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Observation of fluid flow characteristics by bottom blowing in the EAF-shaped vessel using physical modelling

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Electric arc furnace steelmaking is an important way to bring carbon neutrality to the steel industry by 2050 because the blast furnace and basic oxygen furnace processes release the higher CO2 emissions than the EAF process. However, as the heat generated by the arc affects the upper part of the molten steel locally, the stirring energy of the EAF molten steel is insufficient to achieve the high efficiency operation. To improve the stirring energy in EAF, bottom blowing technology has been developed and widely adopted. It is well known that the bottom blowing technology can promote fluid flow in the molten bath, accelerate the melting rate and decarburization rate and enhance the quality of molten steel. In fact, when technology was applied in the 55- ton of EAF, the tap-to-tap time was reduced, and the yield of iron was improved. Therefore, in this study, to identify the characteristics of fluid flow under the bottom blowing conditions, the water vessel with shape of EAF was designed by 1/8 scale of 120-ton EAF. The dynamic similarity between the real EAF process and the water vessel was obtained using a modified Froude number and hydraulic diameter which is assumed the eccentric shape of the EAF as a cylinder. By using electrical conductivity, the perfect mixing time was measured to investigate the influence of gas flow rate on the mixing time in the EBT zone and determine the optimal stirring conditions. When the electrical conductivity was achieved about 95 pct, the time was assumed to be the perfect mixing time. Furthermore, using particle image velocimetry methods, the effect of gas flow rate on the fluid flow was observed. The movement of water flow was filmed at 15 frames per second for 10 seconds to obtain 150 frames of data per area.

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