Effect of alumina on microstructures of iron ore sinters from the perspective of the phase equilibria of the CaO-SiO_2-Fe_2O_3-Al_2O_3 system

Miyuki Hayashi[1], Amane Takahashi[2], Yukihiro Uchisawa[3], Takashi Watanabe[4] and Masahiro Susa[5]

1.Professor, Tokyo Institute of Technology, Tokyo 152-8552. E-mail: hayashi.m.ae@m.titech.ac.jp:
2.Student, Tokyo Institute of Technology, Tokyo 152-8552. E-mail: takahashi.a.az@gmail.com:
3.Student, Tokyo Institute of Technology, Tokyo 152-8552. E-mail: rintaro9773@gmail.com:
4.Assistant Professor, Tokyo Institute of Technology, Tokyo 152-8552. E-mail: watanabe.t.ai@m.titech.ac.jp:
5.Emeritus Professor, Tokyo Institute of Technology, Tokyo 152-8552. E-mail: susa.m.aa@m.titech.ac.jp:

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ABSTRACT

Owing to the deterioration of iron ore, the Al_2O_3 concentration in iron ore increases, and thus it is important to investigate the effect of increment in Al_2O_3 concentration on the microstructures of sinters. During the sintering process, a melt is present in the sinter for only a few minutes, and consequently, the microstructure of the sinter hardly reaches thermodynamic equilibrium. Nevertheless, the formation process of the microstructures can be interpreted and predicted to some extent from the equilibrium phase diagram. Thus, this study investigated the liquidus isotherm in the CaO-SiO_2-Fe_2O_3-5 mass%Al_2O_3 system at 1240^{o}C in air and the phase equilibria of SFCA and SFCA-I by XRD and EPMA: (i) The ferrite melt region with a high Fe_2O_3 concentration shift to the lower Fe_2O_3 side compared to the liquidus isotherm in the CaO-SiO_2-Fe_2O_3 system. (ii) The compositional region of SFCA extends in the $CaO{\cdot}3Fe_2O_3$-$4CaO{\cdot}3SiO_2$ direction compared to the SFC composition region with a 0 mass%Al_2O_3. (iii) SFCA-I is observed in the present system, which suggests that the addition of Al_2O_3 contributes to the stability of SFCA-I. (iv) The effect of alumina on microstructures of iron ore sinters can be predicted as follows: In the maximum temperature of the sintering process (approx. 1300^{o}C), hematite iron ore coexists with molten slag, and SFCA phases are precipitated from molten slag during the cooling cycle. The results of the present study imply that an increment in alumina leads to a decrement in the volume fraction of molten slag, i.e., the volume fraction of the bonding phase. Furthermore, it is implied that the fraction of SFCA phases in the bonging phase increases, and the fractions of $2CaO{\cdot}SiO_2$ and slag phases decrease with an increase in Al_2O_3 concentration. The SFCA-I phase is also precipitated from the slag with an Al_2O_3 concentration around 5 mass%.