

Butanol

BIOREFINING PROCESS SOURCE

Fermentation of 6-carbon sugars & starches, fermentation of lignocellulosic biomass

DESCRIPTION

Butanol is a platform chemical with several large-volume derivatives, and is used in plasticizers, amino resins and butylamines.¹ It is also used as a solvent in lacquers, lacquer thinners, liquid printing inks, disinfectants and fungicides. Butanol has been suggested as a biobased oxygenated fuel for blending in gasoline, with advantages over methanol and ethanol.² The energy content of butanol is closer to that of gasoline, and it has no compatibility or miscibility problems.² In 1999, domestic demand for butanol was 1.85 billion pounds and it is projected to increase 3 percent per year.¹ Use within gasoline would expand this volume significantly.

One difficulty with butanol production is that unlike ethanol, which can be distilled off from water, the boiling point of butanol is significantly higher than water and must be recovered from the still bottoms after the water has evaporated. Also, whereas typical concentrations of ethanol are 6 to 12 percent, butanol is much more toxic and cannot be produced at concentrations higher than 2.6 percent.³

During the early 20th century the primary method of butanol production was glucose fermentation, but the process was complex and the yields were low, leading to replacement by petrochemical routes to butanol.¹ The U.S. Department of Energy is funding research through the Small Business Innovation Research program to improve the biobased route to butyric acid and butanol and make it cost-competitive with the petroleum based route.^{4, 5} A material and energy balance predicts that a yield of 2.5 gallons of butanol per bushel of corn could be achieved, increasing the Btu's derived from a bushel of corn by about 25 percent when compared to ethanol.⁶

REPRESENTATIVE BIOBASED PRODUCT OPPORTUNITIES

BIOBASED PRODUCT	CLASSIFICATIONS	MARKET OPPORTUNITY	MARKET SIZE
Butanol	Solvent, plasticizer, polymers, resins	Butanol and derivatives are used in plasticizers, amino resins, and butylamines. It is also used as a solvent in lacquers, lacquer thinners, liquid printing inks, disinfectants and fungicides. Butyl butyrate is proposed as a biobased solvent, and currently used as a fruity food flavoring.	Markets for butanol and derivatives in the previous column are 1.85 billion pounds per year, at a market price of \$0.55 per pound. ¹
Butanol	Transportation fuel, oxygenate	Butanol has been suggested as a biobased oxygenated fuel for blending in gasoline, with advantages over methanol and ethanol. ²	Large

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.

² Brown, Robert C. 2003. Biorenewable Resources Engineering New Products from Agriculture. Iowa State Press, Ames IA.

³ Jeffries, Tom. Professor, Department of Bacteriology, University of Wisconsin-Madison, Madison, WI. Technical review. (17 May 2004)

⁴ Dr. David E. Ramey, Environmental Energy, Inc.; 1253 North Waggoner Road; Box 15; Blacklick, OH 43004; eei@infinet.com; Tel: 614-864-5650; DOE Grant No. DE-FG02-00ER86106.

⁵ Zhu Ying and Shang T. Yang; Department of Chemical Engineering; The Ohio State University, Columbus, OH.

⁶ David E. Ramey, Zhu Ying, and Shang T. Yang. 2002. A Novel Two-Stage Fermentation Process for Butanol Production from Corn. Ohio State University, Columbus, OH.