World Pulp & Paper

THE INTERNATIONAL REVIEW FOR THE PULP AND PAPER INDUSTRY

2012

Maximyze your fibre basket

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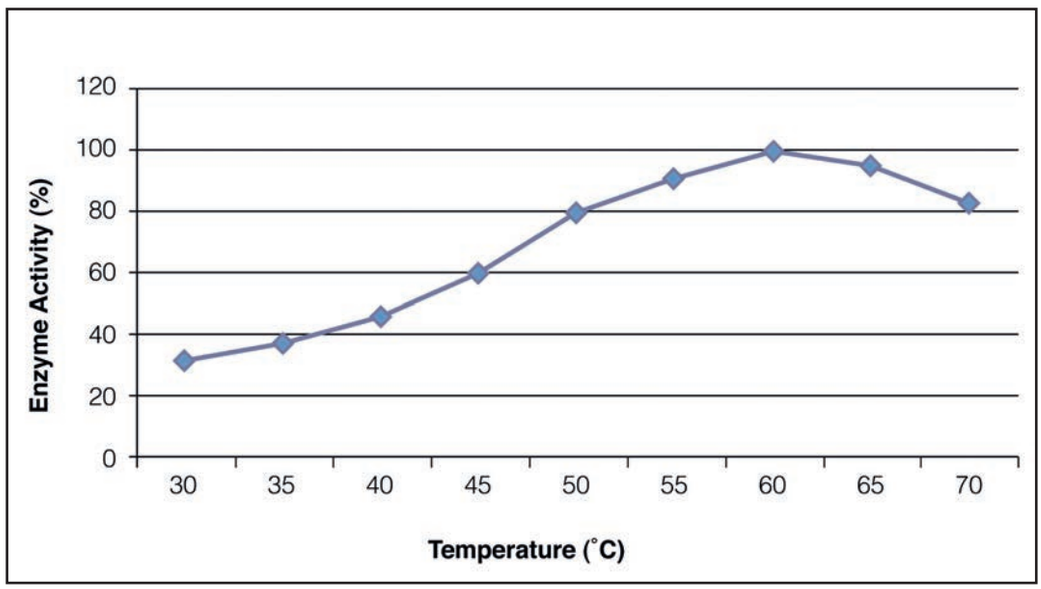
"Buckman GREEN. Our color. Our commitment". This statement conveys Buckman's dedication to being a sustainable company. It is an important part of our culture and a cornerstone of our business model.

Buckman has been front and centre in the development of enzyme-based products for the pulp and paper industry. This started many years ago with the introduction of the Neoteric® products for microbial deposit control. The Neoteric product range includes enzyme-based products and biodispersants that break down the microbial slime that form deposits. Another important advancement in enzyme-based solutions was the introduction of the Optimyze® product line for stickies control. Since then, this range of products has been expanded with the new Optimyze Plus products. Buckman has enzyme-based products for other applications including cleaning, deinking, bleaching, and starch conversion, to name a few.

One of the newest enzyme based-product lines is the Maximyze™ family. Maximyze is composed of enzyme-based products that modify or fibrillate fibre to give the same effect as mechanical refining with less of the negative aspects.

The Maximyze products' mode of action is discussed and case studies presented.



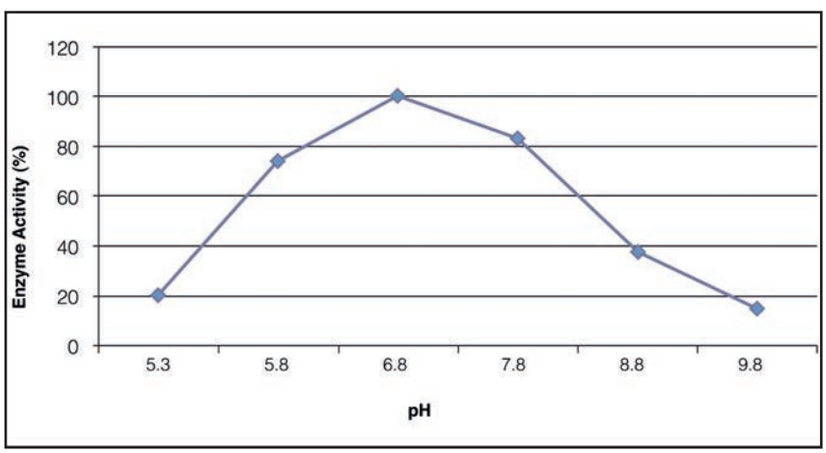


Figure 1 *Typical Enzyme Temperature and pH Curves*

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MAXIMYZE YOUR FIBRE BASKET

Enzymes have been used in various industrial processes for hundreds of years. The yeast used in beer and wine making, for example, contains enzymes that produce fermentation. Now, enzyme products can be and are produced that contain one specific enzyme. This has allowed the industrial use of enzymes to expand. One area where the use of enzymes is expanding is in the pulp and paper industry. Some pulp and paper processes that utilise enzymes include deinking, bleaching, deposit control and starch conversion. An innovative use of enzymes is in fibre modification. Buckman introduced the Maximyze product line six years ago. Since the introduction of Maximyze, over 60 mills around the world are reaping the benefits of this technology.

What are enzymes? They are nature's catalysts. Enzymes are protein-based molecules that catalyze the various reactions in all living things, i.e., respiration, nutrients and

growth. Enzymes are true catalysts in that they are not consumed in the reaction, and each enzyme molecule can catalyze thousands and thousands of reactions per second. Enzymes are very specific to the reaction that they drive. Each individual type of enzyme does one thing and one thing only. Enzymes are complex molecules and their shape determines their function.

The reaction rate of an enzyme varies with pH and temperature. In the case of temperature, as the temperature increases, the reaction rate or enzyme activity rate increases. This increase is fairly linear until a temperature comes to a point where the enzyme molecule breaks down. This breakdown is called denaturing and is not reversible. The pH effect is different; each enzyme type has a pH where the activity is at the highest. As the pH goes up or down from that point, the enzyme activity decreases. The effect of this is that each enzyme type has an effective pH range. The pH effect is reversible. For example, if a given enzyme has a maximum activity at pH 7 and the enzyme is in a part of the process that has a pH of 5, then the activity will be lower than the maximum. However, if you change the process pH to 7, then the enzyme will once again be at maximum activity.

The temperature and pH activity curves vary from enzyme to enzyme. The curves above are examples and are not specific to any of the Maximyze products. It is important to know the temperature and pH curves for the enzymes that you are utilising to ensure that system parameters match the product. Other factors that affect the activity of enzymes are inhibiting and denaturing compounds. A good example of a denaturing compound is chlorine; most enzymes can only tolerate a fairly low level of free chlorine. This denaturing is irreversible. Inhibiting compounds block the activity of the enzyme. The inhibiting compound can block the site of the reaction or attach to the enzyme. Inhibiting compounds do not denature the enzyme; they just inhibit the enzyme's activity. The compounds that inhibit activity vary from enzyme to enzyme.

Figure 2 *Buckman's 8 Business Management Standards*

In any enzyme application system, system knowledge is essential. Temperature, pH and process additives need to be known and documented. Other essential information includes tank and chest volumes, levels and flows. This information is important to calculate retention time in the system. The more contact time there is the more each enzyme molecule can do. System knowledge is one of the Buckman 8 Business Management Standards that ensure communication and a true partnership between all stakeholders.

Replacing softwood kraft with hardwood kraft and reducing mechanical refining gives improved softness, an important quality for tissue grades

The Maximyze products are enzymes that work on the cellulose chain in the fibre. Mechanical refining is used to impart various characteristics to fibre, depending on the grade and type of wood. Mechanical refining is employed to increase tensile, internal bond and other sheet properties. The mechanical refining 'beats' the fibre, damaging the fibre wall. This weakening leads to wall stripping, delamination, collapse and fibrillation. This increases the sites for fibre-to-fibre bonding and, therefore, increases sheet strength properties such as tensile.

Maximyze does on a molecular level what mechanical refining does on a macro level. By breaking bonds in the cellulose chain the fibre is weakened and wall stripping, delamination, collapse and fibrillation occur. The Maximyze is working at the bond level so there is less fibre cutting and fines generation than with mechanical refining. You can think of the fibre as a rope made up of many strands. A blade can cut the rope. This is similar

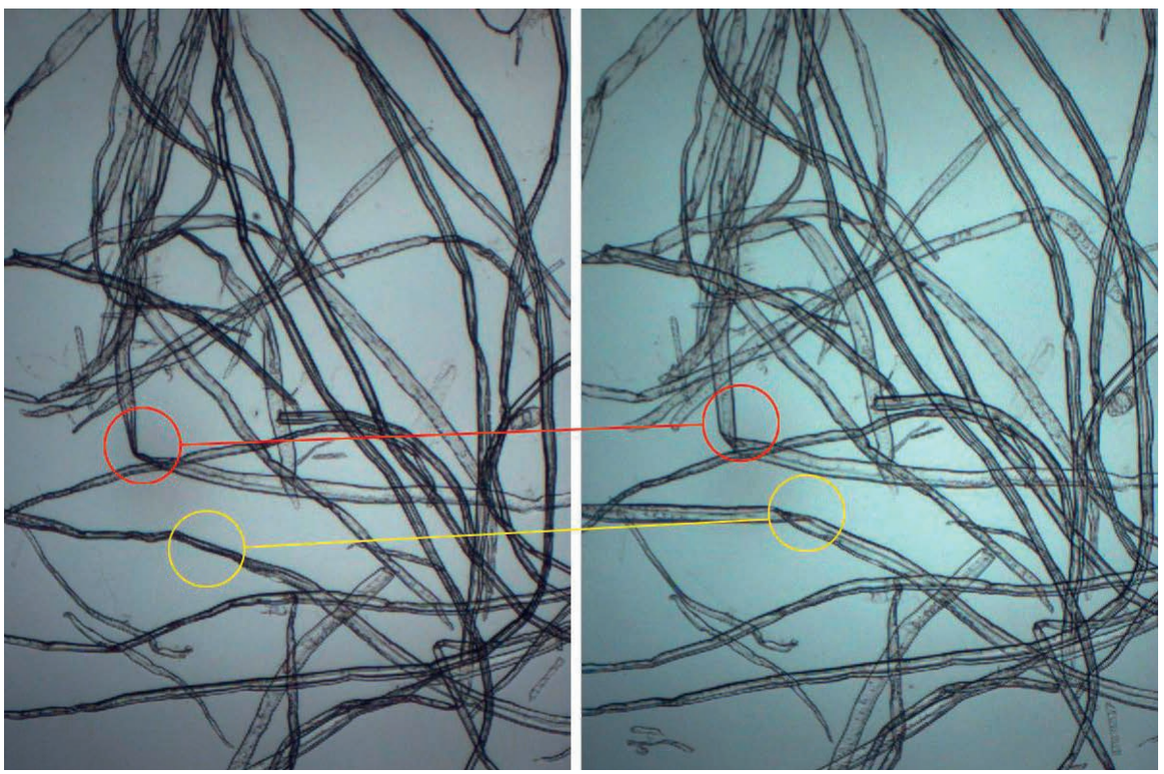

Figure 3 *Maximyze Activity – Before (left) and After (right)*

to what occurs in mechanical refining to some extent and is one of the downsides. Thinking about the same rope, Maximyze would have to cut each individual strand to cut all the way through the rope. Given enough time, this could occur, but a well-designed application will prevent this from happening. In most cases, Maximyze is added before the mechanical refining. Maximyze preconditions the fibre and widens the window of refining. In some mills, mechanical refining has been completely bypassed and all refining is done with Maximyze. The photomicrographs above show the effect of Maximyze on fibre. It can be seen that fibres are collapsing and flattening out. Maximyze is providing positive ROI to many mills using bleached kraft. These mills produce a number of different paper grades. Tissue mills can especially benefit from the use of Maximyze. The benefits include reduced production cost by the replacement of softwood kraft with hardwood kraft or by replacing virgin kraft with deinked MOW (mixed office waste) pulp. Another benefit for tissue mills is improved sheet characteristics. Replacing softwood kraft with hardwood kraft and reducing mechanical refining gives improved softness, an important quality for tissue grades.

CASE #1 – MAXIMYZE 2545 APPLICATION IN A NAPKIN GRADE

One of the first applications for Maximyze was a tissue mill producing a napkin grade using virgin kraft and deinked MOW pulp. The furnish mix was targeted at 33% kraft and 67% MOW. To meet sheet strength targets required increasing kraft content up to 40%. Maximyze 2545 was introduced into the pulper at 1.0 kg/tonne and now this napkin grade is produced with 100% MOW and no refining. The cost differential between the virgin kraft and the deinked pulp results in a very positive ROI (return on investment).

CASE #2 – MAXIMYZE 2545 APPLICATION IN A PREMIUM BATH GRADE

Maximyze has also allowed a tissue mill to improve sheet qualities on a premium bath grade. To meet sheet strength targets the mill needed to mechanically refine a 100% virgin kraft furnish. The refining resulted in a loss of sheet softness. Maximyze 2545 was again the product of choice, and its application resulted in the elimination of mechanical refining. This resulted in an increase in bulk to basis weight ratio and improved sheet softness. Maximyze 2545 was added to the pulper at 1.0 kg/tonne.

CASE #3 – MAXIMYZE 2530 APPLICATION IN A PREMIUM BATH GRADE

A mill is producing a premium bath tissue grade with a mix of virgin kraft and deinking MOW pulp. To meet the target for tensile the mill had to overweight the sheet by 0.5 g/sqM and use a dry strength additive. The use of

the dry strength additive required the addition of a cationic coagulant for charge control. The coagulant resulted in a brightness loss and, therefore, it was necessary to use an optical brightening additive (OBA) to meet the brightness target.

Maximyze 2530 was introduced and the results were dramatic. The mill is now able to produce this grade at target basis weight with no dry strength additive, no cationic coagulant and no OBA. Furthermore, the mill has been able to eliminate mechanical refining. The application rate for the Maximyze 2530 is 0.25 kg/tonne. All of the benefits from the introduction of Maximyze 2530 add up to a reduction in production costs of US$30/tonne.

CASE #4 MAXIMYZE 2535 APPLICATION IN AN UNCOATED FREE SHEET

A mill has to mechanically refine at a high level to meet its targets for strength and porosity. The high refining levels caused excessive cutting and fines generation. This led to reduced drainage and loss of strength. The strength loss meant that filler levels were limited and a higher percentage of softwood kraft was needed in the furnish mix. When Maximyze 2535 was started the mechanical refining was decreased. This allowed the following results to be achieved: reduced softwood kraft by 5% (based on total softwood), increased filler content by 1% and increased production rate by 6% This was all achieved with improvements in sheet qualities such as internal bond and smoothness. Overall, the total ROI is equal to US$29/ tonne.

CASE #5 MAXIMYZE 2563 APPLICATION TO CONTROL VESSEL ELEMENTS

Maximyze is proving to be a great asset to pulp and papermakers in many areas. One area that has been a challenge to many papermakers is vessel elements. Vessel elements are a big problem in mills using fast-growing tropical hardwoods. In printing papers vessel elements can cause picking and linting. In the printing process these vessel elements can be pulled from the sheet and deposited on printing rolls. This leads to breaks and problems with print quality.

Maximyze has proven to be a successful solution to vessel elements. The enzymes in Maximyze work on the vessel elements to weaken them. The effect on the vessel elements is greater than on the fibre as the vessel elements have a greater surface area. The weakened vessel elements are then more susceptible to being broken up in mechanical refining.

A mill is producing offset paper with a furnish of 100% tropical hardwood. Vessel elements were causing issues with picking. To control this picking the mill needed to increase mechanical refining and use increased levels of starch at the size press.

Maximyze 2563 was introduced at an application rate of 0.5 kg /tonne. The results were a reduction of 20% in mechanical refining energy and reduced size press starch usage. Picking as measured with the IGT test was reduced by 60%.

The reduced picking allowed the mill to increase the selling price of its paper. The increased revenue, along with the starch and energy savings, is estimated to be worth at least US$1,000,000 per year.

One important aspect of the use of enzymes in industrial processes is the ‘green’ aspect. Enzymes are naturally occurring in nature and have low environmental impact. Enzymes have a low health hazard to workers when compared to many industrial chemicals. Buckman is heavily involved in supplying enzyme solutions to pulp and paper, and our R&D Department is working on expanding existing applications and developing new innovative applications for enzymes. Being a sustainable company is important to Buckman.

This innovative enzyme based product line works on the fibre to produce the same effects as mechanical refining with less of the downside of mechanical refining, such as fibre cutting and the production of fines

Buckman’s sustainability message is captured with “Buckman GREEN. Our color. Our commitment.” As well as ensuring that Buckman’s internal processes are sustainable, we work as partners with our customers to assist them to reach their sustainability goals. A good example of this is replacing a dry strength additive with Maximyze. This reduces toxicity to the effluent and also has ROE (return on the environment) for reduced shipping. The volume of a dry strength additive is much greater than for Maximyze, so trucking costs and the use of fossil fuel is greatly reduced.

Maximyze is proven technology that has delivered ROI and ROE to many mills around the world. This innovative enzyme based product line works on the fibre to produce the same effects as mechanical refining with less of the downside of mechanical refining such as fibre cutting and the production of fines. Maximyze is delivering benefits in pulp substitution, improved sheet qualities and elimination of other strength additives. Mills experiencing issues with vessel picking are also benefiting from the application of Maximyze.

Other pulp and paper grades that are investigating the potential benefits of a Maximyze program are market kraft pulp mills and lightweight coated operations. Buckman continues to research further applications of the Maximyze product line, an example of which is use in mechanical pulps such as TMP.