

## Enabling the Biorefinery Concept

**G**lenn Nedwin credits his 10th grade biology teacher for turning him on to science, and he has spent a great deal of his life exploring the expanding scope of the biological world. He received his education in biochemistry, earning his Ph.D. from the University of California Riverside in 1981. "I went back to business school at MIT in 1986," he says. "I was intrigued by the business side of science. I loved the big picture and steering the ship into bigger goals."

He has put this education to use throughout his career, leading research and development efforts to where he is now one of the most influential leaders in the industrial biotech and enzyme industry. Nedwin has worked for 25 years in the world of biotechnology. He served as president of Novozymes Inc. for 14 years, where he was instrumental in getting Novozymes into the energy field by lining up an \$18 million subcontract from the U.S. DOE to work on enzymes for cellulosic ethanol. He is also co-editor of the *Industrial Biotech Journal*.

Last March, he moved to his current position as chief science officer and executive vice president at Dyadic International Inc. He tells EPM that he moved to Dyadic—a smaller company—because he was intrigued by the company's focus on and tools for large-scale commercial production and its strong board of advisors and directors, of which he is a member. Dyadic sought him out to take the company to the next level in biorefining via industrial enzymes and microbes, hence he is

also president of Dyadic's biosciences division.

In these capacities, he has been involved with significant developments. Nedwin is leading a \$10 million collaborative project with Abengoa Bioenergy Co. to develop large-scale enzyme production systems and manufacturing processes for use in the production of abundant, low-cost fermentable sugars from biomass, with the initial focus on cellulosic ethanol production.

Additionally, Dyadic has filed several patents in the cellulosic ethanol area, including a soil-derived fungal cell called C1. "Our C1 fungal production strain has a mutation that allows it to be 100 times less viscous [than traditional fungal fermentation]," he says. "It needs less energy, and the cycle time is two days less." It also makes more protein per unit of biomass and can be used in high-throughput screening. These properties will provide for huge economic savings, Nedwin points out. "We recently sequenced the genome, so we are able to manipulate the genetics to make higher-level strains," he says.

Nedwin's team is also focusing on finding optimal enzyme combinations to complement the fungal cell for different biomass feedstocks. "We are still in the process of discovering other novel enzymes for protein that can help with efficient, economic enzyme hydrolysis," he says. Many companies are sampling and testing the company's enzymes. As far as commercial scale, Nedwin esti-

mates the economics will be right within one to three years. Dyadic doesn't currently produce enzymes for the corn starch-to-ethanol process.

Although Nedwin's work is concentrated on producing enzymes for cellulosic ethanol, the whole field is much larger than ethanol. "Once you break down fibers into sugar, the same sugar can be used by microbes to produce chemicals and polymers, such that in the future you could make a dent in the nonrenewable sources," he says. He adds that the biorefinery concept, in which hundreds of different products are made from a renewable feedstock using enzymes and microbes, is about inexpensive sugars and the conversion process. "This technology works," he says. "We can turn any biomass into ethanol."

He notes that economic opportunities in the biorefining field will be realized when the different process steps—pretreatment, enzyme hydrolysis and fermentation—are integrated.

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ON THE JOB