Lactic Acid

BIOREFINING PROCESS SOURCE

Fermentation of 6-carbon sugars & starches. Fermentation of lignocellulosic biomass is being researched.

DESCRIPTION

Lactic acid is commercially produced today through the fermentation of glucose derived from plant starch. Approximately 72 million pounds are used annually in the U.S., primarily in food and beverages.[1] There are many potential derivatives of lactic acid, some of which are new chemical products, and others that represent biobased alternatives to chemicals currently produced from petroleum.[1]

Extensive research to develop improved fermentation and separations technology have reduced the cost for corn-derived lactic acid from $1.00 per pound to about $0.50 or less per pound in 2003,[1] and further reductions in cost to $0.25 or less per pound are anticipated.

Intense private and Federal research seeks to expand lactic acid fermentation to processes that begin with lignocellulosic feedstocks.[2, 3,4] Commercialization is being pursued by Cargill Dow, National Renewable Energy Laboratory, Genencor, and others. Genencor and NREL are working to deliver enzyme systems enabling a 10-fold improvement in the economics of breaking down cellulosic material (plant matter) and other complex carbohydrates into fermentable sugars. Others are working to develop advanced hydrolysis methods and organisms that ferment lignocellulose components directly.[4]

REPRESENTATIVE BIOBASED PRODUCT OPPORTUNITIES

BIOBASED PRODUCT	CLASSIFICATIONS	MARKET OPPORTUNITY	MARKET SIZE
Polylactic Acid (PLA)	Thermoplastic polymer	Commercialized by Cargill Dow in 2002 with a 300 million pound capacity plant in Blair, NE as NatureWorks™ PLA.[2] NatureWorks can be used for a variety of uses, including consumer goods packaging, food packaging, and fibers for apparel, bedding, carpet, and other uses. In 2000, over 21 billion pounds of thermoplastics were used in packaging.[1]	Cargill Dow projects a possible market of 8 billion pounds by 2020[1]
Ethyl Lactate	Solvent	Ethyl lactate is an environmentally friendly solvent that has recently been commercialized.[5] Lactate esters have found industrial applications in specialty coatings, inks, cleaners and straight use cleaning. The solvent market is estimated at 8 to 10 billion pounds per year, at prices from $0.90 to $1.70 per pound.[1] Selling prices for ethyl lactate have ranged from $1.50 to $2.00 per pound, but processing advances could drive the price as low as $1.00 to $0.85 per pound.[6] Argonne Laboratory has developed a process based on a selective membrane separation and purification process that permits low-cost synthesis of high-purity ethyl lactate from fermentation-derived lactic acid.	Potential to displace 80% of the 8 to 10 billion pounds of solvents used per year.[1]
Acrylic Acid	Adhesives, polymer	Acrylic acid is an attractive target for new biobased products, at about 2 billion pounds of production annually. Conversion of lactic acid to acrylic acid would require either the enzymatic or thermochemical dehydration of lactic acid. Researchers have attempted to develop a biobased route to acrylic acid, but have not yet found an economical process, which would have to yield a selling price of around $0.48 per pound.[1]	2 billion pounds used per year.[1]
Propylene Glycol	Resins, antifreeze, solvents, hydraulic	Propylene glycol is a commodity chemical with domestic production of about 1.1 billion pounds used in a variety of	1.1 billion pounds used per year.[1]

BIOBASED PRODUCT	CLASSIFICATIONS	MARKET OPPORTUNITY	MARKET SIZE
	fluids, detergents	industrial and consumer applications. It is possible to convert lactic acid to propylene glycol, but research must be done to reduce the cost in order to compete with petroleum derived propylene glycol at $0.39 to $0.48 per pound.[1]	
Pyruvic Acid	Solvent, fungicide, specialty uses	Pyruvic acid is a small-volume chemical whose derivatives are used in a variety of applications from emulsifiers to pharmaceuticals.[1]	Small volume specialty market, but the market price is high.

REFERENCES

[1] Energetics Incorporated. 2003. Industrial Bioproducts: Today and Tomorrow. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Office of the Biomass Program, Washington, D.C.

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[3] Bioproducts Agri-Processing. Genencor, International. http://www.genencor.com/ (21 April 2004).

[4] U.S. Department of Energy, Office of Industrial Technologies. 2001. Chemicals From Lignocellulose, Agriculture Project Fact Sheet. http://www.oit.doe.gov/agriculture/factsheets/lignocellulose.pdf (21 April 2004).

[5] Vertec BioSolvents, Inc.; http://www.vertecbiosolvents.com/ (21 April 2004).

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