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Title	PHYSICOCHEMICAL STUDY OF ABSORPTION OF CO_2 INTO ELECTRIC ARC FURNACE SLAG

(800 words)

Increase in the CO_2 concentration in atmosphere due to the combustion of fossil fuels has caused serious global warming. In dealing with this issue, the absorption of CO_2 into EAF steelmaking slag was experimentally studied by the utilization of mechanical grinding method. The final objective of this research is to develop a new mineral carbonation process that has a high efficiency in the capture and storage of CO_2 with low energy consumption and at the same time has some value added features that leads to the feasibility of the overall carbonation system.

In the first stage of this study, the absorption behavior of CO_2 into metal powders and CaO contained material was studied by dry grinding in a centrifugal ball mill. It was found that CO_2 was not decomposed during the grinding, but the sorption of it occurred on the ground sample. In both cases of CaO and waste concrete, formation of $CaCO_3$ was confirmed. While, in the case of metal powders, the CO_2 absorption into ground powders was firstly occurred, thereafter, it decomposed to form metal oxides and carbon. CO_2 sorption into the samples depended on the newly exposed surface area that was formed by grinding. It was found that the newly exposed surface area increased linearly with the increase in the grinding time. However, the dry grinding resulted in the agglomeration of particles in the latter stage of grinding. The agglomeration of particles has then led to the limitation of the CO_2 absorption.

In the next stage, the behavior of CO_2 absorption into EAF normal and stainless steel reducing slag was investigated with wet grinding method. The slag was wet ground under CO_2 atmosphere by a vibrating ball mill which has larger capacity than the centrifugal ball mill. The amount and the initial rate of CO_2 absorption for the wet grinding were higher than those for the dry grinding. The optimum ratio of fillings to vessel's volume was found to be about 1/2. CO_2 was stored into the slag mainly as $CaCO_3$ and no desorption of CO_2 was observed. Thus, this indicates that the CO_2 can be stored permanently inside the slag with this method. This study also revealed that the increase in the interfacial area between CO_2 and the slurry of water and slag was necessary to enhance CO_2 absorption. It was found that the absorption capacity of CO_2 into the normal and stainless steel reducing slag using this method on the most optimum grinding condition was 0.21 and 0.31 kg CO_2/kg slag respectively.

To profoundly investigate the mechanism of CO_2 absorption, study on the absorption behavior of CO_2 into EAF normal and stainless steel oxidizing slag with wet grinding method was also conducted. The results showed that the conversion ratio of CaO to $CaCO_3$ was not solely affected by the CaO content in the slag, but by the CaO/Al_2O_3 ratio in the slag. The conversion ratio linearly increased with the increase in the CaO/Al_2O_3 ratio. The rate of CO_2 absorption in the slag with wet grinding method was highly depended on the dissolution behavior of Ca^{2+} ion from the slag into water and the interfacial area between the CO_2 gas and water. The rate increased with the increase in the both factors. The dissolution behavior of Ca^{2+} differed between each slags depended on the main phases reaction in the slag. Thus, the main phases in each slags affected the overall reaction of the CO_2 absorption. The $2CaO \cdot Al_2O_3 \cdot SiO_2$ was found to hinder the absorption of CO_2 into the slag. While $CaO \cdot SiO_2$ and $2CaO \cdot SiO_2$ phases in the slag were favorable for the CO_2 absorption. It was found that the absorption quantity of CO_2 into the stainless steel oxidizing slag with low Al_2O_3 content on the most optimum grinding condition was about 0.26 kg CO_2/kg slag. Comparison between the amount of CO_2 absorption in this study and the amount of CO_2 emitted from various power plants, which was estimated by the energy consumption of the vibrating mill, revealed that the former was not always higher than the latter. Reduction amount of 1% from overall CO_2 emission from steel industry can be expected by this method. Use of other possible materials will lead to the increase in the potential reduction amount.

The overall cost for the system is expected to be very low and this also indicates that this method is economically feasible. Along with the absorption of CO_2, Zn could be removed by using this method with high removal ratio. The dissolutions of Cr were low for all conditions and the pH of the slurry were within the environmental quality standard. It was also found that even though the mortar made from the ground carbonated slag can't be used to concrete, however, it can still be used as normal mortar.