Volume Changes of Iron Oxide Compacts under Isothermal Reduction Conditions

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Compacts made from chemically grade Fe2O3 were fired at 1473K for 6 hrs. The fired compacts were isothermally reduced either by hydrogen or carbon monoxide at 1073–1373K. The O2 weight-loss resulting from the reduction process was continuously recorded as a function of time using TGA technique, whereas the volume change at different reduction conditions was measured by displacement method. Porosity measurements, microscopic examination and X-ray diffraction analysis were used to characterize the fired and reduced products. The rate of reduction at both the initial and final stages was increased with temperature. The reduction mechanism deduced from the correlations between apparent activation energy values, structure of partially reduced compacts and application of gas-solid reaction models revealed the reduction rate (dr/dt) at both the initial and final stages. In H2 reduction, maximum swelling (80%) was obtained at 1373K, which was attributed to the formation of metallic iron plates. In CO reduction, catastrophic swelling (255%) was obtained at 1198K due to the formation of metallic iron plates and whiskers. At early stages, the reduction was controlled by a combined effect of gaseous diffusion and interfacial chemical reaction mechanism, while at the final stages the interfacial chemical reaction was the rate determining step.