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High-yield hydrogen production by supercritical water gasification of various feedstocks: Alcohols, glucose, glycerol and long-chain alkanes

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A B S T R A C T

Continuous supercritical water gasification (SCWG) of various feedstocks of C1–C16 was conducted to produce hydrogen-rich gas. These feedstocks represent model compounds of biomass such as methanol/ethanol (alcohol-type), glucose and glycerol (byproducts of biodiesel synthesis), and model compounds of petroleum fuels such as iso-octane/*n*-octane (gasoline), *n*-decane/*n*-dodecane (jet fuels) and *n*-hexadecane (diesel). Almost complete gasification of all the feedstocks was achieved at 25 MPa, 740 °C and 10 wt% with low total organic carbon values of their liquid effluents. The hydrogen gas yields of each feedstock were very similar to the theoretical equilibrium yields estimated by Gibbs free energy minimization. SCWG at different gasification temperatures (650 and 740 °C) and concentrations (10 and 20 wt%) revealed that methanol and ethanol (alcohols), the simple oxygenated hydrocarbons, were easier to be gasified, producing negligible amounts of liquid products, when compared with long-chain hydrocarbons (iso-octane and *n*-decane) under the identical conditions. When the feedstock concentration was increased from 10 to 20 wt%, the equilibrium hydrogen ratio from iso-octane gasification decreased from 1.02 to 0.79 while that of *n*-decane increased from 1.12 to 1.50, implying that a branched hydrocarbon may be more resistant to gasification in supercritical water.

Keywords: Supercritical water gasification; Hydrogen; Equilibrium yield; Hydrocarbon

1. Introduction

Hydrogen has been considered one of the most promising clean energy alternatives to fossil fuels due to the depletion of fossil resources and the global warming. Hydrogen production by supercritical water gasification (SCWG), high-pressure gasification conducted above the critical point of water (374 °C and 22.1 MPa), has many advantages over conventional

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