

Project Title: Demonstration of Continuous Biobutanol Fermentation Integrated with Membrane Solvent Extraction

Principal Investigator: Erik Hagberg

Objectives: This project proposes coupling fermentation integrated membrane solvent extraction (FIMSE) with isobutanol fermentation to continuously remove isobutanol from dilute fermentation broth, further concentrate to >90 wt%, and reduce the energy needed to recover it by 50%. The goal is to produce isobutanol as a precursor for sustainable aviation fuel (SAF) using the waste pea starch from the production of alternative proteins as the biomass feedstock. The objectives of the project are: 1) Upgrade the waste pea starch to a fermentation grade hydrolysate; 2) Adapt Gevo's isobutanol fermentation technology to use the pea starch hydrolysate; 3) Develop FIMSE conditions for the recovery of isobutanol from the broth; and 4) Couple the FIMSE to the fermentation to demonstrate stable operation and recovery of isobutanol with reduced energy and water usage compared to direct distillation from the broth.

Project Description: The team will establish baseline metrics for the hydrolysis and fermentation of pea starch and compare to hydrolysate produced from standard starch sources such as corn. The team will provide the baseline membrane performance data and procedures from previous model studies. ADM and Gevo will collaborate to produce fermentation grade pea starch hydrolysate and develop fermentation conditions to meet performance target metrics. U of M will investigate the performance of the MSE with model broth mixtures and cell free broth to establish the long-term performance of the candidate membrane(s). ANL will collaborate with U of M to characterize membrane properties and fouling. ADM and ANL will collaborate to develop a TEA and a LCA for the technology. ADM will complete design work for pilot demonstration. ADM will integrate the technologies and pilot the FIMSE. ANL will identify fouling control strategies and U of M will optimize the multistage MSE. ADM and ANL will complete a TEA and LCA for the demonstrated technology.

Project Impact: This project will enable development of the first low energy FIMSE based process at TRL 6 to produce isobutanol for upgrading to SAF. This effort will bring together:

- Commercially available hollow fiber (3M™) membrane application for FIMSE, technology developed by U of M and ADM. Membrane characterization, fouling studies, and mitigation expertise of ANL.
- A pilot scale FIMSE and distillation process using Gevo fermentation technology in combination with MSE to produce isobutanol from waste pea starch as starting biomass.
- Provide evidence-based, diversity-focused education and outreach programs to teachers and students from underrepresented schools and underserved communities to provide education opportunities for bioenergy technologies and develop the future workforce for the biofuels and bioproducts industry.

Participants: Archer Daniels Midland (ADM), Co.; Gevo, Inc.; University of Minnesota, Argonne National Laboratory (ANL)

Project Summary for Public Release

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