LINCOLN PULP & PAPER STARTS NEW BLEACHING PROCESS

ART BONIFACE

FIRST U.S. DOUBLE-OXYGEN SYSTEM

LINCOLN PULP & PAPER, A SUBSIDIARY OF EASTERN PULP & Paper, is located on the Penobscot River approximately 40 miles north of Bangor, ME. The pulp mill has two continuous digesters, a Kamyr running on hardwood chips (maple, beech, and birch), and an M&D unit, which has a feedstock of waste softwood sawdust (spruce, fir, and hemlock). Each produces about 225 tons/day.

Eastern's president, Pepe Torras, points out that Lincoln was the first pulp mill in North America to have a high solids black liquor crystallizer. It had the second Kamyr continuous digester in North America; it had the second low odor B&W recovery boiler in the United States; Lincoln's M&D digester was the first in North America to run entirely on small particle waste sawdust, from which 50% of Lincoln's pulp is made. Lincoln is continuing this extraordinary history of innovation with its new, first in the U.S., double oxygen bleaching operation, which it has named EnvirO2.

Bill Valance, corporate director of process engineering at Lincoln Pulp & Paper, at the base of the new liquid oxygen supply system

Approximately 150 tons/day of the 450 tons/day of pulp produced is processed across a pulp drier and sent to Eastern Fine Paper's (Lincoln's sister mill in Brewer, ME, which is 50 miles away) specialty machines. The balance is used in the furnish for the fine paper and tissue machines at Lincoln. Products manufactured with Lincoln's pulp meet the current U.S. government recycled paper procurement criteria, as defined by Presidential Executive Order, due to the high content of waste sawdust pulp.

The two pulps are combined after their respective blow tanks. After blending, the pulp is deknotted and washed on a 3-stage vacuum drum brownstock washing system. The pulp is then sent to a high-density storage tower. After brown high-density storage, the pulp is pumped to a closed screening/cleaning and decker system. The kappa number of the blended pulp entering the bleach plant is 22. The old bleaching sequence was CdEpDD with 40% ClO_2 substitution. Final pulp brightness was 86 ISO.

PROJECT BACKGROUND AND GOALS

As early as 1992, Lincoln was actively studying alternatives to bleaching with elemental chlorine. Conventional ECF bleaching using chlorine dioxide to replace chlorine was the direction in which most North American mills were heading. Lincoln took a serious look at this as well as oxygen, ozone, and hydrogen peroxide technologies. Extensive use of oxygen appeared to have the most long-term promise. The Cluster Rules further underscored the need for major bleaching process revisions. Oxygen delignification (OD) was investigated but this process presented several disadvantages. These included high capital cost and replacement of existing carbon steel equipment in the brownstock washers and screen room. Another disadvantage was increased solids loading to the black liquor recovery boiler, which was already approaching its maximum capacity. However, the use of oxygen was deemed highly desirable. It was readily available, low in chemical cost, environmentally friendly, and would leave the mill better positioned to become total chlorine free in the future. However, Lincoln had concerns about the ability of a powerful oxygen system to preserve the pulp strength being provided by the original bleaching process.

Lincoln's new No.1 and No. 2 oxygen reactors

Process and project development moved forward under the leadership of Bill Vallance, corporate director of process engineering, and Nana Barde, vice president, corporate engineering. Laboratory testing was begun to verify a new process and concept of using oxygen without incurring the disadvantages mentioned above, while at the same time maintaining brightness, strength, and low cost. Strength was a major consideration in assuring Lincoln's pulp retained the high standards necessary for manufacturing their specialty paper and tissue products.

Encouraging results from the lab work led to further process development work, mainly at Lincoln with assistance from Paradigm Engineering Inc., St. John, NB, Canada. In the latter parts of process development, the bleaching skills of Hassan Lutfi of Paradigm and Norm Liebergott of Norm Liebergott & Associates were very valuable. Ahlstrom supplied major new equipment, and the mill was pleased with their support.

In addition to Vallance and Barde, other members of the Lincoln team included Marco L'Italien, pulp mill superintendent; Gene Etchie, project engineer; Abby Young, senior maintenance project manager; Bob Wurzel, E/I manager; Alan LaFlamme, E/I engineer; Jason Lyons, process control engineer; John Fitzgerald, technical service plant chemist; Fred York, pulp mill day supervisor; and Dennis McComb, environmental/safety manager.

NEW BLEACHING PROCESS DESCRIPTION

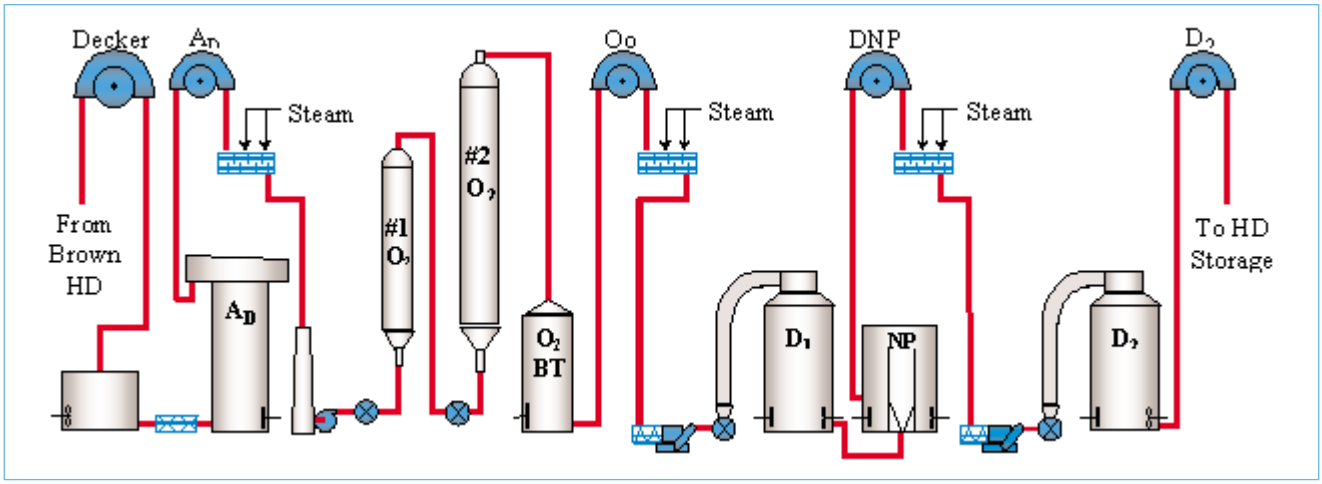
A year after the final lab work was completed, Lincoln was ready to go to the commercialization stage. The new bleaching process was AdOo(DNP)D. The installation of the new equipment was designed to meet operating conditions as specified by Lincoln. The new bleaching process is shown in **Fig. 1**.

The first stage is called the Activation or Ad stage. In this stage the chemicals are sulfuric acid and/or spent acid (from the Solvay ClO_2 plant) along with a small amount of chlorine dioxide. The objectives for this stage are metals removal, partial treatment for hexenuronic acids, washing, and activation of the lignin prior to the oxygen stage. Proper conditions in the Ad stage allow the oxygen reactors to be pushed to a lower outlet kappa number without losing selectivity (change in viscosity per unit change in delignification). ClO_2 is introduced into low consistency pulp using a static mixer. The former chlorine tower provides the necessary 30 minutes retention time. The pulp then is washed on the former Cl_2 washer, a vacuum drum unit of fiberglass construction. The pulp from this washer is heated in a conventional double-shaft steam mixer and is delivered to the oxygen stage feed pump.

The second stage is the oxygen or Oo stage. Delignification is accomplished in two reactors in series. Two reactors were chosen instead of one to allow delignification to a lower outlet kappa number with good selectivity. The Oo stage is currently delivering about a 7 kappa number pulp to the DNP stage.

One of the major objectives during detailed process design was to minimize the amount of gas channeling that typically occurs in oxygen reactor systems. This can often limit the performance of the system and adversely affect selectivity. Therefore, design emphasis was placed on a close-coupled system that could run at high pressure and consistency (over 12%) with a minimum number of piping elbows after oxygen injection. Operation with a single MC pump was chosen for process control stability and reduced variability.

Current retention times are 20 min for No. 1 reactor and 60 min for No. 2 reactor. Sufficient total retention time was provided to allow for easier bleaching in the following stages at any given kappa number.



1. A schematic of the new bleach line at Lincoln

It also significantly improves the bleach plant's ability to handle wood shives with no chlorine and less chlorine dioxide. The mill has the flexibility to add oxygen, alkali, and high-pressure steam to each reactor in order to maximize process capabilities. Magnesium sulfate is applied prior to the oxygen reactors for viscosity protection. Hydrogen peroxide also can be added to each reactor but currently is used only for startups.

The oxygen reactors are Ahlstrom units. The first stage reactor is constructed of 316L stainless steel. The second reactor, also by Ahlstrom, has Avesta 2205 duplex stainless steel wetted parts. This allows for the possible future use of hydrogen peroxide.

The pulp feed pump is an Ahlstrom MCV model with internal degassing. The mill's existing tile-lined carbon steel caustic tower was converted to a blow tank with about 40 min retention time. The oxygen stage washer is the former extraction stage washer and is of 316L stainless steel construction.

The third stage is called the DNP stage. The first segment is a medium consistency chlorine dioxide tower. ClO_2 is introduced in a modified peg mixer between the thick stock pump and the D_1 tower. The D_1 tower was also the old D_1 tower and provides about 120 min of retention time. Pulp is discharged from the D_1 upflow-downflow tower at low consistency and proceeds with no interstage washing to the Neutralization/Peroxide (NP) tower. Caustic and hydrogen peroxide are added to this tower. The NP tower provides about 60 min of retention time. Washing after the DNP towers is performed on a vacuum washer of fiberglass construction.

The final stage is a chlorine dioxide or D_2 stage and is unchanged in function from the original process. From the DNP washer, the pulp is heated again in a double-shaft steam mixer. From this mixer, the pulp is fed into a thick stock pump and then to a peg mixer, where the final chlorine dioxide charge is introduced. Retention time, normally 120 min, is achieved in the D_2 tower, a standard upflow-downflow unit. The pulp then is washed on the D_2 vacuum drum washer. Discharge from this washer is to a series of high-density towers that provide 24 hours of storage for the paper, tissue, and pulp machines.

INSTRUMENTATION

The bleach plant, and in particular the oxygen stage, utilizes a high degree of instrumentation. Pressure, flow, temperature, consistency, and pH are measured at multiple points in the process. Brightness sensors are in use on all stages. A residual sensor is used only on the D_1 stage. Special emphasis is placed on stock flow and consistency, as these two parameters have a large effect on the variability of the entire process.

Control of the MC standpipe, critical to stable operation, is achieved with a gamma gauge level measurement and an AC variable frequency drive on the MC pump. MC pump discharge consistency is also measured and controlled.

Control strategies, designed by mill personnel, are implemented in the existing distributed control system and have been extremely effective in minimizing process variability and reducing off-quality production. A key feature of the controls is the stage-by-stage automatic startup and shutdown sequences. The mill continues to optimize the process controls through tuning, automation, on-line calculations, and control strategy upgrades.

STARTUP

After years of process development and less than one year of construction, the bleach plant was ready to be converted to the new process. The new Oo stage was run "offline" on water for about two weeks. During this period, the operators received final training. A few minor problems were found and corrected. Final tie-ins and startup of the new process were successfully accomplished on an 18-hour planned bleach plant shutdown. The use of chlorine was permanently discontinued on June 8, 1999, within 24 hours of startup. Needless to say,

everyone associated with the project was extremely proud of this achievement.

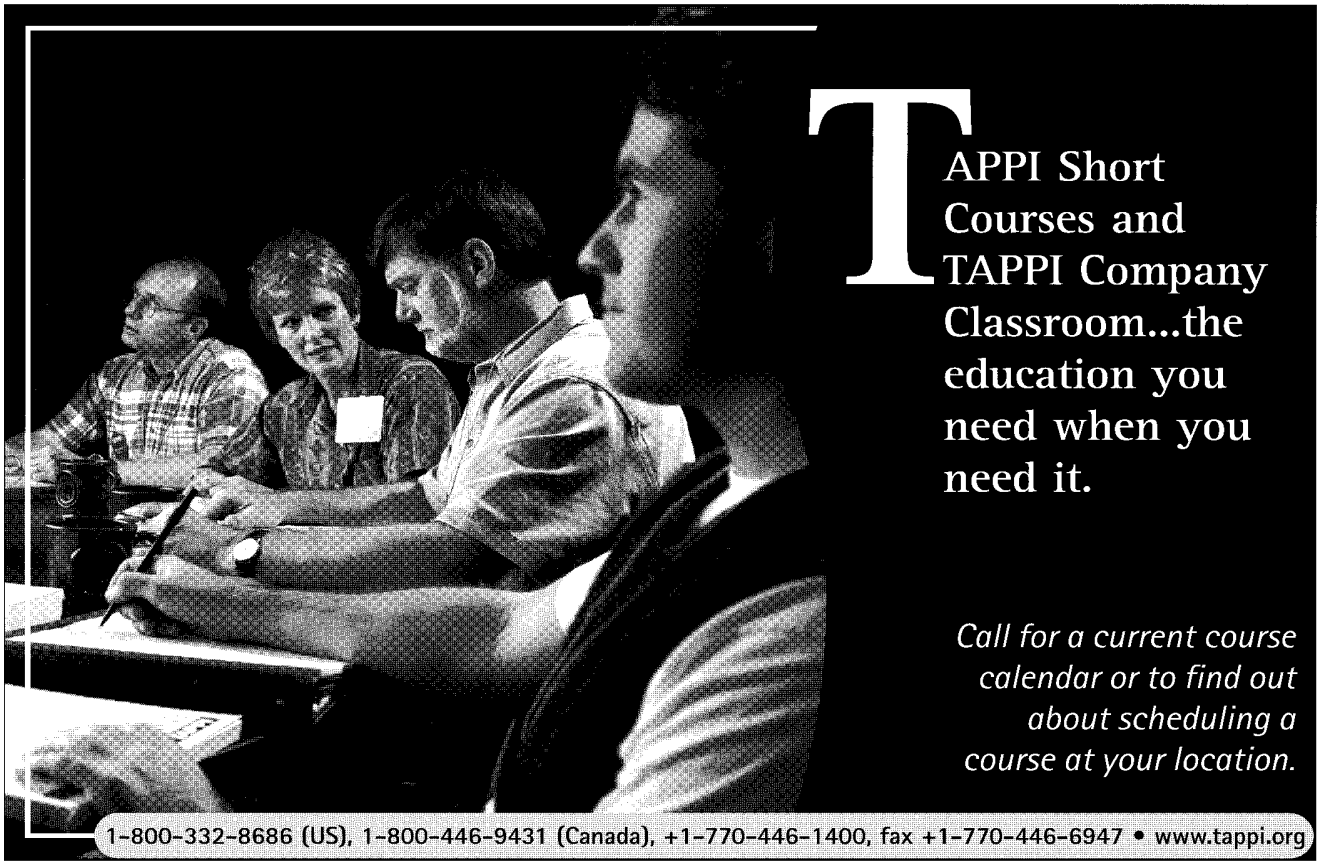
Operator acceptance of the new process has been excellent. Their skill, attitude, observations and helpful suggestions were key during the startup and follow-up optimization.

SUMMARY

This new bleaching system has surpassed all of the original fiber quality and environmental criteria while achieving an attractive rate of return. The performance of the post-oxygen washer, while acceptable, still presents opportunity for further improvement. The new process has resulted in a pulp that averages a one-point increase in brightness (87 ISO vs 86 ISO), equivalent strength properties, and a 50% reduction in dirt count. Pulp shrinkage in the bleach plant is estimated at 0.5% less than with the former bleaching configuration. Chlorine dioxide usage is about 50% of what a conventional ECF sequence without oxygen would have been. The mill effluent quality has been improved and exceeds current state and federal Cluster Rule requirements. AOX now averages less than 0.1 kg per metric ton, which is far less than the required 0.65 kg/mt Cluster Rule limit. This process allowed Lincoln assured compliance with Maine's stringent 1997 Dioxin law, which required achievement of nondetectable levels for TCDD and TCDF at the bleach plant effluent by December 1999. Meeting the Maine limits for dioxin/furan assures compliance with the federal EPA dioxin/furan limits required by 2001. Since installation, all of Lincoln's bleach plant effluent dioxin/furan monitoring data has been below laboratory detectable limits with labs achieving detection levels below 1 ppq.

Chlorinated phenolics are also non-detect and chloroform is less than 20% of the Cluster Rule limit.

This project involved a significant percentage of the hourly and salary workforce at Lincoln. Its success is a tribute to the quality of that workforce.

Eastern Pulp & Paper, Lincoln's parent, has applied for patent protection on the product and the process. TJ

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