DOE and Chemicals Industry Collaborate on Aggressive Research Agenda

The U.S. chemicals industry, one of the Industries of the Future, is working with DOE's Office of Industrial Technologies (OIT) to support development of a relevant scientific research program. Several ORNL projects have resulted from that collaboration:

Plastic, fibers, and solvents from bioderived organic acids (succinic acid). A five-partner CRADA (NREL, ORNL, ANL, PNNL, and Applied Carbochemicals) resulted in a successful process to produce succinic acid as a platform chemical (see accompanying article for details).

Succinic acid from lignocellulosic hydrolyzates. ORNL and ANL are investigating fermentation and microbial modifications to use mixed sugars (glucose and xylose) from biomass hydrolyzates instead of corn glucose. The current patented strain consumes both glucose and xylose to produce succinic acid, but it needs to be made more efficient.

Biocatalysis under extreme conditions. Enzymes can be modified or used in nonaqueous media to carry out chemical transformations. A collaboration among ORNL, Massachusetts Institute of Technology, Rensselaer Polytechnic University, and UC-Berkeley seeks to extend the use of nonaqueous enzymes to oxidative enzymes for epoxidation or polyphenol polymerization.

Computational fluid dynamics for multiphase flow. This six-partner project will develop and validate a scalable parallel version of the MFIX code to enable it to predict fluid behavior during dense phase bubbling and spouting fluidization of fine cohesive particles. ORNL staff are characterizing temporal and spatial patterns and translating the MFIX code into FORTRAN 90.

A more comprehensive DOE research program, involving some $12 million in funding, is planned in FY 2000. The areas of work are expected to include catalysis, computational fluid dynamics, separations, and structural materials, among other topics.

By: Tom Schmidt, 423-574-4977, schmidttw@ornl.gov
Sponsor: Office of Industrial Process Systems

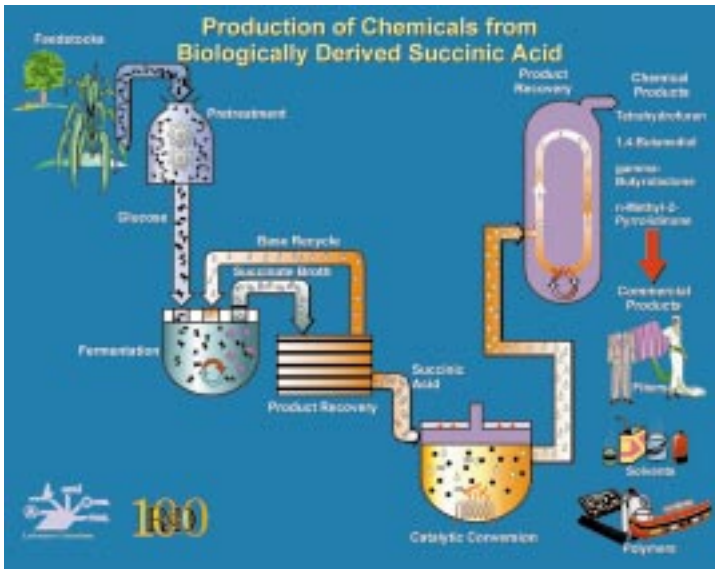
Brewing Corn into Feedstocks

Fermenting corn is a time-honored tradition in the Tennessee hills. So it seems particularly appropriate that ORNL researchers have helped develop a process to ferment corn into a chemical feedstock to make dozens of industrial and consumer products.

The process, developed by ORNL and three other national laboratories, employs a new microorganism to ferment the glucose sugar in corn efficiently into succinic acid. The succinic acid can then be converted into chemical feedstocks used to manufacture plastics, fabrics, paints, inks, food additives, and other products. The bioprocessing method is much less expensive than conventional petroleum-based methods of producing succinic acid and is competitive with current petrochemical commodities such as butanediol. In addition, it eliminates gypsum, a by-product of conventional fermentation methods that must be landfilled.

ORNL was the technical leader of the project. ORNL researchers developed the fermentation process using a novel microorganism, developed by ANL, that converts corn-derived glucose to succinic acid at very high yields. ORNL also scaled the process from bench to 500 L. The dilute broth was concentrated and purified into pure succinic acid at ANL. NREL performed economic analysis, and PNNL researchers focused on catalysis of succinic acid to commodity chemicals, including tests with the actual purified succinic acid.

The bioprocess has been licensed to Applied Carbochemicals of Pennsylvania. The company plans to break ground for a manufacturing plant in 2001 and has developed several new markets for succinate derivatives. Existing



domestic markets for such chemicals total almost 1 billion pounds—and more than $1.3 billion—a year. The project team received a 1997 R&D100 award.

The new process promises to reduce reliance on imported oil and expand markets for domestic agriculture. It is estimated that if chemical feedstocks normally produced from petroleum were instead generated using a single combined biological and chemical plant, the oil saved would be enough to heat 80,000 single-family homes for a year.

By: Brian Davison, 423-576-8522, davisonbh@ornl.gov
Sponsor: Office of Industrial Process Systems