Lime Magnetite Pellets - An Alternative Iron Ore Feedstock for Lower Carbon Footprint Ironmaking

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ABSTRACT

The current practise of magnetite ore agglomeration involves high temperature oxidation roasting (typically at 1200 to 1350 °C) of magnetite to hematite phase in order to improve the strength and reducibility of pellets. The requirement to pre-oxidize the magnetite before introduction to an ironmaking plant increases the CO_2 emissions generated during the ironmaking process. In this paper, a novel, alternative agglomeration route for magnetite ores is presented where magnetite is converted to a reducible $CaFe_3O_5$ (CWF) phase through the addition of lime to magnetite that can be directly charged to iron-making units. The concept was tested by thermodynamic calculations and high temperature experiments under mildly reducing conditions. Experimental results suggested perceptible CWF formation within 5 min of reaction at 950 to 1050 °C and reaching near equilibrium percentage after 1 hour of reaction for pure laboratory grade chemicals. Microstructural analysis suggested an interconnected platelet shaped morphology of CWF phase and an overall open microstructure of the LMPs. The effect of impurity oxides on CWF formation was also studied. The presence of SiO_2 favored the formation of larnite and decreased the CWF percentage. The prospect of using LMPs as an alternative, reactive feed material in ironmaking was examined by studying the reactivity of LMPs of various compositions using a scaled-down version of the ISO standard reducibility test and a compact tumble strength test. Results were comparable to industrial sinters. Mass and energy balance analysis of the LMP process suggested potential reduction in CO_2 emission with the LMP usage in the blast furnace are significant. The paper also discusses the potential advantages and challenges associated with commercialization of the LMP process.