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Analysis on Characteristics of Fly Ash from Coal Fired Power Stations

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Abstract

The paper studied the characteristics of fly ash samples from two power stations, focusing on cenospheres and superfine ash particles. Sieving tests and floatation tests were performed in the lab. Chemical composition, PSD, structure, morphology and cross-section structure of fly ash samples were analyzed using XRF, XRD, SEM, Laser Sizer.

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Keywords- Fly ash, cenosphere, morphology

1. Introduction

Coal as the important fossil fuels supplies over 30% of the world's primary energy. In China, coal accounts for more than 60% of the primary energy supply. Typical ash content in Chinese coals is around 10%-15%. In Chinese thermal coals, the ash content is usually even higher, some may exceed 20%. Therefore, the yield of fly ash as the solid waste by-product of power generation in China is very high, exceeding 200Mt in 2009. Such solid waste occupies huge land and causes environmental pollution. Currently, the utilization of fly ash from power stations includes brick making, road construction, production of cement and concrete. It is now widely realized that fly ash should be accounted as a useful mineral resource and the development of technologies for high value-added utilization of fly ash is important [1, 2]. The understanding of the characteristics of ash particles and the transformation of coal minerals during combustion are essential to the development of value-added ash utilization technologies.

Minerals in coal exist in two forms, i.e. inherent minerals which spread inside coal particles and may not be washed away by washing processes; and discrete (or excluded) minerals which is separated from the

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coal particles and may be removed by washing process. The transformation of coal minerals to ash during combustion inside boilers is very complicated. About 80% of the coal minerals are transformed into fly ash particles during pf combustion. The composition of coal ash is complicated, containing amorphous materials and crystallites such as silica, mullite, iron oxide, calcium oxide, etc. Some of the ash particles have high iron and are known as magnetic microspheres. Some porous carbonaceous particles may also exist in the fly ash [1-5].

During pf coal combustion at high temperatures, some hollow ash particles are formed, known as cenospheres and their formation has been researched in the literature [2, 5-8]. Cenospheres that can float in water usually has large particle size with thin wall (wall thickness is less than 10% of the diameter) and accounts about 1-2% (wt) of the total fly ash. The cenospheres have been widely used as thermal insulating materials and filling materials or coating due to their properties such as low bulk density, low thermal conductivity, low electric conductivity, excellent chemical stability, etc. Cenospheres with particle size small than 10 microns are called superfine cenospheres and can be used as filling materials for rubbers and plastics and advanced composite materials. Analysis of characteristics of ash is useful to understand the formation of different ash particles and promote their applications.

2. Experimental

A. Samples

Samples used in this study include: Eraring fly ash (assigned as EA sample) supplied by Eraring Power Station (firing bituminous coal) through Newcastle Innovation Ltd (Australia), and Anshan ESP fly ash (assigned as AA sample) supplied by the Angang No 2 Power Plant (firing lignite) through Liaoning Fu-an Group (China).

B. Characterization of ash samples

The raw fly ash samples were first subject to sieving tests. The sieving tests were done with three size fractions, i.e. 38.5 μ m, 38.5-70 μ m and 70 μ m. Magnetic separation was also performed with the two fly ash samples to obtain the magnetic portion of the ash samples. Floatation test was done using water as the density medium to obtain the float cenosphere samples. Both fly ash and cenospheres were analyzed using different analytical approaches such as chemical composition analysis, XRD, XRF, SEM, optical microscope and Laser Sizer.

3. Results and discussion

A. Analysis of raw ash samples

The chemical compositions of the raw fly ash samples were analyzed and are shown in Table 1.

It can be seen that the predominant compositions of both raw fly ash samples are silica, alumina, iron oxide and calcium oxide. Alumina content and magnesium oxide content in Anshan ash are higher than those in Eraring ash.

TABLE I. Chemical Composition of Raw ash Samples

<i>Sample</i>	<i>AA</i>	<i>EA</i>	<i>Sample</i>	<i>AA</i>	<i>EA</i>
SiO ₂	60	61.6	K ₂ O	0.93	1.2
Al ₂ O ₃	29	24.5	TiO ₂	1.1	1
Fe ₂ O ₃	3.3	5.4	Mn ₃ O ₄	0.02	0.12
CaO	1.4	3.5	P ₂ O ₅	0.03	0.37
MgO	1.4	0.7	SO ₃	1.0	0.1
Na ₂ O	0.4	0.58	V ₂ O ₅	0.04	0.04

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