CHEMICALS PRODUCTION FROM BIOMASS AND ORGANIC WASTES WITH HIGH-TEMPERATURE WATER
–FOR SUSTAINABLE CHAMICALS PRODUCTION SYSTEM–

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Abstract

Environmentally benign systems to produce valuable chemicals from biomass-derived compounds and organic wastes using high-temperature water were studied. Three examples, (1) hydrolysis of poly(ethylene terephthalate) to terephthalic acid and ethylene glycol in high-temperature liquid water, (2) dehydration of polyols to the corresponding cyclic ethers in high-temperature liquid water under high-pressure carbon dioxide, and (3) gasification of lignin over supported metal catalysts in supercritical water, are shown in this manuscript.

Keywords: *Compact chemistry, Supercritical fluids, High-temperature liquid water, Carbonic acid*

1. Introduction

To establish sustainable chemicals production, we have to utilize inexhaustible resources, such as biomass and organic wastes. Also, the technologies for such transformations should be safe and easy. Water is an environmentally benign media because of its non-toxic and non-flammable properties. The dielectric constant values of water decrease with an increase in temperature, indicating that solubility of organic compounds increases. Ion product values of water increase with an increase in temperature to 10^{-11} at around 523 K. These properties indicate that high temperature liquid water around 523 K could be a media for acid- and base-catalyzed reactions of organic compounds. In this paper, three examples of chemical reaction using high-temperature water including supercritical water are reported.

2. Materials and Methods

Catalytic reactions under high-pressure conditions were studied with a batch reaction system using stainless steel tube reactors.

3. Results and Discussion

3.1. Hydrolysis of polyethylene terephthalate

Poly(ethylene terephthalate) (PET), which is a polyester of terephthalic acid (TPA) and ethylene glycol (EG). Hydrolysis behavior of PET resin in water was studied with a batch reactor [1]. TPA and EG were produced at higher than 473 K. The maximum yields of TPA and EG were both 95 % at 543 K.

3.2. Dehydration of polyols

Five- or six-membered cyclic ethers were obtained by an intermolecular dehydration reaction of polyalcohol compounds, which could be obtained by selective decomposition of cellulose, in high-temperature liquid water (523-573 K) [2]. The formation rates of the cyclic ethers were enhanced by the addition of high-pressure of carbon dioxide (17-27 MPa). Carbonic acid is formed in the mixture of water and carbon dioxide and proton derived from carbonic acid catalyzes dehydration rates.

3.3. Supercritical gasification of lignin

Lignin is a component woody biomass and high-molecular-weight compound with random structure. Organosolve-lignin and real biomass containing lignin (sugarcane bagasse) [3] were completely gasified and fuel gases (methane and hydrogen) were obtained over carbon supported ruthenium catalysts in water at 673 K.

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References

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