Production of Syngas from Biomass

(No. T4-1716)

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Summary

An efficient and selective decomposition of plant biomass carbohydrates to their basic components, carbon monoxide and hydrogen, for use as syngas.Terrestrial plants contain about 70% hemicellulose and cellulose, which constitute a significant renewable bio-resource with potential as an alternative to petroleum feedstock for carbon-based fuels. Traditional conversion of biomass to liquid fuels has been in the form of ethanol and bio-diesel, but this process is inefficient and much of the starting material is unusable and ultimately becomes waste.[1] Additionally, use of ethanol or bio-diesel is not universal to all engines as vehicles require specialized components to run on these fuels.The presented technology allows for significantly greater efficiency in use of starting material, and the versatile final product of syngas, which can be a fuel itself or used as a fuel precursor in the well-known Fischer-Tropsch process to create hydrocarbons.[2] Alternatively, in a hydrogen economy scenario, this method can also be used to convert carbon monoxide to hydrogen via the water-gas shift reaction. Advantageously, both processes allow for the polyoxometalate (POM) catalyst to be reused without the need for recovery, which enables continuous use in a refinery setting.

Applications

Liquid hydrocarbon fuel synthesis from syngas

Entry into a new market – hydrogen production from biomass

Advantages

Efficient and complete breakdown of starting biomass material

Possible to produce hydrogen or syngas as product

Technology's Essence

The technology allows for preparation of syngas by reaction of a carbohydrate with a POM catalyst in the presence of a concentrated acid under anaerobic conditions, to yield carbon monoxide, followed by electrochemical release of hydrogen. This two-step process allows for easy separation and storage of the desired products. An alternative application of the same POM catalyst relates to a method for preparing formic acid in a similar method, but in a solvent consisting of a mixture of alcohol and water.This reaction is based on the unexpected finding that POM catalysts, such as $H_5PV_2Mo_{10}O_{40}$, catalyze plant biomass derived polysaccharides of general form $(C_nH_{2n}O_n)_m$, with high selectivity and efficiency under mild conditions. Formation of CO occurs through an intermediate formation of formic acid and formaldehyde, and transformation of these transition compounds in concentrated acid results in the desired CO product. During this process, hydrogen atoms are stored on the POM catalysts as protons and electrons. Hydrogen gas is subsequently electrochemically released from the POM catalyst, which returns the catalyst to its original oxidized state and allows for continued reuse.

Patent Status

USA Granted: 9,873,612