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Status and perspectives of municipal solid waste incineration in China: A comparison with developed regions

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ABSTRACT

With the rapid expansion of municipal solid waste (MSW) incineration, the applicability, technical status, and future improvement of MSW incineration attract much attention in China. This paper aims to be a sensible response, with the aid of a comparison between China and some representative developed regions including the EU, the U.S., Japan, South Korea, and Taiwan area. A large number of up-to-date data and information are collected to quantitatively and impartially support the comparison, which covers a wider range of key points including spatial distribution, temporal evolution, technologies, emissions, and perspectives. Analysis results show that MSW incineration is not an outdated choice; however, policy making should prevent the potentially insufficient utilization of MSW incinerators. The structure of MSW incineration technologies is changing in China. The ratio of plants using fluidized bed is decreasing due to various realistic reasons. Decision-makers would select suitable combustion technologies by comprehensive assessments, rather than just by costs. Air pollution control systems are improved with the implementation of China's new emission standard. However, MSW incineration in China is currently blamed for substandard emissions. The reasons include the particular elemental compositions of Chinese MSW, the lack of operating experience, deficient fund for compliance with the emission standard, and the lack of reliable supervisory measures. Some perspectives and suggestions from both technical and managerial aspects are given for the compliance with the emission standard. This paper can provide strategic enlightenments for MSW management in China and other developing countries.

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Abbreviations

APC	air pollution control	MSW	municipal solid waste
CEMS	continuous emission monitoring system	PCDD/Fs	polychlorinated dibenzo-p-dioxins and dibenzo-furans
FGR	flue gas recirculation	SCR	selective catalytic reduction
GDP	gross domestic product	SNCR	selective non-catalytic reduction
LHV	lower heating value		

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1. Introduction

Municipal solid waste (MSW) incineration is favorable due to its well-recognized properties in volume reduction and energy recovery. In China (only referring to mainland China in this paper), MSW incineration has boosted more than twelvefold in the past decade, in response to rapid increase in MSW generation (China NBS, 2004–2015). MSW incineration capacity in China has reached 231,600 Mg/d (Mg is short for Megagram; 1 Mg equals to a metric ton) in 2015 and may grow to 500,000 Mg/d by 2020 according to China NDRC (2016). However, this rapid expansion caused continuous public criticisms and even recurrent anti-incineration protests in big cities such as Beijing and Guangzhou (Johnson, 2013a, 2013b; Wong, 2015). These criticisms and protests are partly caused by sub-standard emissions in some plants (Ni et al., 2009) and by government's top-down, non-consultative approach to waste management (Johnson, 2013b). Although similar issues have occurred in other countries like the U.S. (Walsh et al., 1993), Ireland (Davies, 2006), and South Korea (Soo, 2001), the criticisms and protests do put China's local governments in a passive position and would send the public into an alarmed panic on waste incineration. Both China's local governments and citizens desire to know answers to the following three questions about MSW incineration: (i) Whether MSW incineration is outdated around the world or applicable to China? (ii) Whether MSW incinerators in China discharge more pollutants than in other regions from a technical perspective? (iii) How to develop MSW incineration in China in the future?

A comparison between China and other regions with large capacities of MSW incineration is helpful to answer the above three questions. Such a comparison should look into various aspects such as regional distributions, state of the art, emission control, and perspectives. Enough data and rigorous analyses are needed to support the comparison. Several official and semi-official organizations have published credible lists of MSW incineration plant in Europe (ISWA, 2013), the U.S.

(Michaels, 2014), Japan (Japan MOE, 2015a), and South Korea (KINC, 2014); however, no publication has presented a credible and up-to-date inventory of MSW incineration plants in China due to the fast expanding rate. There is a worldwide incinerator list shared on the Internet, which contains a portion of incinerators in China (Coenrad, 2013), but this list is incomplete and lacks accuracy to support this sophisticated comparison. Furthermore, there were several comprehensive evaluations about MSW incineration in certain regions recently, for example, the comparison of technological availability in the U.K. (Nixon et al., 2013), the energy efficiencies in South Korea (Ryu and Shin, 2012), the dioxin emissions from almost all incinerators in France (Nzihou et al., 2012), the historical change of incineration emissions in the U.S. (Psomopoulos et al., 2009), and the bioeffects of incineration emissions to nearby crops and cow milk in the Netherlands (van Dijk et al., 2015). The evaluations in China covered an overview of technological applications (Cheng and Hu, 2010), a national emission inventory of hazardous pollutants (Tian et al., 2012), and several case studies concerning the environmental impact (Chen and Christensen, 2010) and the mass balance of hazardous pollutants (Zhang et al., 2012; Zhang et al., 2013b; Zhang et al., 2013a). However, these existing evaluations are scattered for certain regions and cannot support a holistic comparison on MSW incineration around the world. Similarities and differences among regions were even less concerned, and what decision-makers should do in both technical and managerial aspects was not considered.

This paper collects a large number of up-to-date data and information to quantitatively and impartially compare the status and perspectives of MSW incineration between China and some representative developed regions. Three most concerned questions about MSW incineration are answered to provide strategic enlightenments for MSW management in the future. Experiences and lessons of MSW incineration around the world are beneficial to developing a strategy, which would help MSW incineration in upgrading from a controversial technique to an acceptable solution in the future.

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