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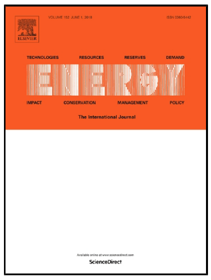

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A.M. Mauerhofer, F. Benedikt, J.C. Schmid, J. Fuchs, S. Müller, H. Hofbauer

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Influence of Different Bed Material Mixtures on Dual Fluidized Bed Steam Gasification

A. M. Mauerhofer[1,*], F. Benedikt[1], J. C. Schmid[1], J. Fuchs[1], S. Müller[1], H. Hofbauer[1]

[1] TU Wien, Institute for Chemical, Environmental and Biological Engineering, Vienna, 1060 Getreidemarkt 9/166
* Corresponding author: anna.mauerhofer@tuwien.ac.at
E-Mail address: florian.benedikt@tuwien.ac.at (F. Benedikt), johannes.schmid@tuwien.ac.at (J. C. Schmid). josef.fuchs@tuwien.ac.at (J. Fuchs), stefan.mueller@tuwien.ac.at (S. Müller), hermann.hofbauer@tuwien.ac.at (H. Hofbauer)

Abstract

Within this paper, investigations to convert softwood with four different types of bed materials in the 100 kW_{th} dual fluidized bed steam gasification pilot plant at TU Wien are presented and discussed. The results of ten different experiments were compared. Quartz, olivine and feldspar were mixed with limestone in mass ratios of 100/0, 90/10, 50/50 and 0/100. Limestone was used due to its catalytic activity at high temperatures as CaO and thus enhanced tar, char and water conversion of quartz, olivine and feldspar. The admixture of limestone to quartz, olivine and feldspar shifted the product gas compositions towards higher hydrogen and carbon dioxide and lower carbon monoxide contents. By using 100 wt.-% limestone as bed material a hydrogen content of 47.4 vol.-% could be generated. Additionally, the tar concentrations as well as the tar dew points decreased and especially the heavy tar compounds could be reduced. Already small amounts of limestone (< 10 wt.-%) to the bed material mixture influenced tar reduction in a positive way. The low abrasion resistance of limestone resulted in increasing dust contents by increasing its amount. However, this could be balanced by the specific design of the separation system of the advanced pilot plant.

Keywords: tar reduction, catalytic activity, limestone/CaO, olivine, quartz, feldspar

1. Introduction

The worldwide coverage of electricity, heat and fuels increases the research on alternative feedstocks and technologies to enable a sustainable production in the future. Thus, the thermo-chemical conversion of biogenic feedstock is an auspicious way to promote an eco-friendly, sustainable supply of these basic goods in daily life. The dual fluidized bed (DFB) steam gasification, presented in Fig. 1, is a main subject of research at TU Wien. The DFB steam gasification consists of a gasification reactor (GR) and a combustion reactor (CR) and generates a nitrogen-free product gas by converting solid fuels. The nitrogen-free product gas mainly consists of hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4) and ethylene (C_2H_4). This product gas can be utilized e.g. for generation of heat, electricity, energy, fuels for transportation [1] or synthetic chemicals, like mixed alcohols [2].
The two reactors, the combustion and the gasification reactor are connected through a circulating bed material. Via this bed material circulation it is possible to transport heat from the combustion reactor to the gasification reactor, so that the endothermic gasification reaction is able to take place.
The first 100 kW_{th} DFB steam gasification pilot plant was established in the 1990s at TU Wien [3]. Afterwards, industrial-sized plants followed. In 2002, a demonstration plant with a fuel capacity of 8 MW_{th} [4] in Güssing, Austria was built. Six years later a 8.5 MW_{th} plant in Oberwart, Austria was constructed [5]. A 15 MW_{th} plant in Senden, Germany [6] followed shortly afterwards. In 2014, a plant with a fuel power of 32 MW_{th} was realized in Gothenburg, Sweden [7].

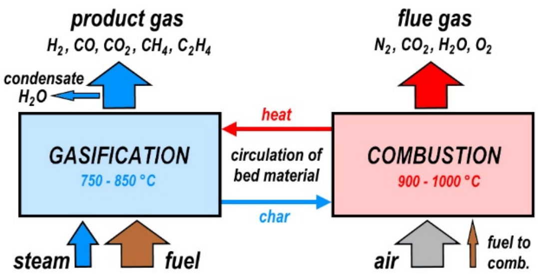

Fig. 1: Basic principle of the DFB steam gasification