

ABSTRACT

The lumps of iron ore procured from Rajhara mines were crushed and ground to fine size and analysed for its size distribution and chemical analysis. The phase analysis of the powder was carried out by x-ray diffraction using copper target and nickel filter. Hematite is the major constituent of the ore associated with goethite and iron oxalate hydrate minerals. Kaolinite and eudialyte $[\text{Na}_4(\text{Ca,Fe})_2\text{ZrSi}_6\text{O}_{17}(\text{OH,Cl})_2]$ are the associated gangue minerals.

The thermal analysis of the ore powder was carried out using alpha alumina as reference and with heating rates of $10^\circ\text{C}/\text{min}$ to $30^\circ\text{C}/\text{min}$ in air, nitrogen and oxygen atmosphere. Sequence of physical and chemical processes were identified. Decomposition of iron oxalate hydrate, goethite, kaolinite and eudialyte are observed. Oxidation of decomposed product, interaction between minerals, melt formation were also observed. Kinetic parameters as activation energy and order of reaction for goethite decomposition were evaluated applying non-isothermal kinetic equations. The goethite decomposition was found to be a first order reaction with activation energy of 175 kJ/mol. Quantitative phase analysis of minerals present were carried out by identifying the reaction, associated weight change and stoichiometry by using simultaneous thermal analysis data. The ore was found to

contains hematite 79.52%, goethite 9.74%, iron oxalate hydrate 1.09%, Kaolinite 4.44% and eudialyte 5.21%.

This ore powder was pelletized in a disc pelletizer and fired at temperatures ranging 950°C -1275°C to get pellets with porosity ranging 24% to 38%. Pellets with lower porosity of 14% to 22% were also prepared by briquette the powder in to cylindrical shape and carving them to spheres. The thermal diffusivity and conductivity (for radial heat flow) of these pellets were measured by recording the surface and centre temperature of pellet while heating. Exponential form of temperature distribution within pellet were assumed and the average temperature of the pellet at a specified time was calculated. The thermal diffusivity and conductivity were evaluated by applying principles of heat balance.

The thermal conductivity and diffusivity were co-related with porosity of the pellet. Model equations available in literature were tried to co-relate the results. The observed thermal conductivity values were satisfactorily co-related to the ratio between actual volume of pellet to its volume at zero porosity in porosity range of 24-38%. The conductivity at zero porosity was calculated by extrapolation and found to be $1.75 \text{ Wm}^{-1}\text{K}^{-1}$. At lower porosity value, the average pore size and pore distribution seems to play a vital role. The conductivity and diffusivity value dropped sharply, at around 20% porosity. The drop is explained due to increase in pore/solid interfacial specific surface area adding resistance to heat flow.

Some experiments were also conducted with pure iron oxide⁶ synthesised by precipitation of ferric hydroxide from ferric chloride.