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Adding Nickel Formate in Alkali Lignin to Increase Contents of Alkylphenols and Aromatics during Fast Pyrolysis

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ABSTRACT

The composition of pyrolysis vapors obtained from alkali lignin pyrolysis with the additive of nickel formate was examined using the pyrolysis gas chromatography-mass spectrometry (Py-GC/MS). Characterization of bio-chars was performed using X-ray diffraction (XRD). Results showed that the nickel formate significantly increased liquid yield, simplified the types of alkali lignin pyrolysis products and increased individual component contents. The additive of nickel formate increased contents of alkylphenols and aromatics from alkali lignin pyrolysis. With an increase in temperature, a greater amount of the relative contents can be achieved. The nickel formate was thermally decomposed to form hydrogen, resulting in hydrodeoxygenation of alkali lignin during pyrolysis. It was also found that Ni is in favor of producing alkylphenols. The analysis based on the experimental result provided evidences used to propose reaction mechanism for pyrolysis of nickel formate-assisted alkali lignin.

Keywords: Alkali lignin; Nickel formate; Pyrolysis; Alkylphenols; Aromatics

1. Introduction

As a major component of biomass, lignin is an aromatic polymer consisting of methoxy (-OCH₃), hydroxy (-OH), carboxyl (-COOH) and other active functional group structures, and is also a high-value raw material for making fine chemicals such as alkylphenols and aromatics. Alkylphenols have a wide range of applicability as important precursors in various fields like pesticide formulations, detergents, as additives for fuels and lubricants, polymers and as important components in phenolic resins (Kim, 2015; Fan et al., 2010). Aromatic hydrocarbons can improve the quality of the produced bio-oil by decreasing its reactivity and tendency of aging (Zhang et al., 2014). However, as a drawback, lignin is very difficult to be thermal-degraded due to its complicated structure (Zhang et al., 2012;

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