



# ***Green Chemistry Case Studies: Presidential Green Chemistry Challenge Awards 2012 Winners***

Nicole Casasnovas  
Hannah Needleman  
July 2012





# **Case 3:**

# **Buckman International, Inc.**

Winner in the Area of Design of Greener Chemicals

# **Buckman**

Commitment makes the best chemistry.

# Overview

**Title:** *Enzymes Reduce the Energy and Wood Fiber Required to Manufacture High-Quality Paper and Paperboard*

## Summary:

Traditionally, making strong paper required costly wood pulp, energy-intensive treatment, or chemical additives. But that may change. Buckman's Maximize® enzymes modify the cellulose in wood to increase the number of "fibrils" that bind the wood fibers to each other, thus making paper with improved strength and quality -- without additional chemicals or energy. Buckman's process also allows papermaking with less wood fiber and higher percentages of recycled paper, enabling a single plant to save \$1 million per year.

# Buckman Receiving EPA Presidential Green Chemistry Challenge Award



# Motivation

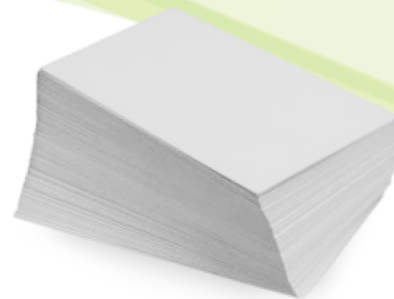
## *Business Drivers*

- **The paper and packaging industry is an important part of the US economy**
  - Product sales: \$115 billion per year
  - Employment: About 400,000 people
  - Shipping: Over 95% of all products in the US are shipped in corrugated boxes
- **Why was it important to spend resources developing this technology?**
  - Buckman has been developing this type of technology for over 20 years
  - Many good reasons to use enzymes, which helps in making profits to keep the company sustainable
  - History of creating and improving enzymes for the paper industry

# Motivation

## *Innovations in Science and Engineering*

- Cellulose fibers are the basic structural material of paper
- Properties of a sheet of paper like strength and weight depend on bonding between cellulose fibers
- Existing Technology:
  - Papermakers can improve paper strength by:
    - Adding different wood pulps (costly)
    - Increasing mechanical treatment (requires significant energy expenditure)
    - Using various chemical additives (many derived from non-renewable resources)
  - In nature, cellulases are enzymes that catalyze the hydrolysis of cellulose to degrade and recycle this organic compound
    - *Endoglucanases* disrupt the crystalline structure of cellulose and expose individual chains
    - *Exocellulases* separate pieces of two to four sugar monomers from the exposed chains
    - *Cellobiases* hydrolyze those fragments into glucose
  - Can enzymes like cellulases be used to improve papermaking?
- **Can we do better?**

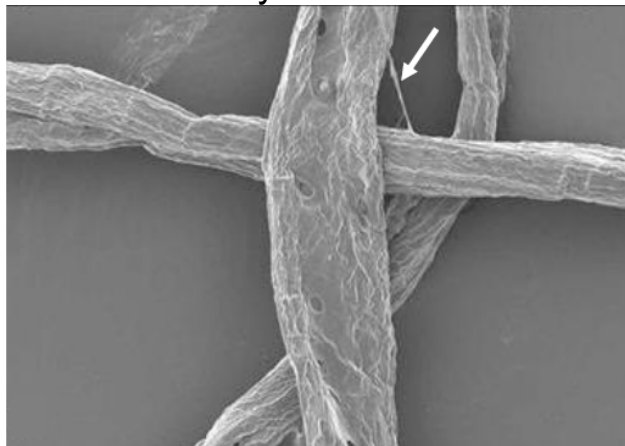


# Technology Development

- **Approach:** Select enzymes within the cellulase group to modify cellulose fibers in order to improve paper quality and support greener manufacturing practices.
- Maximyze technology consists of specific enzymes that improve inter-fiber bonding in cellulose, increasing the strength of paper.

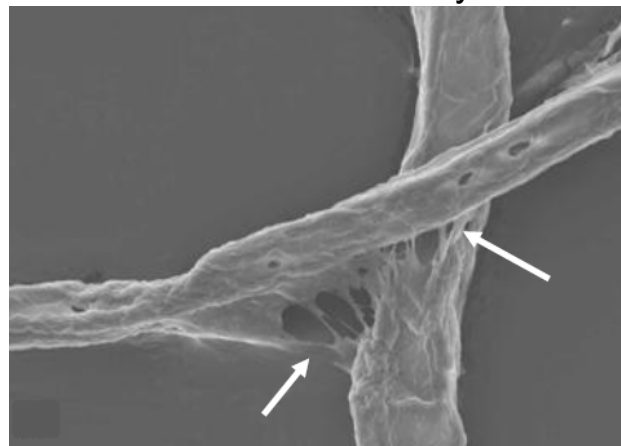
## Bonding of Refined Cellulose Fibers (500x)

No enzyme treatment



*Limited number of fibrils (arrow) can be seen connecting adjacent fibers*

Treated with Maximyze



*Fibrillation is evident through multiple fibrils (arrows) between cellulose fibers*



# Business Activities

- Partnered with some major suppliers of enzymes
- Buckman has established long term relationships with customers
- Intimately involved in the entire papermaking process
- Unique sales people with biology and chemistry backgrounds form personal relationships with customers



# Impact

## ***Environmental, Health, and Safety Benefits***

- Less cellulose fiber required to produce paper and related products
  - Less trees required to produce pulp, which helps maintaining our woodsources
  - Increase in the proportion of hardwood fiber needed to maintain paper strength (reduces amount of softwood fibers, which have a higher cost)
- Reduced energy per ton of paper produced due to a more efficient refining process and using less steam to dry products during the papermaking process
- Less resources required for shipping due to lighter paper weight
- More utilization of recycled paper, which reduces volumes in landfills
  - *The paper industry has a strong commitment to sustainability, maintaining forest lands, and recycling: 63.5% of paper consumed in the US is recovered and recycled to be reused back in the manufacture of paper and paperboard.*
- Use of enzymes, which are safer with regard to human health and the environment
  - Made using renewable raw materials in a fermentation process
  - Completely biodegradable

# Impact

## *Economic Benefits*

- Manufacturing plants using Maximize see clear economic benefits and improved sustainability in a variety of areas.
- **Estimated total savings: \$1,058,000 per year**

Economic and Environmental Benefits of Maximize			
Parameter	Before	With Maximize	Benefit (\$/ton)
Tons of steam per ton of paper (@\$16/ton of steam)	2.23	1.86	\$5.90
Average production (ton/day) incremental value = \$100/ton	125.8	147.6	\$15.60
Total filler (%) @ \$5 benefit/1% filler replacing fiber in sheet	23	24	\$5.00
Total benefits (\$/ton)			\$26.50
Estimated total savings (\$/day)			\$3,200
Estimated total savings (\$/year)			\$1,058,000



# Thank You!

- The following representative was integral in the creation of this report:
  - Philip Hoekstra, **Buckman International Inc.**