Study on the Direct Electrochemical Reduction of Fe₂O₃ in NaCl-CaCl₂ Melt

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The electrochemical reduction kinetics of Fe₂O₃ in melts were investigated by cyclic voltammetry, square wave voltammetry, open circuit potential and i-t curve analyses at 800°C utilizing a Fe₂O₃ cathode filled in a metal pore molybdenum strip and a graphite rod anode. The composition and morphology of the product obtained by different cell voltage electrolysis were analyzed by XRD and SEM. The reduction mechanism of solid Fe₂O₃ was a three-step electronic process, and two electrons were transferred each time to reduce it to metal iron (Fe₂O₃→Fe₃O₄→FeO→Fe). Among them, Fe₃O₄ and Fe_xO were produced in the process. In addition, an electrolysis voltage of 1.2~3.0 V was selected for constant potential electrolysis to determine the high current efficiency and low energy consumption. Finally, when an electrolysis voltage of 1.2V was applied, metallized iron with a particle size of 5 μm was obtained, and the current efficiency was 95.3%. The energy consumption was 3.35 kWh/kg. These studies provide a reasonable potential range process parameter for the green preparation of metallic iron by molten salt electrolysis.

Keywords: Fe₂O₃; Electrochemistry; Direct Reduction; Reduction Mechanism

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