Stability of SFC (silico-ferrite of calcium): solid solution limits, thermal stability and selected phase relationships within the Fe$_2$O$_3$-CaO-SiO$_2$ (FCS) system

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Abstract: Quenching experiments have been performed to investigate the thermal stability, solid solution limits, and selected phase relationships of SFC (silico-ferrite of calcium) within the Fe$_2$O$_3$-CaO-SiO$_2$ (FCS) system. Experiments were performed in air over the temperature interval 1050-1260°C using a combination of synthetic oxide mixtures and SFC compositions which had been pre-synthesized at 1200°C.

SFC forms a solid solution along a trend line between the theoretical end-members CF$_3$ and C$_4$S$_3$. The maximum solid solution range occurs between compositions containing approximately 7.0 through to 11.7 wt% C$_4$S$_3$ component. The solution range is valid between 1060°C and 1240°C. Above 1240°C the compositional range narrows until the liquidus is reached. The maximum liquidus temperature for SFC is composition dependent with the highest melting point (T = 1252°C) recorded from a sample containing 9.0 wt% C$_4$S$_3$.

Determination of ferrous iron content in SFC shows a range between 0.24 -0.37 wt% at 1200°C compared to 0.40-0.64 wt% at 1250°C. The absolute Fe$^{2+}$ content is both temperature and composition dependent, with higher ferrous iron values measured at high temperature and high C$_4$S$_3$ contents. EPMA data, combined with the ferrous iron measurements, indicate a coupled substitution mechanism in SFC represented by the reaction 2(Fe$^{3+}$) = (Ca$^{2+}$, Fe$^{2+}$) + Si$^{4+}$.

Data obtained in the present investigation combined with those available in the literature enable the construction of a series of isothermal sections showing phase relationships within the broader FCS system. These diagrams may be used as a guide to improving the understanding of fundamental sintering phase relations in the high iron corner of the FCS ternary system, as well as providing some insight into the compositional and thermal conditions required to maximize the stability of SFC phase in iron ore sinter.

Key-words: SFC solid solution, phase relations, thermal stability, iron ore sinter.

Introduction

Phase relationships within the Fe$_2$O$_3$-CaO-SiO$_2$ (FCS) ternary system provide a useful model for mineral parageneses developed, and reaction paths followed, during the sintering of iron ore. Recently, detailed phase relations within the Fe$_2$O$_3$-rich part of the FCS system in air and at temperatures likely to be encountered during sintering (i.e. 1240-1300°C) have become available (Pownceby et al., 1998). During this study, Pownceby et al. (1998) described the occurrence of an equilibrium crystalline phase denoted SFC$_{ss}$ (silico-ferrite of calcium solid solution) which lies along a pseudobinary join connecting the theoretical end-members CF$_3$ and C$_4$S$_3$. The SFC$_{ss}$