

Lignin: Technology, Applications and Markets

Special Market Analysis Study

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2. Introduction, Methodology, and Scope

Lignin, cellulose and hemicellulose are the three main organic compounds in plant cell walls.

It has been said you can make anything from lignin except money. Anything from fuel to animal feed to vanillin to carbon fiber. But today, people *are* making money from lignin.

Lignin has been known since the early 1900s, first in tanning extracts, but mainly as an unwanted byproduct of the sulfite pulping process. Production of lignosulfonate emerged in the 1920s as one of the few profitable solutions for the organic waste generated in the pulping process. Later, with the development of the modern kraft process, lignin became an important source of fuel in kraft pulp mills.

More recently, as the need evolved for alternative fuels, biorefineries emerged to produce ethanol from biomass, and again, there was lignin to be either disposed of or used for value. At the same time, as the paper industry matured and began to decline in developed markets, mills sought new revenue streams.

The expanding interest in lignin gave rise to this study. What is the difference between kraft lignin and lignosulfonate? What are the different types of biorefinery lignins? Which applications offer potential for high value? For high volume? Which biorefinery processes will yield high value lignin? What is the state of the industry? What is the outlook for 2020 and 2025? This report will answer these questions and more.

Introduction

This report was written by Jack Miller, Founder and Principal Consultant, Market-Intell LLC and Associate Consultant, RISI, with the assistance of Marina Faleiros, Senior News Editor, RISI.

Jack has more than 30 years' experience in market research and marketing strategy related to paper and paperboard, as well as related markets such as print and packaging. For the past five years, his focus has been on marketing and business development for emerging materials such as nanocellulose and lignin. Jack is the author of *Nanocellulose: Technology, Applications and Markets* published by RISI in 2014.

Marina Faleiros has been working as a journalist and editor for the pulp and paper industry for more than 10 years. She currently manages pricing data for the market pulp, graphic paper and boxboard markets for RISI, and reports trends and in-depth information about key moves by producers and buyers in Latin America. Marina has visited more than 20 pulp and paper mills across Latin America and holds an MBA degree in economics and financial journalism.

For technical support, the authors enlisted the help of technical advisors, including:

- Hasan Jameel, North Carolina State University

- Joseph J. Bozell, University of Tennessee, Knoxville
- Michael Paleologou, FPInnovations
- World L-S Nieh, US Forest Products Laboratory

Methodology

The study methodology includes extensive primary and secondary research. Primary research includes more than 25 interviews conducted by Market-Intell and RISI, in person and by telephone and email, specifically for this study, including:

- Adrian van Heiningen, University of Maine
- Anders Larsson, Manager LignoBoost and Innovations, Valmet
- Bernard de Galembert, Innovation and Bioeconomy Director, Confederation of European Paper Industries (CEPI)
- Blaine Kunkel, CEO, BlueGoose Biorefineries
- Caio Falcão, Strategy and Business Development Manager, Suzano
- Fabio Figliolino, R&D Innovation Manager, Suzano
- Gurminder Minhas, Managing Director, Performance BioFilaments Inc.
- Hasan Jameel, Distinguished Professor, North Carolina State University
- Hiroaki Namba, Deputy Gen. Mgr. Chem Div. R&D, Nippon Paper Industries
- Hou-min Chang, Professor Emeritus, North Carolina State University
- Joseph Bozell, Professor, University of Tennessee, Knoxville
- Lani O'Flynn, CEO/Vice President, Pure Lignin Environmental Technology Ltd.
- Mats Nytorp, Business Director, Lignin, Domsjö Fabriker
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- Peter Axegård, Vice President, Bioeconomy Strategy, Innventia
- Richard Gosselink, Coordinator Wageningen UR Light Platform, Wageningen University
- Robert Rapier, Managing Editor & Director of Analysis, Energy Trends Insider
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- David van Vliet, Adviseur, Structural Reliability, TNO

- Vesa Pylkkanen, CTO, American Process
- World L-S Nieh, National Program Lead, Forest Products and Wood Utilization, US Forest Service

Secondary research included an extensive review of technical journals, conference presentations, magazine articles and websites. More than 100 are listed in the "References," most with hyperlinks to the source material. Many of these are cited in the text; the balance provided background.

Secondary research also included a high level patent search. We identified and reviewed more than 300 patents and patent applications that were deemed relevant. These are referenced in the text as appropriate, and listed in several tables.

This report is the result of that research. It is business and market focused, but of necessity includes some high-level technical discussion, and every attempt has been made to put the technical discussion in non-technical jargon. Chemists and materials scientists may find it oversimplified, and perhaps less than precise, while business executives may find that it has too much technical detail. We have tried to strike a balance.

Scope

The scope of this study is global. It includes the various forms of lignin, characteristics, preparation and applications. It includes an assessment of the market potential, and profiles the various companies and research centers that are producing lignin or conducting research related to lignin technology, applications and markets.

Notes

Active hyperlinks to source documents in Google Patents and other references are provided. Hyperlinks are indicated by [blue type](#).

The symbol "\$" is used to mean US dollars (USD or US\$) unless otherwise noted.

Volumes mentioned in this report are in metric tons (tonnes). Data obtained in short tons were converted.