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Final Report

CRADA with International Polyol Chemicals, Inc. and Pacific Northwest National Laboratory (PNL-053): Process Optimization for Polyols Production from Glucose

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Process Optimization for Polyols Production from Glucose

Objective

The objective of this CRADA is to provide sufficient process development to allow a decision for commercialization of the International Polyol Chemicals, Inc. (IPCI) process for production of polyols from glucose. This cooperative research allowed Pacific Northwest National Laboratory (PNNL) to focus its aqueous processing systems expertise on the IPCI process to facilitate process optimization. The project was part of the Department of Energy's (DOE/EE-OIT) Alternative Feedstocks Program (AFP). The project was a demonstration of the cooperative effort between the AFP and the Department of Agriculture's Alternative Agriculture Research Center, which was also funding IPCI research.

Summary of Activities Performed

With the signing of the CRADA in July 1994, PNNL initiated an experimental program of batch reactor tests to evaluate catalysts and operating conditions for the IPCI technology. Catalyst selection was based on experience in aqueous phase processing, specifically low-temperature catalytic gasification of organics. Supported metal catalysts were tested including both nickel and precious metals. The temperature range investigated was primarily below that typically used by IPCI. Lower temperature operation with a particular nickel metal catalyst was specifically evaluated in detail based on the expected improved lifetime of the catalyst. Based on these initial tests an operating regime was identified for product specification of interest to IPCI. Continuous-flow reactor tests were initiated to further evaluate the operating conditions. These tests were facilitated by a funds-in amendment to the CRADA in which IPCI provided a $5000 cash payment to allow tests in advance of the planned schedule.

In the second year of the PNNL CRADA effort, batch reactor tests were continued with a renewed emphasis on product characterization. Additional catalyst types were tested including promoted nickel metal catalysts and copper chromite catalysts. The research was completed with additional continuous-flow reactor tests with the promoted-nickel metal catalyst.

The IPCI CRADA effort included a research effort, a marketing effort, and a process evaluation effort. The experimental work included both bench-scale testing at Montana State University (MSU) and small pilot scale operation at Hydrocarbon Technology, Inc.(HTI). The MSU work was coordinated with bench-scale testing at PNNL. They evaluated cocatalysts for the process and methods for reduction in hydrogen consumption. The HTI pilot scale testing attempted to demonstrate the results obtained at both MSU and PNNL. IPCI coordinated exchange of samples of products, catalysts, and standards between MSU and PNNL in order to better compare results. IPCI also carried out economic evaluation of process developments and marketing of the process to industry.

Significant Accomplishments

- New catalysts and processing conditions were identified which allow the process operators to maximize specific products from the product slate.

- A range of catalysts were tested in bench-scale batch and continuous-flow reactor systems to evaluate their utility in the IPCI technology.

Significant Problems

The development of chemical analytical methods was the biggest problem in this research effort. Effective and reproducible methods are key to monitoring chemical processing development. The wide range of volatility of the feedstocks and products in this process chemistry, as well as the complexity of the product slate, made chemical analysis difficult and required the development of several methods to adequately quantify the results of the experiments.

DOE/Laboratory Benefits Realized

Expanded application of the aqueous phase catalysis expertise was demonstrated. New analytical methods were developed and used. A modified liquid phase sampling system was developed for the batch reactor to improve the productivity in equipment utilization.

Industry Benefits Realized

The process research was aimed at the development of new catalyst formulations and process condition optimizations to allow a directed product slate composition which could be designed for the specific application and varied as market forces dictate. A preliminary economic assessment of the PNNL improvements to this technology by IPCI suggests that they may be useful for market circumstances in Asia. IPCI has licensed the improved catalysts and operating conditions for use in their plants as determined by the market for the products.

Recommended Follow-on Work

Continued pursuit of an industrial demonstration of this technology is important next step for IPCI. PNNL should continue its catalyst development effort to support the commercialization effort.

Potential Benefits from Pursuing Follow-on Work

Continued refinement of our catalyst formulations should provide improved lifetime and product specification. Commercialization of this technology will provide an important element of a new category of chemical manufacture based on renewable feedstocks and which displaces fossil resource-based chemicals production.

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