Billerud Karlsborg AB
Better pulp for better sack paper
Improved pulp quality sets the stage for better sack paper

By updating pulping process measurements, integrating automation functions and adding optimization controls, Billerud Karlsborg AB reduced pulp variability. Steam savings and extra pulping capacity were additional benefits. Mutually beneficial cooperation with Metso Automation has lasted for over two decades and has led to many significant process improvements.

Under the ownership of Assi Doman, the original eight-digester Sunds Defibrator (now Metso Paper) fiber line was started in 1979. The conventional batch process was converted to a cold blow process in 1985 and oxygen delignification was added in 1991. Billerud became the mill owner in 2001.

Sack papers need even strength and porosity

Porosity and strength are key, interrelated qualities of sack papers, especially for Billerud’s QuickFill product, which is used for cement bags – right now a very attractive, growing market for sack papers. Porosity is an especially important performance indicator because it affects the cleanliness of the filling operation and the bag filling rate. Billerud made the investment in new process controls and automation to achieve a significant reduction in the variation of the pulp Kappa number which they projected would result in as improved stability of the furnish quality and then as consistent paper quality.

To establish this stability right at the beginning of the fiber line, Billerud Karlsborg, at the top of the Gulf of Bothnia in Sweden, upgraded the process measurements and process controls and added higher level digester line optimization controls to their 290,000 ADt/a cold blow batch kraft digester line during 2001–2002. About 130,000 tons per year of the 89.5 brightness ECF bleached pulp is consumed by the on-site kraft paper machine. The rest, mostly softwood pulp, is sold as market pulp.

They also foresaw chemical savings in the bleach plant and steam savings in the digesters. The projected payback period was estimated at 1.7 years for the total investment in updating the basic process automation and adding optimization control.

Better control reduces Kappa variation

The new metsoDNA automation network supplied by Metso Automation integrates process and motor controls, sequence controls, feedforward and feedback digester controls using a new online Kajaani alkali analyzer, and optimizes the scheduling and coordination of digester blows to achieve smoother fiber line operation and higher production capacity. The optimization package includes digester steam leveling controls, a digester temperature minimization strategy and tank farm management. This latter strategy helps the operators
New process controls and automation solutions have contributed to more consistent paper quality at Billerud Karlsborg.

To manage the levels in the numerous liquor tanks by predicting upcoming changes in tank levels. The new automation network joins other Metso Automation systems on the rest of the fiber and recovery lines.

Altogether, the improved control over the pulping process, process management and scheduling has led to an impressive reduction in Kappa variation of about 40% at the softwood Kappa level of 24 and a carry through quality benefit in the paper mill. With the new controls extra pulping capacity is now available.

In addition, by more precise control over cooking conditions, the cooking temperatures have been lowered, producing a 7 to 10% steam saving at the lower production rate.

Batch cooking automation concept.
The time was right for an integrated control network

Operators too busy, scheduling suffered

A 1980 vintage Valmet Automation Damatic Classic system, one of the first to be installed in a pulp mill, interfaced to the instrumentation, pump motors and valves. There were no supervisory process controls, only panel instrumentation.

Nils-Olov Ekholm, Process Engineer, describes the difficulty for the process operators in maintaining the digester scheduling and achieving a consistent product: “It was a very old way to control. To manage the scheduling of the 8 digesters, the operators were busy all the time.” Without the process visibility of a modern system, he says they weren’t sure where the Kappa variations were originating. Some might have come from scheduling problems, perhaps waiting for a blow, or from initiating an action a few minutes too late. Certainly, these scheduling problems affected the stability of the line.

Rolf Wälivaara, the Fiber Line Superintendent, emphasizes the lack of process visibility: “We could not search for errors, and production changes were difficult.”

The mill invited proposals for upgrading the automation in two stages, with the view to integrate the scope of supply in the final operating system. First they decided on the system for the basic instrumentation, valve controls, motor controls, sequence controls and interlocks. Then they evaluated the supervisory or optimization controls.

They chose this two-step approach because the evaluation criteria were quite different. The evaluation of basic instrumentation, motor control and sequence control systems was based on product reliability, service support and technical issues like easy and accessible function block programming, diagnostics and visibility into process hardware problems. As usual, system openness and compatibility with IT networks are important issues today.

The supervisory or optimization systems were gauged mainly on vendor knowledge. Ekholm says, “It’s a challenge for an outside company to understand pulp making processes that are different at each mill. But it is the equipment supplier who might be the best party to help with the process.”

The selection team chose Metso Automation’s solution for both parts. By integrating the basic process controls, sequence controls and optimization controls into one open network, the old, inaccessible black boxes and computer interface issues of the 1980s are avoided.

Stabilizing liquor charging and cooking

Improved pulp quality stability starts with the online measurement
Thanks to the new system, the operators now have a much clearer view of the process.

and control of effective alkali to wood ratios in the digester charging phase followed by the measurement and control of residual alkali in the digesters’ circulation lines as the control follows the progress of H-factor during the cooking process. These feedforward cooking zone controls are supervised and trimmed by a feedback control of the Kappa number using an existing online analyzer located just before the oxygen delignification process. The Kappa analyzer’s signal is time delayed so the control knows in which digester the pulp was cooked.

The new Kajaani alkali analyzer, installed in March 2002, replaced an older analyzer that proved to be unreliable. The reliability of these online analyzers is critical since traditional one-per-shift laboratory measurements cannot determine the alkali concentrations frequently enough for accurate and stable control. At the Karlsborg mill the measurement reliability issue was even more acute since routine lab testing has been suspended on weekends since 1996.

The analyzer is an automatic online titrator whose measurement is based on the SCAN-N 33:94 laboratory standard. Since its titration method is exactly the same as in the lab, no calibration is required. It measures residual alkali levels in each digester’s circulation line as well as the effective alkali of white liquor and mixed white and black liquor. The analyzer takes samples automatically from up to 8 different sampling points, in the desired order, and backflushes the lines after each sampling with high-pressure water to prevent plugging.

Just-in-time sampling
As its first priority, the analyzer measures residual alkali in each of the digesters’ circulation lines at two points during the heat-up phase and at two points nearing the end of the cook. Residual alkali variations are caused by process variables such as alkali to wood ratio in the initial charge, chip characteristics like size, age or bark content, sulfidity and temperature – all factors which affect the chemical reaction rate.

The two samples which form each analysis result are taken five minutes apart. The higher level cooking controls ensure the just-in-time schedules for these analyses coincide with the desired H-factor check points in each of the eight digesters. The sampling schedules are adapted to the cooking cycles determined by the production rate optimization control.

The control algorithm calculates the deviations between the measured alkali profile and a typical reference residual alkali profile during the cook. The feedforward control then updates the H-factor target at the end of each cook to reduce deviations in the final Kappa number projected by a model in the control algorithm.

Variations in white liquor strength or the mixed liquor strength are automatically compensated in the alkali to wood ratio control so the correct amount of chemical is applied. These liquor samples, which are scheduled to fit within the high priority residual alkali sampling periods, are taken every ten to fifteen minutes, depending on the production rate.

With the online measurement and model-based controls, the short term variation of the pulp Kappa number has been reduced significantly. “The control does a great job when white liquor quality is varying,” says Wälivaara.
Optimization uncovers hidden problems

Scheduling adds stability, increases capacity

The cooking zone controls stabilize the chemical reaction processes in the digesters. But, in any batch process, imprecise scheduling, production rate changes or grade changes can detract from process stability. Peter Carlsson, Process Specialist, described one of the typical instability problems caused by imprecise scheduling with the old manual operation. “When the operators were too busy, they could lose track of the manual filling operation for a few minutes. The liquor filling would therefore be inaccurate. That could be made up by increasing the temperature to meet the cook's target schedule.” In this case, the cooking temperature would be higher than normal.

The scheduling control has proved its value by ensuring good repeatability of the cooking conditions from batch to batch. The control sets the digester conditions to achieve even pulp quality while, at the same time, manages the digester scheduling during steady state production and during production rate or grade changes. It recognizes any resource limitations such as the number of digesters in service or the maximum steam consumption allowed. Digester scheduling and cooking cycle time estimations minimize the risk of overcooking as conflict situations are recognized earlier so they can be prevented.

Carlsson describes the results of automated scheduling: “The only manual action our operators have to make is to start chip filling. Even that will be added later. The production is so even now and without disturbances we can achieve more blows per day.” Since the controls were implemented, the mill has set single day production records of 40 blows and a weekly record of 37 blows per day. That's up from about 32 blows per day before the automation project.

Ekholm adds, “Even if one digester is off line we don’t lose production capacity, since the schedule is re-adjusted by the system. It’s also easier to change the production rate. The operator just enters the number of blows.”

Not all of this extra capacity potential can be realized right now because the mill is limited by evaporation capacity. This will be alleviated by an evaporator plant upgrade project scheduled for June 2003. Wälivaara rates this increased capacity as the most significant outcome of the project even though it wasn’t projected in the initial ROI calculations.

The reduction in pulp quality variation has confirmed the mill’s expectations. At 24 Kappa number the variation has been reduced by 40%. The mill also reports better stability in their most important paper grades.
Lowered cooking temperatures give steam savings
The system also minimizes steam consumption by automatically lowering cooking temperatures, within an operator set window, if the H-factor target can be achieved in the scheduled time. This lowering of cooking temperature has been made possible by the improved repeatability between cooks. The digester temperatures have been reduced from about 168°C to 165°C, resulting in steam savings of 7 to 10% at the lower production rates.

Operators have a much better view of the process, and it is much easier for a new operator to learn. This improved visibility has also uncovered some previously hidden problems. Carlsson says, "We are now more sensitive to valve problems. But with this system we can discover and solve many problems we couldn't see before."

The mill is continuing to develop and refine the line operation. Work in progress includes optimization of the cooking temperatures and refining the cooking conditions in individual digesters.

The positive results gained in terms of quality and steam consumption speak for themselves.
Key Facts: Karlsborg Billerud Mill

Production capacity: 130,000 ADt/a tpy of sack and kraft paper, 160,000 ADt/a of market pulp
Personnel: 470

Metso Automation deliveries to Billerud Karlsborg

Batch digesters
1980  Damatic Classic system
2001  metsoDNA; motor controls, sequence controls and optimization controls (DNAcook-B) integrated

Washing and screening
1980  Damatic Classic
1991  Damatic XD
1994  Motor controls and sequence controls integrated into Damatic XD

Oxygen delignification
1990  Damatic XD
2000  OXYTRAC high level control

Bleaching
1980  Damatic Classic
1992–1994  Damatic XD; motor controls integrated
1997  More advanced controls

Pulp storage
1985  Damatic Classic, the first integrated system in the mill to control motors, instrument loops and valves

Recovery boiler
1979  Damatic Classic
1998  Damatic XD

Evaporation
1979  Damatic Classic
2002–2003  metsoDNA

Lime kiln/mixing towers
1980  Damatic Classic
1992  Damatic XD

Bark boiler
1981  Damatic Classic
1995  Damatic XD; integrated motor and on/off controls

Field devices

Kajaani products
kajaaniMCAi-F, total consistency microwave transmitter
Nove-S, sampling devices (23)
kajaaniALKALi, analyzer for cooking
kajaaniCORMECi, (3) brightness analyzer
kajaani DSA, ClO₂, concentrations' analyzer
kajaani RM-200 (2-sensor system), continuous retention monitoring and control system
PQM-IL (3 sampling devices), inline pulp quality analyzer
kajaaniFS-200, fiber length analyzer
kajaaniMCAi, total consistency microwave transmitter

PaperLab, automated paper testing system

Neles products
NP, NE positioners
ND800 intelligent valve controllers
PX500 capping valves
Ball valves, Series PK, PJ & PL,
MBV ball valves
Neldisc® butterfly valves, Series LJ, L1CM & L12
R-series segment valves

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