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DRY SLAG GRANULATION OF MODIFIED BOF SLAG

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Introduction

Molten slag is the by-product in the steel making process. It is hot and full of energy but the energy is now totally wasted due to lack of available technology on molten slag heat recovery. Recently, many studies have devoted into this topic. The main process of the molten slag heat recovery consists of two parts, namely dry granulation and heat extraction (Figure 1). Two types of dry granulation techniques are commonly seen. One is direct solidification by rotating disc (or cup) method, such as in CSIRO's[1], POSCO's[2] and SVAI's[3] process. The other is solidification first, then granulation for subsequent heat extraction, such as JFE's[4] and PaulWurth's[5] processes. Some of them have lab scale or pilot scale test, but none of them has reached demo scale. The slag heat recovery is still a developing technology. Dry slag granulation is the key to molten slag heat recovery. In this paper, we will present our current status on BOF slag modification and dry granulation. Therefore, the paper will be composed of two major parts, the first part is the introduction BOF slag post treatment system developed by CSC. The second part will be the current status and future outlook of the modified BOF slag granulation.

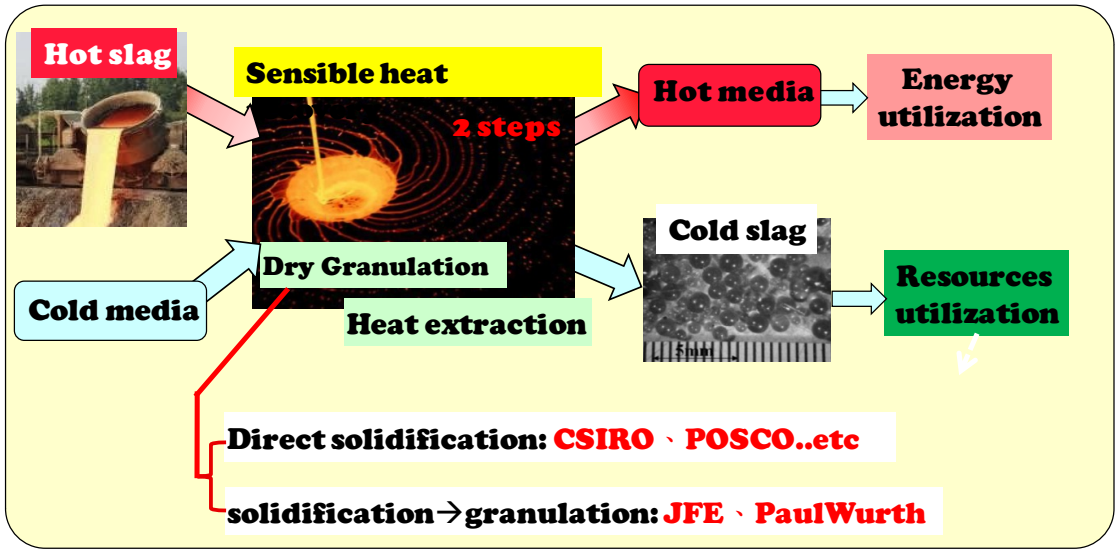


Figure 1: Process of molten slag heat recovery

Hot Stage BOF Slag Modification System

For slag recycling and reuse, it is important to solve the volumetric expansion problem of BOF slag. By injecting silica and oxygen into the molten slag, the f-CaO would thus react with silica, forming calcium silicates so as to removal of f-CaO. This technique, called hot stage BOF slag modification (HBM) technique, was developed in CSC in 2012. The volumetric expansion of the BOF slag decreases largely (< 0.4 % after aging at 90 °C for 30 min), indicating the removal of f-CaO is done efficiently by HBM treatment. At present, the successful rate of BOF slag modification is around 90 %, which is the best-ever achieved among the other steel factories in the world. By establishing and developing our own HBM technique, the volumetric expansion problem of BOF slag is solved, which sheds lights on BOF slag recycling and reuse.

Properties and utilization plans for the modified BOF slag

With good volumetric stability of HBM-treated slag, the modified BOF slag (MBOFs) was utilized for making concrete based products. Currently, high compressive concrete bricks/grass bricks and concrete based-revetment blocks were made by using MBOFs as a raw material. The compressive strength, abrasion resistance and the volumetric stability of bricks and revetment blocks was examined. Satisfactory results were revealed after testing these MBOFs based building blocks. In addition to material tests in the laboratory, the MBOFs based bricks were also used as the pavement in CSC (Figure 2b). Up to now, good volumetric stability of the bricks is revealed (6 months duration). The same outdoor experiment will be applied to

MBOFs based revetment blocks (Figure 2c) soon. With the combination of HBM and dry slag granulation technique, not only f-CaO removal but also particle size adjustment of BOF slag can be achieved, which shows promises for utilization and reuse of converter slag.

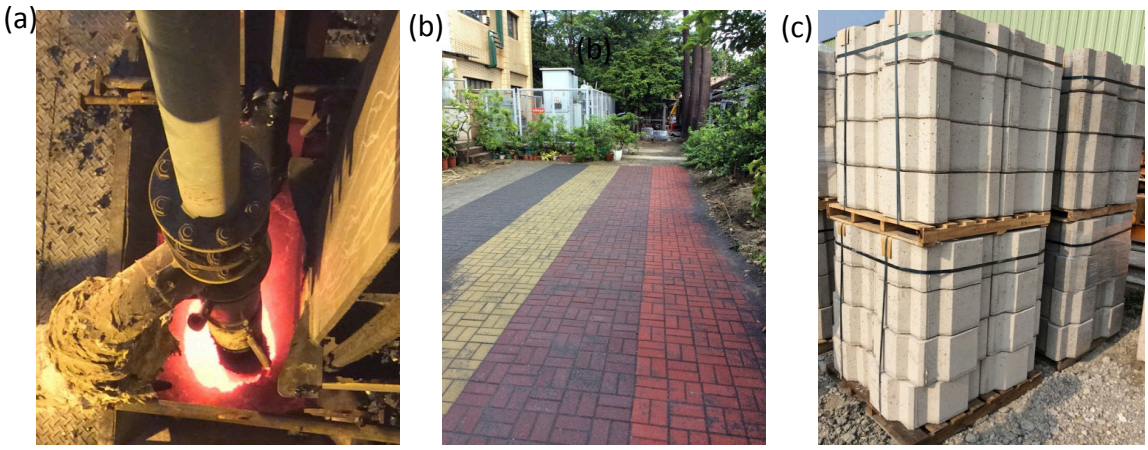


Figure 2: (a) The BOF slag modification was carried out by injecting silica and oxygen in the HBM setup; utilization of the MBOFs as (b) the high compressive concrete bricks, and (c) the revetment blocks.

Dry slag granulation tests

To test the rotary granulation method on the process of MBOFs, we have made some trials. The test procedure is as Figure 3a. The air-cooled modified BOF slag (about 500 g) was first melted by electric furnace at 1500 °C. Then, the molten slag was moved out the furnace and manually discharged to the granulator. Two versions of slag granulator have been tested (Figure 3b). In first trial, we built a rotary disc granulator with vertical surrounding chamber. On the second trial, we modified the chamber geometry and changed the disc to cup shape. The granulation snapshot is illustrated as Figure 3c. From the trials, we first noticed that the molten slag can be granulated by rotating disc or cup. The granulated particles adhered to the chamber wall. This phenomenon is lessened when the chamber wall changed to inclined one as trails II device. Though the slag can be granulated in to small particles, but the molten particle hits the chamber wall before it can be solidified. As a consequence, most of the particle is adhered to the chamber wall leaving little hot particle for subsequent process. To enlarge the chamber is one option for subsequent development; another option is to design fast cooling technique or adhere-proof chamber wall.

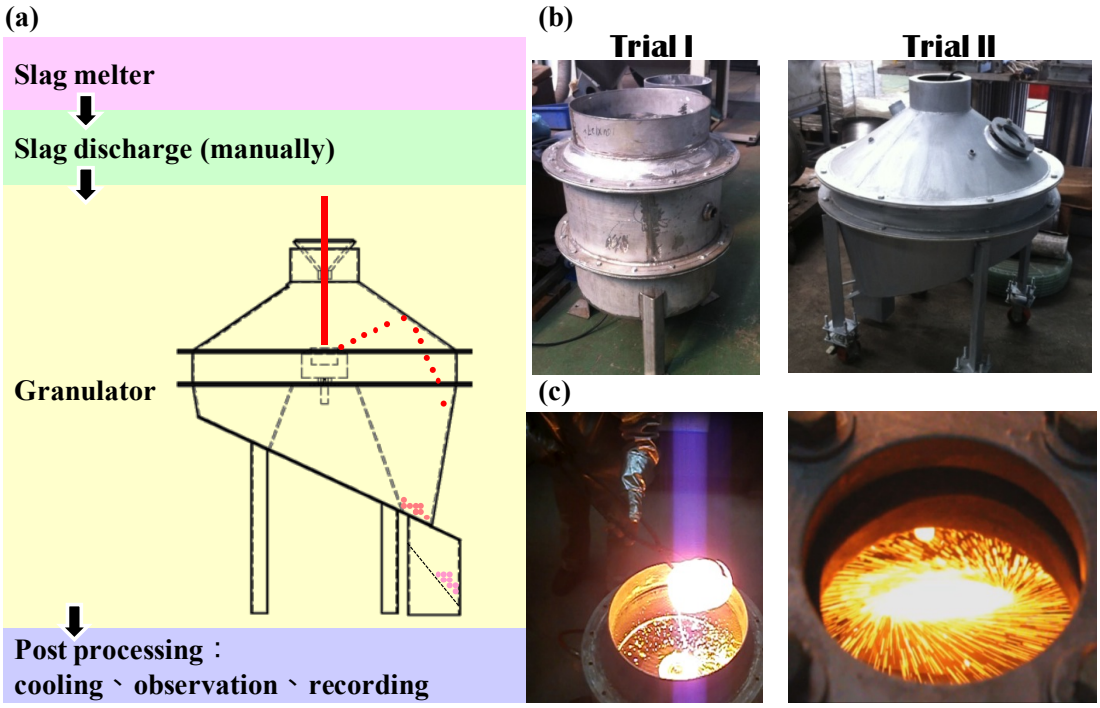
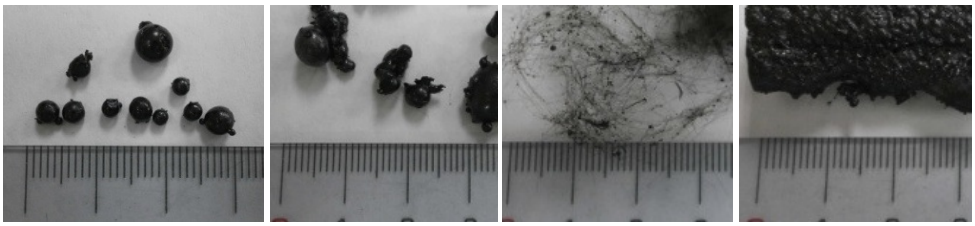


Figure 3: Lab-scale dry slag granulation testing devices. (a) test sequence; (b) device appearances; (c) granulation snapshots.

The granulated slag has several appearances from current testing apparatus as illustrated in Figure 4. They are (a) spherical particles of 2~4 mm, (b) aggregated particles, (c) slag wool and (d) blocks of slag with tiny particle hit marks. Due to the restriction of current test devices, the slag can only be manually discharged. The slag flow rate is extremely unstable, since the rotation speed is fixed, subsequently the granulated particles exhibits various appearances. Since the final goal is to extract the heat from the granulated particles, the slag particle came out of the granulator should be as uniform as possible.



(a) (b) (c) (d)

Figure 4: Particles granulated by rotary disc method.

Future works

The modified BOF slag process has been demonstrated that it can produce good quality BOF slag with almost zero expansion. This facilitates future utilization of BOF slag. We started the heat recovery of BOF slag from developing a dry slag granulation process. There are still much to be study in order to have a good and stable granulator to produce high temperature and uniform particles for subsequent heat extraction. In addition to development the granulator by our own, CSC is also open to import any ready technology for slag dry granulation to speed up the slag heat recovery development.

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