

Catalytic Conversion of Biomass to Hydrocarbons

R.D. Cortright, Ph.D.

*Virent Energy System, Inc.

3571 Anderson Street, Madison Wisconsin 53704

Randy_Cortright@virent.com

ABSTRACT

Virent Energy Systems Inc. is an energy technology company developing catalytic processes to convert a range of sugar-based compounds into fuels and chemicals now made from fossil fuels. Virent is developing capabilities to produce renewably energy dense liquid fuels, such as gasoline, diesel, jet fuel, fuel gases such as hydrogen and other combustible gases, and chemicals such as propylene glycol. Virent's patented BioForming™ platform technology is based on the Aqueous Phase Reforming process. The BioForming process react sugar-based oxygenated feedstocks with water in simple catalytic reactors at relatively low temperatures and pressures. The process selectively removes oxygen from compounds and generates hydrogen, hydrocarbons, and/or high valued chemicals.

Keywords: Biogasoline, Catalytic Aqueous Phase Reforming

1 BIOFORMING TECHNOLOGY

The patented BioForming process is based on Aqueous Phase Reforming, a unique and innovative pathway to biofuel and bioproduct production. This catalytic route is superior to high-temperature thermochemical or fermentation pathways. It is simple, thermally efficient and entirely scalable for small, distributed or large, centralized production. Unlike time-consuming fermentation, this robust and fast process does not depend on living microbes or enzymes. The simplicity of the process results in low capital and operating costs. The process uses a simple reactor system at relatively low temperatures and pressures, and once it is operating, no additional energy inputs are needed. As a platform technology, the BioForming process can reliably convert many types of sugars into many different fuels and chemicals.

2 FUEL WITHOUT THE FOSSIL

Imagine biomass used to replace fossil fuels on a significantly broad scale— that's the potential of Virent's patented BioForming™ process.

The BioForming process is an unrivaled method for converting the carbohydrates in plant matter into carbon-neutral, renewable fuels and chemicals. Virent's breakthrough technology will produce proven products such as gasoline, diesel and hydrogen using carbohydrate-based feedstocks instead of petroleum.

Our products will achieve significant market acceptance because they are cost-effective and easily deployable. Unlike ethanol, they use existing infrastructure: car engines, fuel pumps, distribution pipelines, etc. Plus the BioForming process extracts significantly more net energy from inexpensive and plentiful feedstocks, making more efficient use of agricultural resources and producing greater amounts of energy per acre of land. The potential cumulative effect is more total energy than existing biofuel methods can supply without reducing available food supplies.

Together, these characteristics make Virent's BioForming technology the key to a historic shift away from today's fossil fuel economy to tomorrow's renewable carbohydrate economy.

Key Advantages

- **Carbon Neutral:** Low energy input and biomass-based feedstocks offer nearly zero net CO₂ emissions.
- **Water Positive:** Produces more water than is used in the production process.
- **Efficient:** A fast and robust process that uses little energy to convert sugars into gasoline, diesel, and jet fuel with significantly more net energy yield per acre than traditional ethanol processes.
- **Feedstock Flexible:** Uses a range of feedstocks, and can use lowest cost biomass sources available in each location. Able to use non-food feedstocks.
- **Maximizes Land Utilization:** Producing fuels with greater energy yield per acre provides more value for farmers.
- **Economical:** Gasoline made via the BioForming process will enjoy a 20% to 30% per BTU cost advantage over ethanol. The system's scalability enables the economical

matching of production with available feedstock supplies.

- **Immediate Market Acceptance:** Virent's products are cost-effective and universally usable, requiring no new infrastructure investment. They are compatible with existing engines, pipelines, and fuel pumps.

- **Catalysts, not Bugs:** Avoids dependence on fragile creatures and biology and increases ability to successfully process cellulosic biomass.