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FINAL CRADA REPORT

Vertec Biosolvents
Downers Grove IL

Argonne National Laboratory
Energy Systems Division
Argonne IL

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CRADA Title: Advanced Membrane Separation Technology for Biosolvents
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Summary of Major Accomplishments:

Argonne and Vertec Biosolvents investigated the stability and performance for a number of membrane systems to drive the "direct process" for pervaporation-assisted esterification to produce lactate esters. As outlined in Figure 1, the target is to produce ammonium lactate by fermentation. After purification and concentration, ammonium lactate is reacted with ethanol to produce the ester. Esterification is a reversible reaction so to drive the reaction forward, the produced ammonia and water must be rapidly separated from the product. The project focused on selecting pervaporation membranes with 1) acid functionality to facilitate ammonia separation and 2) temperature stability to be able to perform that reaction at as high a temperature as possible (Figure 2). Several classes of commercial membrane materials and functionalized membrane materials were surveyed. The most promising materials were evaluated for scale-up to a pre-commercial application.

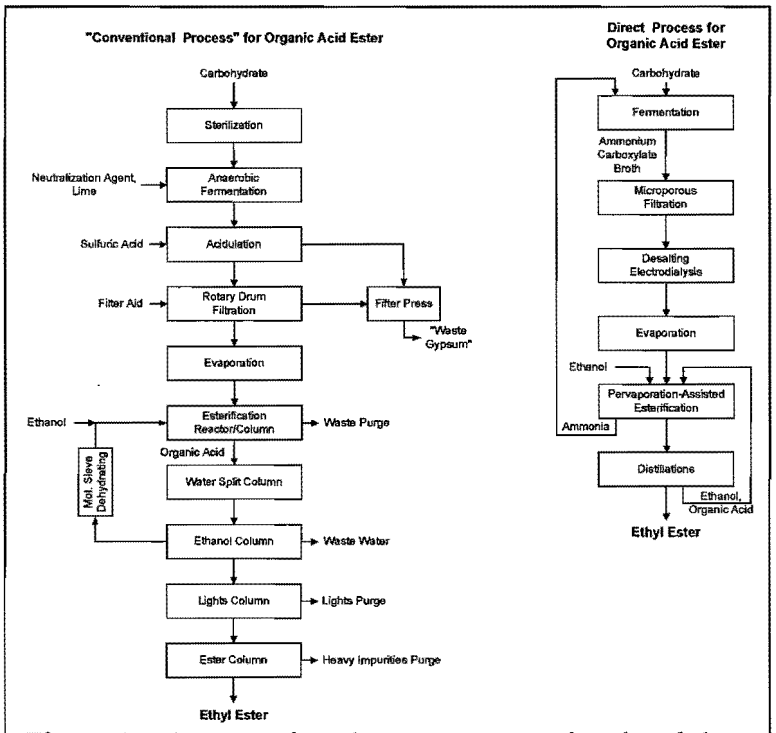

Figure 1 – A comparison between conventional and the direct process for producing organic acid esters.

Summary of Technology Transfer Benefits to Industry:

Over 4 million metric tons per year of solvents are consumed in the U.S. for a wide variety of applications. Worldwide the usage exceeds 10 million metric tons per year. Many of these, such as the chlorinated solvents, are environmentally unfriendly; others, such as the ethylene glycol ethers and N Methyl Pyrrolidone (NMP), are toxic or teratogenic, and many other petroleum-derived solvents are coming under increasing regulatory restrictions. High performance, environmentally friendly solvents derived from renewable biological resources have the potential to replace many of the chlorinated and petrochemical derived solvents. Some of these solvents, such as ethyl lactate; d-limonene, soy methyl esters, and blends of these, can give excellent price/performance in addition to the environmental and regulatory compliance benefits.

Advancement of membrane technologies, particularly those based on pervaporation and electrodialysis, will lead to very efficient, non-waste producing, and economical manufacturing technologies for production of ethyl lactate and other esters.

Other Information/Results: (Papers, Inventions, Software, etc.)

Presentations

Results from this project were presented at:

1) R. Datta and M.P. Henry "GREEN" SOLVENTS – EMERGING MARKETS, APPLICATIONS, AND DEVELOPMENT OF MEMBRANE BASED MANUFACTURING TECHNOLOGIES AIChE Spring Meeting, April **2004**, New Orleans, LA

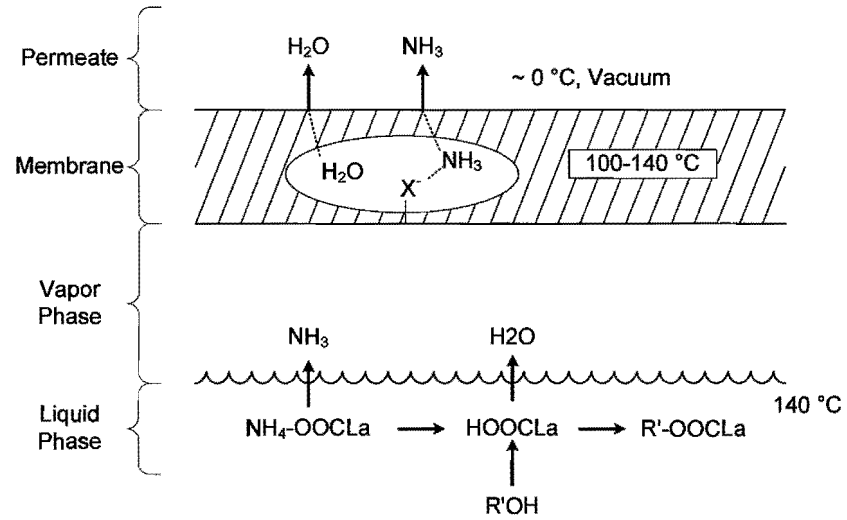

Figure 2 – Schematic of the direct process for pervaporization assisted esterification