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PULPING INNOVATIONS AND NEWS FROM THE PACIFIC RIM

p. 44, 48

TIPS TO MAINTAIN MILL WATER SYSTEMS

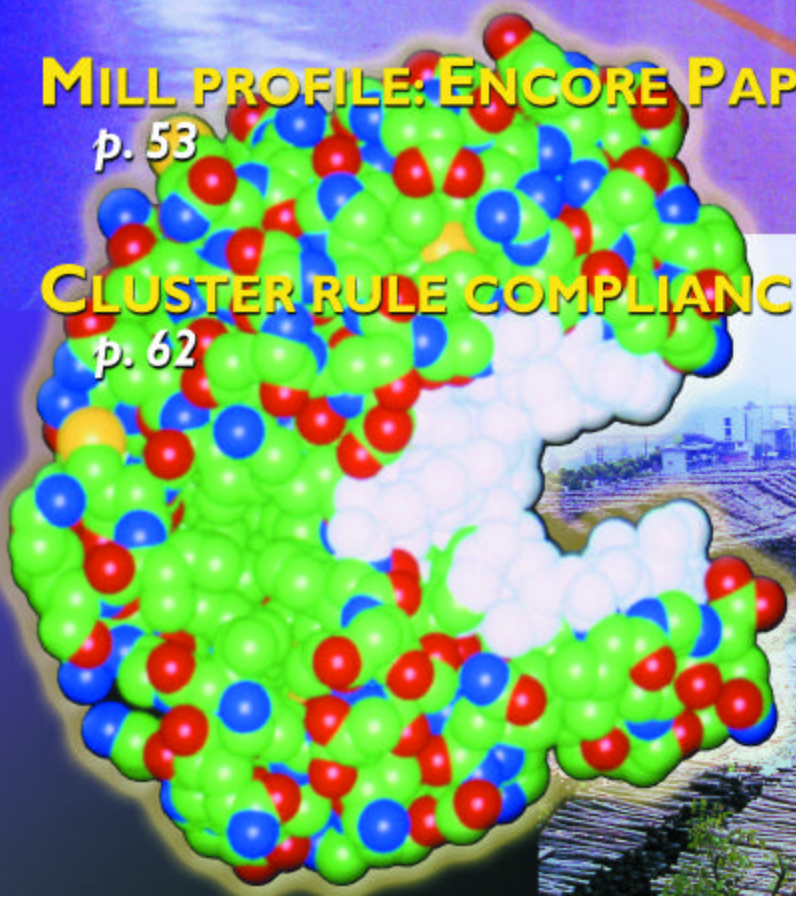
p. 37, 39

MILL PROFILE: ENCORE PAPER

p. 53

CLUSTER RULE COMPLIANCE TOOLS

p. 62



CONTENTS

APRIL 2001 VOL. 84, NO. 4

PAGE 34

PAGE 44

PAGE 48

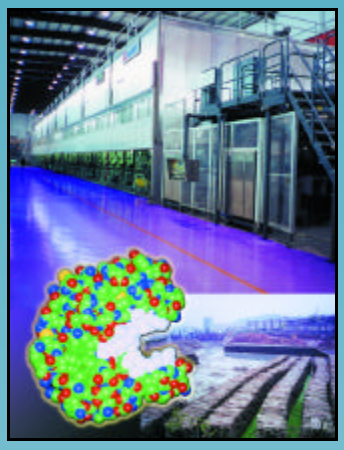
ARTICLES

SUMMARIES OF PEER REVIEWED PAPERS

Expanded summaries of the following reviewed papers are printed in this issue of TAPPI JOURNAL. The full text is available through TAPPI's web site (www.tappi.org) at no cost to members, and through TAPPI's Service Line. For instructions, see p. 58.

CONTENTS

COVER



This month's cover is composed of images provided by Enzymatic Deinking Technologies (EDT) of Norcross, GA, showing PM 5 at Nanping Paper Mill in China, the mill's pulp log aging basin and storage field, and an illustration of an enzyme molecule.

TAPPI'S VISION STATEMENT

We share the strengths of individuals for the benefit of the industry.
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We serve as an international forum to exchange technical information and promote research.
We provide outstanding educational and professional growth opportunities and recognize individual achievement.
We provide the public with sound scientific information on industry related issues.
We create success by the quality, timeliness and innovativeness of our products and services.
Integrity and fellowship characterize our association.

SUMMARIES OF PEER REVIEWED PAPERS

ENZYMATIC PITCH CONTROL AT NANPING PAPER MILL

SHOUQIN CHEN, YITING LIN, YUDE ZHANG, XIANG H. WANG, AND JAN L. YANG

ENZYMATIC PITCH CONTROL SOLVES PROBLEMS AT CHINESE MILL.

IN DECEMBER 1999, NANPING PAPER MILL STARTED THE world's fastest newsprint paper machine, PM No. 5, with a design speed of 1800 m/min. and a production capacity of 180,000 tons/year. The main pulp supply comes from the company's own production of 160 tons/day groundwood and 200 tons/day thermomechanical pulp (TMP) using local Masson pine as the raw material.

Due to the very high pitch content and organic extractives present in the Masson pine, conventional polymer retention and pitch control programs were ineffective in preventing frequent pitch outbreaks on various parts of the paper machine during startup. The pitch outbreaks caused many unscheduled shutdowns for cleaning, and hampered the effort to increase speed of the new paper machine to its design specifications. Facing this new challenge, the mill investigated alternative pitch control technologies and invited many well-known suppliers to propose solutions. In March 2000, the mill decided to conduct a trial with a custom-formulated enzymatic pitch control process and analytical method from Enzymatic Deinking Technologies in Norcross, GA.

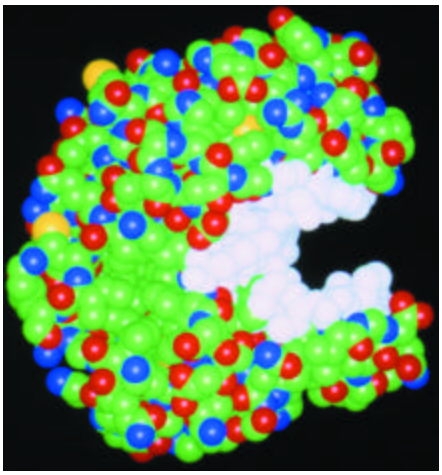


Illustration of an enzyme molecule

Using this novel enzymatic pitch analysis method to quantify troublesome pitch components in its process, Nanping Paper Mill worked with the enzymatic pitch control process supplier to implement this patented process. The efforts focused not only on the PM No. 5 operation, but also on the pulp mills where the pitch has the highest concentration and is most easily broken down and fixated. Using a stepwise plan, the pitch outbreaks were controlled within weeks. Downtime on PM No. 5 decreased from an almost daily shutdown for cleaning before the enzymatic application to a weekly cleaning frequency after addition of the enzyme program. No upsets occurred during implementation of the enzyme application in the pulp mills or PM No. 5. Through systematic optimizations and evaluations, the enzymatic pitch control process has demonstrated its cost effectiveness in maximizing PM No. 5 uptime, operating speed, and product quality. The quality improvement is most clearly evident in reduced pitch deposits, fewer holes in the sheet, and improved sheet strength properties.

With the new enzymatic method to control pitch outbreaks, the mill could also increase brightness significantly with increased use of fresh logs that had not been used in an attempt to minimize the pitch. The mill increased the use of fresh logs to 50% from practically zero before enzyme use. This change allows reduction of wood inventory and more efficient use of the woodyard.

Nanping Paper Mill feels confident that the new enzymatic pitch control process is a reliable and superior technology. The application has successfully solved the historically frequent pitch outbreaks at the mill associated with the use of Masson pine. The new technology creates additional possibilities to meet future mill capacity growth needs and achieve improved profitability.

NANPING PAPER MILL

Located in the mountainous region of Southeast China, Nanping Paper Mill is one of the largest paper mills in the country. Built as a greenfield mill in 1956 by the Chinese Government, Nanping Paper Mill started newsprint production in 1958 with an initial capacity of 30,000 tons/year. Nanping Paper Mill now has five paper machines with newsprint capacity of 300,000 tons/year and four pulp mills including groundwood, TMP, kraft, and old

newsprint (ONP)/old magazine (OMG) deinked pulps. One additional ONP/OMG deinked pulp line with a design capacity of 500 tons/day should come on line in May 2001. Nanping Paper is a shareholder-owned company with stock traded on the Shanghai Stock Exchange.

FIBER RESOURCES

Historically, Nanping Paper Mill has relied heavily upon the local Masson pine as its raw material for pulp production. The logs are harvested year-round in the surrounding area. A significant proportion of the logs comes from local tree farms that raise trees for resin production. The logs are the by-product of the farms and contain very high pitch content and organic extractives of as much as 3% by weight on pulp. To reduce the organic pitch content before the pulping operation, the logs age in a large area in a water basin for a minimum of three months. Although this aging process was effective in reducing organic extractives, it caused many detrimental side effects. These included reduced pulping yield, lower brightness and strength, and odor problems in the surrounding area especially during the summer months. Additionally, such a long storage period required large pulp wood inventories, high capital investment, and a very labor intensive operation.

TRADITIONAL PITCH CONTROL METHOD

Besides the extensive log aging process, Nanping Paper Mill also tried traditional pitch control methods. Before the startup of PM No. 5, Nanping Paper Mill had four paper machines with a top speed of less than 600 m/min. Evaluation of many polymer-based programs showed they were ineffective at this relatively low speed. They did not help control the pitch deposits on the forming wires, Uhle boxes, and dryer fabric. Instead, the mill relied upon a large quantity of alum and talc as additives in the stock preparation stage with use of 50–75 kgs/ton to control pitch. Particularly during the summer months, the pitch outbreaks were very serious.

Frequent shutdowns and cleanings using harsh chemicals were necessary in the summer seasons. On average, a cleaning time of two hours was necessary to clean dryer fabric and forming wires. Such a cleaning step often involved caustic solvents and high-pressure showers, washing of the felts and wires, and manual scraping of dryer fabric. This process was unpleasant and cost considerable lost production time. More significantly, the pitch resulted in poor newsprint quality such as holes in the sheet, poor formation, and printing press difficulties.

CHANGING NEWSPRINT MARKET AND NEW PAPER MACHINE

With the rapid economic development in China and an increasing demand of newsprint over the last 15 years, China has relied partially upon imports of newsprint to meet its domestic needs. Due to its historically planned economic structure and much higher production costs

Pulp logs from resin tree farms marked with scratch tracks from resin production

Pulp log aging basin and storage field

Stacking of logs for aging

per ton—resulting from smaller and slower paper machines and high staffing levels, domestically produced newsprint could no longer compete with imported newsprint in price or quality. This impact was particularly severe during the global newsprint slump in 1996–1998. To balance supply and demand, the total

The new PM5 at Nanping Paper Mill

production of Nanping Paper Mill was seriously curtailed from 150,000 tons/year in 1996 to a low of 85,000 tons/year in 1998. A much lower sales price and a diminishing profit margin accompanied the change.

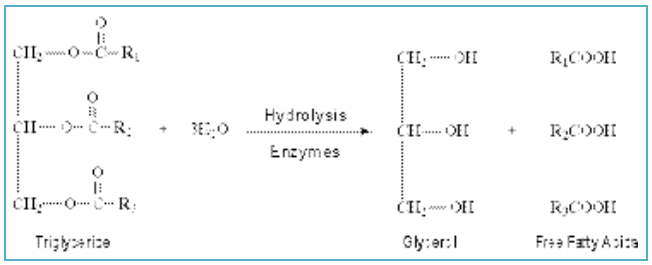
To address the challenges of increasing competition and meet a higher quality requirement, Nanping Paper Mill underwent reorganization in 1998 as a shareholder company. It made the bold decision to bring on line a new PM No. 5 using the latest generation of paper making technology. The new PM No. 5, with a production capacity of 180,000 tons/year, began operation in December 1999. After obtaining the financing and approval for PM No. 5, the project progressed rapidly from planning and designing to installation and startup. Completion of the entire project took 18 months and demonstrated a phenomenal effort by Nanping Paper Mill.

With its historical background and circumstances, this PM No. 5 project was a great leap in many respects and a success from a mechanical standpoint. Within weeks of startup, the mill was making high quality newsprint. With the signing of large contracts, the production capacity quickly sold out ahead of plan.

ENZYMATIC PITCH CONTROL TECHNOLOGY

Nanping Paper became familiar with this enzymatic pitch control technology in the beginning of 1999 during the PM No. 5 installation stage. Initially, this technology did not receive serious consideration due to other more pressing priorities. Another factor was the history of pitch control failures with other conventional chemistries. Other paper mills had looked at enzyme-based pitch control technology and conducted trials without much success. A major challenge was lack of effective tools to quantify and track pitch. Another challenge was identifying how to apply the technology in the mills properly without causing paper machine upsets.

Jujo Paper Co initially developed enzymatic pitch control technology in the 1980s. This technology now has wide use in pulp mills in Japan. Some mills in North America have also adopted it. The most troublesome



1. Principle of enzymatic hydrolysis of triglycerides

pitch deposits on paper machines are due to the nonpolar fraction of pitch—triglycerides (TG)—especially when using pine wood species in the mechanical pulping process. With application of the proper enzyme treatment, the nonpolar fraction of pitch can hydrolyze and convert into free fatty acids and glycerol as Fig.1 shows. Regulation of the hydrolysis of triglycerides by enzymes is possible, and the technique has a high degree of commercial success. The main challenges have been determining the best points to apply the enzymes, best management of the free fatty acids released from treatment, and deciding how much pitch is allowable for a given paper machine without causing pitch deposits.

CHALLENGE OF PITCH DETERMINATION

The most difficult aspect of pitch control is determining the most troublesome pitch components. For a papermaker, pitch has always been an elusive problem. One only knows a pitch problem exists when a pitch outbreak occurs. The traditional pitch analysis method is to measure the organic extractive content in the wood chips or pulp. This step alone can require 24 hours and does not produce reliable data to solve the problem. For example, the same type of wood chips could result in very different outcomes concerning pitch deposits depending on the degree of refining, temperature, and other factors. To manage the pitch problem soundly, an effective tool is essential to determine quickly and rapidly within minutes the available free pitch on the pulp fiber surface and in the white water system. The results obtained can then be used to adjust enzyme dosage to optimize the treatment and prevent an outbreak on the paper machine.

RAPID PITCH DETERMINATION METHOD

The supplier company has developed a unique test method to quantify quickly the troublesome pitch in a paper making system. This test uses enzymatic chain reactions to determine the available triglyceride content on the pulp fibers and in the white water system. The total required test time is 20 minutes and does not require any capital investment by the mill. The method is repeatable and reliable across the range of different process chemical additives and pulp species. The method has had use at Nanping to monitor the pitch content and optimize the continuing enzymatic treatment efficiency.

PERFORMANCE OF ENZYME APPLICATION

With the successful development of an effective pitch testing method, the next step was to break down the pitch in the operation systematically and gradually and use a cost-effective means to fixate the released fatty acids onto the fiber surfaces properly. This maintains the system balance on cationic charge demand. The use of a special enzyme formulation developed for the mill conditions at Nanping Paper provided clear improvement to the paper machine operation.

Within days of enzyme application, the pitch deposits on the machine press, felt, wire, and dryer fabric decreased dramatically, machine uptime increased, web breaks per day decreased, and production tonnage grew. Within the first month of application, the machine shutdown cleaning frequency went from 7–10 times per week to once per week. The machine speed increased from 1100 m/min. to 1350 m/min. Within the first six months of use of the enzymatic technology, the machine cleaning frequency further improved to once every ten days. Pulp brightness increased from the initial value of approximately 52% ISO with aged wood to 55%–57% ISO using up to 50% fresh wood. Machine speed increased to 1500 m/min. Figure 2 shows the final pulp brightness from the TMP plant vs. fresh wood use during the enzyme treatment. The enzyme treatment allowed significant increases in use of fresh wood and substantially improved brightness.

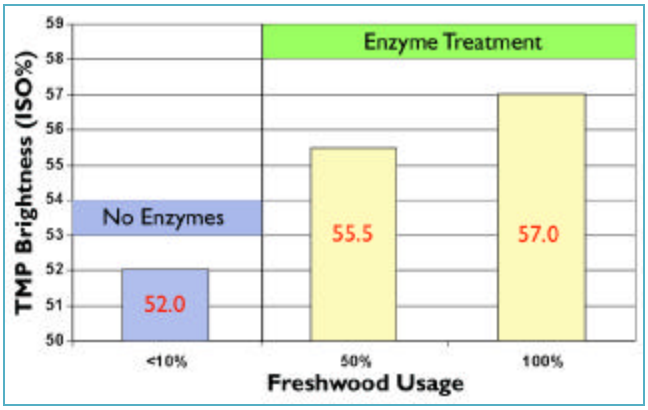
TEST OF A TRULY EFFECTIVE TECHNOLOGY

On the eve of the May 1st week-long Chinese national holidays, a mechanical malfunction in the TMP plant triggered disablement of the disk thickener. The necessary spare parts were not on site and would not arrive at Nanping Paper for at least three weeks. To maintain the mill production, the TMP pulp process underwent modification to bypass the disk thickener unit. Enzyme addition was suspended due to this change. A pitch outbreak started to occur only 8 hours later on PM No. 5. The pitch deposits on various parts of the machine were so severe that they were clearly visible and evident to the touch. Visible pitch spots and holes in the sheet caused web breaks at the press sections that seriously impacted paper production.

After a quick meeting, the mill decided to resume the enzyme addition into the TMP process immediately and conduct intensive testing with close supervision. The objective was to reduce to the same pitch level as before the interruption. Within 24 hours from the resumption of the enzyme application, the production at PM No. 5 returned to normal.

CONCLUSION

Since the beginning of Nanping Paper 40 years ago, pitch has always been an issue affecting production, product quality, and the daily lives of the employees. Investment of significant capital and resources have been necessary to deal with pitch. The efforts with different chemical treatment programs did not yield satisfactory solutions to this pitch issue until the arrival of biotechnology. The success of this enzymatic technology has brought new possibilities and changed the way of thinking for raw material handling and future wood supply. The results of using this technology so far are very significant:



2. Effect of enzyme treatment on TMP brightness and wood use

- Essentially solved pitch deposit problem
- Reduced sheet breaks and machine cleaning frequency
- Increased paper machine uptime and production
- Improved pulp brightness and strength properties
- Minimized maintenance costs
- Extended felt and wire life spans
- Increased operational cash flow by reducing the capital needs for wood storage
- Improved operating environment.

The trial with the enzymatic pitch control technology was highly successful and exceeded expectations. It also opened new possibilities for biotechnology in other processes at Nanping Paper Mill such as enzymatic bleach boosting of kraft pulp, deinking, biocide, and water treatment. The mill learned from their experience with the implementation of this enzymatic pitch control technology that one must have the courage to lead and take bold steps to succeed in a competitive market. At the dawn of this new century, the mill is excited about the benefits the new technologies can offer. It intends to be a pioneer in this technical revolution. TJ

Chen is mill manager and Lin is chief engineer of Nanping Paper Mill. Zhang is general manager of Enzymatic Deinking Technologies (EDT) in China. Wang is director of technology and Yang is senior manager of EDT, 5305 Oakbrook Parkway, Norcross, GA 30093. Address correspondence to Xiang Wang at pitchcontrol@edt-enzymes.com.

Acknowledgment: EDT thanks the management of Nanping Paper Mill for their support and cooperation that have made this application possible. EDT also expresses special appreciation to Dr. Kunio Hata for his advice and pioneering work in this field.