

Pyrolytic Bio-Oil

BIOREFINING PROCESS SOURCE

Fast pyrolysis

DESCRIPTION

Pyrolytic bio-oil is a free-flowing, dark brown liquid that can be stored and transported, allowing decoupling of feedstock, process, and use.

A complex, combustible mixture of oxygenated hydrocarbons, with a low pH in the range of 2.5, a specific gravity of 1.2 (about 40 percent greater than fuel oil), and a moisture content of 15 percent to 30 percent. Chemical constituents vary widely with the feedstock, but for pine and spruce with bark, include:¹ water (23.4 percent), methanol insoluble solids and lignin (24.9 percent), cellulubiosan (1.9 percent), glyoxal (1.9 percent), hydroxyacetaldehyde (10.2 percent), levoglucosan (6.3 percent), formaldehyde (3.0 percent), formic Acid, (3.7 percent), acetic acid (4.2 percent), acetol (4.8 percent).

Prior to removing extractives for secondary products, “whole” bio-oil has a higher heating value of approximately 7500 Btu/lb, and a lower heating value of 6850 Btu/lb.² After extracting value added chemicals, the residual bio-oil heating values are reported to be approximately the same or slightly higher.² For improved economics, the manufacturer³ recommends extracting higher value secondary products such as resins and food additives prior to using the residual as fuel.

REPRESENTATIVE BIOBASED PRODUCT OPPORTUNITIES

BIOBASED PRODUCT	CLASSIFICATIONS	MARKET OPPORTUNITY	MARKET SIZE
Bio-oil, whole or residual	Liquid Fuel	Pyrolytic bio-oil has been used commercially for industrial heat since the early 1990's, ³ has been successfully tested as a boiler fuel, ² and is being tested as fuel for diesel transportation and stationary turbine and diesel power. ³	
Various extracted chemicals	Resins	Petroleum derived phenol-formaldehyde resin is used in plywood, oriented strand board, and other wood composites. Resin from pyrolysis bio-oils could replace up to 50 percent of the phenol-formaldehyde. Ensyn has developed several natural resin products that are produced from bio-oil. ³	3.9 billion pounds per year at \$0.30 per pound ⁴
Various extracted chemicals	Food Additives	Extracted additives impart “smoked”, “roasted” and “grilled” flavors to food products. Commercialization by Red Arrow Food Products Company of Wisconsin (www.redarrowusa.com) using bio-oil from the Ensyn fast pyrolysis process. ³	Specialty market
Levoglucosan	Polymers, Pharmaceuticals, Pesticides, Surfactants	Levoglucosan is considered a potential building block for synthesis of polymers, pharmaceuticals, pesticides, and surfactants. ⁵ Microorganisms have been identified that can ferment levoglucosan to citric acid and itaconic acid. ⁵	Large

REFERENCES

¹ BioOil. DynaMotive Energy Systems Corporation. <http://www.dynamotive.com/> (21 April 2004).

² Sturzl, Ray. 1997. The Commercial Co-firing of RTP™ Bio-Oil at the Manitowoc Public Utilities Power Generating Station. Manitowoc Public Utilities, Manitowoc, WI. <http://www.ensyn.com/info/info.htm> (21 April 2004).

³ Ensyn Group, Inc. <http://www.ensyn.com/> (21 April 2004).

⁴ 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.

⁵ Brown, Robert C. 2003. Biorenewable Resources Engineering New Products from Agriculture. Iowa State Press, Ames IA.