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Catalytic conversion wood syngas to synthetic aviation turbine fuels over a multifunctional catalyst

Qiangu Yan [a], Fei Yu [a,*], Jian Liu [b], Jason Street [a], Jinsen Gao [b], Zhiyong Cai [c], Jilei Zhang [d]

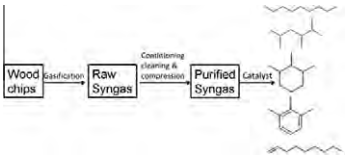
[a] Department of Agricultural and Biological Engineering, Mississippi State University, Mississippi State, MS, USA
[b] State Key Laboratory of Heavy Oil, China University of Petroleum, Beijing 102249, PR China
[c] USDA Forest Service, Forest Products Laboratory, Madison, WI, USA
[d] Department of Forest Products, Mississippi State University, Mississippi State, MS, USA

HIGHLIGHTS

- A continuous process was developed to make synthetic aviation turbine fuels from biomass.
- The process involved gasification, syngas cleaning, and Fischer–Tropsch synthesis.
- Synthetic aviation turbine fuels were produced from syngas over a multi-functional catalyst.

GRAPHICAL ABSTRACT

Synthetic aviation turbine fuels were produced from wood syngas over a multi-functional catalyst.



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ABSTRACT

A continuous process involving gasification, syngas cleaning, and Fischer–Tropsch (FT) synthesis was developed to efficiently produce synthetic aviation turbine fuels (SATFs). Oak-tree wood chips were first gasified to syngas over a commercial pilot plant downdraft gasifier. The raw wood syngas contains about 47% N_2, 21% CO, 18% H_2, 12% CO_2, 2% CH_4 and trace amounts of impurities. A purification reaction system was designed to remove the impurities in the syngas such as moisture, oxygen, sulfur, ammonia, and tar. The purified syngas meets the requirements for catalytic conversion to liquid fuels. A multi-functional catalyst was developed and tested for the catalytic conversion of wood syngas to SATFs. It was demonstrated that liquid fuels similar to commercial aviation turbine fuels (Jet A) was successfully synthesized from bio-syngas.

1. Introduction

Biomass-derived fuels are becoming more popular due to the rising costs of fossil fuels as well as concerns of national security and the national economy. A wide range of fuels and chemicals can be produced from biomass, including gasoline, diesel, heating fuel, jet fuel, synthetic natural gas, and oxygenates (Huang et al., 2012; Che et al., 2012). Aviation turbine fuels (ATFs) are a complex mixture of C8–C17 hydrocarbons, which include paraffins, iso-paraffins, aromatics and naphthenes (Huber et al., 2006). They are currently produced from the kerosene fraction of petroleum distillation and hydro-processing of heavier fraction of the petroleum (Wright et al., 2008). In the past decades, many efforts have been performed on production of ATF from shale, coal, and tar sands (Daggett et al., 2008). Shale-derived JP-4 has been tested and demonstrated using aviation engines, and no harmful consequences were found (Edwards, 2003). No negative impact was found on engine operation when using syngas-based Jet fuels (Moses et al., 1997). Since almost all the ATFs are from the non-renewable petroleum, it is necessary to find a sustainable route for producing SATFs. The most highly developed and technically proven route for producing alternative fuels from lignocellulosic biomass involves the gasification process. Syngas is produced, cleaned, and then catalytically converted via Fischer–Tropsch synthesis (FTS) or CO hydrogenation (alcohol synthesis). The products

* Corresponding author.
E-mail address: fyu@abe.msstate.edu (F. Yu).

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