A Modern ECF Fiberline for the Production of Bleached Eucalyptus Pulp

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Abstract

CMPC Celulosa S.A. selected Andritz to supply a fiberline, pulp machine, recovery boiler, and white liquor production plant for the new Santa Fe Line 2 Pulp Project. When completed in 2006, the line will produce 780,000 tonnes/yr of bleached eucalyptus market pulp.

This paper will discuss the technology which was selected for the fiberline which consists of the following main equipment:

- A two-vessel Lo-Solids® continuous digester with TurboFeed™ chip feeding system
- Four high-efficiency Drum Displacer™ (DD) Washers for brownstock and post oxygen washing
- Post oxygen pulp screening
- Four stages of ECF bleaching utilizing high-efficiency DD Washers and the A-stage process for reducing chemical consumption

Cooking Plant

A two-vessel continuous digester was selected for the cooking plant. A schematic of the digester is shown in Figure #1. The digester is designed to produce 15 Kappa eucalyptus pulp.

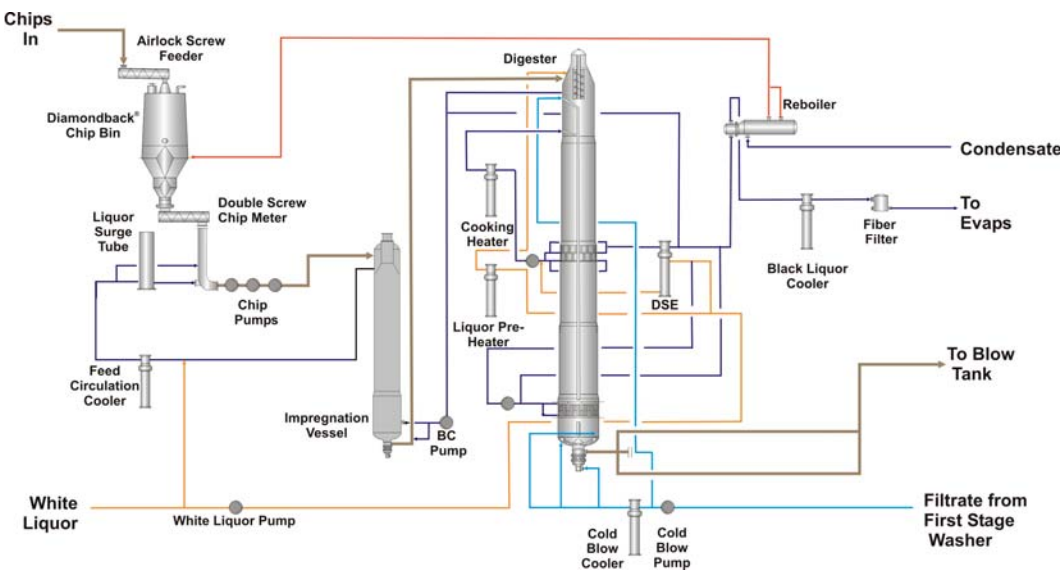

Figure #1: Downflow Lo-Solids® Digester with TurboFeed™ System

The digester system will utilize TurboFeed™, Andritz's latest technology for feeding chips to the digester. This system utilizes three centrifugal pumps in series to pump chips from the Diamondback™ chip bin to the top of the impregnation vessel. The high pressure feeder which has been used since the invention of the continuous digester is no longer required with this new feed system which is illustrated in Figure #2.

Not only is the high pressure feeder eliminated, but the chip chute circulation pump, in-line drainer, level tank, and make-up liquor pump are no longer required. This simpler feed system wil contribute to reduced maintenance costs for the Santa Fe mill.

The Santa Fe digester will be the fifth digester in the world which utilizes the TurboFeed system.

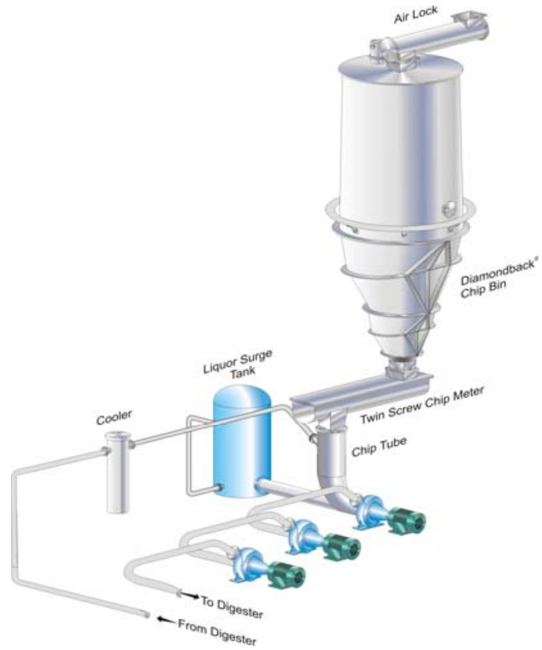

Figure #2: TurboFeed™ System

The digester system will be operated with Downflow Lo-Solids® cooking which is very similar to the process that the Santa Fe mill has been successfully operating on their existing Line #1 digester since April 2002. This cooking process utilizes multiple liquor extractions and multiple additions of white liquor and filtrate in order to keep both the alkali and dissolved solids concentrations low throughout the cooking process. Performing the cook in this manner results in higher digester yield and improved pulp properties. With Downflow® Lo-Solids, long counter-current zones have been eliminated. This contributes to improved digester chip column movement and reduced Kappa variability.

CMPC elected to install a reboiler (Figure #3) instead of conventional flash tanks for digester heat recovery. Hot black liquor which is extracted from the digester will pass through the tube-side of the reboiler. Heat from this liquor will be transferred to clean condensate, generating steam for use in the digester chip feed system. Unlike flash steam, the steam generated will not contain any TRS compounds. Because of this, the use of a reboiler results in an odor-free chip feed system.

Another advantage of the reboiler is that the digester black liquor pump has been eliminated. Digester pressure is used to transfer the extracted liquor through the reboiler, black liquor filter, and black liquor cooler directly to the weak liquor storage tank in the evaporator area.

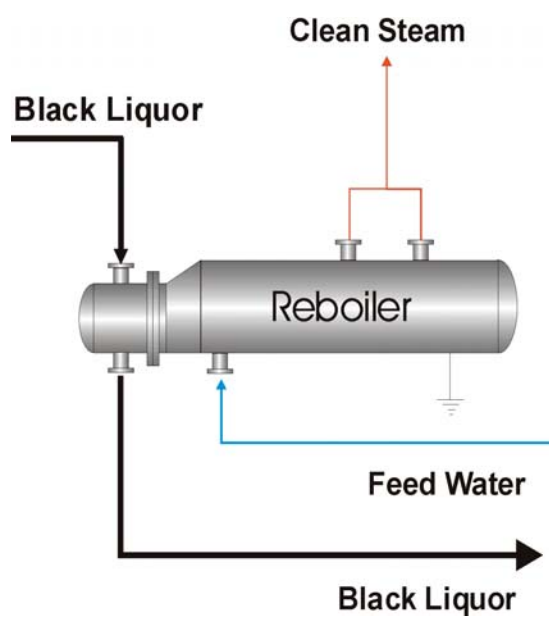

Figure #3: Digester Reboiler

Brownstock Washing

Brownstock washing (Figure #4) will consist of in-digester washing followed by two Drum Displacer™(DD) washers which will be operated in parallel. Each DD washer will have two washing stages and will be fed at medium consistency (≈10%). The amount of washing has been selected to give a carryover to the oxygen stage of less than 100 kg of COD per ADt.

There are approximately 150 DD Washers installed throughout the world. The first DD washers to be installed in Chile will be started up at CMPC's Laja mill several months prior to the start-up of Line #2 at the Santa Fe mill.

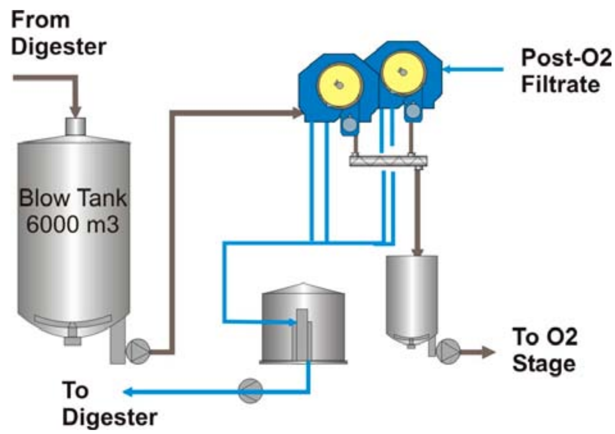

Figure #4: Brownstock Washing

Operating Principle of the DD Washer

Figure #5 illustrates the operating principles of the DD Washer. The illustration is for a two stage DD washer. However, up to four washing stages can be installed on one drum.

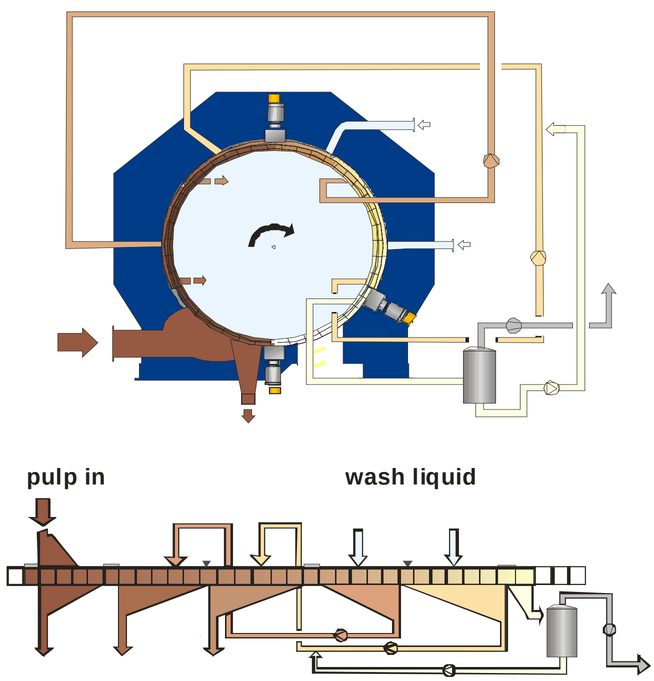

Figure #5: Operation principle of two-stage DD-washer

Pulp is pumped to the feed zone of the DD washer at a pressure of 10 - 50 kPa and at a consistency approximately 10%. The pressurized pulp is thickened on the surface of the perforated plate of the drum and fills the trays which form the drum. Filtrate removed in the feed zone passes through the perforated plate and is removed through the end valve of the drum to the filtrate tank. The feed pressure is kept constant by adjusting the drum speed.

When the trays which are filled with pulp pass the first sealing element, excess pulp is wiped off and a very uniform pulp cake is formed. This is one of the reasons for the high washing efficiency which is attained in the DD washer.

There are two in-line circulation pumps installed on the two stage DD washers. They pump filtrate removed from the second washing stage directly to the top of the pulp cake of the first stage. Dirtier filtrate is taken to the later part of the first stage and cleaner filtrate is taken to the first part of the first stage. This principle, referred to as fractional washing, further improves the efficiency of the DD washer. A sealing element separates the first washing stage from the second. Even though the washer is operated as a full two stage washer, only one filtrate tank is required for filtrate removed from the first washing stage.

Filtrate from the Post-O_2 DD Washers is used as washing liquid in the second washing stage. The pressure of the wash water is approximately 100 kPa (1 bar). The pressure of the wash filtrate is increased by the inline filtrate pumps located between the washing stages. The entire washer and associated filtrate circulations are pressurized by the wash water pressure and the inline filtrate pumps. This prevents air from mixing with the pulp further improving the uniformicty of the displacement washing.

After the second washing stage, a small vacuum system is used to increase the outlet consistency. The pulp then enters the discharge zone where a pulse of mill air is led below the perforated plates to blow the cake from the surface of the drum and into the repulper.

After the pulp has been discharged, the perforated plate of the drum is washed with filtrate through a specially designed shower pipe.

Oxygen Delignification

CMPC selected a two stage oxygen delignification system (Figure # 6) in order to assure that the maximum amount of delignification could be achieved. The operating temperature of the first stage will be approximately 92 °C. Steam is not added prior to the first stage and this temperature is achieved by the recirculation of hot Post-O_2 filtrate to the Bro

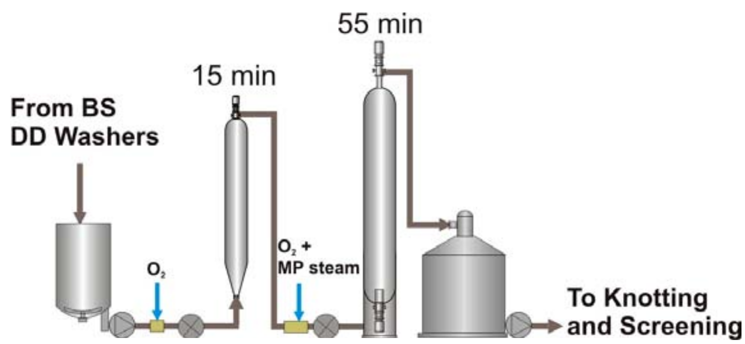

Figure #6: Oxygen Delignification

The temperature of the second stage will be increased to approximately 95 °C with the injection of MP steam prior to the second oxygen mixer. The design kappa number from the oxygen delignification system is 9.5.

Knotting, Screening and Post-O_2 Washing

Knotting and screening (Figure #7) is done after the oxygen delignification stage and before the Post-O_2 washers. This is possible because, unlike other washing devices, the DD washers are insensitive to knots. Knotting and screening in this position instead of before the oxygen stage improves the overall fiberline yield. This is due to the fact that approximately 60% of the shives which would have been removed from the system in a pre-O2 screen room are converted to good fiber in the oxygen system. A second advantage is that when any material is being removed from the system it is much cleaner when the screen room is located after brownstock washing.

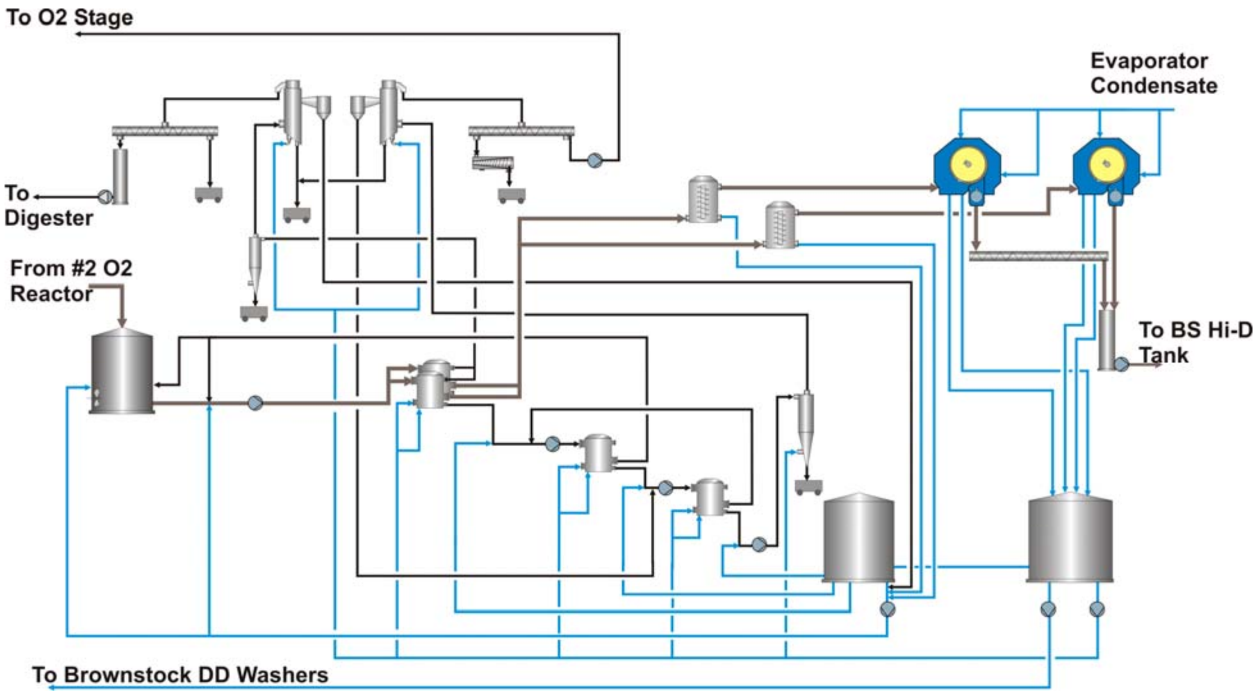

Figure #7: Knotting, Screening, and Post-O_2 Washing

Two combined knotter/primary screen units are used in the screen room. Knots removed from the knotter section of these units pass through a magna-cleaner and a knot washer. The washed knots will normally be pumped back to the digester chip tube for recooking. Rejects from the screening section of these units pass through secondary and tertiary screening and a set of sand separators before being sent to a reject washer. The washed rejects are then pumped back to the oxygen stage feed tank. A reject press is being installed to remove additional filtrate during times that rejects are being removed from the system.

Accepts from the primary screens pass through pre-thickeners prior to the Post-O_2 DD washers. In many mills it is necessary to operate the screen room at higher consistencies than optimum for maximum screening efficiency due to limitations of the downstream washing device. Installing pre-thickeners allows the screen room to be operated at the best consistency for screening (2.5%-3.0%) while still delivering pulp at the appropriate consistency to the DD Washers (3.5%-4.0%).

Two parallel DD washers will be used for Post O_2 washing. Each washer will have two full stages of washing. Unlike the brownstock washers, these washers are designed to be fed at low consistency (3.5%-4.0%). Evaporator condensate will be used as wash water to the Post-O2 DD washers. The high washing efficiency of the DD Washers will result in a very low amount of carryover in the pulp to the bleach plant (<6 kg COD/ADt).

Bleaching

The Line #2 fiberline is designed to produce bleached pulp with a brightness of 92 ISO. The sequence which will be used is AD_o-E_{op}-D_n-D. A schematic of the bleach plant is given below in Figure #8. Bleaching chemical consumptions measured in the laboratory with Lo-Solis® pulp produced from CMPC chips is given in Figure #9.

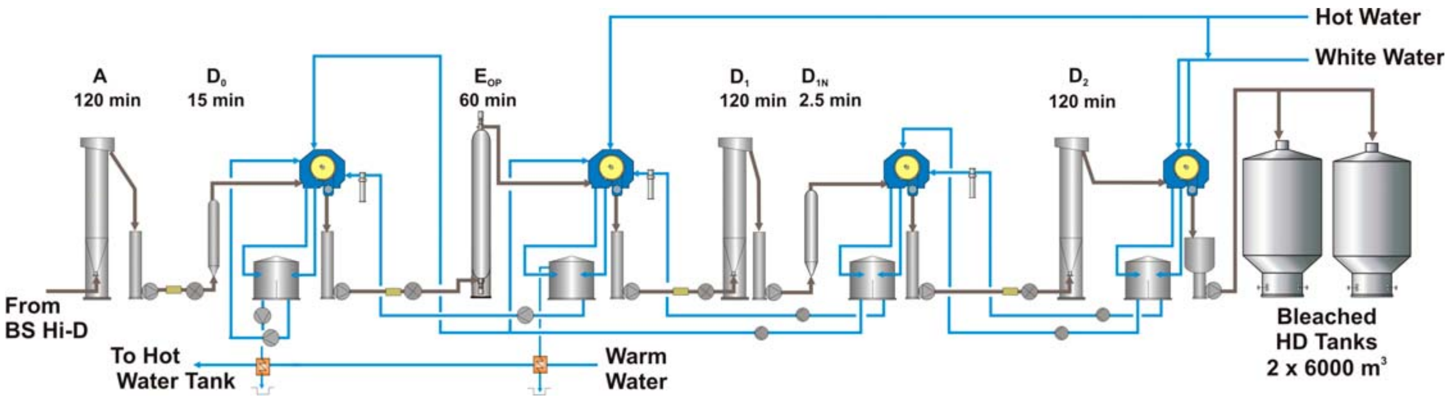

Figure #8: AD_o-E_{op}-D_n-D Bleach Plant

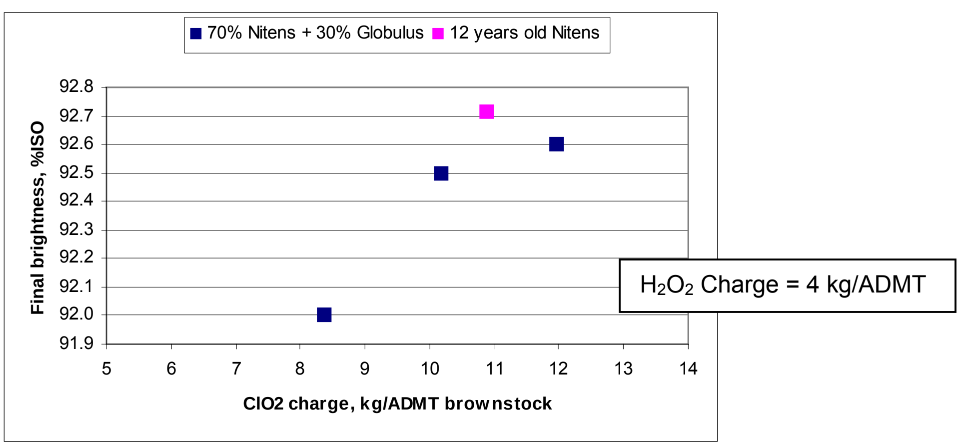

Figure #9: AD_o-E_{op}-D_n-D Laboraory Bleaching Results

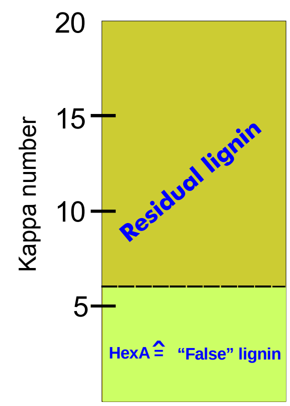

Figure #10: Typical HexA Content in Eucalyptus Pulp

The first bleaching stage is the AD_0 stage. It consists of a two hour acid stage followed by a 15 minute chlorine dioxide stage. The acid stage is used to remove hexenuronic acids from the pulp prior to the chlorine dioxide stage. As illustrated in Figure #10, hexenuronic acids (HexA) are measured as part of the pulp Kappa number. The HexA's cannot be removed in the oxygen delignification stage, but they do consume chlorine dioxide if not first removed in an acid stage prior to the first chlorine dioxide stage. The A stage will reduce the kappa number entering the D_0 stage to approximately 6.

The Do stage is designed with 15 minutes retention time. This short time is possible due to the rapid reaction between chlorine dioxide and lignin in this stage.

The second bleaching stage is the E_{op} stage. It consists of a sixty minute pressurized reactor. Pulp discharged from the reactor will go directly to the DD washer inlet box, eliminating the requirement for an additional stock pump.

The third bleaching stage is the D_n stage. This stage consists of a 120 minute upflow chlorine dioxide tower followed by a short neutralization reactor (2.5 minutes). The neutralization stage improves the washing on the D_1 DD washer by causing the fibers to swell. It also improves the efficiency of the subsequent D_2 stage by modifying the structure of the remaining lignin.

The last bleach stage is the final D stage. This stage consists of a 120 minute upflow tower. The height of this tower is sufficient to allow pulp to be fed to the DD washer by gravity. The metallurgy of this stage has been selected to allow it to be operated as a P stage if desired.

The filtrate recycle scheme in the bleach plant is designed to achieve maximum benefit from the fact the several filtrate streams of different COD concentrations are available from each washer. An example of this principle is shown in Figure #11 for the D_o and E_{op} Washers at one bleach plant in Finland.

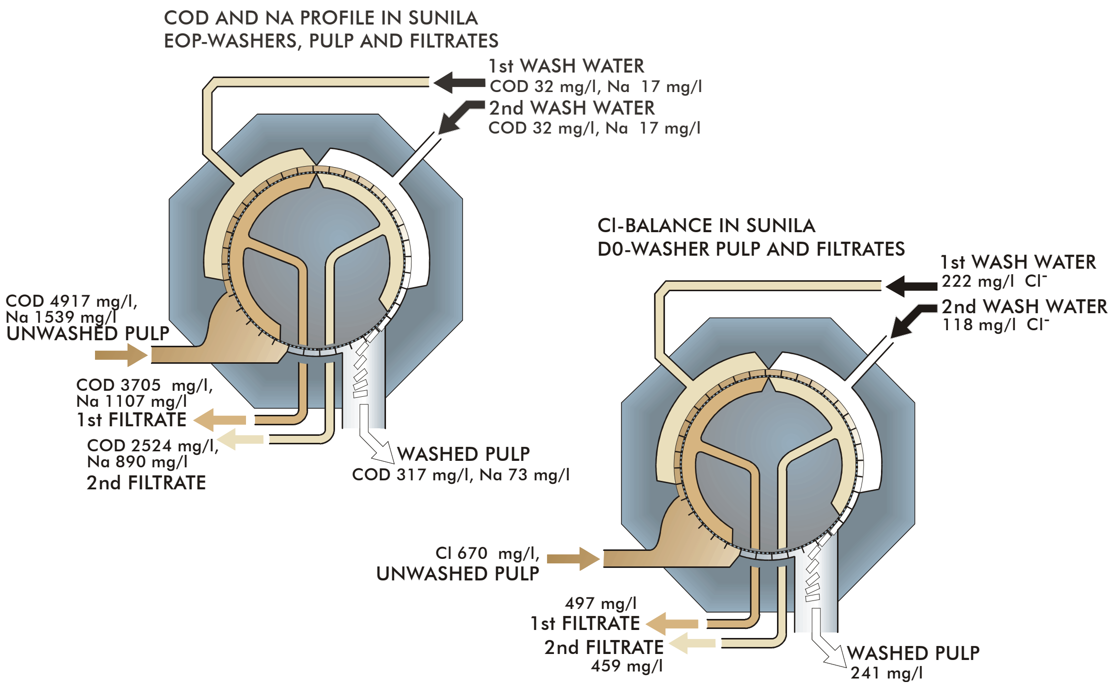

Figure #11: Process Measurements from a Finnish Bleach Plant

In the Santa Fe fiberline, the dirtier filtrate from the D_2 washer is used as the front wash of the D_1 washer and the cleaner filtrate washer is used as the rear wash. The dirtier filtrate from the D_1 washer is used as the front wash of the Do washer and the cleaner filtrate as the rear wash of the E_{op} washer. The dirtier filtrate from the E_{op} Washer is sewered and the cleaner filtrate is used as the rear wash on the Do washer. This recycle scheme keeps COD concentrations in all bleach stages at a minimum level and contributes to the low chemical consumption of a DD Washer based bleach plant.

Additionally, all DD Washers in the Santa Fe bleach plant are designed to be operated as 1.2 stage washers. This means that in addition to the filtrate recycle scheme described above, a portion of the cleanest filtrate removed from each washer will be used as additional wash water on the front part of that stage's washer. This was incorporated into the Santa Fe bleach plant to further increase the washing efficiency of each washer, saving bleaching chemicals.

Effluent from the bleach plant will be used to produce hot water. The heat recovered in the effluent coolers in addition to the heat recovered from the digester's black liquor cooler is sufficient to produce enough hot water for the fiberline, without the use of any low pressure steam for water heating.

Summary

Fiberline #2 at CMPC's Santa Fe mill is currently under construction and scheduled to start-up in mid-2006. This paper has discussed many of the key design features that will make this fiberline one of the most efficient in the world for the production of bleached eucalyptus pulp.

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