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Effect of an Acid Catalyst on the Hydrothermal Conversion of Biomass to Coal

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Cellulosic and lignocellulosic biomass from agricultural waste (wheat, rice, com and soy straw) as well as forestry (brushwood), industrial (sawmill dust and wood chips) and municipal (grass and yard clippings) waste is more and more viewed as a renewable and carbon-efficient energy source. Pyrolysis and hydrothermal degradation are procedures known to convert biomass to fuel. Compared with the pyrolysis at 700 °C, however, hydrothermal conversion is conducted in aqueous solution at only 180 °C. Thus, it is potentially the more energy efficient procedure, and may even convert very wet biomass such as pulp or mill sludge to fuel. The mechanism of hydrothermal degradation, which is largely unknown, has been investigated in this study by nuclear magnetic resonance (NMR) spectroscopy using D-glucose as a biomass model substrate. The chemical substances 5-hydroxymethylfurfural (5-HMF) and 4-oxopentanoic acid (levulinic acid) were identified as primary reaction products. Our studies also reveal a substantial influence of acid as a catalyst in the degradation reaction. Quantitative measurements of the 5-HMF and levulinic acid yields are presented as a function of reaction time and/or pH value of the reactive, hot compressed aqueous solution.

Megan Oldroyd is a sophomore majoring in chemistry and math, with minors in biology and cognitive neuroscience. She participated in the Opportunities for Undergraduate Research Program this past year, and is presenting her research here at the Undergraduate Research Conference. Megan is a recipient of the Chancellor's Scholarship here at Missouri S&T, and has also been presented scholarships from both the chemistry and math department. Megan was awarded chemistry student of the year both her freshman and sophomore years.