NOVODIESEL – THE NEXT BREAKTH

Chemical methods of biodiesel production are most prominent in the world today, but the technological, economic, and sustainability advantages of enzymatic biodiesel production are extensive.

Jesper Brask, Per Munk Nielsen, and Hans Christian Holm believe in the benefits of producing biodiesel using enzymes and are working hard to make the technology widely available.

Biodiesel made using enzymatic transesterification with ethanol instead of methanol has been suggested as a cleaner, more sustainable alternative. And enzymatic biodiesel production has many advantages over its chemical counterpart:

- It works well with fluctuating raw material quality
- It needs fewer processing steps
- It produces higher-quality glycerol (a valuable coproduct)
- It uses less energy and generates less wastewater

Due to these significant benefits, more and more research is being done in the field, and a viable, sustainable solution is well within reach.

From FAME to FAEE

Today, commercial biodiesel is fatty acid methyl esters (FAME), which is made with methanol. Methanol works well in a chemically catalyzed process, and more importantly, it is a cheap type of alcohol in most regions. But with increased global bioethanol production, any price advantage over ethanol could soon change.

Ethanol is the preferred alcohol for the enzymatic process, resulting in fatty acid ethyl esters (FAEE). Ethanol is a larger and heavier alcohol than methanol which means a mass yield gain of the FAEE biodiesel. This mass yield gain means that more biodiesel is made from a unit of oil in the enzymatic ethanol process than in the chemical methanol process.

"Ethanol is already sold at prices lower than methanol in certain countries such as Brazil," says Hans Christian Holm, Global Marketing Manager at Novozymes. "Since the alcohol component is always significantly cheaper than the oil component, the extra volume gain when using ethanol instead of methanol could become a major sales argument, particularly for the Brazilian market."

THE SUSTAINABLE BIODIESEL PROJECT

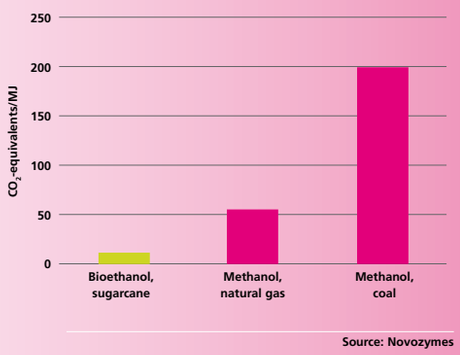
An EUR 2.4 million grant contract from the Danish National Advanced Technology Foundation (HTF) was given in late 2008 to a project consortium to establish a world-leading enzyme technology for the next generation of biodiesel production. The project will take place over the next three years and the goal is to develop and document a biodiesel process that is cost-effective and environmentally superior to chemical transesterification. Complete documentation of the process including a quantitative sustainability assessment is also within the project's scope.

The project is formed as a consortium of Danish companies and academic groups, including Novozymes, Emmelev – a Danish biodiesel producer – the University of Aarhus, and the Technical University of Denmark.

ROUGH IN REDUCING CO_2 EMISSIONS

"Enzymatic biodiesel production using bioethanol and waste oils could become a 'green-green' biodiesel for the future," says Per Munk Nielsen, Senior Science Manager at Novozymes.

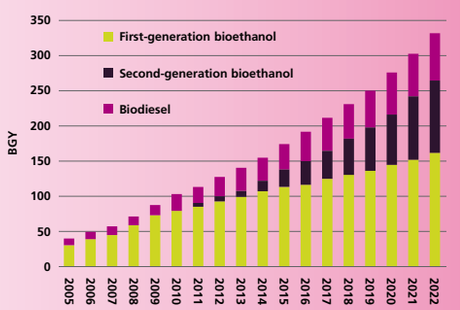
FIG. 1. ETHANOL-BASED BIODIESEL REDUCES CO_2 EMISSIONS



Source: Novozymes

Biodiesel made using enzymes together with bioethanol and low-quality oils, such as used frying oil, gives the world a significant reduction of CO_2 emissions compared to existing technologies.

FIG. 2. GLOBAL BIOFUEL PRODUCTION



Source: VOPAK, Emerging Markets Online, F.O. Licht, Novozymes estimates

Growth is expected for all types of biofuels in the next few years.

Added to this, the chemical ethanol process is troubled with technical issues, giving further advantage to the enzymatic ethanol process.

Moving to lower-quality feedstocks

The fundamental advantage of an enzymatic biodiesel process is that triglycerides (and partial glycerides) as well as free fatty acids (FFA) can be efficiently transformed into biodiesel under the same mild conditions. By selecting the right enzyme composition, it is possible to make a continuous single-step process, even with very high FFA content in the oil. This allows the use of low-quality and nonfood oils without a negative impact on the environment.

The choice of feedstock for today's commercial biodiesel plants depends largely on geography, with rapeseed oil dominating in the EU, soybean oil in the US and Latin America, and palm oil in Asia. These oils can easily be used as feedstock for enzymatic biodiesel production. Already today, research shows that this is a possibility with practically all the known plant oils. But the greatest benefits of enzymatic treatment can be obtained with low-cost, low-quality oils with high FFA content. These types of oils include animal fat, used oils, acid oils, and fatty acid distillates. Using these feedstocks for enzymatic biodiesel production is sound, not only from a technical perspective, but also economically and from a sustainability standpoint as well.

"Enzymatic biodiesel production using bioethanol and waste oils could become a 'green-green' biodiesel for the future," says Per Munk Nielsen, Senior Science Manager at Novozymes.

Not widespread yet

Yet, despite the obvious environmental benefits of enzymatic biodiesel production using bioethanol, the process is still not widespread.

"There are valid reasons why plants are not using this technology for commercial-scale production at this point in time," says Jesper Brask, Science Manager at Novozymes. "It's mainly due to the lack of an optimized process design coupled with the lack of cost-effective enzymes."

However, recent data documenting the productivity of the enzymatic process for biodiesel together with the development of new immobilization technology, which allows the reuse of the enzymes, indicate that enzyme catalysts can soon become cost-effective.

Part of the future energy mix

The world faces an urgent climate change challenge – action is needed now to mitigate further damage to the planet. Boosting the amount of renewable liquid fuels of all types is key to reducing global CO_2 emissions.

The US is a major user of gasoline and consumes a smaller proportion of diesel for its transport fuel needs than other regions of the world. But Europe, China, India, and Brazil have a larger proportion of their transportation needs tied to diesel.

"A greener biodiesel solution will positively affect large areas of the world and is a very important part of a cleaner energy mix," says Hans Christian Holm. ■

FOR MORE INFORMATION
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