Assessment of RedOx Biofuels' Ethanol Production Technology

VENTURES IN SUSTAINABLE TECHNOLOGY

Introduction

RedOx Biofuels is developing a process to convert ligno-cellulosic materials to ethanol (and other biofuels) using an electrochemical synthesis platform. Developed by Applied Intellectual Capital (AIC), RedOx's parent company, the inherently flexible, metal-mediated reduction/oxidation(MMR) approach provides the opportunity to produce a range of biofuels and chemical products. This report provides an assessment of the potential to produce ethanol using the RedOx process.

Executive Summary

RedOx Biofuels is investigating feedstocks with low life-cycle greenhouse gas (GHG) emissions. Fuels produced from this process would be viewed as environmentally favorable, especially when compared with crop-based biofuels. A life cycle assessment of RedOx ethanol plant configurations shows reductions in GHG emissions ranging from 50% to 80% of gasoline levels.

A viable market exists for biomass-based ethanol production using the RedOx process given the potentially competitive cost of producing ethanol. Biomass resources would provide sufficient feedstock for several facilities producing 100 million gallons per year. The ethanol production yields achieved in laboratory tests for the most favorable feedstocks show conversion of 14% to 20% of the mass to ethanol. These values correspond to 42 and 61 gallons per ton.

Depending on the success of the RedOx process with a broad range of feedstocks, the market could be significantly larger. Many competitors are also exploring both the conversion of biomass to ethanol as well as the use of biomass as fuel. Corn ethanol plants will have incentives to use feedstocks such as corn stover to meet the GHG reduction goals. Further development of the RedOx technology as well as the evolving policy debate over GHG emissions will determine its competitiveness with other fuel production technologies.

Significant opportunities exist for converting a wide range of biomass feedstocks to ethanol and other biofuels. Currently the predominant energy crops being cultivated for fuel production are corn and soybeans in the US, rapeseed and barley in Europe, sugar cane in Brazil and palm oil in the tropics. At least in the US, cellulose based energy crops probably won't appear before existing waste resources have been depleted.

Report Highlights

*Corn production in the U.S. in 2007 increased by 24% from 2006 levels to a total of 13.1 billion bushels. Similarly, corn ethanol production increased by 32% from 2006 levels to total 6.5 billion gallons. Producing the 15 billion gallons of ethanol projected from the 2008 energy bill would require additional corn. The net effect will be an increase in corn acres planted and a reduction in other crops including soybeans, cotton, and rice.

*In the near term, agriculture and forestry residues and municipal waste streams are likely to be the most competitive biomass feedstocks and these will be utilized first.

*Feedstocks account for 50% to 80% of biofuel production costs, so the price paid by ethanol producers is a key factor in biofuel economics.

*Cellulosic ethanol production is considered a promising and viable method for agricultural and forestry residue disposal without burning.

*Sufficient biomass residue resources are available to produce about 5% to 10% of motor fuel in the U.S. Expanded planting of energy crops could triple these figures.

*Regulations and research grants have stimulated biofuel demand growth and increased producer profitability in the U.S. The recent phase out of MTBE has also driven ethanol demand.

*The total potential ethanol capacity is 16.7 billion gasoline gallon equivalent/yr, or 25.4 billion gallons ethanol/yr, compared to annual U.S. gasoline consumption of 137.8 billion gallons/yr.

*EIA projections suggest that demand for biofuels will significantly exceed blending requirements by 2012, due to ethanol use as a fuel oxygenate, an octane enhancer and due to the blender's tax credit.

*California Executive Order S-06-06 mandates significantly greater biofuel production in state in the future for blending with conventional fuels (20% in 2010, 40% in 2020 and 75% by 2050). This translates to in-state ethanol production of approximately 700 million gallons/yr in 2010, 1,400 million gallons in 2020 and 3,250 million gallons in 2050.

*Currently in the laboratory stage of development, the RedOx process for ethanol production, MMR, uses electrochemical processes to convert ligno-cellulosic materials into ethanol and other high-value fuels and chemicals. The electrochemical processing takes the place of pretreatment options.

*RedOx's MMR technology works by attacking the cellulosic bonds with metal ions to facilitate the cleavage of the cellulose chain in a more effective manner than water hydrolysis. The conversion is flexible and readily scalable, and generates little or no secondary waste—a serious drawback of competing acid hydrolysis technologies.

*RedOx's approach appears to provide reasonable ethanol conversion yields for some feedstocks while eliminating the complexity of acid separation from a liquid phase solution. Sewage sludge and rice straw are some potential feedstocks for the RedOx process.

*In examining cost associated with two small-scale cellulosic ethanol production opportunities, costs were found to be competitive with corn ethanol and gasoline today. Costs range from $1.5 to $2.7 per gallon, depending on feedstock used and other site-specific factors, such as integration with existing facilities.

Conclusions

The RedOx MMR process potentially provides a viable technology for ethanol production. The process, if successfully developed has some inherent advantages over other production options. Using a limited electrochemical pretreatment, the process requires only a small amount of electricity. The process steps are also mechanically simple. Securing feedstock for an ethanol plant will require a reliable and secure source of feedstock that will likely be secured through contracts and partnerships with biomass providers.

In the near term, starch based ethanol will continue to expand, becoming less fossil-fuel intensive and more efficient while crop residues, including corn stover, cereal straws and hay, and forestry residues offer the greatest potential for additional biofuel production. In the long term, agricultural residues will continue to provide biofuel feedstock in increasing quantities while dedicated energy crops such as switchgrass, reed canary, willows and poplar become competitive.

The fuel industry and government agencies have spent billions in efforts to produce biofuels economically from various starch and ligno-cellulosic feedstocks. The biggest challenges remain the difficulty in securing adequate feedstock supply, developing robust processes insensitive to feedstock variability and competing with other fuel producers in the market. Competition among fuel producers remains tight, driven by federal grants and subsidies, and numerous conversion technologies continue to develop. Developing the feedstock supply and conversion technology to produce competitively priced ethanol will give successful biofuel producers access to a huge and expanding fuel market.

Applied Intellectual Capital, AIC Labs 2450 Mariner Square Loop
Alameda, California 94501-1010 | Tel:(510) 239-0025 | Fax:(510) 217-6826