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To: XL-2 Collaborative Team Date: August 12, 2001
From: Joseph Genco (University of Maine) and Ben Leber (International Paper Co.)
Subject: Effluent Reduction by Process Closure Short Course

Introduction

This memorandum summarizes information obtained from the "Effluent Reduction by Process Closure Short Course" sponsored by TAPPI and held in Asheville, North Carolina between June 25 to June 27, 2001. Tony Johnson served as the course Chairman. The instructors in the course were Tony Johnson, Neil McCubbin and James Frederick (see Table 1).

Table 1
Company Affiliation

Name	***Company***	***Location***
Anthony (Tony) Johnson	Beca Simons Ltd.	Tauranga, New Zealand ajohnson@beca.co.nz
Neil McCubbin	N. McCubbin Consultants, Inc.	Foster, Quebec neil@mccubbin.com
James Frederick	IPST	Atlanta, Ga. Telephone 404-894-5700

The course was worthwhile attending and the lecturers did a very good job. A complete set of lecture notes was provided. These notes can be made available to members of the XL-2 Collaborative Team for those who are interested, assuming permission can be obtained from TAPPI.

Focus

The focused of the course was closure of a Kraft mill and reductions in water usage and sewer losses by process modification rather than end of pipe treatment. It was directly applicable to reducing COD and color going to the waste treatment plant and receiving water bodies. As such it was directly applicable to the IP XL-2 project.

Course Organization

The course consisted of two days of lecture on June 25 and 26 with a mill visit to the Blue Ridge Paper Company on Wednesday, June 27, 2001. The experience at Blue Ridge Paper Company, formerly Champion-Canton, located in Canton, N. C. served as a good illustration of what could be done to close a Kraft mill through process

modification. There were several case studies presented during the course that featured participation by the attendees.

Topics Covered

The topics covered in the course are listed in Appendix A and depict their importance relative to closing a Kraft mill.

Material (Water) Balances (Johnson)

The mill must have a water map, that is the sources and sinks must be identified. Material balances should be used as a guide to estimate water usage and the nature and quantity of the process effluents. Simple balances can be done on a spreadsheet, but for substantive work a process simulator is required. Several simulators were mentioned, CADSIM, MAPPS, GEMS, MASSBAL etc. The methods applicable to performing material balances in a mill were reviewed.

Mill Process Closure (Johnson)

The rudiments of mill process closure were discussed. Data were presented for mill water usage in m^3/ADMT of pulp for current and low effluent flow mills. Foundation technologies must be in place to close up a Kraft mill or it becomes very difficult. Capital monies must be spent on the foundation technologies. The technologies mentioned were effluent monitoring, spill control methods (filtrate buffer tanks, spill ponds etc.), extended pulping, oxygen delignification, segregation and treatment of evaporator condensates, cooling towers to permit reuse of non-process water within the mill, effective brown stock washing and bleaching sequences that permit bleach plant closure.

Importance of Black Liquor Spill Control

Neil McCubbin reviewed the importance of spill control for black liquor as a technique for minimizing process effluents. This involves primarily process knowledge, the training of people and diligence to prevent black liquor from escaping the process. It also involves proper design of sumps and drainage system to permit monitoring and pumping process discharges back to holding tanks and spill ponds so that the spilled material may be gradually bled back to the process. McCubbin was of the opinion that complete elimination of spills is impossible, but most mills can reduce spills substantially at relatively low cost.

Millwide Water Reduction Opportunities and Mill Closure (Johnson and Frederick)

Tony Johnson and Jim Frederick reviewed opportunities to reduce water in the Kraft mill (Tony Johnson) and in the recovery cycle (Jim Frederick). Each mill is different, but for any mill numerous opportunities exit for the reduction in water. This leads to a reduction in the mill effluent since input equals output. Areas discussed were the digester, brown stock washers, bleaching, screening, pulp machine and chemical recovery area. The key is to perform the necessary process engineering studies to identify major water use areas and methods for reduction. Each mill is unique and what works for one mill will not necessarily work for another. Thus the team working on water reduction projects must be flexible.

Interfacing with the Recovery Cycle (McCubbin)

Invariably as a pulp mill and bleach plant are closed and purge points in the process reduced, more solids will find there way to the recovery cycle and more process elements will build up or accumulate in the process, especially in the recovery cycle. These materials must be handled appropriately or corrosion, scaling, plugging, deposition and other operational problems will ensue.

Sources, Identification, Buildup and Control of Non-process Elements (Tony Johnson)

Non process elements enter the process system with the wood, in the intake water and chemicals added to the Kraft process, for example in the lime, caustic, saltcake, etc. Non-process elements such as Al, Si, Ca, Mg, Ba, K, Cl, Mn, Fe, Cu, and oxylate ion were discussed. To avoid deposition problems, trace elements in the process chemicals and the wood must be identified and the methods of removal from the system developed. Johnson identified sources of non-process elements in the wood, fiberline and bleach plant that accumulate in the system because of system closure. Non-process elements only have three places to go, they are either removed with the pulp, in the dregs, in precipitator ash and in assorted water streams that go to the waste treatment system, or they deposit on the equipment. As the waste streams leaving the process are decreased, it is important to improve existing areas for removal or install new points of removal. If this is not done than the concentration of non-process elements will increase and operational problems will occur.

Problems Encountered in the Recovery Cycle (Jim Frederick)

Jim Frederick discussed the impact of effluent reduction on the recovery cycle. The most common problems encountered are scale formation in the evaporators and corrosion and tube plugging in the recovery boiler. Often there is loss of evaporator capacity and there is an increase in the shut down time for maintenance and cleaning of evaporators and superheater tubes. Solutions to these problems usually lie with adding evaporator heating capacity, improving the causticizing efficiency and improving dregs washing and dregs removal.

Cost of Closure

Neil McCubbin discussed the cost associated with mill closure. Capital costs can be appreciable depending upon the age of the mill and whether foundation technologies have been installed previously or not. Sometime the mill will realize a positive rate of return since raw materials and energy losses decrease with mill closure.

Mill experiences in Europe and North America (Tony Johnson)

Tony Johnson discussed experiences associated with closure of assorted Kraft mills. A list of low effluent mills was presented. By far the greatest amount of experience with mill closure is in Europe; but several mills in North America served as examples. The most important mill in North America with direct experience is the Blue Ridge Paper Mill located in Canton, North Carolina. Other North American examples of mills that

have been active in mill closure, mentioned in the course, include IP Franklin, Loi9siana Pacific, Samoa, California and Weyerhaeuser, Tacoma.

Case Studies (all instructors)

Case studies were used throughout the course to illustrate mill closure and problems encountered.

Blue Ridge Paper Mill

A visit was made to the Blue Ridge Paper Mill located in Canton, North Carolina. The objective of the visit was to have first-hand discussions and observations on water and effluent reduction arising from closure of a Kraft mill. Mr. Michael Ferguson, Kraft Mill Manager lead this discussion and did and excellent job. Mr. Ferguson used slides to describe the work done at Canton on "Environmental Improvements Through Process Modification and Closure (see Appendix B).

- **Mill Location.** The mill is located on the Pigeon River in Canton, North Carolina in the heart of the Blue Ridge Mountains.
- **Color Problem.** The Pigeon River has very low flow and mill has had problem with color discharge to the river.
- **Effluent Reduction Program.** The effluent reduction program was undertaken by Champion International Corp. to solve the color problem and to demonstrate mill closure.
- **Greatly Reduced Water Usage and Effluent Discharge.** The mill considers the environmental improvement program a success with greatly reduced water usage, color, COD, BOD, and AOX (see slide 5).
- **Major Contributors for Improvements.** The mill attributes the success experienced at the Canton Mill to three fundamental factors; (1) mill modernization, (2) development of the BFT process, and (3) installation of best management practices (see slide 10).
- **Mill Modernization.** A mill modernization project was completed in which the mill installed "foundation" technologies or processes that permitted mill closure and the effluent to be reduced (slides 13). At this time of the modernization the mill (1) installed modern brown stock washers to reduce carry over to the bleach plant, (2) oxygen delignification to reduce the kappa number going to the bleach plant, with good post oxygen washing, and (3) closed up the screen rooms. The mill also retrofitted the black liquor evaporators (slide 27). In this effort the mill changed the liquor flow arrangement, added addition heat exchanger capacity (Slide 28), segregated the steam condensate streams (Slide 30) and improved the vacuum capabilities in the system (Slides 29). During the modernization the mill installed steam stripping. Changes to the evaporators permitted odor control and reuse of evaporator condensates within the pulp mill.
- **Reconfigured Hardwood Line.** The mill converted the old pine line to a hardwood line (slides 14 through 22). The hardwood line consists of 9 batch digesters, two stage knotting, vacuum washers, 1 brownstock washer line consisting of 4 brown stock washers and 3 stage post oxygen washers, four stages of pressurized fine

screening, and a medium consistency bleach plant with a OD100EoD bleaching sequence (Slides 18 and 19).

- **New Softwood Line.** The mill installed a new modern pine softwood line (slides 23 to 26). The softwood line consists of 9 batch digesters, two stages of knotting, compaction baffle washers, 1 brownstock washer line consisting of 3 stages of pre-oxygen and 3 stages of post oxygen washing, four stages of pressurized fine screening and one medium consistency bleach plant line consisting of the OD100EopD sequence. (Slides 23 and 24).
- **Process Water.** To reduce process cooling water and seal and pump water, the mill installed a cooling water loop. As part of the loop, a cooling tower was installed and water is cooling water is reused as much as possible.
- **White Water Reuse.** The mill also tries to use excess machine white water as much as possible. Machine white water is used in mining high-density storage and some is used in the bleach plant.
- **Bleach Filtrate Recycle (BFT^{Ô}) Process**. With closure of the mill, the first two stages of the pine fiber line are recycled to the evaporators (slide 39). In addition about 20% of the Eo filtrate on the hardwood line (slide 45). Because of the recycle of bleach plant filtrate from the pine line and chloride ion makes its way to the recovery boiler. Also, as the mill is closed metal ions coming in with the wood, process water and the chemicals build up in the system. To solve these problems, Champion International developed the BFT^{TM} Process that purges chloride ion and metal ions (primarily Ca^{++} and Mg^{++}) from the system (Slides 33 to 44). A flow sheet for the basic concept is shown in Slide 35. In the BFR process, black liquor from the evaporators goes to a recovery boiler where it is burned. Ash from two electrostatic precipitators goes to a chloride removal process where chloride and potassium ions are washed out of the ash and sent to a sewer as a purge (Slide 36). Saltcake (Na_2SO_4) that is recovered goes back to the recovery boiler. Trace metals (primarily Ca^{++} and Mg^{++}) are removed in a metals removal process (Slides 37 and 38), which is predicated on the use of ion exchange columns, much as is done by a homeowner that uses well water that is "hard".
- **Best Management Practices**. Best management practices have been installed at the mill (slides 46 to 48). Best management practices consist of an extensive spill collection system, expanded planning for outages, increased monitoring during outages, daily monitoring of individual sewers, tracing of excursions, using SPC to track in-mill sewer areas and annual refresher training for the operators. The use of Best Management Practices" permits mill personnel to respond quickly and responsibly when spills and malfunctions occur.
- **Spill Collection System**. The spill collection system at the Canton was very impressive. They have an extensive monitoring system, numerous sumps and receiving tanks for collecting and storing the water collected from the sewer system when the conductivity proves high. Each sewer has a conductivity probe, two probes on important streams, and numerous spill collection tanks (Slide 47).

- **Production Decreased With Mill Modernization.** With the mill modernization program, the pulp production decreased from 1500 T/D to 1430 T/D.

Rudiments of Mill Closure and Effluent Reduction

The rudiments of mill closure methodology deriver from the course and the mill visit include the following tasks.

1. Perform material balances on a regular basis,
1. Install sewer monitoring and spill containment,
2. Close up the screen room,
3. Reduce the kappa number as much as possible going to the bleach plant by optimizing the digester operation, use of extended delignification and oxygen delignification.
4. Reduce the carryover of black liquor going to the bleach plant by improved washing,
5. Segregate the condensates in the evaporator system,
6. Treat foul condensates and reuse the evaporator condensates as much as possible internally within the Kraft mill,
7. Reuse water as much as possible internally within the process,
8. Minimize the use of gland and cooling water to the greatest extent possible, this may involve installation of a cooling tower,
9. Switch to ECF, and preferably TCF, technology
10. Close up the bleach plant by judicious use of condensates and recycling condensates to the recovery boiler,
11. Treat and reduce non-process elements that build up in the system.

cc: George Frantz/Tom Saviello/Steve Groves/Doug Barton-NCASIP/Doug Johnson/Marquita Hill/Chris Rascher/Phil Sekerak/Curt Treadwell/Sterling Pierce/Don Albert/Shiloh Ring/John Cronin/Neil McCubbin/Mark Perez/Donald Anderson/Betty Frazier/Betty Ingraham/Files

APPENDIX A

2001 TAPPI Effluent Reduction by Process Closure Short Course - June 25-27, 2001, Asheville, North Carolina

Short Course Schedule

2001 TAPPI Effluent Reduction by Process Closure Short Course

June 25-27, 2001 - Great Smokies Holiday Inn SunSpree Resort, Asheville, NC

Short Course Chairman • Anthony (Tony) Johnson, Technical Manager, Beca Simons Ltd.
Short Course Sponsor • Bleach Effluent Minimization Committee of TAPPI's Pulp Manufacture Division

Short Course Schedule

Monday, June 25, 2001

8:30 a.m.	Morning Coffee Service
9:00 a.m.	**Introduction** *Anthony (Tony) P. Johnson, Beca Simons Ltd.*
	Water Use Reduction **Developing the Water Balance** *Tony Johnson*
9:45 a.m.	**Spill Control** *Neil McCubbin, N. McCubbin Consultants, Inc.*
10:15 a.m.	**Break**
	Water Use Reduction (continued)
10:30 a.m.	**Opportunities to Reduce Water-Fiberline** *Tony Johnson*
11:00 a.m.	**Opportunities to Reduce Water-Recovery Cycle** *William J. (Jim) Frederick* *Institute of Paper Science & Technology*
11:30 a.m.	**Opportunities to Reduce Water-Millwide** *Tony Johnson*
12:00 p.m.	**Class Exercise:** Effluent reduction in a bleached kraft mill
12:30 p.m.	**Lunch**
2:00 p.m.	**Class Exercise:** Group Reporting
2:30 p.m.	**The Interface Between Pulping, Bleaching, and the Recovery Cycle** The overall process balance *Neil McCubbin*
3:00 p.m.	**Break**
	Non-process Elements (NPEs)
3:15 p.m.	**Non-process Elements: Sources and Accumulation** *Tony Johnson*
3:45 p.m.	**Individual Elements and Their Effect** *Tony Johnson*
4:15 p.m.	**Case Study** - IP Franklin
4:30 p.m.	**Quiz - NPE Jeopardy** *Neil McCubbin*
5:00 to 7:00 p.m.	**Networking Reception**

Tuesday, June 26, 2001

8:00 a.m.	Morning Coffee Service
	Non-process Elements (continued)
8:30 p.m.	**Non-process Element Control -Fiberline and Bleach Plant** *Tony Johnson*
9:00 p.m.	**Non-process Element Control - Recovery Cycle** *Jim Frederick*
9:40 p.m.	**Case Study** - LP, Samoa
10:00 a.m.	**Break**
10:15 a.m.	**Impact on the Recovery Cycle** • Impact of Pulping Changes • Impact of Oxygen Delignification • Effects of Bleaching Effluent and Bleach Chemical Generation • Capacity Limits in the Recovery Cycle • Purge Technologies *Jim Frederick*
12:15 p.m.	**Lunch**
1:30 p.m.	**Case Study** - Canadian 4-mill study *Neil McCubbin*
2:00 p.m.	**Class Exercise:** Recovery Impacts Quiz Effects on make-up chemicals, purging, chloride and potassium levels, and recovery performance *Jim Frederick*
2:45 p.m.	**Break**
3:00 p.m.	**Cost and Operability Issues** *Neil McCubbin*
3:45 p.m.	**Mill Experiences:** Low effluent mill examples *Tony Johnson*
4:15 p.m.	**Question and Answer Session:** Mill issues, problems, opportunities *Panel Discussion*
4:45 p.m.	**Course Evaluation** *Tony Johnson*

Wednesday, June 27, 2001 - 8:30 a.m. to Noon

8:30 a.m.	Leave from hotel
	Blue Ridge Paper Mill • Mill Description • Technical description of BFR process • Mill Visit

(Over)

APPENDIX B

Slides Presented
By
Michael Ferguson, Kraft Mill Manager,
Blue Ridge Paper Products Company
Canton, North Carolina