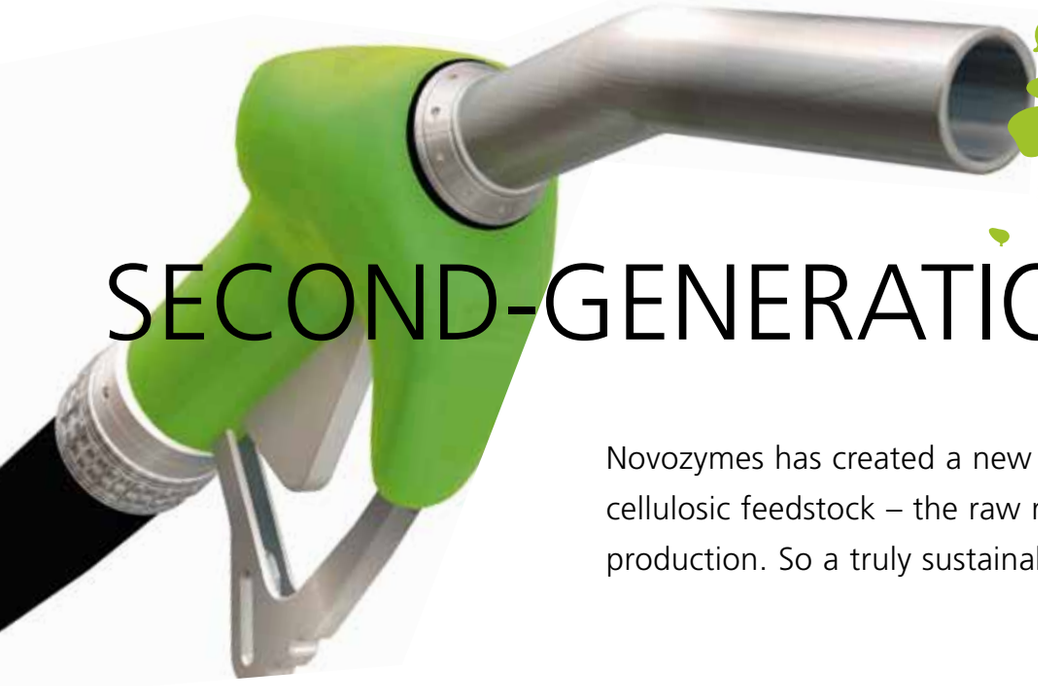
With this Novozymes product family, the biofuel industry has just taken a giant leap forward. These products have the best cost/performance ratio seen so far in the industry.



SECOND-GENERATION BIOFUELS

Novozymes has created a new product family that can hydrolyze cellulosic feedstock – the raw material of second-generation biofuel production. So a truly sustainable transport fuel is closer than ever.

"Novozymes' latest products for second-generation ethanol production are much better than anything previously seen on the market," says Cynthia Bryant, Global Marketing Manager, Biomass industry at Novozymes. "While this in itself is a giant leap forward for the biofuel industry, we must remember that it's also only the first of many steps down a road to a truly commercially viable industry."

The promise of cellulosic ethanol

Biofuels are the only ready-at-hand technology that can significantly reduce oil dependency, cut greenhouse gas emissions from the transport sector, and create thousands of green jobs. For all these reasons the eyes of the world have been focused on the biofuel industry for many years.

"Novozymes is a true believer in the benefits of first-generation biofuels as well as a major contributor to the industry. But we also know that the future lies with the advancement of cellulosic ethanol. By developing and commercializing cellulosic ethanol we boost the biofuel industry's ability to deliver all of the benefits of biofuels while helping to address many of the concerns that are currently being debated for first-generation bioethanol," says Cynthia Bryant.

In fact, studies indicate that with cellulosic ethanol as a major contributor, 25% of the global consumption of gasoline can be replaced by 2030*. And this cannot be accomplished with first-generation ethanol alone.

Two products to work together

Novozymes' new product family is made up of a cellulase preparation specifically designed to have increased levels of beta-glucosidase activity and a unique performance booster for complete cellulose hydrolysis, as well as a hemicellulase for liberation of hemicellulose, enabling higher ethanol yields. While the cellulase preparation is the key to the entire process, the hemicellulase is a yield booster and can be successfully used in most cellulosic biorefineries regardless of the pretreatment method chosen.

In Brazil, sugarcane is already widely used to make bioethanol. In the future the waste, called bagasse, will also be used.

The future of the industry includes a diversity of feedstock, processes, and players which means that both flexibility and a global perspective are paramount. Together with a range of leading partners, Novozymes is helping the industry explore its wide range of opportunities.

ARE CLOSER THAN YOU THINK

The cellulase is remarkably efficient at breaking down the complex matrix of cellulose contained in a wide variety of biomass substrates, such as corn stover, wheat straw, and sugarcane bagasse. It gives cellulosic ethanol producers the following benefits:

- Best performance/cost ratio seen to date
- Proven on different feedstocks
- Concentrated formulation with long shelf life

To support the cellulase, a new hemicellulase has been developed. This product is very flexible in both its use and benefits, depending on the specific process used in the biorefinery.

"In production processes that use alkaline pretreatments, the hemicellulase can be used to liberate the C5 sugars for further fermentation in ethanol," says Mads Torry Smith, R&D Manager for biomass at Novozymes. "But for cellulosic biorefineries using acid hydrolysis pretreatment, a currently more common method, the hemicellulase can actually boost the action of the cellulase on the C6 sugars, ensuring an even higher yield of total sugars for fermentation."

On the whole, this new product family has the best cost/performance ratio seen in the industry today, making it not only a cost-effective solution for biorefineries, but a ground-breaking one as well.

"When comparing these solutions to others available on the market so far, we find that the 'use cost' is much lower than the competition's. Cellulosic biorefineries can dose our enzymes at much lower levels than other enzymes on the market while still making the same amount of ethanol – in some cases even more," says Mads Torry Smith.

Making fuel from biomass

To make ethanol out of biomass feedstock, the sugar components that are hidden in the substrate must first be liberated.

Biomass is composed of three major fractions: cellulose, hemicellulose, and lignin. Cellulose and hemicellulose contain sugars in polymeric form that can be converted by enzymes into monomers for subsequent fermentation. But the hard, wood-like lignin component of the plant protects the fibers against microbial and enzymatic attack by preventing the cellulose and hemicellulose from reacting with water and swelling. Hence, the use of biomass as a raw material requires disruption of the lignin so that the cellulose and hemicellulose fractions become accessible for enzymatic hydrolysis. Typically, an initial physical or chemical pretreatment is applied to open the fiber structure, followed by the use of enzymes to liberate the C6 from the cellulose and in some cases C5 sugars from the hemicellulose fractions. Afterwards, the sugars can be fermented and further processed into ethanol.

"Just the first step"

While Novozymes has promised the biofuel industry that enzymatic solutions for second-generation bioethanol will be ready by 2010, this is only one step in the entire process that needs to be optimized. To make the entire industry economically viable, a myriad of logistical and technological issues must be solved. Novozymes believes that it will take a couple of years for commercial biorefineries to start producing significant amounts of second-generation fuels for the public.

"These solutions are just the first step towards a commercially viable industry," says Cynthia Bryant. "As important as it is to get started with these solutions, we know that the road to making the second-generation biofuel industry commercially viable is a long one. But Novozymes is in it for the long haul. We already see more products coming in the near future, moving the industry closer and closer to total viability."

At the Novozymes laboratory facilities around the world, over 150 scientists and technicians are already looking far beyond these current second-generation solutions. ■

* Perlack et al, The billion ton report, USDA, DOE, 2005.
EEA, Technical Report, 2007.
G. Fischer et al, Assessment of biomass potentials for biofuel feedstock production in Europe: Methodology and results, IIASA part of REFUEL study sponsored by the EU.

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