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Reduction-oxidation kinetics of three different iron oxide phases for CO_2 activation to CO

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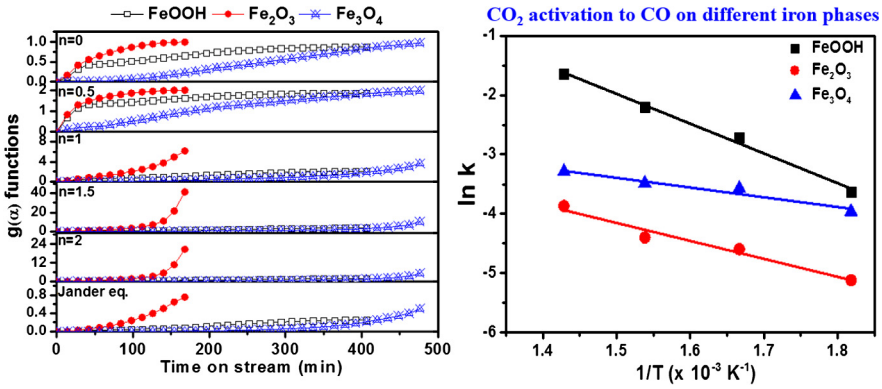
HIGHLIGHTS

- Kinetic model of three different iron phases were investigated for CO_2 activation to CO.
- Three-dimensional diffusion Jander equation was well fitted with experimental data.
- Iron ores having a phase of FeOOH showed a superior activity and stability.
- Large surface area with a stable Fe_3O_4 phase was formed on the porous FeOOH surfaces.

GRAPHICAL ABSTRACT



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ABSTRACT

The reduction-oxidation characteristics and proper kinetic models of three different iron ores having respective main phases of FeOOH, Fe_3O_4, and Fe_2O_3 were investigated using an isothermal method. A proposed kinetic model was well satisfied to explain the experimental data for CO_2 activation to CO with a high accuracy. The kinetic data of the different phases of iron ores for its reduction by H_2 and for the oxidation by CO_2 were relatively well described by a simple three-dimensional diffusion model of Jander equation. Activation energies of three different iron ores with the phase of FeOOH, Fe_2O_3, and Fe_3O_4 for the oxidation by CO_2 were found to be 42, 25, and 12 kJ/mol, respectively. Iron ore having a FeOOH phase exhibited a higher redox property by showing a large amount of CO generation through CO_2 activation with an activation energy of 42 kJ/mol and a rate constant of 0.0065 min^{-1}. The superior activities on the FeOOH were mainly attributed to a large surface area with medium grain size of FeOOH crystallites by forming a thermodynamically stable Fe_3O_4 phase on the outer surfaces even under the reduction-oxidation reaction cycle.

1. Introduction

Global warming and climate change have been issued to be solved with great attention due to steady increases of greenhouse gases (GHG) emissions, where CO_2 takes a larger portion of GHG

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