Production of Ammonia from Low Rank Coal Employing Chemical Looping and Haber-Bosch Process

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Abstract

An integrated production system of ammonia from low rank coal (LRC) is proposed and evaluated in this study. It unites several processes: coal direct chemical looping, nitrogen production, ammonia synthesis, and power generation. To effectively integrate and minimize the formation of exergy destruction throughout the integrated system, the concepts of exergy recovery and process integration are adopted. LRC is initially dried to low moisture content and ground. In coal direct chemical looping, three circulated reactors are adopted: reducer, oxidizer and combustor. The pulverized LRC is directly reacted with the oxygen carrier in the reducer producing CO₂. In addition, the reduced oxygen carrier is then reacted with steam in oxidizer to produce H₂. Finally, the oxygen carrier is finally oxidized using O₂-rich gas in combustor to return to its initial state. The produced H₂ is then reacted with N₂, which is produced in N₂ separation unit, in NH₃ synthesis. The generated heat throughout the integrated system, especially chemical looping and NH₃ synthesis, is recovered for power generation. Some operating parameters, including target moisture content in drying, pressure during chemical looping, and carbon conversion efficiency during reduction, are evaluated in terms of total energy efficiency. The proposed integrated-system shows relatively high energy efficiency, which is about 75%.