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Organosolv lignin valorization via fast pyrolysis towards jet hydrocarbon fuels

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PURPOSE OF THE ABSTRACT

Lignin is one of the three main structural components of the lignocellulosic biomass and the most abundant natural source of aromatics/phenolics. It is widely available in the form of kraft lignin and lignosulphonates, which are derived as by-products of the pulp and paper industry. During the last years and within emerging biorefining approaches, lignin can be directly isolated via the biomass organosolv fractionation or is recovered as side stream during the 2nd generation bioethanol production, as enzymatic hydrolysis lignin. The obtained lignin can be converted to a pool of aromatic/phenolic bio-oils which can be utilized as value added-chemicals towards fuel and polymers (phenol-formaldehyde and epoxy resins, PUs) production. Lignin can be converted to bio-oils via fast pyrolysis and hydrogenolysis process. Fast pyrolysis is performed at relatively high/moderate temperatures (400-600oC) under inert atmosphere resulting in bio-oils rich in alkoxy-phenol compounds [1-3]. The process parameters as well as the nature of parent lignin (softwood or hardwood) can affect the bio-oil composition and yield [1-3]. The lignin derived bio-oils can be upgraded in-situ to BTX aromatic compounds and (alkyl)phenols via catalytic fast pyrolysis. Surface properties and acidity of the catalyst can control the product yields (oil, gases, char) and the bio-oil composition [1-3]. Alternatively, the bio-oils can be upgraded to (alkyl)cyclohexane via hydrodeoxygenation as drop-in jet bio-fuels. In this work, lignin streams isolated via the organosolv fractionation process from beech, spruce, birch wood and wheat straw are converted to bio-oils rich in alkoxy-phenols which can be further upgraded to jet fuels.

The main products of lignin fast pyrolysis are the bio-oil, gases and char. The organosolv lignins resulted in 28-48 wt.% bio-oil, 43-56 wt.% solids and 10-12 wt.% gases. Considering the bio-oil composition, alkoxy-phenols are mainly detected (20-64%) as well as alkylated phenols (5-13%) and phenol derived aldehydes (2-22%) and ketones (1-19%). The lignin composition is transferred in the bio-oil composition, thus softwood lignins led to bio-oils rich in phenolic compounds substituted with one alkoxy group while hardwood lignins resulted in phenolic compounds mainly substituted with two alkoxy groups. The presence of catalyst induced the partial deoxygenation of the bio-oils, towards aromatics (BTX) and alkylated phenols. The catalysts type, the porous and the acid properties can significantly control the composition of the bio-oil. Zeolite catalysts with high acidity induced almost complete hydrodeoxygenation of the alkoxy-phenols, while aluminosilicate catalysts with lower acidity led to alkylated phenols. The fast pyrolysis lignin-derived bio-oils can be converted to jet fuels either via full hydrodeoxygenation of alkoxy/alkyl phenols or via hydrogenation and alkylation of BTX aromatics.

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FIGURES

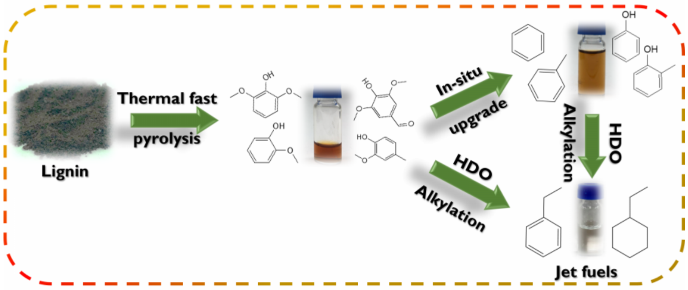

FIGURE 1

Figure 1

Valorization of organosolv lignin towards hydrocarbons fuels

FIGURE 2

KEYWORDS

Organosolv lignin | fast (catalytic) pyrolysis | hydrodeoxygenation | jet fuels

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