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Analysis of MSWI bottom ash reused as alternative material for cement production

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Abstract

The bottom ash sample was obtained from one of three stably running municipal solid waste incineration plants in Beijing. The major components of bottom ash, i.e. CaO, SiO_2, Al_2O_3, Fe_2O_3, were similar to that of ordinary Portoland cement, suggesting that bottom ash had the potential for reuse as cement material. In this paper, the smaple was sieved into 8 fractions according to the particle size distirbution. The content of CaO and chloride in the bottom ash almost decreased with the increase of particle size of bottom ash, contrary to the SiO_2 content variation in the bottom ash. The Al_2O_3 and Fe_2O_3 content were relatively stable in the bottom ash with different particle size. The chloride, which could cause serious corrosion in the cement kiln, in 8 portion of bottom ash were all higher than its allowable limit in raw material for cement production and clinker quality, the dosage of bottom ash used as alternative material for cement production must be stringently controled, and some proper treatment must be used to reduce the corrion caused by chloride.The heavy metals concentration in the bottom ash were relatively high, but met standard requirements for heavy metals concentration in raw meterial. The content of alkaline oxide (K_2O, Na_2O) and sulphur, also affected cement production, in bottom ash with differernt particle size were all relative high. The bottom ash had the potential to be recycled as alternative material for cement production, but proper treatment measures, such as by-pass system, must be taken to satisfy the cement production, clinker quality and environmental safety.

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Keywords: Bottom ash;Alternative material; Heavy metal; Chloride content;

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1. Introduction

In recent years, incineration, which could reduce the massed volume of the solid waste dramatically, became an efficient method to deal with the increasing amount of municipal solid waste [1, 2]. The bottom ash from municipal solid waste incineration (MSWI) was a stony material that contained stone, brick, ceramic, glass and unburned organic matter (wood, plastic and fibre) etc. The component of bottom ash was similar to the cement material, the utilization of bottom ash for alternative cement material was a potential method. And there were advantages of using solid waste to produce cement .The high temperature (above 1450℃) in the kiln can capture most of heavy metals in the clinker; the ash can be efficiently used since its major constituents are similar to those of the cement raw materials; no secondary waste was generated; and the production capacity of a cement kiln was very large

The purpose of this paper was to conduct analysis of MSWI bottom ash reused as alternative material for cement production .

2. Material and methods

2.1. Experimental materials

The MSWI bottom ash was obtained from the municipal solid waste incineration plant in Shunyi district, Beijing. The MSWI bottom ash was first dried until a constant weight was reached. The sample was sieved into 8 fractions according to the particle size distribution (60mm, 40mm, 10mm, 5mm, 0.5mm, 0.25mm, 0.75mm), parts of the eight samples were ground into powder.

2.2. Characterization

XRF was utilized to determine the chemical composition of bottom ash with a scanning rate of 8 deg/min using XRF-1800 (Schimadu, Japan). Chloride concentration in the ash was determined by standard gravimetric methods[3]. The heavy metals concentration in the samples were determined by inductively coupled plasma mass spectrometry (ICP-MS; Thermo Elemental, X Series). To prepare the solution for ICP-MS analysis, approximately 0.1 g of sample was taken in a Teflon beaker and digested successively by 5ml of concentrated HNO_3, $HClO_4$ and HF on a hot plate. The final volume of the solution obtained after dissolution of the residue in 10 ml of concentrated HNO_3 was made up to 100 ml with deionised water. For analysis by ICP-MS, the solutions were again diluted 50 times. From the concentration obtained (μ g/l), the weight percentage of the most abundant oxides of the elements determined in the wastes was deduced[4].

2.3. Cement design

The Cement Modulus used by one cement industry in Beijing were lime saturation coeficience (KH) = 0.9, iron modulus (IM) = 1.5 and silica modulus (SM) = 2.6, respectively.

2.4. Cement production

The raw materials for cement, including limestone, sandstone, coal ash, slag, were provided by the one Cement Corporation in Beijing. The MSWI ash and the cement raw materials were first dried until a constant weight was reached. The samples were ground and sieved through a 200-mesh sieve (equivalent to 0.074 mm). The chemical compositions of raw materials and the MSWI ashe used for cement preparation were determined by using X-ray fluorescence spectrometry (XRF).

The samples were clinkered in an electrical resistance furnace. The heating process was conducted in three stages to simulate the sintering condition of the cement kiln. In the first stage, the temperature was raised to 1000 ℃at the rate of 10℃/min, followed by a 5℃/min increase to the maximum temperature of 1450 ℃. In the last stage, the furnace was maintained at the maximum sintering temperature for 30 min. After the sintering, the sample was removed from the furnace and cooled to room temperature quickly by cold air.