On a clean power generation system with the co-gasification of biomass and coal in a quadruple fluidized bed gasifier

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PII: S0960-8524(17)30359-0
DOI: http://dx.doi.org/10.1016/j.biortech.2017.03.087
Reference: BITE 17791

To appear in: *Bioresource Technology*

Received Date: 7 February 2017
Revised Date: 11 March 2017
Accepted Date: 14 March 2017

Please cite this article as: Yan, L., He, B., On a clean power generation system with the co-gasification of biomass and coal in a quadruple fluidized bed gasifier, *Bioresource Technology* (2017), doi: http://dx.doi.org/10.1016/j.biortech.2017.03.087

On a clean power generation system with the co-gasification of biomass and coal in a quadruple fluidized bed gasifier

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Abstract:

A clean power generation system was built based on the steam co-gasification of biomass and coal in a quadruple fluidized bed gasifier. The chemical looping with oxygen uncoupling technology was used to supply oxygen for the calciner. The solid oxide fuel cell and the steam turbine were combined to generate power. The calcium looping and mineral carbonation were used for CO_2 capture and sequestration. The aim of this work was to study the characteristics of this system. The effects of key operation parameters on the system total energy efficiency (η_{ten}), total exergy efficiency (η_{tex}) and carbon sequestration rate (R_{cs}) were detected. The energy and exergy balance calculations were implemented and the corresponding Sankey and Grassmann diagrams were drawn. It was found that the maximum energy and exergy losses occurred in the steam turbine. The system η_{ten} and η_{tex} could be ~50% and ~47%, and R_{cs} could be over unit.

Keywords: Chemical looping; Carbon capture; Exergy analyses; Control strategy

1 Introduction

Coal is the most abundant fossil fuel on the earth and has been being greatly consumed in China, India, the European Union, America and Japan (U.S. Energy Information Administration, 2016). It is projected that about 36% of the world's electricity will be generated from coal by the year of 2040 in the current policies scenario (International Energy Agency, 2016). However, direct combution of coal in traditional thermal power stations exerts low efficiency and intensive carbon discharge (Abad et al, 2017; Yan et al, 2013), which makes it an undesirable energy source and some countries even plan to forbid steam coal utilization in the next few decades. For the long-term scenario, developing nuclear energy, as well as the renewable energy, can improve the global

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