PULP & PAPER PPI
INTERNATIONAL
BRINGING THE WORLD OF PULP AND PAPER TOGETHER IN ONE PLACE
www.risi.com - November 2012

Forest Farming for paper in India

UBM
RISI

BREAKTHROUGH TECHNOLOGIES

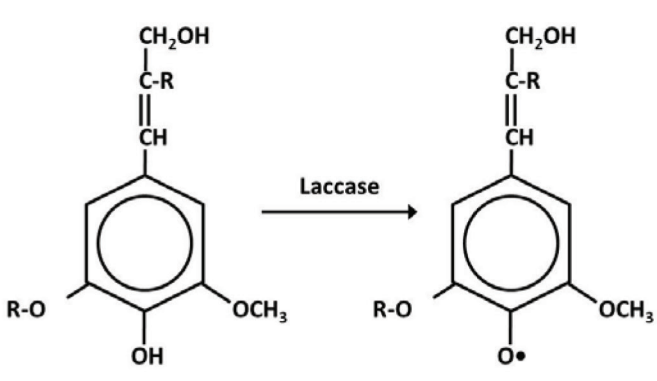
A GREENER ALTERNATIVE FOR IMPROVING STRENGTH IN RECYCLED PACKAGING

Buckman has been a pioneer in the application of products containing enzymes in the pulp and paper industry, resulting in several breakthrough technologies. Buckman won the 2004 Presidential Green Chemistry Challenge Award from the US Environmental Protection Agency for its Optimyze® products that improve control of stickies and reduce their effect on quality and productivity. Application of Optimyze results in improved recycled fiber quality, leading to better fiber utilization. In 2012, Buckman was again awarded the Presidential Green Chemistry Challenge Award, this time for its Maximyze® products. Maximyze products, added to the pulp, can reduce refiner energy, increase sheet strength, enable substitution of lower cost fiber, increase ash content, and reduce steam consumption. Until now, most of the success was limited to fiber sources containing high portions of bleached kraft pulps, predominantly in tissue, printing, and writing grades.

Identifying a Maximyze formulation that worked well in fiber sources containing unbleached fiber was a difficult challenge. Traditional Maximyze formulations had minimal impact on unbleached fibers and were generally not successful. It is possible that residual lignin in the fibers was preventing the enzyme from accessing the cellulose chains, or inhibit the enzyme activity in some other way. Many different types of enzyme were evaluated both in the laboratory and on paper machines, with no consistent, measureable results. A new enzyme product, Maximyze 2540 is proving to be effective, enabling the recycled packaging market to realize many of the benefits previously limited to those markets using bleached fiber.

Maximyze 2540 contains a unique laccase enzyme. Laccases are found in many plants, fungi, and microorganisms. In nature, this type of enzyme is expressed by white-rot fungi and similar organisms that play an important role by breaking down lignocellulosic materials, like wood. These enzymes typically contain copper complexed within the enzyme. Laccases also catalyze the formation of lignin. Laccases are a form of oxidase enzyme and, in the formation of lignin, they require some sort of oxidant. This second substrate necessary for the enzyme to function is called a "mediator". A mediator is required only in the breakdown and not the synthesis of lignin.

With the use of Maximyze 2540 to improve paperboard strength, the likely mechanism is related to that involving synthesis of lignin. The enzyme in this product activates lignin in the fibers. Upon web consolidation, wet pressing, and drying, polymerization occurs where the activated lignin reacts further with the fiber surface or with other lignin in



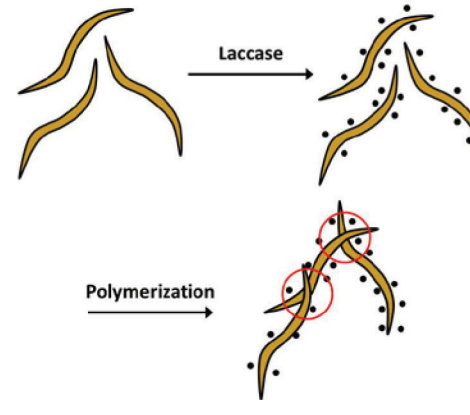


Figure 1 - **Impact of Maximyze on Ring Crush**

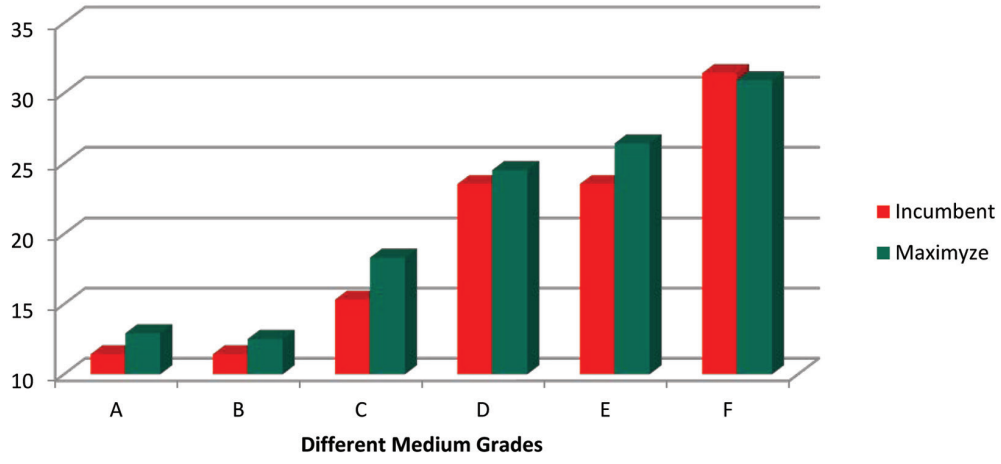


Figure 2 - **Impact of Maximyze on Concora**

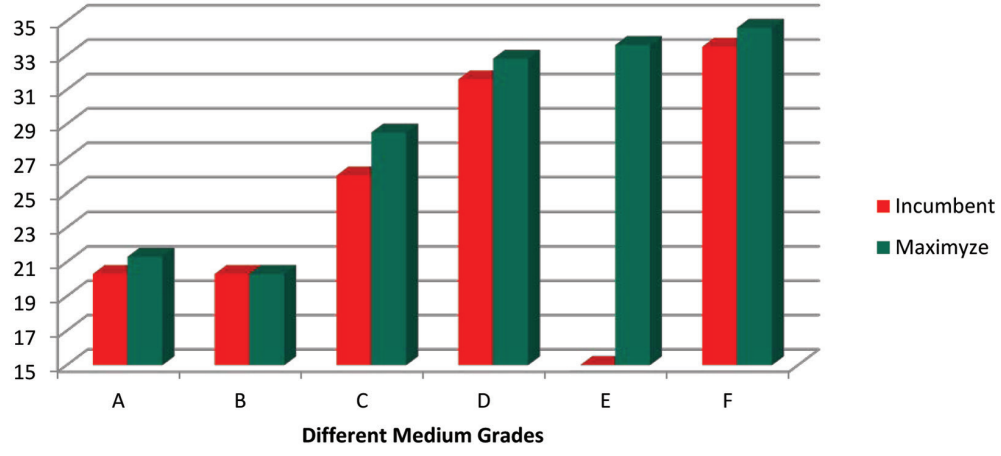


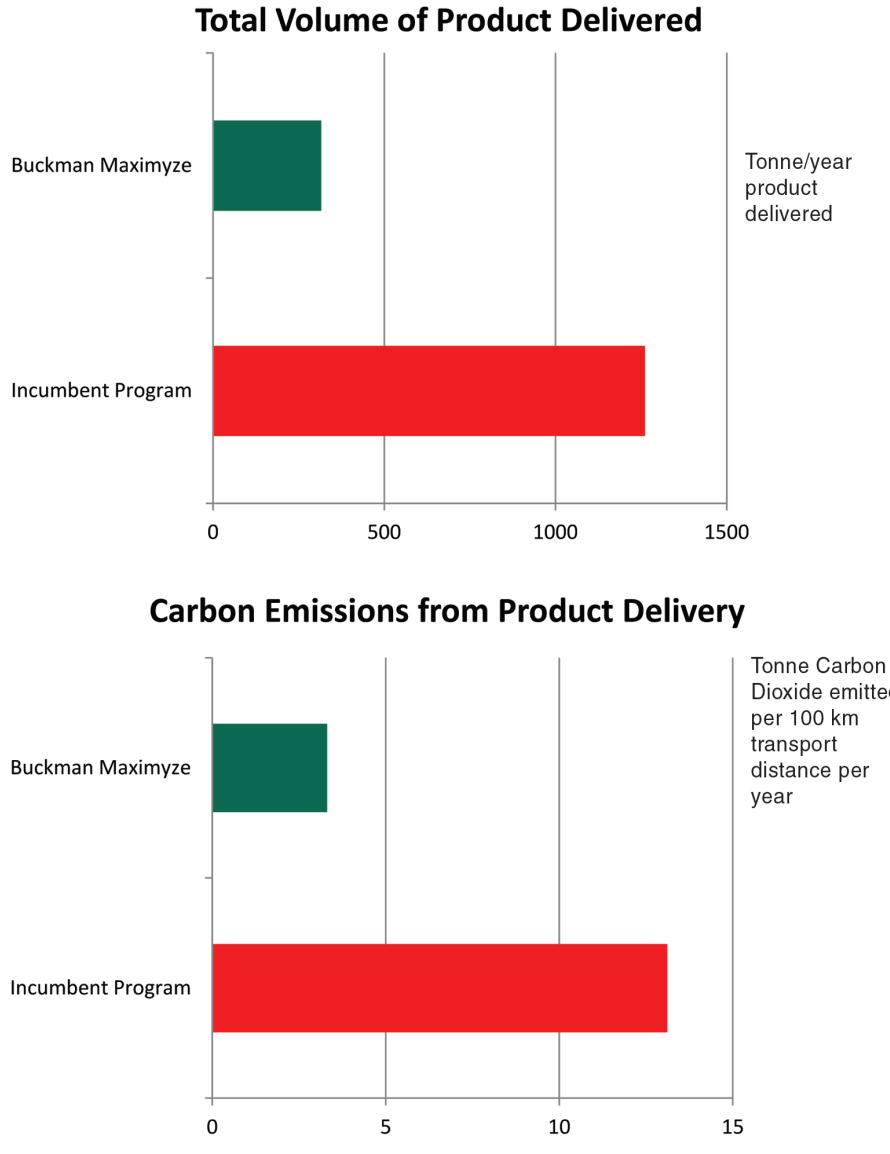
Figure 3 - **Percentage improvements in strength properties with Maximyze**

Grade	Concora % Improvement	Ring Crush % Improvement
A	+ 4.7%	+ 13.2%
B	0.0%	+ 9.6%
C	+ 8.8%	+ 19.6%
D	+ 3.7%	+ 4.3%
E	No Incumbent Data	+ 12.3%
F	+ 3.2%	(-1.6%)
Overall Average	**+ 4.1%**	**+ 9.6%**

Figure 4 - **Comparison of product application quantities**

	Component 1 kg/tonne	Component 2 kg/tonne	Total kg/tonne
Incumbent: Cationic + Anionic Polymers	8	4	12
Buckman: Maximyze 2540 + Bubond 408	0.3	2.7	3

Figure 5 - **Effect of reduced product volume on transportation-generated carbon dioxide emissions**



the system, changing the fiber characteristics and the resulting board strength properties.

CASE STUDY

Consider the example of a paper machine that manufactures corrugating medium using 100% recycled fiber. As the content of curbside mixed recycled waste is increased, the papermakers struggle to maintain board strength parameters, particularly Ring Crush and Concora. Typically, as they increase refining energy to meet strength specifications, drainage is limited and they have to reduce machine speed, resulting in below-budget production rates. Another option is to use less curbside waste. Not only is this option more costly, but there are societal and environmental reasons to increase the use of locally generated waste.

The mill utilized a conventional two-component strength and drainage program consisting of two polymers: one anionic and one cationic. Applied correctly, the paper machine was able to meet strength specifications using curbside waste while maintaining drainage, machine speed, and production rates at budget. However, the program was costly and logistics were complicated. High volumes of product were necessary, requiring close attention to inventories and usage rates. It was looking for an alternative that would reduce the cost and logistical complexity while maintaining the benefits.

Buckman currently treats this paper machine for deposit control utilizing its Busperse 2858 monochloramine technology. This involves the use of oxidant chemistry. With the knowledge that laccase enzymes require an oxidizing environment to function properly, the decision was made to evaluate a two-component program: Maximyze 2540 to provide the strength and Bubond® 408 to maintain drainage and machine speed. Maximyze 2540 is added to a stock chest located between the coarse screening and thin stock cleaners at a dosage of 300 grams/tonne. Total residence time of Maximyze 2540 in the stock, from addition point to sheet forming, is about two hours. Bubond 408 is added to the suction side of the fan pump at a dosage of 2.7 kg/tonne. Both the cationic and anionic components of the conventional strength and drainage program were removed. The Maximyze 2540 - Bubond 408 program was run for several months, and the key strength parameters, Ring Crush and Concora, compared favorably with the averages for the incumbent program across several different grades.

Beyond the increase in key strength characteristics, total chemical program cost was reduced significantly when switching from the incumbent to Maximyze 2540 and Bubond 408. The mill has converted to the Buckman program.

In addition to the increase in board strength and the improvement in overall cost, there are several sustainability-related effects associated with the Buckman program. The overall volume of product required for treatment is significantly less than the incumbent program:

At the current production rate for this paper machine, the mill required delivery of 1,260 tonnes/yr of the incumbent's products, compared with 315 tonnes/yr of Buckman's. Given typical fuel usage and an average load of 20 tonnes, the reduction in carbon dioxide emissions associated with transporting product into the mill was reduced from 13.1 to only 3.3 tonnes/yr for every 100 km transport distance.

In addition, the reduction in volume of product required means simpler logistics at the mill. The Incumbent program required a delivery about every 5.5 days while Buckman deliveries are approximately 22 days apart. The benefits are many: fewer loads to receive, unload, and process the paperwork, less congestion in the mill yard, reduced warehouse space required, and reduced complexity of managing inventory.

SUMMARY

Enzymes are nature's catalysts, present in every living organism, to carry out a wide range of chemical reactions. There is a tremendous variety of enzymes, each performing a different function. Enzymes perform at incredible speeds, which has the immediate advantage of increasing the efficiency of many chemical processes, thereby making them more sustainable. Given that enzymes are proteins, they are completely biodegradable. In addition, because they are typically produced by fermentation from sugars, enzymes are truly renewable catalysts. Identifying a specific enzyme, Maximyze 2540, to improve strength in recycled unbleached fiber represents the future for improving the overall sustainability of the facilities producing packaging grades. **PPI**

Dan Denowski: Global Market Development Manager – Paper; Phil Hoekstra: Director/Systems and Support, Research & Development, Buckman International

REFERENCES

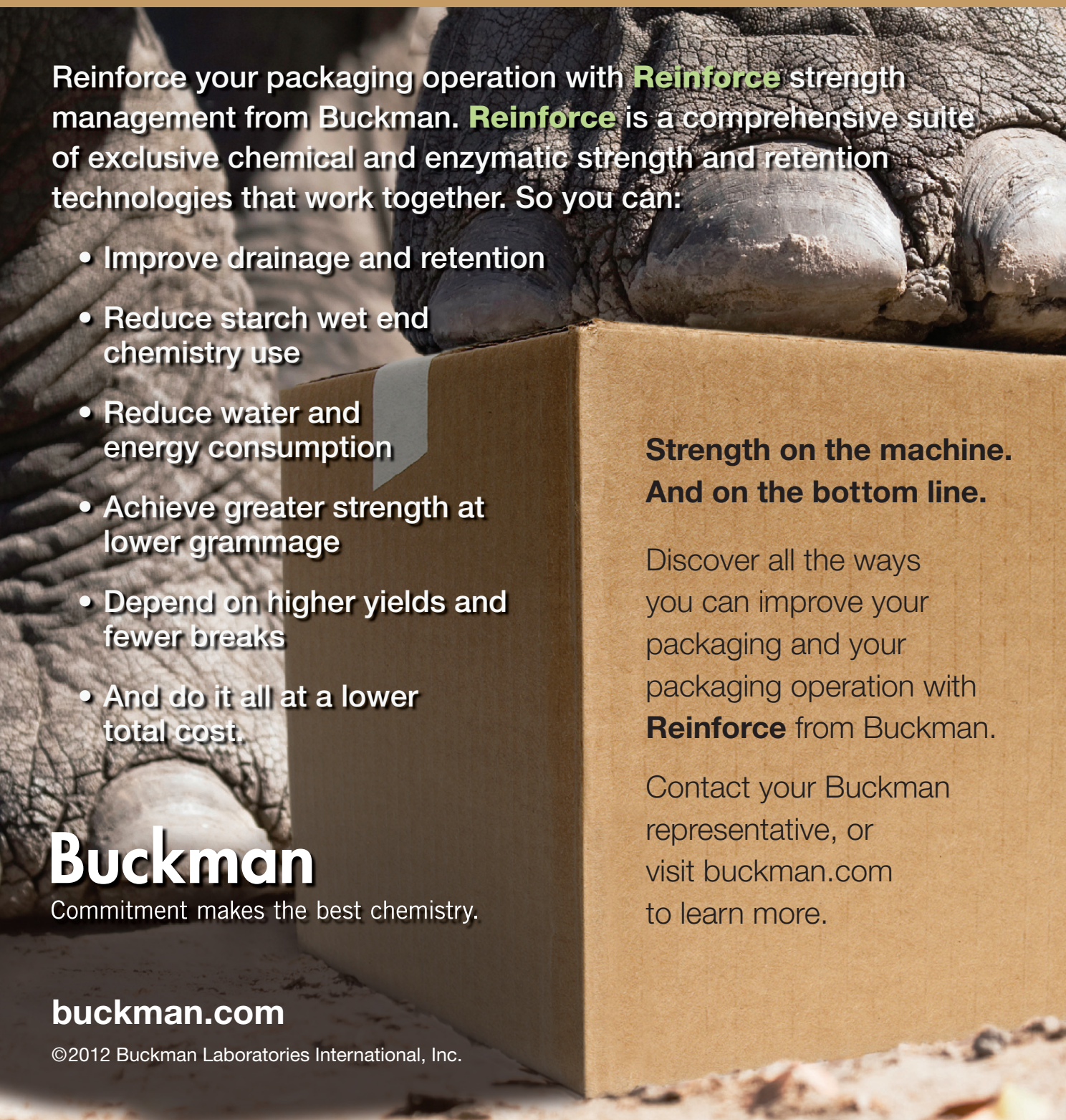
US Environmental Protection Agency, Designing Greener Chemicals Awards (2012). Buckman International, Inc.: Enzymes Reduce the Energy & Wood Fiber Required to Manufacture High-Quality Paper and Paperboard. Retrieved from: http://www.epa.gov/greenchemistry/pubs/pgcc/winners/dgca12.html.

US Environmental Protection Agency, Green Chemistry, Green Chemistry Award Winners (2004). Buckman International, Inc.: Optimyze®: A New Enzyme Technology to Improve Paper Recycling. Retrieved from: http://www.epa.gov/greenchemistry/pubs/pgcc/past.html#2004.

WIDSTEN, P. & KANDELBAUER, A. (2007). Laccase applications in the forest products industry: A review. Enzyme and Microbial Technology, 42 (2008), 293-307.

CONYNGHAM, M. (2011, August-September). Enzyme products offer greener solutions to the Pulp & Paper Industry. White Paper on www.risiinfo.com. (available upon request from webmaster@buckman.com)

Make stronger, smarter, greener packaging at a lower total cost.



Reinforce your packaging operation with **Reinforce** strength management from Buckman. **Reinforce** is a comprehensive suite of exclusive chemical and enzymatic strength and retention technologies that work together. So you can:

- Improve drainage and retention
- Reduce starch wet end chemistry use
- Reduce water and energy consumption
- Achieve greater strength at lower grammage
- Depend on higher yields and fewer breaks
- And do it all at a lower total cost.

Strength on the machine. And on the bottom line.

Discover all the ways you can improve your packaging and your packaging operation with **Reinforce** from Buckman.

Contact your Buckman representative, or visit buckman.com to learn more.

Buckman

Commitment makes the best chemistry.

buckman.com

©2012 Buckman Laboratories International, Inc.