Biofuels News

Catalytic Process Converts Plant Sugars into Gasoline

The presence of oxygen in the molecular structure of ethanol gives rise to substantial disadvantages, such as a lower volumetric energy content, higher operating costs associated with dewatering, and incompatibility with the current fuel manufacturing and distribution infrastructure. Now, novel and innovative catalytic methods are available to convert plant sugars into non-oxygenated hydrocarbon molecules that overcome these limitations.

These methods are based on the BioForming technology platform, which was developed at the Univ. of Wisconsin–Madison and licensed to Virent Energy Systems, Inc. (Madison, WI; www.virent.com). Virent has further improved the process, and expects several pending patents to be published next month.

Co-inventor Randy Cortright, chief technology officer and executive vice president of Virent, explains that the BioForming process utilizes catalysts and reactor systems similar to those found in standard petroleum refineries. Using proprietary catalysts and operating at moderate temperatures (450–575 K) and pressures (10–90 bar), the process converts water-soluble carbohydrate-derived compounds (*e.g.*, polysaccharides, monosaccharides, polyhydric alcohols, mono-alcohols) into a combination of water, hydrogen, gaseous fuels and liquid hydrocarbons. The water, fuel gases and any excess hydrogen are easily separated from the liquid hydrocarbon in a simple three-phase separator, and can be recycled or collected for use in other applications. Depending on the process configuration, hydrocarbon mixtures can be produced with characteristics and properties that are virtually identical to gasoline, jet fuel, diesel fuel, and other chemicals. Fuel gases such as propane can also be produced.

The technology, Cortright says, is not limited to any single type of sugar, unlike other processes, such as fermentation, that rely on certain microorganisms and enzymes. By selecting different catalysts and processing conditions, various types of sugars, including mixed sugar streams and polysaccharides, can be reliably converted into the desired non-oxygenated hydrocarbon fuels, he says. Potential carbohydrate feedstocks include:

- sucrose (from sugar cane or sugar beets)
- corn sugar (glucose from corn starch)
- sugars derived from the hydrolysis of hemicellulose and cellulose
- water-soluble oxygenated compounds, such as diols, glycerol, and sugar alcohols.

With this capability, the BioForming process can utilize the lowest-cost biomass sources available in a particular location and supply more energy without reducing the available food supply. It can be economically scaled to match production with feedstock supply in a given locale, and produces water as a byproduct, providing a potential resource for agricultural and industrial applications. Unlike fermentation, the BioForming process is fast, robust and will have more success using cellulosic biomass resources, notes Cortright.

Stoichiometric analysis shows that the product hydrocarbons capture 64% of the carbon from the carbohydrates and more than 94% of the sugar's lower heating value. The biogasoline has a higher energy content than ethanol or butanol and delivers better fuel efficiency, he says.

Cortright states that fuels made by these routes have a 20% to 30% cost advantage — on a per-Btu basis — over corn ethanol. Preliminary economic analysis suggests that converting sugars to conventional liquid fuels with these catalytic methods can economically compete with petroleum fuels at crude oil prices above $60/bbl.

The fuels and chemicals produced by these catalytic processes are the same as their petroleum-derived counterparts and are compatible at high blend ratios with today's engines, fuel pumps and pipelines. Thus, they can be used immediately in the marketplace, with no new infrastructure investment, Cortright points out. CEP

Above: Small-scale pilot plants are used to convert sugar-water solutions, for example of cane sugar and xylose, to non-oxygenated hydrocarbons.

Top right: The biogasoline produced by the BioForming process spontaneously separates from water, requiring little energy compared with the energy-intensive distillation needed for ethanol production.