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A Biodiesel Breakthrough

Value-added co-products can improve the economics of a climate-friendly fuel

BACKGROUND Diesel trucks are the workhorses of the Canadian economy, transporting 90% of all products and foodstuffs consumed in the country, and the vast majority of our imports and exports. While the trucking industry is vital to our way our life, it also contributes heavily to our national greenhouse emissions, producing 42 million tonnes of carbon dioxide (CO2) each year (diesel used by generators and light duty vehicles contributes another 14 million tonnes). Diesel derived from biomass, or biodiesel, could reduce these greenhouse gas emissions substantially. Unlike fuels derived from petroleum, biomass-based fuels release no net CO2 when burned, because all of the carbon contained in the fuel was originally taken up by from the atmosphere by plants. Fuels derived from biomass can thus reduce our greenhouse gas emissions, while still helping to meet our transportation needs.

Recent advances in technology are paving the way for the development of transportation fuels from biomass. Biodiesel, which can be used in conventional diesel engines, is one such fuel. Biodiesel is traditionally produced from oils and fats using a chemical process called "transesterification", a method that also generates large amounts (up to 10% of the final product) of the chemical glycerol. As the production of biodiesel continues to grow, finding an economic use for glycerol presents both a challenge and opportunity for the biodiesel industry. While glycerol can be used to manufacture soaps and lubricants, markets are limited, and increased production could cause the price to decline. Moreover, the additional processing required to purify glycerol could raise production costs. If glycerol could instead be converted into other value-added products, the overall economics of biodiesel production would be greatly improved.

A SCIENCE POLICY PERSPECTIVE

WHY STUDY BIODIESEL CO-PRODUCTS? Biodiesel and other biomass-based transportation fuels can reduce greenhouse gas emissions and help Canada meet its Kyoto commitments. Biofuels can also provide the foundation of a sustainable bioeconomy. For such an economy to be competitive, however, we must first develop appropriate technologies and economic policies to deal with new waste streams generated by these and other biomass-based products.

WHAT WAS DONE? Biodiesel researchers investigated syngas production from glycerol, an abundant biodiesel co-product that currently has limited markets.

WHAT WAS DISCOVERED? Under the right conditions, pyrolysis of glycerol can produce a final product that is 93% syngas, a high conversion ratio that indicates the technical feasibility of using pyrolysis to produce syngas from glycerol.

WHAT DOES IT MEAN? The federal government has an annual production target of 500 million litres of biodiesel by 2010, a target that will result in 50 million litres of crude glycerol produced each year. The production of syngas (a valuable feedstock for power production) from glycerol will ensure that glycerol markets are not unnecessarily flooded, while significantly improving the economics and competitiveness of biodiesel production in Canada.

BIOCAP RESEARCH Dr. Ajay Dalai, a BIOCAP-supported researcher[1], is investigating ways to produce value-added co-products from transesterification. Dr. Dalai is particularly interested in the production of synthesis gas (syngas) from glycerol. Syngas is a mixture of carbon monoxide and hydrogen that can be converted into variety of products (including methanol, ethanol and liquid and gaseous hydrocarbons) with multiple uses, including power generation and transportation fuels. Because most of these products are currently derived from fossil fuel feedstocks, the ability to produce both biodiesel and syngas from biomass could provide multiple greenhouse gas benefits. Working with his associates at the University of Saskatchewan, Dr. Dalai conducted a systematic study

to identify the most efficient means of producing syngas through pyrolysis, a method which breaks down glycerol under conditions of extreme heat and no oxygen.

RESULTS Dr. Dalai found that adjusting parameters such as temperature and size of the packing material substrate in the pyrolysis reactor had a profound effect on the amount of syngas produced. In general, higher temperatures (up to 800°C) and reduced packing material size resulted in the greatest amount of gas produced, up to 3.1 litres of gas from 2.7 grams of glycerol. Depending on reactor configuration, the final product was composed of up to 93% syngas - a high conversion ratio that demonstrates the potential of using glycerol to produce syngas.

Producing syngas from the co-product glycerol is just one example of how biodiesel production can be made more competitive. Dr. Marcel Schlaf, a BIOCAP-supported researcher[2] at the University of Guelph, is exploring an alternative use for glycerol: as a feedstock for the production of 1,3-propanediol. Propanediol is a widely-used polymer building block with a variety of potential uses that range from coatings and laminates to polyester and anti-freeze. Interestingly, all of these compounds are currently derived from crude oil and natural gas, suggesting that the use of glycerol to produce 1,3-propanediol could help further reduce our reliance on fossil fuels.

In addition to providing important greenhouse gas benefits, biofuels and other biomass-derived products can provide the foundation of a sustainable bioeconomy – and in fact, many of the biomass conversion technologies needed to manufacture these products are already in place. However, we must also develop the appropriate strategies (both technological and political) to deal with the new "waste streams" generated by biomass products. A distinguishing feature of a bioeconomy is that the production cycle becomes more self-contained, with waste products becoming the feedstocks for new products. Ensuring that the potential of these new feedstocks is fully realized will enhance the competitiveness of the new bioeconomy.

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Developed by
The BIOCAP Canada Foundation
Queen's University
156 Barrie Street, Kingston, Ontario K7L 3N6
(613) 542-0025
info@biocap.ca www.biocap.ca