Potential environmental/economic impact reductions using extracted flakes in oriented strandboard production

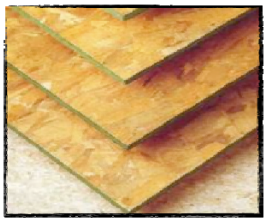
Jay Messer
M.S. Candidate
Center for Renewable Carbon
University of Tennessee, Knoxville, TN

Plant Biotech Building
Room 160

October 12, 2011
12:20PM EST

Overview

- Introduction
  - What is OSB?
  - What is LCA?
- Justification
  - Impacts
- Research Objectives
- Proposed Methods
- Works Cited
- Acknowledgements
- Funding Organizations



Introduction

What is OSB?

- Created in the late 1970's
- Wood composite, evolved from waferboard
- Flakes strategically oriented, not random

Introduction

- Hemicelluloses extracted flake
  - Potential environmental/economic benefits
- Previous study revealed improved panel properties
  - Dimensional stability and mold resistance
- Hemicelluloses, a hydrophilic polymer in wood

ource: Hosseinaei et al. 2011

Introduction

- Reduction in hemicelluloses content via pretreatment
- Reduced inputs needed for meeting industry standards
  - Strength, water absorption, and thickness swell
- Reduction of inputs will likely lead to reduced environmental/economic impact

Introduction

- Previous work has also been done in Life Cycle Assessment (LCA) of OSB
- LCA is an all-inclusive approach for analyzing environmental impact
  - Allows comparison of goods and services on equal & holistic basis

ource: Kline 2005

Justification

- OSB is increasingly used as low cost alternative to plywood
  - Significant because amount of energy used is roughly double

Cradle-to-gate cumulative energy requirements by fuel source		
Energy Type	**Plywood**	**OSB**
Coal	676	1270
Crude Oil	756	1883
Natural Gas	1536	3809
Uranium	50	114
Biomass	2573	3951
Hydropower	43	98
Electricity other	15	20
TOTAL	**5649** *MJ/m3*	**11145** *MJ/m3*

ource: Puettmann and Wilson 2005

Justification

Major sources of impact
- Resin production
- Emissions control

- Resin production is the most energy intensive process
  - Consumes three times the energy than plywood in this area

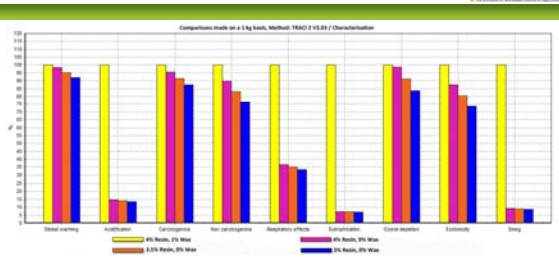
ource: Puettmann and Wilson 2005

Justification

- Emissions control is important
  - Emissions include
    - Carbon monoxide
    - Particulate matter
    - Nitrogen oxide
    - Volatile organic compounds
  - Incineration of volatile organic compounds (VOC)
    - Big contributor of fossil energy use

ource: Paredes 2009

Justification



Source: Puettmann 2005

Research Objectives

- Use existing data to model environmental and economic life cycle of OSB production using hemicelluloses-extracted flakes
- Establish input minimums for resin and wax input for making acceptable OSB with hemicelluloses-extracted flakes

Proposed Methods

Hot water hemicelluloses-extraction

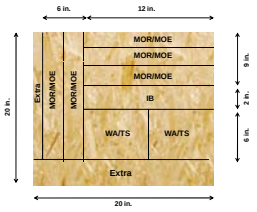
- Large spherical rotating digester
- 41.5kg of Southern yellow pine flake
  - 90% moisture content
- Heated to 155°C and maintained for 30 min.
- Water to flake ratio of 20:1

Proposed Methods

Five treatments, two repetitions
- Normal flake 1% wax 4% resin (Control)
- Extracted flake 1% wax 4% resin
- Extracted flake no wax 4% resin
- Extracted flake no wax 3.5% resin
- Extracted flake no wax 3% resin

Proposed Methods

How the panel is cut is important
- Initial panel size is 24” x 24”
  - Panel trimmed to 20” x 20”
- Cut to maximize testing repetitions
  - Five tests for bending strength
  - Six tests for internal bond
  - Two tests for water absorption



Proposed Methods

Panel Testing
- Bending Strength (MOR)
- Modulus of Elasticity (MOE)
- Internal Bond (IB)
- Water Absorption & Thickness Swell
- Mold Susceptibility

- Measured using ASTM D1037 procedures
- Analyzed using one-way analysis of variance
  - To be performed with SPSS
- Duncan’s multiple range test
  - Used for comparing means

Works Cited

1. Carlson, F. E. "A Study of Formaldehyde and Other Organic Emissions from Pressing of Laboratory Oriented Strandboard." *Forest Products Journal* 45.3 (1995): 71-77. Print.
2. Hosseinaei, Omid, Siquan Wang, Timothy G. Rials, Cheng Xing, Adam M. Taylor, and Stephen S. Kelley. "Effects of hemicelluloses Extraction on Physical and Mechanical Properties and Mold Susceptibility of Flakeboard." *Forest Products Journal* 61.1 (2011): 31-37. Print.
3. Kline, D. Earl. "Gate-to-Gate Life-Cycle Inventory of Oriented Strandboard Production."*Wood and Fiber Science* 37 (2005): 74-84. Print.
4. McKeever, D.B. 2002. Gen. Tech Report. PNW-GTR-524. Portland, OR. US. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 76p.
5. Paredes, J. J. "Influence of hemicelluloses Extraction on Physical and Mechanical Behavior of OSB." *Forest Products Journal* 58.12 (2008): 56-62. Print.
6. Paredes, Juan J. "The Influence of Hot Water Extraction on Physical and Mechanical Properties of OSB." Thesis. University of Maine, 2009. Print.
7. Puettmann, Maureen E. "Life-Cycle Analysis of Wood Products: Cradle-to-Gate LCI of Residential Wood Building Materials." *Wood and Fiber Science* 37 (2005): 18-29. Print.
8. White, Robert H. *Fire Performance of Oriented Strandboard*. Proc. of Seventeenth Annual BCC Conference on Flame Retardancy, 2006, Norwalk, CT. Vol. 17. N.p.: n.p., n.d. 297-309. Print.

Acknowledgements

•Dr. Adam Taylor, Associate Professor, University of Tennessee

•Dr. David Harper, Associate Professor, University of Tennessee

•Dr. Brian Via, Assistant Professor, Auburn University

•Kevin Wise, Director of Applied Research and Pilot Plant Coordinator, North Carolina State University

•Dr. Omid Hoesseni, Center for Renewable Carbon

•Dr. Coskun Kose, Post-doct Research Associate, Center for Renewable Carbon

•Dr. Jae-Woo Kim, Post-doct Research Associate, Center for Renewable Carbon

•Dillion Alley, Student Assistant, University of Tennessee

Funding Organizations

USDA

CRC Center for Renewable Carbon

Center for Renewable Carbon

The University of Tennessee Institute of Agriculture

Questions???