ABSTRACT

Over the years, the Indian steel industry has grown exponentially, making it the second-largest steel producer in the world after China. India has exceeded the 128 MT steel production target by utilizing high-grade iron ore resources. However, the country lacks the necessary high-grade iron ore resources and the iron ore characteristics, such as undesirable clay and fragile goethite minerals content, flaky particles, and weathered pore structure, put forward an unavoidable challenge to look into alternative iron ore processing routes. The present research work has developed a novel process of utilizing low/lean-grade iron ore resources of below 58% Fe(T) by implementing the magnetization roasting process using fossil fuel (high ash non-coking coal) and alternative biomass reductants to produce synthesized magnetite concentrate to produce hematite pellets as a raw material for iron and steel industries. The parameters like roasting temperature, residence time and reductant dosages influencing the yield and grade of the magnetization roasting process were optimized for high-LOI low-grade iron ores, banded iron ores, iron ore beneficiation plant tailings, and complex low-grade oolitic iron ores. A beneficiation process flowsheet has been developed and compared for the magnetization roasting and the conventional deep beneficiation (CDB) process. Iron ore fines (LOI of 7.83%, with high silica (5.52%) and alumina (4.57%), and 57.17% of Fe(T)) were subjected to both CDB and magnetization roasting process to generate concentrate of 62.61% Fe(T) and 67.58% Fe(T) with 64.69% and 85.19% yield, respectively. On the other hand, a concentrate of 66.42% Fe(T) from the BHQ ore (47.15% Fe(T)) was achieved at a roasting temperature of 1100 °C, roasting time at isothermal temperature: 5 min., and head sample to reductant ratio of 10:6. Similarly, magnetization roasting using sawdust biomass generated a magnetite concentrate of 64.86% Fe(T) from the waste iron ore beneficiation plant tailings (56.96% Fe(T)) and compared with magnetic separation. Moreover, a synthesized magnetite concentrate of 64.37% Fe(T) was produced from the complex oolitic iron ore (41.73% Fe(T)) using black plum leaf litter as a reductant. The magnetite concentrate generated from all the cases was pelletized, and the physical and metallurgical properties were studied to utilize as raw materials in the iron and steel-making industries. Advanced characterization techniques like X-ray micro-CT (X-ray microtomography), X-ray diffraction (XRD), Field emission scanning electron microscope (FESEM), and wet-chemical analysis were used to evaluate the suitability of less carbon-intensive magnetite concentrate and indurated pellet production.

Keywords: *Mineralogy; low-grade iron ore; Tailing; Beneficiation; Biomass; Magnetization roasting; Pelletization; Loss on Ignition; Goethite; Kaolinite; synthesized magnetite concentrate; X-ray micro-CT.*