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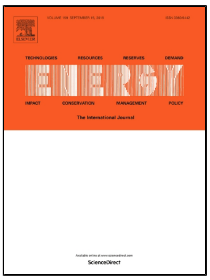

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Fuel Flexible Gasification with an Advanced 100 kW Dual Fluidized Bed Steam Gasification Pilot Plant

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Abstract

Steam gasification enables the conversion of heterogeneous solid fuels into homogeneous gaseous energy carriers. The utilization of biogenic residues and waste fractions as fuel for this technology offers a sustainable waste management solution to produce heat and power, secondary fuels and valuable chemicals after several cleaning and upgrading steps of the product gas. However, residues and waste fuels show unfavorable properties for gasification and, therefore, cause technical challenges. This paper presents experimental results carried out at an advanced 100 kW_{th} dual fluidized bed steam gasification pilot plant from nine single test runs. In the following the fuels that were gasified will be listed: (i) Five biogenic fuels, mainly residues: softwood, sugar cane bagasse, exhausted olive pomace, bark and rice husks; (ii) two different waste-derived fuels: a municipal solid waste fraction and a shredder light fraction; and (iii) a mixture of municipal solid waste fraction with a 25% blending of lignite based on lower heating value as well as pure lignite. Thereby, various product gas qualities were generated. The presented results offer the basis for a sustainable and promising waste management solution for the tested waste fuels.

Keywords: waste gasification, biogenic residues, municipal solid waste fraction, shredder light fraction, calcium oxide

1. Introduction

Taking into account the forecast of the International Energy Agency (IEA), that the global energy demand increases up to 70% and the CO_2-emissions increase up to 60% in 2050 compared to 2011, the research on renewable energy systems still is and becomes more and more important [1,2]. Especially, energy systems and technologies with a high energy efficiency are relevant for the future, because energy efficiency refers to the use of less energy to produce the same amount of services or useful output [3,4]. Only, if this is fulfilled by a technology or an overall energy system, it is possible to contribute to the decrease of fossil fuel demand and the decrease of CO_2 emissions. Additionally, due to the fact, that fuel costs influence the economic behavior and process efficiency in particular, great attention should be paid on the use of non-conventional sources of energy, like biomass in form of residuals and waste materials [5,6]. With regard to this issue, the following work focuses on a thermochemical energy conversion process, the dual fluidized bed (DFB) steam gasification, of alternative fuels to produce a high-valuable product. The DFB steam gasification offers a well-proven technology to produce heat, electricity, secondary liquid or gaseous energy carriers and valuable chemicals from solid fuels. Utilizing residues and waste fractions provides a high potential to produce these commodities in a sustainable, eco-friendly way. Energy or fuel production from biomass via gasification offers an opportunity for a continuous process in contrast to the fluctuating wind or solar based renewable energy sources. Additionally, with a suitable processing of the syngas, a direct storage of the produced commodities (e.g. methane, hydrogen, FT-Diesel) is possible to balance the fluctuating supply by other renewable energy sources.
DFB steam gasification was demonstrated for the gasification of wood at industrial scale in (i) Güssing, Austria (8 MW_{th} fuel power) [7], (ii) Oberwart, Austria (8.5 MW_{th}) [8], (iii) Senden, Germany (15 MW_{th}) [9] and (iv) Gothenburg, Sweden (32 MW_{th}) [10]. However, some of these plants suffer from difficult economic conditions if high-grade wood chips are used as solid fuel - especially because the biomass costs increased significantly in the last decade. In all quoted cases, woody biomass (in form of pellets, chips or partially forest residues) was used as feedstock. Several economic considerations on DFB steam gasification processes showed that the fuel costs have a significant impact on the economic performance as mentioned above [6,11]. In an extensive review on dual fluidized bed gasifiers by Corella [12] it is stated, that the key problem or weakness to this technology is its economic and not the technical feasibility. Thus, fuel flexibility in order to use low-cost fuels is an important issue. By the use of alternative, low-grade fuels, which arise anyway as by-product of different processes, the life cycle of these materials can be increased and the overall CO_2 emissions reduced. Thus, the focus of this paper lies on the conversion of residuals and waste material into a high-valuable product. Additionally, high carbon and