ABTCP 2002
35º Congresso e Exposição Anual de Celulose e Papel
35th Annual Pulp and Paper Congress & Exhibition
14 a 17 de Outubro 2002 - São Paulo - Brasil
October 14-17, 2002

Fábricas kraft americanas estão à frente da implementação de xilanase

US Kraft mills LEAD IN xylanase implementation

Theo Van der Burgt
Jeffrey S. Tolan
Luc C. Thibault
(Iogen Corporation)

ABTCP Associação Brasileira Técnica de Celulose e Papel 35 anos

Associação Brasileira Técnica de Celulose e Papel
Rua Zequinha de Abreu, 27 - Pacaembu - São Paulo - SP - CEP 01250-050
Tel 55 11 38742700 - Fax 55 11 3874 2730
www.abtcp.com.br - abtcp@abtcp.com.br

US KRAFT MILLS LEAD IN XYLANASE IMPLEMENTATION

Theo Van der Burgt
Jeffrey S. Tolan
Luc C. Thibault
Iogen Corporation, Ottawa, Ontario, Canada

SUMMARY

Once again, US Kraft mills have demonstrated that technology can be developed into innovative applications that capture cost savings. Xylanase enzyme treatment, once thought solely for ClO_2-limited Market Pulp mills, has been implemented at impressive rates into 3- and 4-stage integrated mills strictly for cost savings. The US has surged ahead in application rates, now exceeding other better-known technologies like TCF and Ozone bleaching.

The surge in application implementation is a result of several dynamics, one of which is the consolidation of the pulp and paper industry, which in turn has accelerated the sharing of best practices.

This paper outlines how over the past 30 months, American Kraft mills successfully implemented xylanase enzyme applications into new types of process-configurations for the single purpose of cost reduction. This paper outlines the new types of applications and the tools used to achieve auditable results.

RESUMO

Uma vez mais, as fábricas de polpa Kraft dos EUA demonstraram que a tecnologia pode ser desenvolvida em aplicações que geram economias de custo. O tratamento com enzima xilanase, antes utilizado exclusivamente para fábricas de polpa de mercado limitados a ClO_2, foi implementado com uma rapidez impressionante em fábricas de 3 e 4 estágios integrados, estritamente para gerar economias de custo. Os EUA apresentam um índice de aplicação mais elevado, excedendo atualmente outras tecnologias mais conhecidas, tais como branqueamento TCF e com ozônio.

O aumento na implementação da aplicação é resultado de várias dinâmicas, uma das quais é a consolidação da indústria de polpa e papel que, por sua vez, acelerou o compartilhamento de melhores práticas.

Este documento descreve como, ao longo dos últimos 30 meses, as fábricas de polpa Kraft americanos implementaram com êxito aplicações com a enzima xilanase em novos tipos de configurações de processos visando exclusivamente reduzir os custos. Este documento descreve os novos tipos de aplicações e as ferramentas utilizadas para se obter resultados auditáveis.

KEY WORDS

Xylanase, enzymes, kraft mill, bleach plant

PALAVRAS CHAVE

Xilanase, enzimas, moinho de polpa Kraft, planta de branqueamento

INTRODUCTION

Xylanase treatment of brownstock is widely used to enhance the bleaching of kraft pulp. The enzyme typically acts on the brownstock in the high-density storage tower. The enzyme does not bleach or delignify the pulp, but rather makes the pulp easier to bleach in the subsequent bleaching stages. This

results in a decrease in bleaching costs and an increased operation flexibility. Xylanase treatment is implemented with little capital cost.

Xylanase was adopted earlier in Canada than the US primarily due to the early adoption of ECF bleaching. At that time, this created a chlorine dioxide shortage for many mills. Over the past few years, the product, application technology and experience has changed, allowing American mills to catch up and pass their Canadian counterparts in adopting xylanase technology.

XYLANASE IMPLEMENTATION IS NORTH AMERICA

There are now 20 mills in North America using xylanase, 7 in Canada and 13 in the US. Over 3.9 million tonnes of kraft pulp was treated in 2001 and 6 million tonnes in 2002. In Canada , 4,200 tonnes is treated daily, while in the US 6,900 tonnes per day is treated . Figure 1 shows that the usage of xylanase in American mills is roughly 63% hardwood and 37% softwood, with the balance in mills that swing between the two.

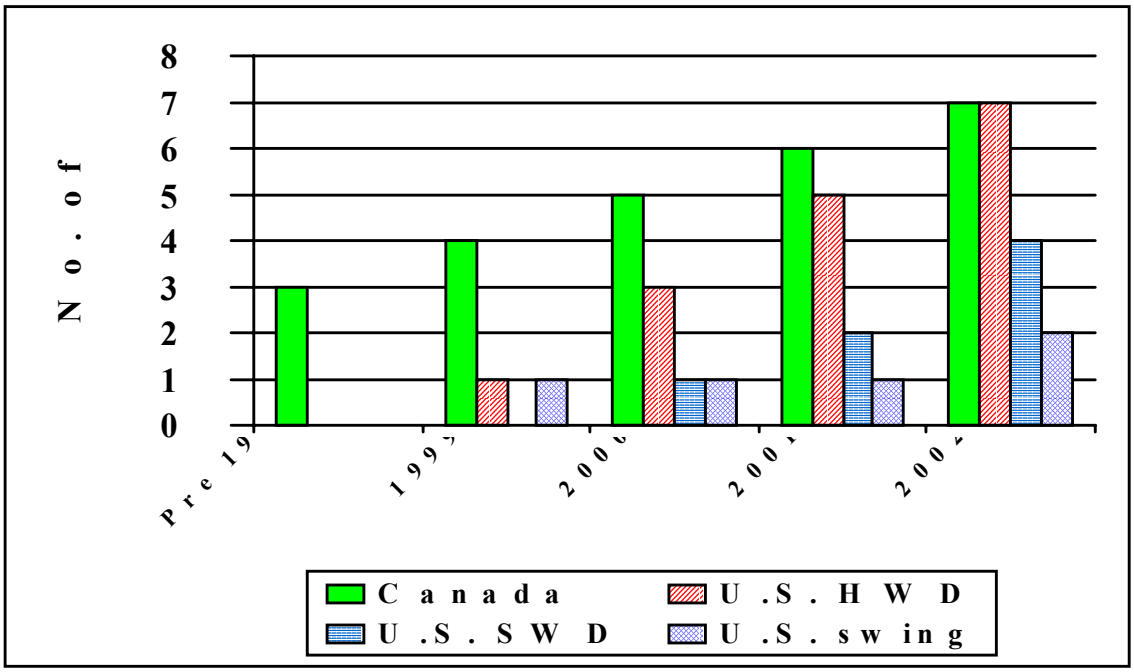

Figure 1: Number of mills using xylanase

One reason for the increase in xylanase usage is that xylanase performance has improved significantly since its first implementation in mills 10 years ago. Cellulase contamination in xylanase is no longer an issue. The new engineered xylanase proteins can now withstand the higher pH and temperatures encountered in the mills, and are effective with as little as 15 minutes contact time. These new engineered products are now better suited for mills with process limitations.
Xylanase treatment of kraft pulp provides the advantages of bleached cost reduction with a minimal capital investment. Xylanase treatment is very versatile. It is carried out in mills that run softwood or hardwood that produce market pulp, integrated mills, mills with oxygen delignification, and mills with 3-, 4- & 5-stage bleaching sequences. The main objectives in mills with xylanase applications are positive process economics. The economic objectives are achieved in bleached cost reduction.

Xylanase is not a fit for all mills. A properly conducted process validation to investigate the potential for xylanase implementation involves a field process audit, an in-depth analysis of the mill's bleached chemical usage and variation, and a laboratory study simulating the mills bleaching sequence and condition. All three of these tasks are crucial for a successful xylanase application. If any one of the above does not meet the requirements for a successful operation, the mill is not a fit for a good xylanase implementation.

Pulp susceptibility can vary significantly for a given Kappa number. A laboratory bleaching study is required to fully assess commercial value. Occasionally a mill will be a good technical fit, but a xylanase implementation would provide little commercial value. Xylanase should not be used in such a mill.

XYLANASE IMPLEMENTATION IN US MILLS

As a result of major US corporations investing in “Best Practices”, US Kraft mills lead in xylanase implementation. Xylanase application is mainly chosen because of the bleached cost reduction it provides, with little to no capital investment.

The competition in the pulp market is at its peak and the value of market pulp is at his lowest; these conditions force the large corporations to be innovative. Together, the US corporate culture and the industry dynamic both drive and subsequently share successful applications. Knowledge and experience are shared within an organization and again when industries consolidate. US corporations have learned that if they want to remain competitive, they must reduce cost. To do so they share good practices. Designated groups called “Best Practices” are formed and have the mandate to come up with new ideas that will produce benefits and/or cost reduction with little or no capital investment. These groups quickly identified xylanase as an easy and practical way to reduce bleaching costs. Once proven in a mill, the technology is then implemented in sister mills where there is a fit for xylanase. The US mills adapted and innovated xylanase use very rapidly; within two years they matched the number of mills using the technology in Canada.

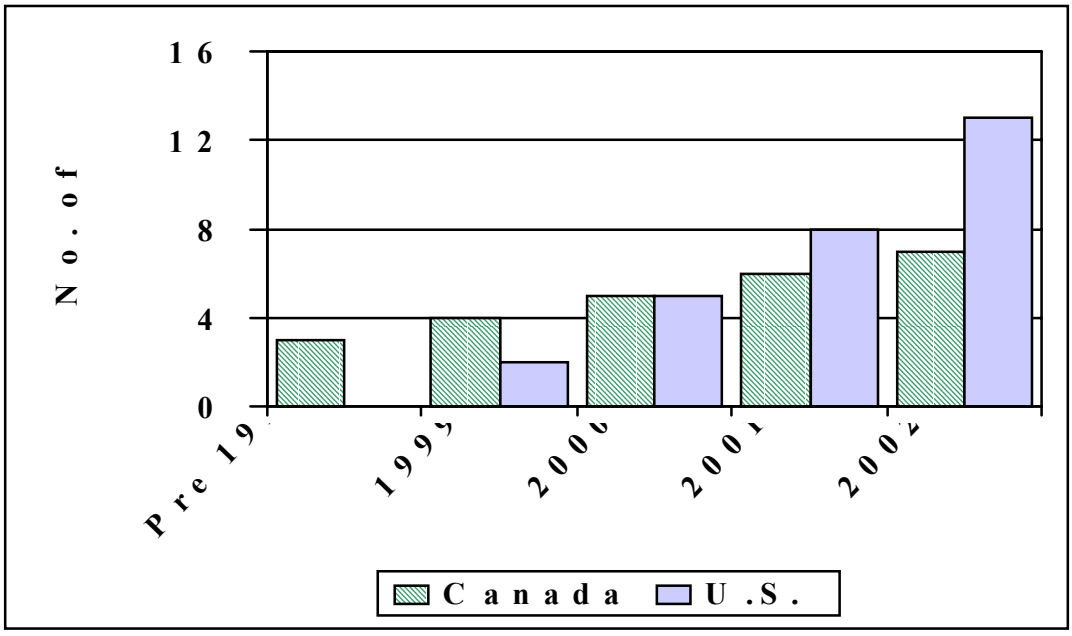

Figure 2: Number of mills using xylanase in Canada and in the US per year

The adoption of xylanase-aided bleaching in US Kraft mills has sharply increased over the past three years. Figure 2 above shows the increase in the number of American mills using xylanase from the very low levels in 1999 to present day levels, where the xylanase usage in the US has risen to the point where it is roughly twice as high as in Canada.

VALIDATION PROCESS

The purpose of the mill process audit is to define whether a xylanase application can be successfully implemented in a mill. Xylanase is added to brownstock at a location where it can be adequately mixed into the pulp prior to a retention stage, with at least 15 minutes pulp retention time. Whether the pulp mixing is by a thick stock pump or an MC pump, there must be good enzyme dispersion into the pulp. The retention time is usually provided by a high-density storage tower. The pulp pH and temperature must be controlled in a range that is both compatible with the enzyme and that the mill is able to maintain without corroding equipment or causing safety problems.

The mill’s chemical usage and process data is used to evaluate whether the effects of a xylanase application would be measurable. Xylanase typically decreases the ClO_2 usage by 10% to 15% for a particular Kappa number. The daily variance in the mill’s chemical usage is determined from studying and correlating data from past mill operations. To some extent, the length of the initial xylanase trial is

chosen in order to provide sufficient time to demonstrate statistical confidence in the change in bleachability. At least three months of data is usually required in order to factor in seasonal and process changes within the bleach plant.

The mill's pulp and bleaching sequence are used to measure the bleachability improvement from xylanase treatment. Samples are bleached with and without xylanase treatment, with a brightness curve generated under varying bleached chemical charges. It is important that the laboratory study be carried out with the enzyme that is to be used in the mill, as not all xylanases have the same effects on pulp. Figure 3 is an example of lab data that illustrates the results a mill can obtain from xylanase treatment. The xylanase treated pulp reaches a higher brightness for a given chemical charge. In a mill, these benefits can be taken as a decrease in ClO_2 usage to achieve a given brightness, or an increase in brightness at a given ClO_2 usage, or a combination of these benefits. If a mill chooses to reduce ClO_2 consumption and is limited in its capacity to produce ClO_2, the mill may now be in a position to increase throughput. Pulp susceptibility can vary significantly for a given Kappa number. A laboratory bleaching study is required to fully assess commercial value. Xylanase should not be used in a mill where, in spite of a good technical fit, a xylanase implementation would provide little commercial value.

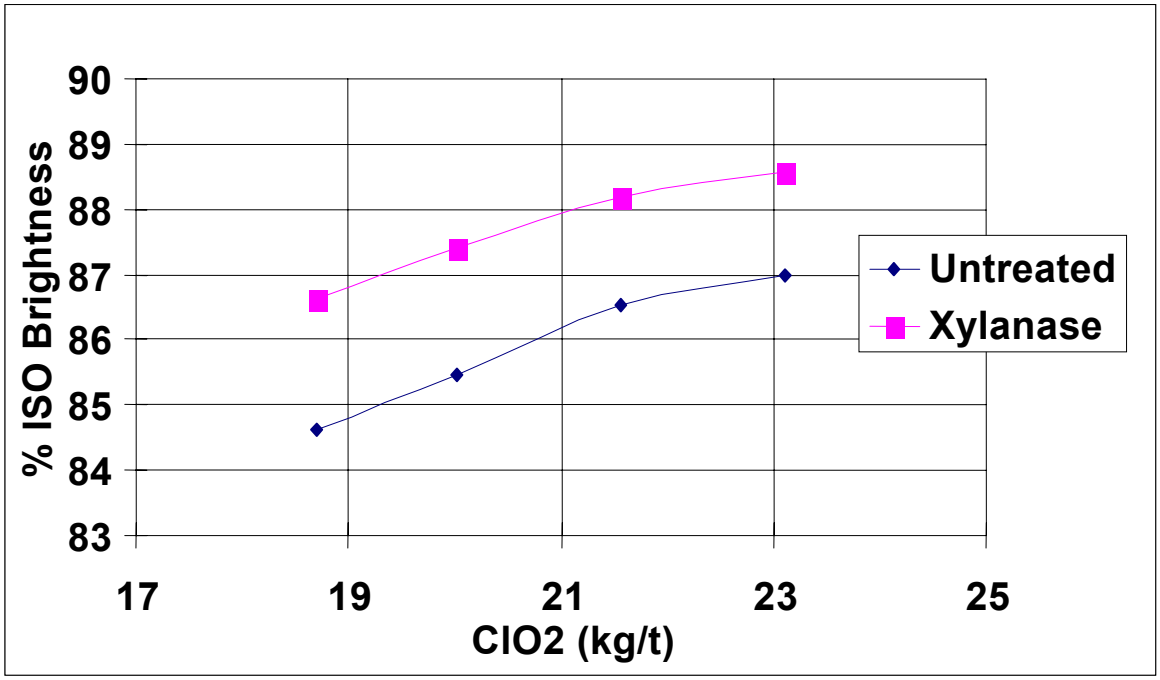

Figure 3: Bleaching profile of pulp xylanase treated and untreated versus ClO_2 charge

Once a mill has passed the validation process and is determined to run xylanase, the supplier usually provides the mill an enzyme addition/brownstock control system. The addition rate of xylanase, which is a solution of protein in water, and the pulp pH are controlled by this system. A designated pump meters the xylanase at a fixed dosage and another pump is designated to deliver sulfuric acid to control the pulp pH in a specific range, typically pH 6.0 to 8.5. Acid can be added before or after the addition of xylanase. In most mills, xylanase is added at the final brownstock washer, decker, or chute. In some mills, where brownstock retention time is not available after the final brownstock washer, the xylanase is added prior to this washer and/or to a screen room to obtain 15 minutes or longer retention time. A typical xylanase implementation can be found in Figure 4. Although xylanase, unlike cellulase, does not have a cellulose-binding domain, some xylanases bind tightly to the pulp. However, not all xylanase enzymes bind to pulp tightly enough for a screen room application. Maintaining the pH and temperature in a range that is compatible with the enzyme is the key performance factor.

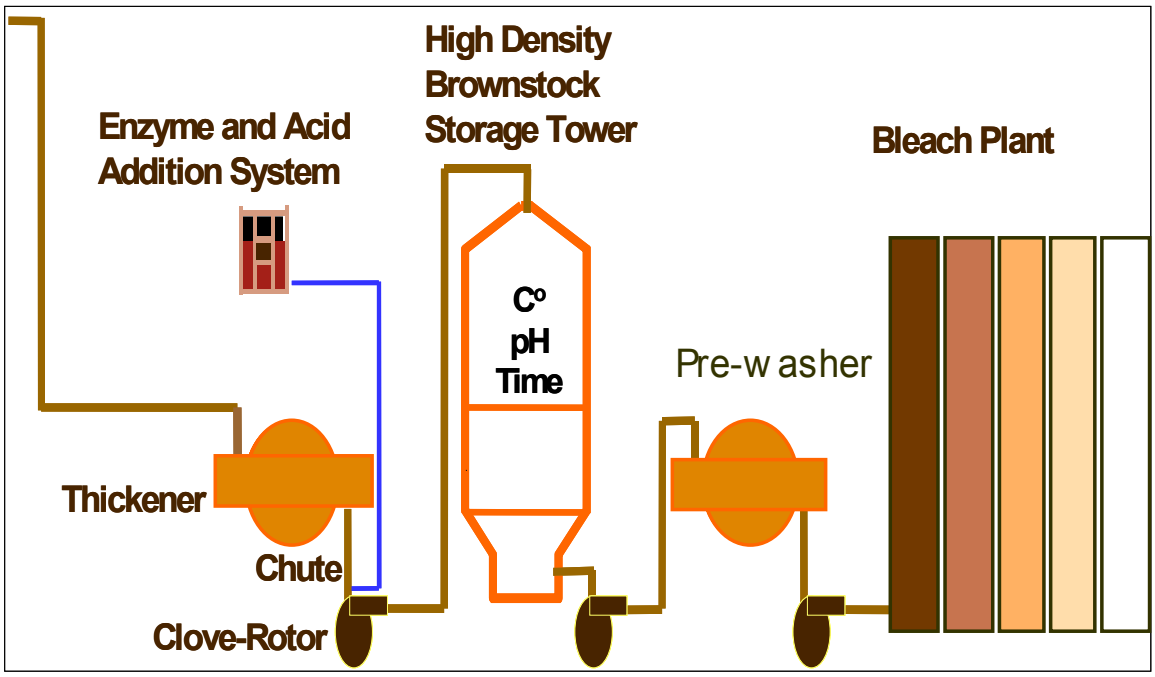

Figure 4: Typical brownstock xylanase application

XYLANASE USE IN US MILLS: APPLICATION INNOVATION CASE STUDIES

Figures 5-7 show data from three American mills using xylanase on a regular basis.

Case 1: First Three-Stage Application

The mill providing the data in Figure 5 is a hardwood mill that was the first to use xylanase in a 3-stage bleach plant that swings between softwood and hardwood. The mill normally runs a 4-stage bleach plant, but with the use of xylanase, they are able run 3-stage and avoid lengthy maintenance shut downs. The mill has been using xylanase for four years and adds xylanase to the brownstock prior to the first bleaching stage. The enzyme increases the bleachability of the pulp, which corresponds to a drop of 20.6 % in the amount of ClO_2 required to achieve the target brightness. This is close to the laboratory data, which predicted a 19.2% decrease in ClO_2 usage. The decrease in ClO_2 usage corresponds to a savings of 11.2 pounds of ClO_2 per ton of pulp.

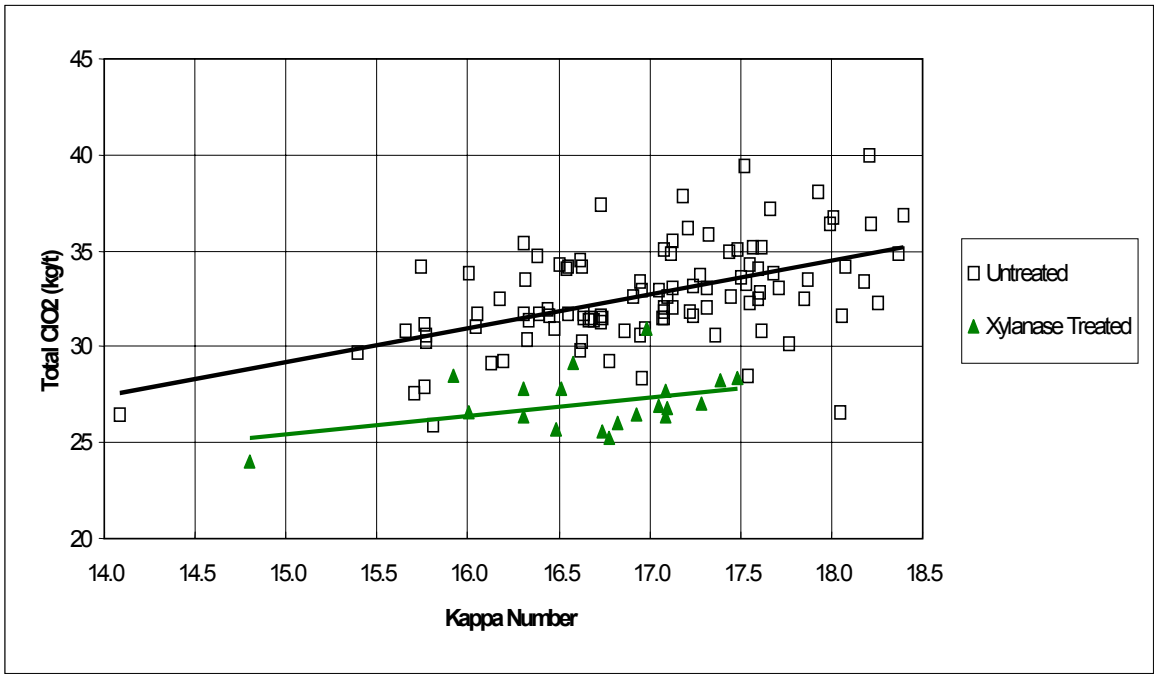

Figure 5: Total active chlorine usage versus brownstock Kappa number – hardwood pulp

Case 2: First Screen Room Application

Figure 6 shows data from a US hardwood mill that was the first mill to implement xylanase in the screen room. The mill adds xylanase prior to its 4-stage bleach plant. Because of the enzyme treatment, the pulp is more bleachable. The mill is operating its second year of xylanase installation. The screen room application takes advantage of the tight binding of a specific xylanase to the pulp, though not all xylanase enzymes will bind to pulp tightly enough for a screen room application.

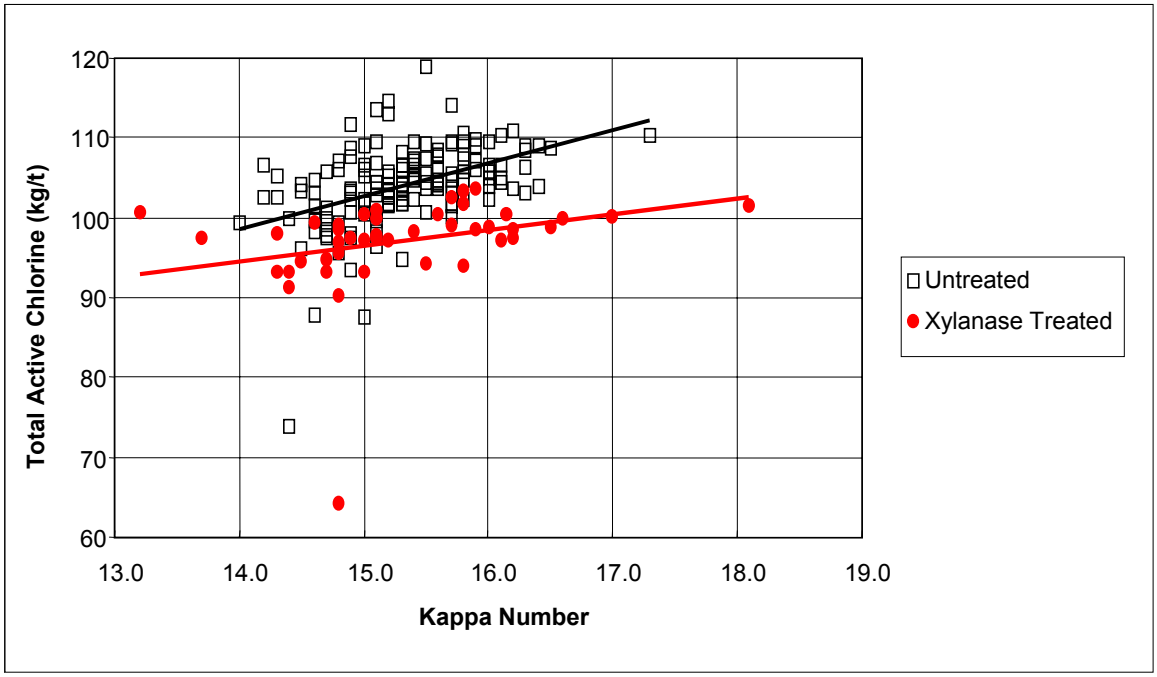

Figure 6: Total ClO_2 charge versus brownstock Kappa number – hardwood pulp, screen room application

Case 3: First Southern Pine Application

Figure 7 shows data from a US southern pine mill that has been using xylanase for 3 years. The mill treats the pulp prior to a 4-stage bleach plant. With the enzyme treatment, the mill requires less ClO_2 at a range of pulp Kappa numbers.

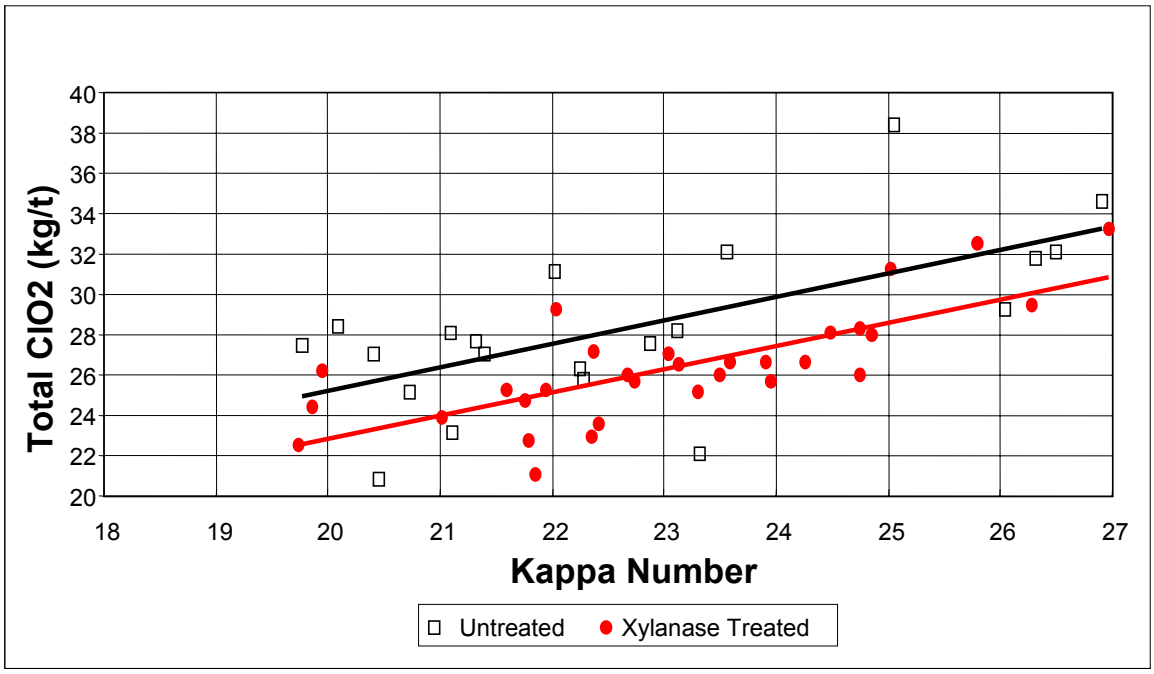

Figure 7: Total ClO_2 charge versus brownstock Kappa number – Southern Pine

CONCLUSION

Xylanase treatment of brownstock is widely used to enhance the bleaching of kraft pulp. US Kraft mills have sharply increased their adoption of xylanase-aided bleaching in the past three years. Xylanase usage in the US has risen to the point where it is roughly twice as high as in Canada. There are now 20 mills in North America using xylanase, 7 in Canada and 13 in the US. Over 3.9 million tonnes of kraft pulp was treated in 2001 and 6 million tones in 2002. In Canada , 4,200 tonnes is treated daily while in the US 6,900 tonnes per day is treated. Xylanase implementation in a mill is straightforward, but requires a careful validation, as not all mills are a fit for the technology.