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Techno economic analysis of Chemical looping system for Indian power plants

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Abstract
Chemical looping combustion (CLC) has been developed as a major new generation CO2 capture technology which involves inherent CO2 separation and high system conversion efficiency. The technology is well-known to have low energy penalty, as compared to other technologies. This paper intends to carry out a numerical investigation on the flow characteristics of the chemical looping combustion (CLC) process using the cold model fabricated and commissioned by CSIR-CIMFR, Dhanbad. It attempts to visualize the hydrodynamic viability of the system, which is very important to know the effect of the configuration of the system on circulation of the oxygen carrier particles. Cost analysis for a power plant implemented with chemical looping based capture system in Indian condition has also been presented. The pressure drop profile, volume fraction distribution of particles and fluidization patterns are analysed and found to give expected results. The effects of gas phase and solid phase velocity are also studied, through which, similarity in flow pattern of ilmenite as well as air can be seen in both the plots. Through the cost analysis, higher temperature in both air reactor as well as fuel reactor has been found to increase plant efficiency while residence time in both reactor was found to have a little effect on the plant efficiency. As cost for O&M for gasifier was found to be more, change and modification of the gasifier unit will play a major role towards increasing the plant efficiency with incorporation of chemical looping as a carbon capture system.

Keywords chemical looping; cold model; computational fluid dynamics; economic analysis

1. Introduction

Coal serves as the backbone of the Indian power sector, contributing to around 61% of India's net installed capacity (CEA, 2016). Multiple researchers have suggested that the dependence on coal will increase at least up to 2050 (Garg and Shukla, 2009; Chikkatur and Sagar, 2009). However, the greenhouse gas (GHG) emissions associated with coal combustion pose a major challenge to the ecological sustainability.