PHYS ORG

UMaine researchers discover revolutionary process for biofuel

October 25 2011

(PhysOrg.com) -- Researchers have long been interested in waste products as sources of biofuel. In Maine, those waste items could include treetops and limbs deemed by the forest products industry as unusable and often left behind in the woods.

A University of Maine engineer and his research team have, however, discovered a revolutionary new chemical process can transform forest residues, along with other materials such as municipal solid waste, grasses, and construction wastes, into a hydrocarbon fuel oil.

Considering the amount of wood in Maine – including around 6 million green tons of additional available biomass, according to a 2008 Maine Forest Service Assessment of Sustainable Biomass Availability– the new fuel has the possibility of 120 million gallons per year of gasoline, diesel, heating oil and kerosene mixtures while providing all the steam and power needs of the processing plants. In addition, the U.S. transportation industry, which is dependent on hydrocarbon fuels because of their high energy density, could benefit from the revolutionary finding.

Based on a mixed-carboxylate platform, the new fuel was developed by M. Clayton Wheeler, a UMaine associate professor of chemical and biological engineering, and undergraduate students in his lab. The fuel has been determined to have a number of properties that make it better suited to serve as a drop-in fuel – which refers to the ease of which it can be used in a number of fuel tanks and pipelines – than many hydrocarbon fuels being widely researched and even those currently on the market.

In an early round of analysis, the UMaine oil was found to have boiling points that encompass those of jet fuel, diesel, and gasoline. Further refinement to meet emissions standards would be needed in order to use the UMaine oil in vehicles that drive on public ways, but Wheeler believes the oil can be refined as simply as any other current oil at a standard refinery.

The process by which the oil is created, known as thermal deoxygenation or TDO, is relatively simple, Wheeler says, and will work on the cellulose found in wood or other substances that contain cellulose or carbohydrates.

“The process is unique,” Wheeler says. “No one else in the world is doing this.”

The TDO process starts with the conversion of cellulose to organic acids. The acids are combined with calcium hydroxide to form a calcium salt. That salt is heated to 450 degrees Celsius (900 degrees Fahrenheit) in a reactor, which constantly stirs the salt. This produces a reaction resulting in a dark amber-colored oil.

The reaction removes nearly all of the oxygen from the oil, which is a key step that distinguishes TDO from other biofuel processes. Oxygen is removed from as both carbon dioxide and water, and without the need for any outside source of hydrogen to remove the oxygen. Therefore, most of the energy in the original cellulose source is contained in the new oil.

“Biomass has a lot of oxygen in it. All of that oxygen is dead weight and doesn’t provide any energy when you go to use that as a fuel,” Wheeler says. “If you’re going to make a hydrocarbon fuel, one of the things you have to do is remove oxygen from biomass. You can do it by using hydrogen, which is expensive and also decreases the energy efficiency of your process. So if there's a way to remove the oxygen from the biomass chemically, then you've densified it significantly. Our oil has less than 1 percent oxygenates. No one else has done anything like this. ”

Researchers in Wheeler's lab at UMaine recently used unpurified, mixed carboxylates which were produced from grocery store waste such as banana peels, cardboard boxes and shelving to successfully make a batch of the fuel. The use of municipal solid waste illustrates another important point about the potential of the UMaine fuel – it does not require an uncontaminated cellulose source, which makes the TDO process and resulting oil even more attractive. Many other pathways to hydrocarbons require purified feedstocks or intermediates, which adds more complexity and cost to their processes.

“You don't need pure wood or pure cellulose,” says Wheeler. “Anytime you can use something without having to separate it, your costs go down.”

Wheeler and his team already have the ability to produce several liters of the fuel per month in the laboratory. The process can be scaled up using equipment and chemicals commonly found in facilities such as some pulp mills.

Provided by University of Maine

Citation: UMaine researchers discover revolutionary process for biofuel (2011, October 25) retrieved 26 April 2024 from https://phys.org/news/2011-10-umaine-revolutionary-biofuel.html

provided for information purposes only.