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PCDD/Fs in Fly Ash from Waste Incineration in China: A Need for Effective Risk Management

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Incineration has gradually become one of the key means to dispose of municipal solid waste (MSW) and hazardous waste (HW) in China. With great concern for emissions of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) in incineration flue gas, control standards were further improved and many terminal measures applied to pollution control of flue gas in the country. This resulted in PCDD/Fs being further transformed into fly ash. Based on current disposal and management, however, PCDD/Fs in the fly ash have not been effectively eliminated, and will probably reenter the environment and in turn become a new source of dioxin emission. Therefore, the risks of PCDD/Fs in fly ash should be given importance and management should be strengthened.

Waste incineration is an important source of dioxin emission. In China, PCDD/F emissions in 2004 reached approximately 1757.6 g TEQ[1] from incineration of municipal solid, medical and hazardous wastes. It is estimated that 65.3%[1] of overall dioxin (about 1147.7 mg) from waste incineration was discharged into the environment in the form of fly ash. In recent years, the amount of waste incineration in China has rapidly grown. The Chinese Ministry of Environmental Protection reported that the total quantities of MSW and HW, respectively, increased from 6.66 and 0.271 million tons in 2004, to 23.167 and 1.344 million tons in 2010. In the latter year, total medical waste in the country reached 336 000 tons, which was also mainly disposed of by incineration. Assuming that fly ash production is 4% of incineration waste, fly ash generated nationally currently exceeds an estimated 100 million tons/year. Further, more PCDD/Fs have entered fly ash with the control measures to reduce atmospheric dioxin emissions during waste incineration. Based on previous studies, PCDD/Fs even exceeded 20 ng I-TEQ/g [2] in some of the country's incineration fly ash.

Incineration fly ash is typically dealt with by landfills in China. According to current environmental policy in the country, fly ash must undergo treatment for solidification/stabilization of heavy metals, and can then be disposed of in hazardous waste landfills. Regrettably, there have been no PCDD/F limits in pollution control standards for hazardous waste landfill site security. Consequently, the pollution of PCDD/Fs within fly ash present in hazardous waste landfills was not given much attention. On the other hand, because existing hazardous waste landfills are unable to meet the increasing demand for fly ash disposal, incineration fly ash with dioxin content less than 3 ng TEQ/g can be disposed of in MSW landfills, based on national pollution control standards for MSW landfill sites.

Whether disposed of in hazardous waste or MSW landfills, there are great environmental risks from PCDD/Fs that remain in fly ash. In landfills, solid fly ash represents an important potential PCDD/F release source, with erosion or rupture of ash-cement solidified bodies or landfill leakage. Owing to abundant organic acids and different surfactants present in MSW landfills, the PCDD/F release potential from solids is greatly enhanced, leading to high concentrations of PCDD/Fs in landfill leachates.[3] Based on previous studies, PCDD/F content in surface soil of landfill sites was hundreds of times greater than that in urban soils.[4] PCDD/F concentrations in groundwater and treated leachates of landfill sites for solidified fly ash were both higher than those at control sites.[4] In China, the environmental risks of PCDD/Fs have not been systematically investigated for MSW landfills, but based on findings in other countries, the risks cannot be ignored.

These problems indicate that the environmental risks of dioxins were not eliminated under current disposal and management of fly ash in China. If insufficient emphasis is placed on PCDD/F control in fly ash, flue gas pollution control

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measures at waste incineration sites will be ineffective. This is because the PCDD/F controls only change the form of emissions, and PCDD/Fs are not actually being destroyed. Therefore, more effective risk control measures should be considered in response to growing environmental risks associated with the sharp increase of incineration fly ash. First, relevant pollution control standards should be improved and strictly implemented for hazardous waste landfills. Second, effective technical measures should be taken for detoxification of PCDD/Fs in fly ash, such as mechanical chemical detoxification treatment, high-temperature melting or cement kiln coprocessing, together with restriction of heavy metals. If detoxified fly ash is used as an alternative material for cement production, it should be developed using the PCDD/F control standards for building materials. Finally, management of landfills containing fly ash should be strengthened, including monitoring of dioxins in landfills and the surrounding environment.

Incineration fly ash contains not only dioxin, but also polychlorinated naphthalenes (PCNs), polychlorinated biphenyls (PCBs), pentachlorobenzene (PeCB), hexachlorobenzene (HCB), and other persistent halogenated hydrocarbons.[5] However, to our knowledge, little information and no control standards are available regarding these persistent halogenated hydrocarbons in the country's fly ash. The unknown risks of these pollutants may be greater than those of PCDD/Fs.

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Notes

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