

Principal Research Results

Development of foaming technique to promote utilization of coal gasification slag

– Improvement of foaming characteristics of slag by addition of fly ash –

Background

Integrated coal gasification combined cycle power generation system (IGCC) is anticipated as a major clean coal technology that can achieve high efficiency power generation. The temperature inside the gasifier of IGCC is so high that all the ash in coal fed to the gasifier melts and is discharged as liquid slag. Liquid slag flows into water bath and is quickly quenched into glassy particles. It is significant to establish new usage of the slag, by adding higher value on slag. Because it will be a good help to promote the spread of IGCC technology all over Japan. In previous work *¹, appropriate range of chemical composition of slag for high quality artificial light-weight aggregate *² was found. And applicability of slag balloon for lightweight aggregate was clarified *³. But the technique is required to improve foaming characteristics of slag, whose composition is not within the appropriate range.

Objectives

To develop a technique to improve foaming characteristics of slag by adjusting its chemical composition through adding mainly fly ash. And in order to confirm appropriate composition for foaming, it is necessary to clarify the effect of slag chemical composition on foaming characteristics, especially concerning iron, one of the main components of coal ash;

Principal Results

1. Improvement of foaming characteristics of slag

It was clarified that foaming characteristics of slag can be improved by control of its chemical composition with addition of fly ash or some sand (Fig.1, 2). Slag of DL coal doesn't foam well, but addition of fly ash into pulverized DL coal, prior to gasification, improved foaming characteristics of the slag, and average density of slag balloon was reduced to the target value of artificial lightweight aggregate (1.6 g/cm³).

2. Effect of iron concentration of slag on foaming characteristics

In our previous work, appropriate composition was found from the viewpoint of ration of SiO₂ and Al₂O₃, and other components such as CaO (SiO₂ 40% to 50%, Al₂O₃ 15% to 30%). Fe₂O₃ is one of the main components of coal ash, but the effect of Fe₂O₃ has not yet been examined precisely yet. Therefore foaming characteristics of 3 kinds of slag, whose Fe₂O₃ content is more than 10%, was evaluated. As a result, it was clarified that all 3 samples foamed well and the average density of slag is reduced to target value (1.6g/cm³) with heat treatment at less than 1050 °C (Fig.3).

The slag of DD coal expanded to float on the water. This super lightweight slag balloon is expected to be applicable to various usages, such as substitution of expanded obsidian (Fig.4).

Experimental data showed that increase of SiO₂ content improves foaming characteristics (Fig.5 (1)). And increase of Fe₂O₃ content improves foaming characteristics, if SiO₂ content is stable in the range of 40% to 60% (Fig5 (2)).

Future Developments

Required density for slag balloon is different on each usage, therefore control technique for density of slag balloon will be developed, and uses of the super lightweight slag balloon will be found, for example, substitution of expanded obsidian *⁴ and so on.

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Reference

Y. Oki, et al., 2006, "Development of foaming technique to promote utilization of coal gasification slag" CRIEPI Report M06006 (in Japanese)

* 1 : K. Ichikawa, et al., 2003, "Development of foaming technique to promote utilization of coal gasification slag" CRIEPI Report W03040 (in Japanese)

* 2 : Lightweight aggregate is one of the construction materials appropriate for concrete skyscrapers. Traditionally natural ore, such as perlite or obsidian is expanded to lightweight aggregate by heat treatment.

* 3 : I.Kurashige, et al., 2006, "Engineering development on high-valued added effective utilization of coal-gasification-slag", CRIEPI Report N05040 (in Japanese)

* 4 : Expanded obsidian is used as soil improvement materials to improve water drainage characteristics and so on.

6. Fossil Fuel Power Generation - Environmental and innovative technology

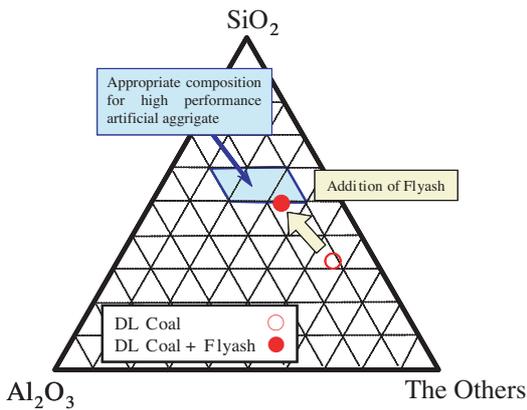


Fig.1 Composition adjustment by adding fly ash

As SiO_2 50-60%, Al_2O_3 10-30% is appropriate composition for lightweight aggregate, slag composition was modified.

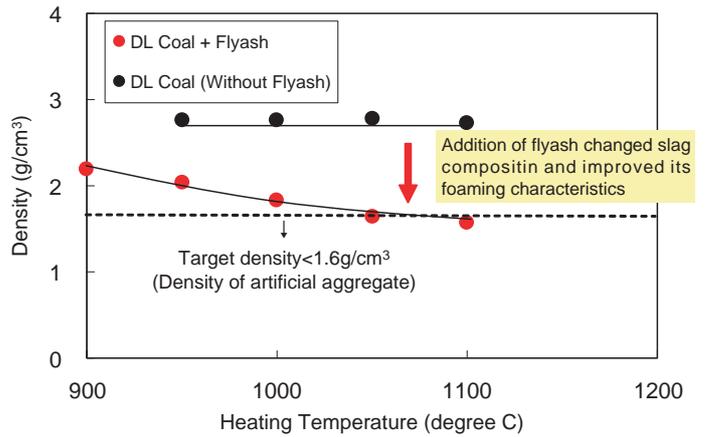


Fig.2 Improvement of foaming characteristics

With addition of fly ash, composition of slag was modified and foaming characteristics were improved.

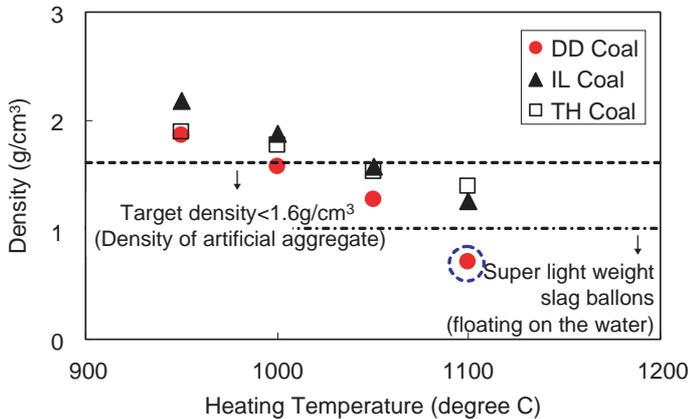


Fig.3 Foaming characteristics of slag with high iron content

All 3 kinds of newly examined slag, whose iron content is more than 10%, formed to target density.

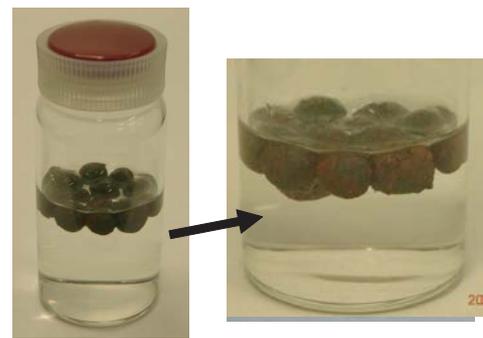
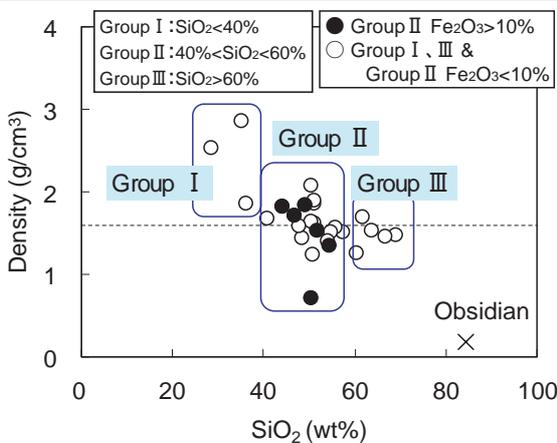
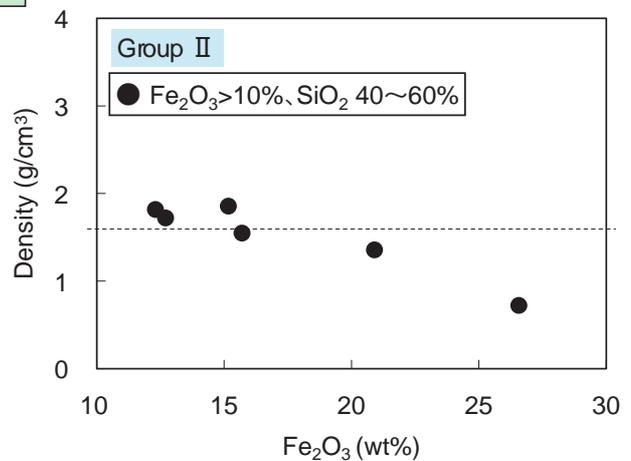


Fig.4 Super light-weight slag balloons

Slag of DD Coal expanded to float on water.



(1) Effect of SiO_2



(2) effect of Fe_2O_3

Fig.5 Effect of chemical composition on foaming characteristics

It was clarified that not only SiO_2 and Al_2O_3 but also Fe_2O_3 affects forming characteristics. If SiO_2 content doesn't change drastically, increase of Fe_2O_3 content improves foaming characteristics.