Thermal treatment on MSWI bottom ash fines

THERMAL TREATMENT ON MSWI BOTTOM ASH FINES

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Abstract

The municipal solid waste incineration (MSWI) bottom ash is the main by-product in the waste-to-energy plant, which accounts for about 80% of the total by-products. The further challenge after incineration is to find a suitable way to dispose or use the solid residue. It is well understood that the bottom ash contains contaminants, such as heavy metals, which pose an environmental risk. In order to reduce landfill of these residues and enhance the recycling of resources, different treatments are applied to upgrade the quality of the bottom ash, for instance, weathering, washing, etc. However, the treatments on the MSWI fine bottom ash particles are less sufficient. Hence, in this study the thermal treatment is applied on fine bottom ash and its effect on the bottom ash properties are investigated.

Key Words: *MSWI bottom ash fines, thermal treatment, cement hydration, leaching properties*

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1. INTRODUCTION

The municipal solid waste incineration (MSWI) bottom ash has the potential to be used as a building material ingredient [1]. However, the leaching concentration of some heavy metals, as well as salts, poses an environmental risk [2]. Hence, treatments are conducted on the bottom ash to upgrade its quality [3]. The leachable contaminants in fine bottom ash (< 2 mm) are higher than that of coarse bottom ash particles. In this study, the thermal treatment is conducted on the bottom ash fines, and its effect on the bottom ash properties is investigated. Moreover, the possibility of use of treated bottom ash fines as cement replacement is studied.

1.1 Treatment and materials

The MSWI bottom ash is provided by the waste-to-energy plant of Attero (the Netherlands), and the particles below 2 mm which contains higher amount of contaminants than coarse bottom ash particles is chosen to be investigated. The cement used in this study is CEM I 52.5 R. Thermal treatments at different temperature, combined with milling and sieving is performed on the fine bottom ash. The procedure is described below and summarized in Fig. 1.

- Method 1: milling the bottom ash to reduce its particle size, the sample is labelled as S1;
- Method 2: firstly milling the bottom ash, followed by a thermal treatment at 550 ˚C or 750 ˚C in an oven, the samples are labelled as S2 and S3;
- Method 3: thermally treating the bottom ash in an oven under 550 ˚C, and then milling the treated bottom ash, the sample is labelled as S4;
- Method 4: thermally treating the bottom ash in an oven at 550 ˚C, followed by selecting the particles below 63 µm after milling, the sample is labelled as S5.

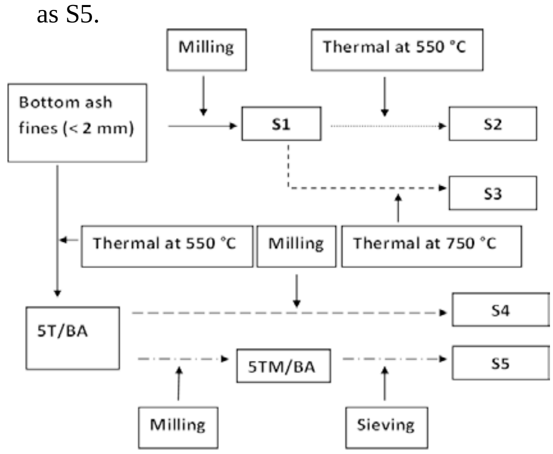

Fig. 1: The description of treatments procedure on bottom ash fines

1.2 Methods

The chemical compositions of the treated bottom ash and cement are determined by the x-ray fluorescence (XRF). The effect of treated bottom ash on the cement hydration is investigated using the isothermal calorimetric measurement. The water to cement ratio is 0.7 and 30% of cement is replaced by the treated bottom ashes. The leaching properties of the treated bottom ash are evaluated by applying column leaching test according to Dutch standard NEN 7383 (2004) [4].

2. RESULTS

The treated bottom ashes have similar chemical compositions as cement, and the total amount of SiO_2-CaO-Al_2O_3-Fe_2O_3 accounts for more than 70% wt. of the bottom ash. However, the treated bottom ashes contain higher amount of SiO_2 and less CaO than cement, and the content of Al_2O_3 and Fe_2O_3 is relatively high. Thermal treatment contributes to a decrease amount of Cl and SO_3. S5 has higher content of CaO, and relatively lower amount of SiO_2. Furthermore, the Cl and SO_3 content in this sample are the highest.

Table 1: Chemical compositions

% wt.	CEM	S1	S2	S3	S4	S5
SiO_2	17.4	39.3	42.1	41.8	37.3	26.7
CaO	66.0	21.9	20.2	20.3	22.6	30.0
Al_2O_3	3.9	10.1	9.8	10.0	10.3	11.8
Fe_2O_3	3.6	12.7	12.2	12.3	12.8	9.8
Cl	0.0	0.8	0.7	0.6	0.8	1.1
SO_3	4.0	5.7	5.4	5.3	6.1	9.2
Others	2.9	8.7	8.4	9.0	8.8	9.0

The heat development during the hydration of cement and treated bottom ashes mixes (Fig. 2) shows that the bottom ash has a retardation effect on cement hydration and thermal treatment of pre-milled bottom ash can minimize this effect. Moreover, it is observed that the aluminate reaction in the decelerate stage is enhanced by adding treated bottom ashes.

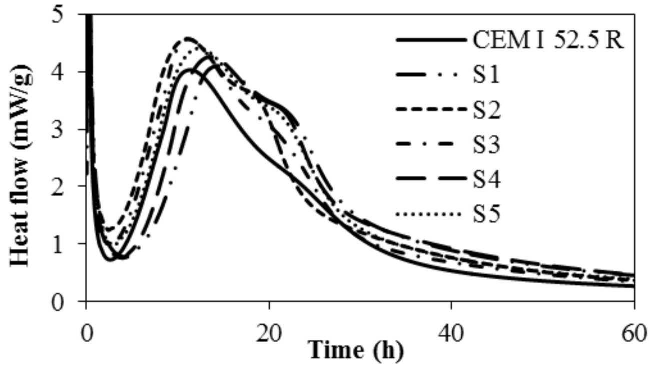

Fig.2: The heat evolution of cement with 30% treated bottom ash

Table 2: The leaching properties of treated samples

(mg/kg)	Limited value	S1	S4	S5
Sb	0.16	0.79	0.037	0.023
Cu	0.9	3.6	<0.050	0.3
Mo	1	0.67	1.4	2.6
Cl	616	4400	3300	6600
SO_3	1730	16000	20000	23000

The leaching results shown in Table 2 indicate that the leaching of Sb and Cu of bottom ashes after thermal treatment is significantly reduced, and is well under the limit level. The leaching of Cl after thermal treatment decreases. S5 has highest leaching concentration of all the analysed compounds.

CONCLUSIONS

The thermal treatment on milled bottom ash contributes to the decrease of Cl and SO_3 content. Moreover, the thermal treatment reduces the retardation effect of fine bottom ash on cement hydration. The higher amount of SO_3 in the treated bottom ash enhances the second aluminate reaction in the decelerate stage of cement hydration. After thermal treatment the leaching properties of the bottom ash is improved, especially copper and antimony.

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BIOGRAPHIES

P. Tang is a PhD candidate at Eindhoven University of Technology since 2011. Her PhD topic is concerning the treatment and application of secondary raw materials.

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