

Study on Hydrogen Production via Photothermal Synergistic Catalytic Reforming of Light Fractions from Lignin Hydrothermal Liquefaction

Jiachen Han, Haijun Zhang*

School of Energy and Environment, Shenyang Aerospace University, Shenyang, China

Email address:

1399647985@qq.com (Jiachen Han), zhanghaijun@sau.edu.cn (Haijun Zhang)

*Corresponding author

Abstract

The light components generated during the hydrothermal liquefaction of lignin are characterized by high water content, complex composition, difficult separation, and limited resource utilization, which have become major constraints on the high-value utilization of all lignin-derived fractions. In this study, the light components derived from lignin hydrothermal liquefaction were employed as feedstock for hydrogen production via photothermal synergistic aqueous-phase reforming, providing a promising route for waste-liquid valorization while alleviating the energy supply–demand imbalance and environmental pressures. However, systematic studies on photothermal synergistic reforming systems and the corresponding reaction mechanisms for lignin hydrothermal liquefaction-derived light components remain relatively limited. During the reforming process, these components undergo side-chain cleavage, and deep reforming reactions, ultimately producing gaseous products dominated by H_2 and CO_2 . To regulate the catalyst structure and enhance catalytic performance, three catalyst systems were rationally designed and systematically optimized, including the biochar-modified $Ti_{(5)}Ni_{(2)}-HT_{180}$ catalyst, the $TiO_2/g-C_3N_4$ heterostructured $TiO_2/Ni-g-C_3N_4$ catalyst, and the Ni–Co bimetallic synergistic $Ni/Co_{(3:1)}-TiO_2$ catalyst. The average hydrogen production rate increased from 7.60 to 14.04 $mmol \cdot g^{-1} \cdot h^{-1}$ and ultimately reached 74.48 $mmol \cdot g^{-1} \cdot h^{-1}$. These findings provide mechanistic insights and technical guidance for the comprehensive valorization of lignin-derived fractions.

Keywords

Lignin Liquefaction, Aqueous-phase Products, Photothermal Catalysis, Hydrogen Production by Reforming