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## A review on the management of municipal solid waste fly ash in American

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### Abstract

With the accelerating process of urbanization, the amount of municipal solid waste (MSW) generation increases continuously. Landfill occupies a lot of land resources, leading several cities run into a condition being surrounded by MSW. In recent years, MSW incineration rises gradually. Incineration can reduce the MSW volume by 85%~90% and the mass by about 80%, and incineration with energy recovery is one of the several waste-to-energy (WtE) technologies [1-3]. However, municipal solid waste incineration fly ash, byproducts of MSW incineration, contains large amounts of heavy metals and dioxins, improper disposal will cause serious environmental and human health hazards. This review summarizes the MSW incineration fly ash management system and related policies and regulations in United States, as well as the main disposal methods and utilization technology, in order to provide reference for the management of MSW incineration fly ash in China.

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### 1. Introduction

Waste incineration was proposed by the Americans in 1901. With such features as small floor area, harmlessness, quantity reduction, effective recycle and prolong the service life of the landfill, incineration can eliminate a large number of MSW continuously, stably, safely and reliably, which makes incineration become one of the important

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MSW harmless treatment methods. MSW incineration (MSWI) produces two main types of ash, which can be grouped as bottom ashes (BA) and fly ashes (FA). MSWI fly ash is the residue collecting from flue gas purification system of waste incineration power plant, and most of them contain heavy metals, dioxin and other characteristic pollutants, so in some countries the fly ash can be considered to hazardous waste. Fly ash is generally considered higher potential risk than bottom ash, because the fly ash comprises higher concentration of heavy metals.

MSW incineration started in late 1980's in China. According to the "12<sup>th</sup> Five Year Plan", the daily processing capacity of MSW incineration in China will be increased from 0.896 million tonne/d in 2010 to 3.072 million tonne/d in 2015. The mass of fly ash will reduce to 1%~6% of MSW after incineration, so according to this ratio, the MSWI fly ash production will reach 1 million tonne/y to 6 million tonne/y during the "12<sup>th</sup> Five Year Plan" period. In China, MSW is commonly burned unsorted. MSW entering an incinerator may contain kitchen waste, wood, paper, glass, construction waste and all kinds of plastic, etc. Unsorted kitchen waste, wood and PVC may cause high concentrations of Na, K and Cl in fly ash [4, 5]. According to solubility, fly ash composition can be divided into soluble substances (salt) and insoluble substances (slag). The main components of soluble substances are harmful salts to cement kiln calcination, such as Na, K, Cl, etc. The remaining 70% of fly ash are insoluble substances, which contain calcium, silicon, aluminum, iron and other cement ingredients.

MSWI fly ash has great harm to the environment and human health. With the decrease of the landfill site, the harmless treatment and utilization of MSWI fly ash has been drawn more and more attention by the government and researchers. Although the MSWI fly ash contain high concentrations of pollutants like heavy metals, slats, chloride and organic waste, there are still many utilization methods successfully used in developed countries. This paper summarized the management practice of MSWI fly ash in United States, including current regulations, disposal methods and utilization technology.

## 2. Regulations related to MSWI fly ash in United States

The Resource Conservation and Recovery Act (RCRA) is the nation's primary law governing the disposal of solid and hazardous waste in United States. The hazardous waste management, under Subtitles C of RCRA, established a system for controlling hazardous waste from "cradle to grave". The RCRA regulations governing hazardous waste identification, classification, generation, management and disposal are set forth in different parts of title 40 of the Code of Federal Regulations (CFR). The following table indicates where the RCRA regulations appear in the Code of Federal Regulations.

Table 1. RCRA Subtitles C regulations appear in the Code of Federal Regulations

Section of RCRA	Coverage	Final regulation
Subtitle C	Overview and definitions	40 CFR part 260
3001	Identification and listing of hazardous waste	40 CFR part 261
3002	Generators of hazardous waste	40 CFR part 262
3003	Transporters of hazardous waste	40 CFR part 263
3004	Standards for HWM facilities	40 CFR parts 264, 265, 266, and 267
3005	Permit requirements for HWM facilities	40 CFR parts 270 and 124
3006	Guidelines for State programs	40 CFR part 271
3010	Preliminary notification of HWM activity	(public notice) 45 FR 12746 February 26, 1980

Title 40-Protection of the Environment arranges mainly environmental regulations that were promulgated by the US Environmental Protection Agency (EPA). According to 40CFR 260.10, generator is "any person, by site, whose act or process produces hazardous waste identified or listed in part 261 of this chapter or whose act first causes a hazardous waste to become subject to regulation." 40CFR 262 required that a person who generates a solid waste must determine if the waste is a hazardous waste and supervise the final disposal of the waste. Once the waste is identified as hazardous waste, which is defined in RCRA, it becomes the management objective, and the generators will be responsible for the management. The generators are required to ensure and demonstrate that the hazardous waste is properly identified,

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