Aqueous-Phase Reforming

FEEDSTOCK CLASSIFICATION

Starches and sugars, lignocellulosic biomass

FEEDSTOCK EXAMPLES

Glucose, glycerol, sorbitol, **waste beer**, **whey**, xylitol, xylose

FEEDSTOCK RESTRICTIONS

The process requires water-soluble oxygenated compounds such as sugars, sugar alcohols, and glycerol. Using other biomass components (e.g. cellulose, hemicellulose, starches) requires that they first be converted into water-soluble compounds.

PROCESS DESCRIPTION

Aqueous-phase reforming (APR) produces hydrogen from biomass-derived oxygenated compounds such as glycerol, sugars and sugar alcohols. APR is unique in that the reforming is done in the liquid phase. The process generates hydrogen without volatilizing water, which represents major energy savings. Furthermore, it occurs at temperatures and pressures where the water-gas shift reaction is favorable, making it possible to generate hydrogen with low amounts of CO in a single chemical reactor. By taking place at low temperatures, the process also minimizes undesirable decomposition reactions typically encountered when carbohydrates are heated to elevated temperatures. In another mode, the reactor and catalysts can be altered to allow generation of high-energy hydrocarbons (propane, butane) from biomass-derived compounds.

A multitude of technologies handle the separation of carbohydrates from biomass, and the appropriateness of a feedstock for this process depends on determining the proper separation technology. Some feedstocks, like those listed above, are already aqueous carbohydrate streams. Unlike other hydrogen-producing technologies, APR requires no non-renewable resources and is emissions neutral, and unlike steam reformation processes, APR produces hydrogen from liquid-phase solutions, resulting in considerable energy savings.

PRIMARY BIOBASED PRODUCTS

Hydrogen, hydrocarbon fuels

PROCESS BYPRODUCTS

Carbon dioxide

MAJOR EQUIPMENT

The process uses a single reactor vessel. A phase separator is needed to remove the hydrogen. This hydrogen can be used in fuel cells. Additional equipment may be necessary to create the aqueous carbohydrate streams.

ENERGY REQUIRED

The process occurs at a low temperature and medium pressure.

CAPITAL AND OPERATING COST

Unknown. Production-scale facilities have not been developed.

COMMERCIALIZATION STATUS

Looking for commercialization partners

COMMERCIAL SUPPLIERS

Virent Energy Systems[1] has exclusive rights to the APR process.

REFERENCES

[1] Virent Energy Systems Inc., 3591 Anderson St, Madison, WI 53704, 608.663.0228
http://www.virent.com

Kenyon, Kenneth. 2003. Renewable Hydrogen Demonstration and Education Project. Energy Center of Wisconsin, Madison, WI. January 2003.