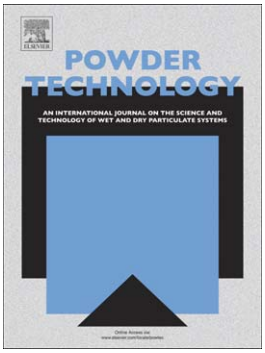

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Fluidized bed reactor design study for pressurized chemical looping combustion of natural gas

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1. Abstract

Chemical Looping Combustion (CLC) is considered a viable option for efficient power production with inherent carbon sequestration through an unmixed combustion process. Pressurized reactor systems promise the potential for increased efficiency compared to atmospheric processes because gas turbine technology can be used in a combined cycle to achieve high electric efficiency, comparable to GTCC plants with up to 60%$_{el}$. A design study was conducted to investigate the potential of pressurized Chemical Looping Combustion of natural gas for power generation, as well as its limitations. Basic design calculations have been carried out based on fluidization engineering methods and a practical process configuration has been evaluated based on mass- and energy balances. It turns out that a high gas turbine single cycle efficiency (>14%$_{el}$) can only be reached if the CLC air reactor is operated at high temperature levels (>1000°C). An optimal range of operating conditions was identified for operation of a pressurized CLC plant and design considerations for a dual circulating fluidized bed reactor system are reported. Accordingly, also the fluidization gas (steam) demand for loop seals turns out to be relatively increased for pressurized systems. Based on the results of the present work, a net efficiency of up to 40.34%$_{el}$ can be expected for power generation from pressurized CLC, which is low compared to standard GTCC technology with and without CO_2 capture measures implemented. The reasons are the limitation of reactor/turbine inlet temperature, higher relative pressure drop of CLC systems compared to conventional turbine combustion chambers, and the required loop seal fluidization steam.

2. Keywords

chemical looping combustion; power generation; fluidized bed; carbon capture

3. Introduction

The CLC process has first been proposed in 1954 by Lewis [1] and further assessed by Richter and Knoche [2], as well as by Ishida [3], Anheden and Svedberg [4]. Fuel and air enter separate reactor units where they never come in contact with each other directly.