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Review Article

A review of municipal solid waste environmental standards with a focus on incinerator residues

Alec Liu [b], Fei Ren [b], Wenlin Yvonne Lin [b,*], Jing-Yuan Wang [a,b,*]

[a] School of Civil and Environmental Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798, Singapore
[b] Residue and Resource Reclamation Centre (R3C), Nanyang Environment and Water Research Institute, Nanyang Technological University, 1 Cleantech Loop, CleanTech One, Singapore 637141, Singapore

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Abstract

Environmental issues are often neglected until a lapse in the care for environment, which leads to serious human health problem, would then put regulation gaps in the spotlight. Environmental regulations and standards are important as they maintain balance among competing resources and help protect human health and the environment. One important environmental standard is related to municipal solid waste (MSW). Proper MSW management is crucial for urban public health. Meanwhile, the sustainability of landfills is also of concern as increasing volumes of MSW consume finite landfill space. The incineration of MSW and the reuse of incinerated residues help alleviate the burden on landfill space. However, the reuse of MSW incinerator residues must be regulated because they may expose the environment to toxic heavy metal elements. The study of environmental standards from different countries applicable to MSW is not widely published, much less those for incinerated MSW residue reuse. This paper compares extant waste classification and reuse standards pertinent to MSW, and explores the unique recent history and policy evolution in some countries exhibiting high environmental regard and rapid changes, so that policy makers can propose new or revise current MSW standards in other countries.

Keywords: Municipal solid waste; Environmental regulation; Incinerator residues; Leaching standard; Leaching criteria

Contents

* Corresponding authors at: Residue and Resource Reclamation Centre (R3C), Nanyang Environment and Water Research Institute, Nanyang Technological University, 1 Cleantech Loop, CleanTech One, Singapore 637141, Singapore. Tel.: +65 6790 4102; fax: +65 6792 7319 (W.Y. Lin). Tel.: +65 6790 4100; fax: +65 6792 7319 (J.-Y. Wang).
E-mail addresses: wylin1@e.ntu.edu.sg (W.Y. Lin), jywang@ntu.edu.sg (J.-Y. Wang).
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1. Introduction

An important purpose of environmental regulations is to regulate the use of resources to ensure minimal impact on the environment and human health. As the economy grows and income rises, the increased demand for natural resources and manufactured consumer goods has put strains on the environment (Swanson, 2008). Subsequently, the amount of solid waste generated increases in parallel to economic development, due to excessive consumerism. According to the United States Environmental Protection Agency (USEPA), solid waste that is not properly managed poses risk to human health and the environment by contaminating water, attracting insects and rodents, increasing flood due to blocked drainage of canals or gullies, among others (USEPA, 2002). Wastes can be classified as municipal solid waste (MSW), medical waste, hazardous waste, industrial waste, or radioactive waste (Links, 2006).

MSW is of particular concern in developing economies, as a significant portion of the population there does not have access to a waste collection service (Schübeler, 1996). Therefore, MSW management can have important consequences for public health, well-being, and sustainability. In the US, most of the MSW is handled in one of the three ways: landfilling (53.8%), recycling (34.5%), and incineration (11.7%) (USEPA, 2012). Although the incineration rate is still low in some countries, the reuse and recycle of incineration ash can greatly lower disposal burdens of MSW and provide valuable materials to countries that have limited natural resources (Huang et al., 2006). One of the benefits of incineration is volume reduction in waste, which alleviates limited landfill space, providing extra source of energy from combustion, and the potential recycling of incinerator residues. There are more than 200 waste-to-energy plants in 14 European countries, managing about 23% of MSW in these countries, and 89 waste-to-energy plants operating in 27 states in the US (Ornebjerg et al., 2006).

Generally, there are two types of MSW incineration ash, which are the remaining residues after burning: bottom ash (IBA) that remains after combustion on the grate and fly ash (IFA) that is removed from exhaust flue gases (Huang et al., 2006). Millions of tons of IBA are produced worldwide each year, and varying portions of them are recycled for structural applications. In Germany, over three million tons of IBA were generated, two million tons of which were reused in 2003 (Ornebjerg et al., 2006). On the other hand, Denmark, having recycled only slightly more than half a million tons of IBA in the same year, had a high IBA reuse rate of nearly 98% (Ornebjerg et al., 2006). These and other statistics are shown in Table 1. Numerous studies have been conducted on the assessment of reusing incineration ash (Chang et al., 1999; Erdem et al., 2011; Tang et al., 2014) and found it suitable as secondary construction material (Cai et al., 2004). IBA can also be reused as road bases and dye adsorbents (Lam et al., 2010). IFA is seldom reused due to its hazardous nature. In fact, IBA cannot be reused unless it meets the environmental regulations set out in individual countries.

The proper reuse of IBA as a new resource requires environmental regulations. The MSW environmental

Table 1
Incineration bottom ash quantities in selected countries (Ornebjerg et al., 2006).

Country	Tons of ash available per year (2003)	Tons of ash reused per year (2003)	Percent of ash reused (2003) (%)
Denmark	644,626	629,278	97.6
France	2,995,000	2,366,000	79.9
Germany	3,140,000	2,025,700	64.5
The Netherlands	1,075,000	950,000	88.4
United Kingdom	725,000	410,000	56.6
United States	9,000,000	500,000	5.6