Characterizing Bubble Size Distribution and Generation Position in Iron Oxide-Containing Slag Smelting Reduction

K. Ohno[1] *and T. Kon*[2]

Note: Presenting author's name should be underlined.

1. Professor Dr., Kyushu University, Fukuoka Fukuoka 819-0395. Email: ohno.ko-ichiro.084@m.kyushu-u.ac.jp
2. Assistant Professor Dr., Kyushu University, Fukuoka Fukuoka 819-0395. Email: kon.tatsuya.682@m.kyushu-u.ac.jp

Keywords: slag foaming; bubble formation; Iron oxide slag; smelting reduction; high-resolution X-ray CT

ABSTRACT

Slag foaming is an important control item in the process of refining molten steel. Slag foaming is a phenomenon resulting from the generation of CO bubbles caused by the reaction between iron oxide in the slag and carbon in molten iron. This study aims to investigate the factors controlling slag foaming by observing the bubble formation behaviour resulting from the chemical reaction between iron oxide and Fe-C alloy in the slag. In this study, 0.06 g of Fe-C alloy was introduced at the bottom of a BN crucible, and 6.0 g of slag (SiO_2:CaO:Fe_2O_3 = 40:40:30) was placed on top of it. The crucible was positioned inside an infrared image heating furnace, where the temperature was rapidly raised to 1370°C at a rate of 1000°C/min in a nitrogen (N_2) stream, and then held at that temperature for a predetermined time before rapid cooling. Following rapid cooling, the internal structure of the sample was examined using a high-resolution X-ray CT device. The spherical equivalent volume was calculated based on the number of observed bubbles and their equivalent circle diameter. Additionally, the relationship between the volume ratio of small bubbles in the slag volume and the distance from the bottom of the crucible was determined, along with the calculation of bubble density and volume ratio. Under various experimental conditions, numerous bubbles with equivalent circular diameters ranging from 200 to 300 μm were consistently observed. The density and volume fraction of bubbles with circular equivalent diameters between 200 and 500 μm showed a tendency to increase as the distance from the bottom of the crucible increased. Bubbles with equivalent circular diameters of 500 μm or more consistently exhibited lower bubble densities, regardless of their height within the crucible. The formation of larger bubbles is attributed to a decrease in iron oxide concentration within the slag as the reaction progresses. However, this is believed to be due to their higher buoyancy, resulting in shorter residence times within the slag and a reduction in the number of encapsulated bubbles.