-Shing Chen

Graduate Institute of Environmental Engineering and Management, National Taipei University of Technology, Taiwan, ROC

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Abstract

Reduction and recycling initiatives such as producer responsibility and pay-as-you-throw are being implemented in Taiwan. This paper presents a study assessing the impact of recently implemented municipal solid waste (MSW) reduction and recycling management strategies on the characteristics of waste feedstock for incineration in Taiwan. Through the periodic sampling of two typical MSW incineration plants, proximate and ultimate analyses were conducted according to standard methods to explore the influence of MSW reduction and recycling management strategies on incineration feed waste characteristics.

It was observed that the annual amount of MSW generated in 2005 decreased by about 10% compared to 2003 and that the characteristics of MSW have changed significantly due to recent management strategies. The heating value of the MSW generated in Taiwan increased yearly by about 5% after program implementation. A comparison of the monthly variations in chemical concentrations indicated that the chlorine content in MSW has changed. This change results from usage reduction of PVC plastic due to the recycling fund management (RFM) program, and the food waste as well as salt content reduction due to the total recycling for kitchen garbage program. This achievement will improve the reduction of dioxin emissions from MSW incineration. In summary, management strategies must be conducted in tandem with the global trend to achieve a zero-waste-discharge country. When implementing these strategies and planning for future MSW management systems, it is important to consider the changes that may occur in the composition and characteristics of MSW over time.

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1. Introduction

Taiwan is an island in Asia, 361,000 km² in size with a population of 23,600,000. Most of the population is concentrated in the two largest cities: Taipei in Northern Taiwan, and Koushung in Southern Taiwan. Municipal solid waste (MSW) management has become one of the central urban issues confronting Taiwan. In Taiwan, an array of waste management and disposal strategies have emerged, including landfilling, recycling, composting and incineration. Many lawmakers, local city councils and civil groups have proposed ideas to reduce MSW generation, such as restrictions on the use of plastic shopping bags and tableware in Taiwan. Currently, landfilling, recycling,

composting and incineration remain critical elements of the MSW management strategy in Taiwan. The availability of substantial, suitable acreages of land is necessary for land disposal systems to be an exclusive, cost-effective waste management strategy. This disposal method proved to be efficient and inexpensive until changes in waste composition and past disposal methods resulted in groundwater contamination and other problems (Kirkeby et al., 2006; Williams, 1998). These problems caused landfill costs to increase over 300% in some Taiwan areas, with predicted costs increasing because of the potential remediation costs and the need to provide long-term monitoring. In view of the ever-soaring costs of disposal, many municipalities are seeking other methods and solutions to manage MSW (Yeomans and Huang, 2003). However, the modern municipal waste incinerator is a sophisticated system designed for the complete, high-temperature destruction

* Corresponding author. Tel.: +886 2 27712171; fax: +886 2 27714237.
E-mail address: ymchang@ntut.edu.tw (Y.-M. Chang).

of waste. It includes significant post-combustion controls for the removal of undesirable emissions (Holmgren and Henning, 2004).

In Taiwan, each person generates approximately 0.91 kg/day of MSW, of which about 80% is collected by municipalities. As shown in Table 1, approximately 7.51 million tons of MSW were collected in 2005, including roughly 1.75 million tons of recycled material and 0.46 million tons of recovered food waste. The amount of MSW generated is decreasing each year because some programs like pay-as-you-throw (PYT) and total recycling of kitchen garbage (TKG) have been successfully executed. Approximately 60% of the MSW is disposed of by incineration and 30% by landfilling.

Integrated waste management recovers valuable raw materials and energy and reduces the volume of waste sent to landfills (Li and Huang, 2006). Refuse-to-energy (RTE) technology is an important component of integrated waste management systems, and when combined with recycling, composting, and other waste reduction processes, it minimizes the overall disposal costs (Chang and Chen, 1993). In terms of MSW disposal, the Taiwan EPA has adopted a strategy favoring incineration as the primary treatment method with landfills used as a supplement. According to the early “Engineering Project for the Construction of Refuse Incineration Plants”, there are 21 large operational RTE facilities in Taiwan. However, a number of technical issues remain for the mass-burn systems, and further research is warranted in Taiwan. One of the issues is dioxin emission control, which seems to be a problem in the early-designed plants. Dioxin emissions continue to be a major issue in obtaining permission applications and in public relations. Despite numerous technological advances in solid waste combustion, increasing resistance among many public officials inhibits the use of incineration as a rational waste management strategy. (Bébar et al., 2002; Consonni et al., 2005; Thipse et al., 2002).

To achieve these objectives and operate in coordination with RTE plants, the Taiwanese government assists local

governments in constructing “reusable garbage separation plants”. In addition, other treatment methods like “food residue and garbage recycling and reuse” and “jumbo-sized waste recycling and reuse” are utilized to separate and classify MSW and general industrial waste as reusable waste. Through proper sorting, MSW and treated MSW remains are recycled and reused. By doing this, both MSW generation and final disposal will be properly handled (Dioxin and Langer, 2006). Environmental and sanitary conditions will be improved and public health can be well-maintained. Major recycling initiatives implemented in Taiwan include producer responsibility programs and pay-as-you-throw programs. Most people are extremely concerned with the promulgation effectiveness of the recent management programs for MSW reduction. However, information on MSW composition is important in evaluating incineration performance, management programs and plans. Therefore, the major objective of this paper is to study changes in MSW waste characteristics resulting from the recent reduction and recycling management strategies in Taiwan (Koufodimos and Samaras, 2002; Tchobanoglous et al., 1993; Wu et al., 2006).

2. MSW management programs

As listed in Table 2, the management programs for the strategy of MSW reduction and recycling are as described below.

2.1. Pay-as-you-throw (PYT)

Prior to July 2000, waste collection and treatment fees collected by the Taiwanese government were calculated according to the volume of water consumed by a household. Some cities in Taiwan, like Taipei City, collect fees according to the volume of trash discarded. In this regard, Taipei City promulgated a “Municipal Waste Cleaning Fee Collection Ordinance” in August 2000. According to this Ordinance, citizens must pay for and use special trash bags

Table 1
Disposal methods for MSW in Taiwan from 1995 to 2005

Year	Quantity for various disposal methods (ton)										Ratio of recovered food waste (%) (9)	Rate of complete disposal (%) (10)	
	Total (1)	Incineration (2)	Sanitary landfill (3)	General landfill (4)	Dumping (5)	Regulated recovery (6)	Others (7)	Recovered food waste (8)	Utilization of food waste				
									Fertilizer	Pig feed	Other utilization		
1995	9,529,687	1,301,036	4,362,789	2,537,556	776,863	45,128	500,033	6282	6282	0	0	0.07	86.60
1996	9,582,643	1,364,639	4,823,997	2,090,514	790,099	56,124	454,750	2520	2520	0	0	0.03	87.01
1997	9,628,644	1,691,626	5,129,676	1,536,415	649,544	98,325	508,885	14,173	14,173	0	0	0.15	87.97
1998	8,992,239	1,741,095	5,597,979	1,088,934	296,545	111,753	155,405	528	528	0	0	0.006	94.97
1999	8,715,575	2,020,634	5,366,936	857,267	245,183	149,876	56,186	19,493	19,242	251	0	0.22	96.54
2000	8,353,368	3,229,750	3,822,124	697,050	119,116	477,856	4690	2782	2659	123	0	0.033	98.52
2001	7,839,175	3,736,891	2,996,805	433,330	73,040	584,333	14,560	216	216	0	0	0.003	98.88
2002	7,601,960	4,316,049	2,116,375	224,477	55,076	878,319	7958	3706	3506	150	50	0.05	99.17
2003	7,555,372	4,304,574	1,900,438	113,115	20,190	1,048,981	734	167,304	22,290	139,614	5400	2.21	99.72
2004	7,522,263	4,305,822	1,458,234	59,792	15,004	1,387,371	1201	294,799	64,950	221,559	8290	3.92	99.78
2005	7,505,419	4,153,760	1,105,224	36,332	2585	1,749,952	104	460,137	95,820	357,473	6844	6.13	99.96

Remark: (1) = (2) + (3) + (4) + (5) + (6) + (7) + (8) (9) = (8)/(1) (10) = [(2) + (3) + (4) + (6) + (8)]/(1).

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