MANUFACTURING

‘Maximyzing’ productivity in recycled packaging

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First published in World Pulp & Paper 2014

INTRODUCTION

Enzymes are all around us. Every cell contains thousands of different enzymes, catalyzing all the reactions necessary to maintain life. They work by reducing the energy of activation necessary to facilitate a reaction, allowing the reaction to occur at ambient living conditions. As a catalyst, an enzyme is not consumed in the reaction. It is important to remember that enzymes are proteins whose unique shape gives them their functionality as catalysts. They are not living organisms. Performance of a given enzyme is affected by concentrations of the substrate and the enzyme, temperature, pH and presence of any other inhibitors or activators. Enzyme samples from nature contain mixtures of many different enzymes, making their use in systems other than originally intended unpredictable. Advancement in cloning techniques has enabled the isolation of mono-component enzymes, offering many different products with very specific and unique activity.

Widely used in both the food and detergent industries, enzymes are a relatively recent option for papermakers. 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 U.S. Environmental Protection Agency for Optimyze® products that improve control of stickies and reduce their impact on quality and productivity. Application of Optimyze results in improved recycled fibre quality, leading to better fibre utilisation. In 2012, Buckman was awarded a second U.S. EPA Presidential Green Chemistry Challenge Award, this time for Maximyze® products. Maximyze products, when applied to a fibre system, can reduce refining energy, increase sheet strength, enable substitution with lower cost fibre, increase ash content, reduce steam consumption, increase production rate and reduce the papermaking operation’s environmental footprint.

Initially, Maximyze was successful in fibre blends containing high portions of bleached Kraft pulps, predominantly in tissue and printing and writing grades. Recycled fibre, with its high levels of variability of fibre length, ash, starch and lignin content, was more of a challenge. Continued testing of new mono-component enzymes, specific blends of different enzymes and synergistic effects when combined with other products has led to breakthrough success in papermaking systems utilising recycled fibre. This area continues to evolve with new developments occurring rapidly.

One concern of papermakers is the effect of Maximyze when a fibre system is unexpectedly shut down. Since the function of Maximyze products is to catalyze reactions and it is not consumed in the reaction, there is a concern that left alone for too long, the enzyme will continue to cleave cellulose bonds indefinitely. However, unlike the imaginary perpetual motion machine, Maximyze does not catalyze reactions forever in paper mill systems. As proteins relying on their specific shape to catalyze a reaction, enzymes are subject to hydrolysis, particularly in dilute papermaking systems. Testing of Maximyze products in fibre systems demonstrates this eventual loss in activity. Compared to a control, Biochemical Oxygen Demand (BOD) of filtrate from pulp containing Maximyze does not significantly increase after about four hours, indicating that Maximyze is no longer active *(see Figure 1 below)*.

EARLY SUCCESSES WITH MAXIMYZE IN RECYCLED FIBRE

Original success in recycled fibre systems centered around replacing existing and more costly strength additives with Maximyze products offering equal strength and productivity of the operation at reduced cost. Most of these successes involved coupling the Maximyze application with a more traditional strength and drainage aid chemistry, enabling a synergistic effect. Often, when replacing existing strength additives with Maximyze, we also reduce the carbon dioxide footprint of the operation by reducing product volume, handling and logistics. *(See Figures 2 and 3 above)*

Figure 1: Effect on Biochemical Oxygen Demand (BOD) of Maximyze products over time

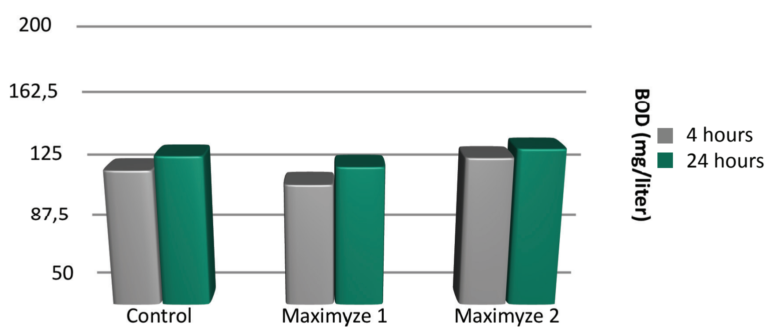


Figure 2: Concora across different grammage grades on a recycled packaging machine

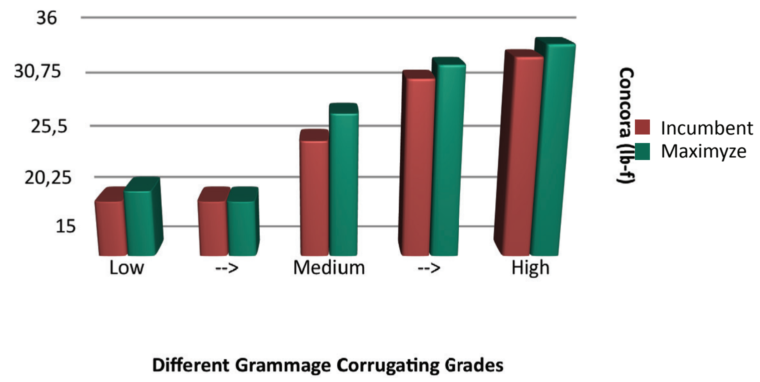


Figure 3: Reduction in CO_2 emissions to transport strength additives to the mill

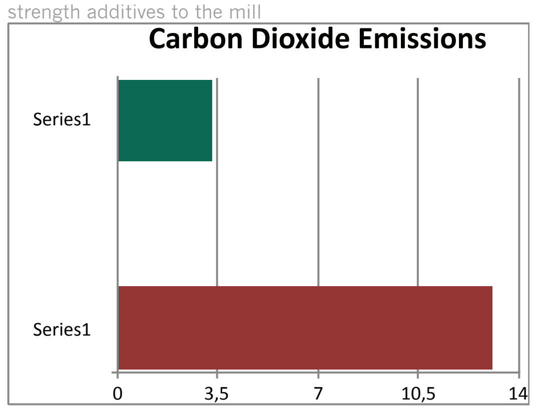
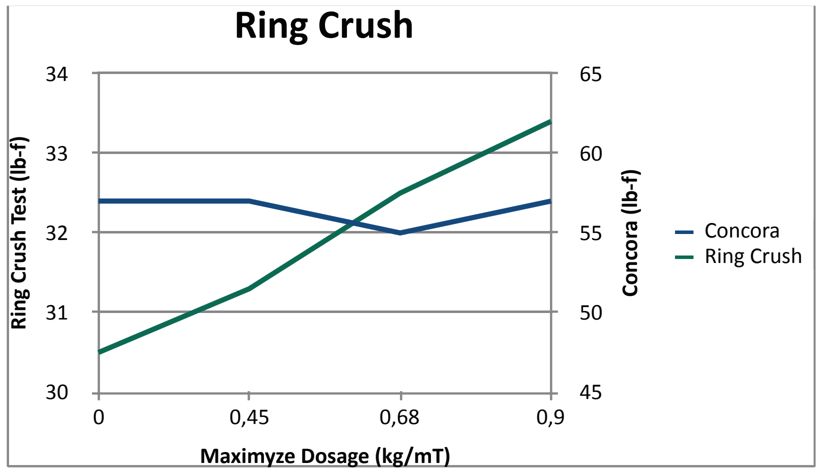


Figure 4: Effect of varying Maximyze dosage on Ring Crush on a recycled packaging machine



Another paper mill needed to increase the Ring Crush values of their grades while maintaining Concora. Several different possible solutions were evaluated without success. When they applied Maximyze, they were able to demonstrate effective increase and control of Ring Crush by varying Maximyze dosage, all while maintaining Concora values (*see Figure 4 above)*.

In order to evaluate the effect of Maximyze, another recycled linerboard machine established a baseline for Ring Crush at a given production rate on a key grade, then introduced Maximyze at 450 g/mT without making any adjustments on the machine. Ring crush increased over 4%. Given this new tool for achieving their key strength parameter, management can now determine the most effective way to optimise overall production costs by a combination of reduced grammage and reduced refining energy. The sustainability of the operation improved with Maximyze by reducing the carbon footprint.

APPLYING MAXIMYZE TO IMPROVE DRAINAGE

Utilising recycled fibre continues to be an increasing challenge for the papermaker. As collection efficiency increases, individual fibres are recycled numerous times. With each iteration, fibre length is reduced while surface area increases.

Ash content in recycled fibre is increasing by 1% every three years and it is forecasted to increase at an even faster rate in the future as point-of-purchase packaging demands higher quality graphics. Productivity rates of some paper machines began to suffer as the drainage rate of the recycled fibre deteriorated. In some situations, the need for drainage to maintain productivity is more of a challenge than meeting strength targets. Another generation of Maximyze was necessary to address this growing gap. Several different approaches were taken, key of which was blending specific mono-component enzymes together into one formulation, providing a synergistic effect.

A large, modern machine making two-ply linerboard from recycled fibre experienced a loss in productivity due to drainage limitations with the current recycled fibre supplied. Excessive water loads in the wire section led to drive system overloads, reduced productivity and high steam usage. A new Maximyze formulation was applied at a rate of 180g/mT to the stock storage chest approximately two hours before the paper machine.

Initial results were…underwhelming. Almost no effects were noted in the first 20 hours of the evaluation. However, as Maximyze began to cycle up in this highly closed system, drainage began to improve. Paper machine speed records were set. Wire section drive loading was reduced 5%. Production rate increased, giving the papermaker incremental tonnes and reducing the overall energy usage per tonne, reducing the carbon footprint for the operation. (*See Figures 5-7 on following page*)

In similar fashion, another recycled packaging machine with a drainage limitation on production rate applied Maximyze at a rate of 1 kg/mT to the pulper with a residence time of approximately one hour before the paper machine.

While maintaining key strength parameters – Short Span Compression Test (SCT) and Flat Crush (CMT) – the paper machine speed increased as drainage improved. In addition, overall steam usage was reduced by 8%, providing substantial reduction in carbon footprint (*see Figure 8 and Table 1 on opposite page*).

NEXT STEPS

Of course, challenges remain, foremost the variability of recycled fibre itself. As producers struggle to turn recycled fibre back into saleable board, they are utilising more starch to maintain strength targets. This in turn reduces the fraction of actual fibre in a tonne of recycled fibre returning to the papermaking operation. Requirements for print and graphic quality are driving use of coated mechanical grades laminated to the outside of the point-of-sale packages on store shelves, introducing even more short, high fines content fibre and ash into the recycled fibre market.

Temperature limitations exist in some packaging manufacturing locations. Maximyze products work best above 50 degrees Celsius. Since the 1889 Arrhenius Equation, we know that increasing system temperature by 10 degrees Celsius will double the reaction rate. Maximyze products also follow this rule, to a point. As proteins whose specific shapes dictate their function as catalysts, the enzymes in Maximyze formulations are easily denatured at high temperatures. However, most Maximyze products are effective up to at least 70 degrees Celsius, above typical paper machine operating conditions. But cold operating conditions can limit Maximyze's effectiveness, requiring dosages higher than economically feasible. Efforts to eliminate wasted energy in papermaking through reduced water usage and more effective pressing and drying systems will help to increase system operating temperatures (*see Figure 9 on opposite page*).

We sometimes see that a given Maximyze product might be quite effective in recycled fibre on one continent but less so on others. Despite the globalization of our economy, local differences in recycled fibre properties exist and can be significant. Differences in papermaking equipment, operating conditions and regional strength specifications can enhance or limit a Maximyze formulation's performance.

Cost of energy is a huge variable as it is often a key contributor to a Maximyze programme's return. In operations where energy is expensive, it is easier to justify an application. For certain, health of the packaging market itself and the associated demand for incremental tonnes, is also a factor.

As packaging producers work to make their operations more sustainable, they are making manufacturing conditions more challenging. Fresh water consumption and efforts to reduce it result in higher whitewater conductivity, higher hardness and reduced pH. These conditions make it a challenge for all chemical additives, including Maximyze products, to perform.

Figure 5: Impact of increased drainage with Maximyze on paper machine speed

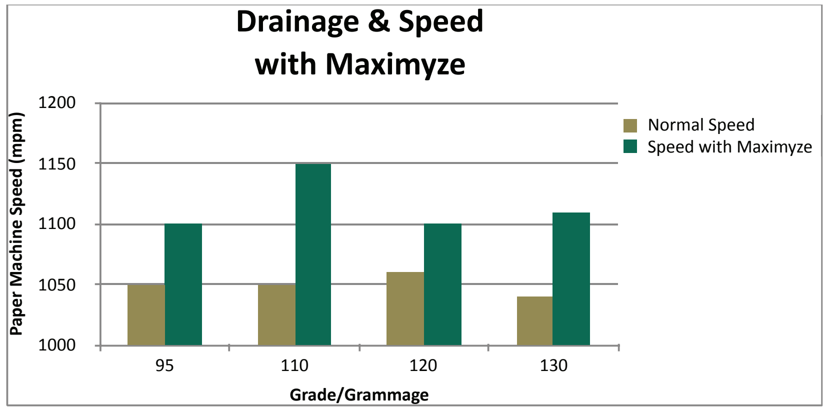


Figure 6: Impact of increased drainage on production

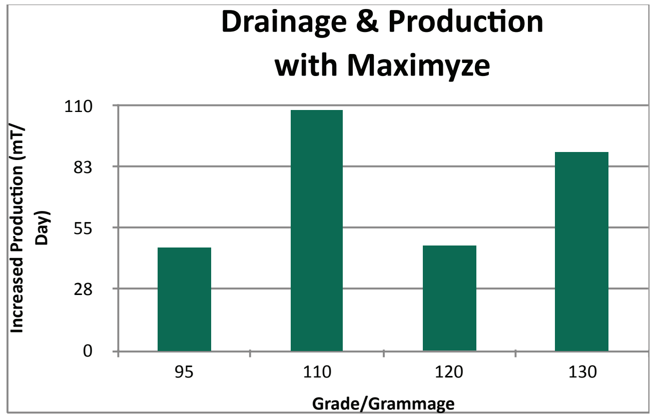


Figure 7: Impact of increased drainage on carbon footprint

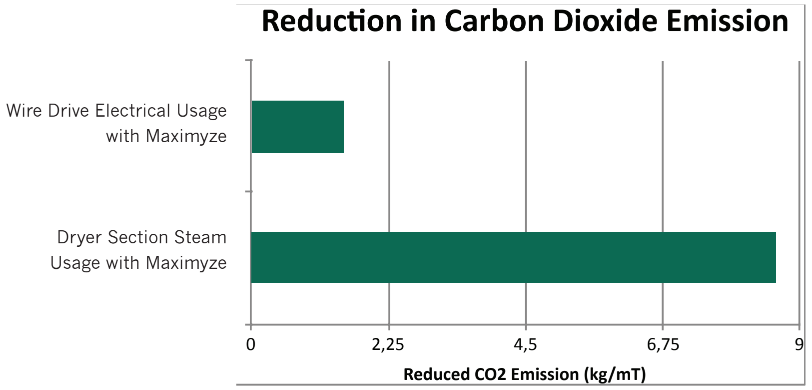


Figure 8: Impact of increased drainage on production

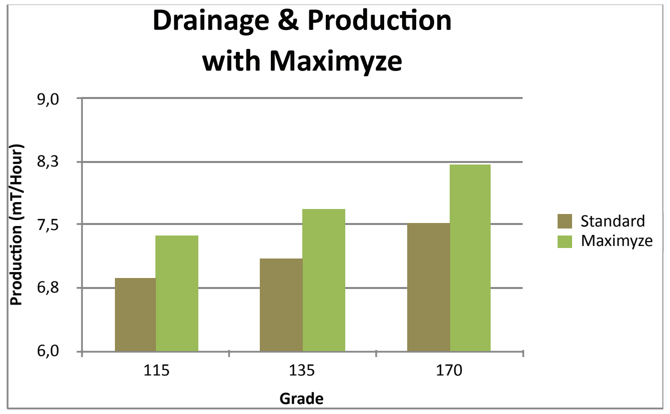
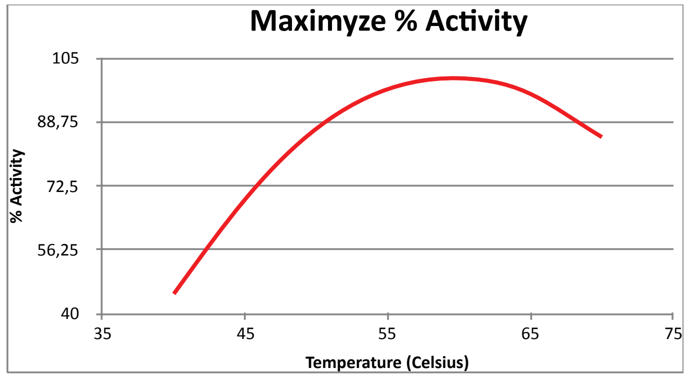


Table 1: Effect of Maximyze on Carbon Dioxide emissions

	Standard	Maximyze
Average Production Rate in mT/hr.	7.08	7.64
mT steam per mT board	1.77	1.51
Reduction in Carbon Dioxide per Year		1806 mT/y CO_2

Figure 9: Typical Maximyze activity vs. Temperature



On the other hand, the drive to improve sustainability through reduced grammage and increased recycled fibre yield while maintaining strength characteristics will provide the continued demand for any product that can enhance either strength or productivity, especially if it also contributes to reduced environmental impact.

Buckman anticipates the continued need to develop specific Maximyze formulations to address ever-changing differences in regional, process and market conditions. To that end, Buckman remains committed to the continued evolution of our Maximyze product line to meet the future challenges of the recycled packaging industry. ■

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