AGRICULTURE

Project Fact Sheet

Clean Fractionation for the Production of Cellulose Plastics

Benefits

- Creates a more energy-efficient process
- Lowers manufacturing costs
- Lowers waste production during processing
- Enables the production of valuable co-products, lignin and hemicellulose, which will be investigated for use as a replacement for phenol formaldehyde resins and in a proprietary product, respectively
- Potential 2020 market is 1.23 billion pounds of highly pure cellulose per year
- Projected 2020 fossil fuel displacement is 6.5 trillion Btu

Applications

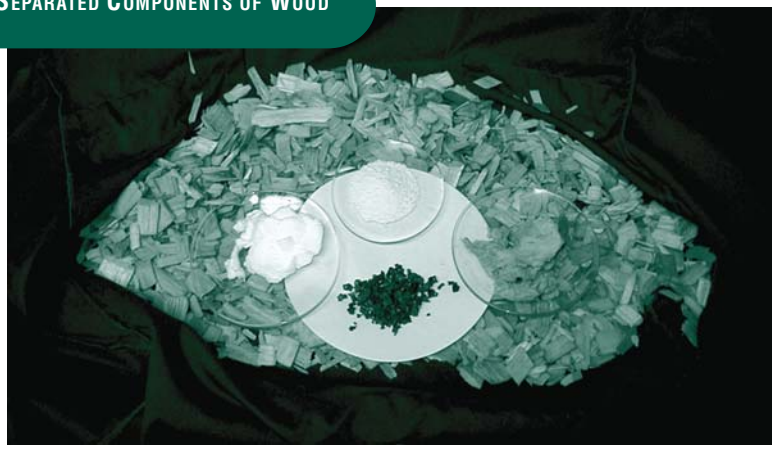
Over 1.5 billion pounds of highly pure cellulose are required each year by the chemical industry. With Clean Fractionation, this demand can be satisfied while reducing energy use and environmental impact. Clean Fractionation may also be applicable to the separation and purification of biomass for other chemical products.

Economical Separation Technology is More Energy Efficient and Produces Valuable Co-Products

Cellulose is one of the few high volume renewable feedstocks used on a large scale by the chemical industry. Over 1.5 billion pounds of highly pure cellulose are used annually to produce chemicals, plastics, food additives, fibers, and textiles. The usual source of cellulose is wood and there are currently two processes used to separate cellulose from the other wood constituents, lignin and hemicellulose. These methods, sulfite and prehydrolysis kraft pulping, use high pressure and chemicals to separate cellulose from lignin and hemicellulose, and to further purify the cellulose to a purity of greater than 97%. They exhibit low cellulose yield of 35-40% by weight, produce malodorous emissions, and deliver the lignin and hemicellulose in an unusable form.

This project will develop a more energy-efficient process to separate cellulose from lignin and hemicellulose using a technology called Clean Fractionation (CF). Clean Fractionation is an example of organosolv fractionation in which a mixture of an organic solvent and water is used to cleanly separate the cellulose, hemicellulose, and lignin. This separation technology has a higher cellulose yield of 47-48% by weight and allows for the use of the lignin and hemicellulose as feedstock for higher value chemicals as compared to the conventional technologies which use the lignin and hemicellulose as fuel. Ninety-nine percent of the organic solvent is recovered and reused, thereby eliminating the odorous emissions and minimizing the downstream effluent treatment. The resulting cellulose requires minimal further purification for use by the chemical industry compared with cellulose from the two conventional pulp and paper processes. Elimination of the high pressure conditions and use of chemicals will result in a significant processing energy reduction.

Cleanly Separated Components of Wood



Project Description

Goal: To investigate the scale-up and commercialization of the Clean Fractionation process for the production of polymer-grade cellulose and co-products, lignin and hemicellulose.

This is a joint project between Eastman Chemical Company, the National Renewable Energy Laboratory (NREL), and a major U.S. producer of chemical-grade cellulose. Clean Fractionation, developed by NREL, uses a mixture of organic solvents and water to separate the cellulose in wood from the other constituents, hemicellulose and lignin. Cellulose is insoluble in the solvent and water mixture and is immediately isolated. It is then purified using a chlorine-free bleaching process. Hemicellulose is dissolved in the aqueous phase while lignin is dissolved in the organic phase. After separating the two phases, evaporation of the organic solvent yields the lignin as a solid. The dilute, aqueous solution containing the hemicellulose is harder to purify, but can be converted into a more concentrated solution or the hemicellulose can be isolated as a solid.

In this project, researchers will focus on process optimization, co-product development, and scale-up. Using small-scale reactors, NREL will determine optimum operating parameters, investigate differences between larger scale operation and the benchtop-scale tests performed at NREL, and continue to study the use of lignin in the production of phenol formaldehyde replacement adhesives. Eastman will optimize the purification of hemicellulose and investigate the production of high value products from the hemicellulose stream. The cellulose producer will improve the cellulose purification process while focusing on the scale-up of the CF process.

Progress and Milestones

- Determine optimum operating conditions for the fractionation process
- Develop an efficient washing operation for removing the solvent, lignin, and hemicellulose liquor from the cellulose
- Develop an optimum bleaching process for the cellulose
- Validate the fitness of using the cellulose in cellulose esters and evaluate the feasibility of use in other cellulose applications
- Demonstrate acceptable sheet formation properties for the cellulose
- Demonstrate end-uses for lignin and hemicellulose
- Successfully scale-up and commercialize the process by 2005

Project Partners

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