Executive Summary

This white paper takes a look at the pulping, stock preparation and the wet end. Topics include refining, bleaching, stock thickening and pulp wash pressing.

First, the mill-scale optimizing results from a BCTMP mill and different refining conditions and segments in a CD refiner are analyzed. The results show an opportunity to decrease refining energy while increasing production rate by optimizing the process and refiner segment design.

Next, bleaching to maximize CTMP brightness with Chinese poplar and eucalyptus is reviewed, with conclusions drawn regarding two-stage peroxide bleaching ($P_{MC}$/$P_{HC}$). Production costs can be reduced by up to 15% at high brightness levels and it is possible to produce pulp with 85% ISO brightness levels.

Finally, improvements in filtering and pressing are presented. These include: the RotoFormer, an easily installed performance upgrade for existing TwinRoll presses; the OptiThick DF filter and WavStar filter bag, for more dependable and higher performing stock thickening; and the TwinRoll Evolution wash press for better washing performance and more capacity.
Low-energy hardwood BCTMP production with a high-capacity CD refiner

This chapter presents the mill-scale optimizing results from a Chinese BCTMP mill, and the theoretical calculations and simulations for comparing different refining conditions and refiner segments in a CD refiner. The results clearly show the possibilities of reducing refining energy together with production rate upgrade by process optimization and segment design. New segment innovations for heavy-wear conditions are also presented.

Valmet has earlier published mill-scale development results from an aspen-based hardwood BCTMP production process. These results show that with process optimization and segment development in high-capacity RGP82CD conical disc refiners (CD) in the chip refining stage, it is possible to save a remarkable amount of energy while still producing fibers of good quality. After this work was published, new high-capacity BCTMP installations have been started up in China. Valmet together with these mills have optimized their processes to meet these new requirements. Operating costs of these installations are low due to minimized energy and chemical consumption.

In China, the first modern high-capacity BCTMP line from Valmet was installed at the Chenming Shouguang mill in 2005. This paper reviews results from the mill for meeting somewhat different requirements than reviewed in previously published hardwood references. The design of this new BCTMP line was based on new hardwood refining ideas and aimed at achieving a high production rate in chip refining. A high production rate in the refining line clearly reduces energy consumption and thus offers both low investment and production costs. It has been also shown that hardwood requires a different refining strategy than softwood. A modern aspen BCTMP mill operating with Valmet turbine refiner segments technology could reduce refining energy by more than 20%. This refining strategy can also reduce the need for bleaching and impregnation chemicals.

Impurities in market chips are a common challenge when a mill switches from one raw material to another because they typically cause a lot of wear in refiner segments. This, together with high capacity in the single refiner, increased the flow of impurities through one refining gap. Demanding wear conditions require wear-resistant refiner segments, which also improve segment lifetime. The addition of AttackBar, the new refiner segment design from Valmet, substantially improved segment lifetime.

Raw materials for BCTMP pulping in China

In certain parts of China, good quality raw material is hard to come by. Such is the case, for example, in Shangdong province. This compels local pulp mills to accept various species of raw material for their processes. Eucalyptus is one of the most challenging species to impregnate and refine because high-density wood is more difficult to process than low-density wood. The density of eucalyptus is approximately 600 kg/m³ while that of aspen is only 400 kg/m³. This means that greater amounts of chemicals as well as refining energy are required. Varying densities in the different eucalyptus grades make it hard to maintain stable process conditions over time.

Figure 1 (on next page) presents the difference of refining energy needed for aspen, birch and eucalyptus to reach a certain level of freeness with the same amount of impregnation chemicals. Eucalyptus requires up to 30% more refining energy compared to aspen. This is why segment selection when refining eucalyptus becomes an even more important issue than with other species.
Obtaining raw material of good quality is difficult. Typically there is a lot of sand and bark in chips. The lifetime of process equipment deteriorates as the amount of impurities in chips increases. Big particles such as stones are rejected from the process in the chip washing stage, but some small particles often remain in the process. The higher the production rate, the greater the likelihood of these impurities getting into the process, shortening the lifetime of all the parts subject to wear. This is why optimal technology is an important issue for segment lifetime.

Chenming Shouguang Paper Holding Ltd.

Chenming Shouguang BCTMP mill was started up in 2005. It produces board grade pulp for an integrated board machine. The main raw materials are eucalyptus urophylla and Chinese white poplar.

The Chenming BCTMP line consists of two Valmet high-capacity RGP82CD refiners, one as the primary refiner and one as the reject refiner. Prior to refining, chips are treated in an impregnation stage and target brightness is achieved in HC peroxide bleaching. The design capacity of this one-line pulp mill is 735 ADMT/D.

Valmet’s turbine refiner segments, shown in Figure 2, are designed to provide an excellent combination of high production, low energy consumption and good quality. Segment lifetime and the size of the operation are the other aspects that were particularly addressed when the segments used at the Chenming BCTMP mill were designed. These segments are based on theoretical calculations made with flow simulations using actual refining conditions.

The Chenming BCTMP mill takes advantage of Valmet turbine segment technology in chip refining. This, in combination with very high production rates, makes producing pulp with record-low energy consumption possible.

Refining theory and simulations at Chenming

All refiners are hydraulic flow machines in which complex flow conditions and heat transfer are combined with very delicate wood fiber processing to produce pulp of the required quality. This requires knowing the flow conditions inside the refiner for controlling the process and for producing a desired pulp grade. It is also important to have a measure of the efficiency of refining to enable connecting refining conditions to achieved pulp quality.
This study adopts the same approach, based on the real physical behavior of a particle suspension and flow conditions inside the refiner, which were widely used in earlier refiner simulations. Therefore, there are no details here concerning the fluid dynamics approach or the design program used. Only a brief introduction to the main parts of the approach, such as refining intensity and freeness-reduction determination are given.

This simulation program is based on the mass, momentum, and energy equation system of fluid dynamics. Based on this equation system, a 1-D Fortran-based computer program is constructed to simulate the main flow features inside the refiner in the radial direction. These calculations yield pressure and temperature profiles in this direction. Furthermore, the relation between the volumetric fractions of steam and fibers from the steam generation term is defined. The change to water phase also modifies the material parameters of the suspension, which, therefore, must be updated constantly during calculation. In fact, the phase change closes the set of equations, and the whole computation procedure involves numerous calculations between these equations. The model has been verified by on-site mill trials measuring temperature and residence time with excellent agreement to the data, on the basis of which the definition for the refining intensity is given by the following equation:

\[ I_{HHS} = \frac{P * 60}{N * n_b * t_r * m_f} \]

where \( I_{HHS} \) is the specific refining intensity [kJ/kg/impact], \( P \) the power consumption [W], \( N \) the rotational speed [rpm], \( n_b \) the number of bars [-], \( t_r \) the residence time of fibers [s], and \( m_f \) the mass flow rate of fibers, i.e., the refiner’s production rate. (This definition of refining intensity is different from the one given by Miles and May and, therefore, it has been noted by HH according to its inventors Hahtokari and Huhtanen.)

Based on the refining intensity, a new way to determine the freeness reduction of a refiner can be expressed as follows:

\[ CSF = e^{r_1 - I_{HHS}/r_2} \]

where \( r_1 \) and \( r_2 \) are dimensionless empirical constants.

Using this refining theory and this tool, a simulation series for Chenming board mill in China were made. The mill uses hardwood as raw material and Valmet’s turbine refiner segments in refiner for producing the quality of pulp required. Hardwood as a raw material needs high intensity refining to enable good freeness and shives reduction capacity. High intensity refining can be achieved by operating with small disc gaps, a high production rate and short residence time. This kind of refining leads to low specific energy consumption and economical savings for the mill, and it is also beneficial for the environment.

The simulation series for this article were made using two types of refiner segments: first, LE-types on flat zone and standard types on the conical zone. Secondly, turbine refiner segments were used on both the flat and the conical zones. In the first case, the simulation followed the mill’s standard operating mode at a low production rate (15 T/h) and high specific energy consumption (600 kWh/T). The second case was
designed as a parametrical study of how turbine segments would perform in different operating situations, varying the production rate from 15 to 33 T/h and SEC from 300 to 600 kWh/T. Otherwise, all other operating parameters were kept as constant as possible.

The results of simulations are shown next, by first comparing the performance of the standard segments to that of the turbine refiner segments during the mill’s normal operating modes, respectively, and then using a "refining window" for turbine refiner segments to show the significance of production rate and SEC to refiner performance.

Comparison of the minimum fiber residence time of standard and turbine refiner segments (Figure 3) with two of the mill’s selected standard operating modes revealed that they are almost the same even though the distribution is different. This indicates that fibers need the same time for refining treatment even though the production rate and SEC are different. Therefore, it can be assumed that the pulp quality produced should be similar. A look at the calculated pulp quality indicator, i.e. specific refining intensity and freeness reduction verifies this observation. Moreover, it can be concluded that it is more beneficial, from the process point of view, to run the refiner at a higher production rate to save specific energy consumption. However, this is not possible with LE and standard type segments. Turbine refiner segments are needed to raise the production rate.

It can also be observed that refining intensity (Figure 4) and freeness reduction distributions (Figure 5) of turbine refiner segments are more even compared to standard ones, which should indicate more uniform fiber treatment along the segments.
This is also beneficial for other pulp quality parameters, such as strength properties. However, these parameters were not simulated here.

The importance of operating parameters can be observed by looking at the "refining windows" for turbine refiner segments as shown in Figures 6, 7 and 8 for fiber retention time, refining intensity, and freeness reduction respectively. This is why production rate and specific energy consumption were selected as the important parameters.

Figures 6 to 8 show that the refiner’s performance is not linearly dependent on these parameters, but a complex function of production rate and specific energy consumption. All the calculated values have local minima and maxima or plateau values along the plotted surface. This indicates the complexity of the refining process and the importance of this kind of analysis for knowing about and controlling process performance.

The refining intensity window (Figure 7) shows how beneficial the rise in production rate is for producing pulp quality: the higher the production rate, the higher the intensity at the same SEC. This fact is also verified by the freeness reduction window (Figure 8), and it is especially true with high SEC. Then again, comparing the calculated freeness reduction capacity values of different operating modes shows that increasing the production rate can reduce the SEC. For example, almost the same freeness reduction is achieved, with the same segments, with 15 T/h at 600 kWh/T and with 33 T/h at 300 kWh/T. This could lead to huge economical savings for the mill in refining expenses.
With this kind of parametric analysis, a mill can direct its process towards optimal operating conditions and then choose which is the best way to save energy.

**New refiner technology for heavy-wear conditions**

High capacity in refiners also increases the amount of impurities that flow through the refiner gap, which leads to shorter refiner segment lifetime. In high consistency refining segments, wear is mainly seen in the wear of the leading edge of the refiner segment bar. This is illustrated in Figure 9.

Traditionally producing segments from harder alloys minimizes wear. However, in rough refining conditions, hard alloys are more brittle and the risk for bar breakage increases. The thought behind the innovative Valmet AttackBar was to produce sharper refiner bar edges from the beginning rather than making them harder. This idea led to the development of a new refiner segments manufacturing process resulting in a new sharp edge segment for launching on the market. This has improved segment lifetime substantially, by as much as two months or about 1,500 hours.

Despite the very high production rate of the refiners at Chenming BCTMP, they have been able to maintain a segment lifetime comparable to other Valmet installations in China. Because of this higher production rate, they produce even more pulp per each refiner segment than what is considered normal in Europe. The operating principle of AttackBar refiner segments is presented in Figure 10.

**Conclusions of BCTMP optimization with high-capacity CD refiner**

This paper presented the results of a mill-scale optimizing operation at the Chenming Shouguang BCTMP mill. The mill produces board grade pulp for an integrated board machine. The main raw materials are eucalyptus urophylla and Chinese white poplar, which are hardwood species and, therefore, require high intensity refining. The theoretical calculations and simulations carried out compare different refining conditions and refiner segments in a CD refiner used at the mill. The results clearly showed an opportunity to reduce refining energy together with a production rate upgrade as a result of process optimization and segment design. The production rate rise was verified as being a real factor for decreasing specific energy consumption. New segment innovations for the heavy segment wear conditions at the mill were presented.

**Two-stage bleaching for maximum CTMP brightness**

There is an increased demand for CTMP pulps of high brightness for production of different kinds of paper and board grades. The raw material used today, especially in China, is based mainly on different types of hardwood species such as eucalyptus, poplar and acacia. Often, hardwood CTMP pulp used for
production of printing and writing grades competes with chemical pulps, so the brightness and bleach response of the CTMP pulps is an important issue. From this perspective, finding a suitable process solution for meeting the wide range of grades and raw material is quite a challenge. This chapter will demonstrate that two-stage (PMCPHC) peroxide bleaching of CTMP can reduce production costs while producing brightness levels of 85% ISO or more for CTMP produced in a pilot plant from Chinese raw materials.

Introduction

The market in China for high-quality pulps for production of different kinds of printing and board grades has increased tremendously in the past decade. The raw material supply in China is based mainly on different types of hardwood species, such as various poplar, eucalyptus and imported acacia. Such a large variation in raw material supply, in combination with an increased demand for high-quality paper and board grades, has focused a lot of research effort toward developing a suitable process solution for meeting these requirements.

It is clear that such a process must meet certain quality targets, for example high brightness and high bulk and opacity as well as acceptable strength properties. It is also obvious that some of these properties interact in such a way that it will be difficult to increase one without affecting another. It is therefore also difficult to find a single process solution that could meet all of the requirements at once. Instead, any process solution will have to be a compromise between and/or a sacrifice of some of the parameters.

This chapter illustrates how a two-stage (PMCPHC) peroxide bleaching system is used to produce very high brightness CTMP from different hardwood species.

The CTMP process

The CTMP process was introduced as early as the beginning of the 1970s. Initially, the CTMP process was developed for market pulp grades based on different softwood raw materials. Many of the grades produced at that time also required high brightness. High-consistency peroxide bleaching systems were developed to meet these requirements. High brightness, pulp cleanliness and low operating cost have since been "key success factors" in the further development of the process. Therefore, to obtain the highest possible brightness levels, as many as five multiple washing stages as well as two-stage peroxide bleaching are not unusual in modern CTMP systems using traditional raw materials such as Canadian and European aspen.

The demand for brightness and bleaching efficiency, or in other words production costs, in China has so far been fairly modest. Brightness levels of 75-80% ISO have in most cases been enough for the production of the majority of printing and writing papers (P&W) as well as for board grades in the Chinese market.

However, the trend towards higher brightness levels in combination with an increased focus on pulp washing for lower COD levels and lower effluent volumes has created the need for further development of the CTMP process in China and elsewhere. The best way of doing this is to add a second peroxide bleaching stage, which also includes the addition of another wash press stage. This not only improves the bleaching response, but also leads to better pulp washing and more efficient use of the wash water.
Peroxide bleaching in two stages

Bleaching with peroxide in two stages has several advantages compared to bleaching in only one stage. Residual peroxide from the second bleaching stage is reused in the first stage and thereby improves bleaching efficiency. The greatest portion of fresh chemicals is added in the second stage, where the pulp is washed better. It is possible to split the alkali (NaOH) charge in two bleaching stages. This results in better overall bleaching efficiency and also offers the possibility of controlling optical fiber properties in a more efficient way while reaching high brightness levels. Better washing also reduces the COD content in final pulp and/or reduces the total volume of wash water needed for washing. Countercurrent washing also lowers the bleaching temperature in the first as well as the second bleaching stage. Too high a bleaching temperature results in lower brightness and has a negative impact on the stability of the bleaching process.

Experimental materials

CTMP from two Chinese raw materials, Chinese poplar and eucalyptus urophylla, was produced on a pilot plant scale at the Valmet Technology Center in Sundsvall, Sweden, see Table 1.

Chips were steamed at atmospheric conditions for 11 minutes, and PREX impregnated charging 30 kg/bdt H₂O₂ and 30 kg/t NaOH. The impregnated chips were collected in plastic bags and stored in boxes at about 80°C for 90 minutes. The impregnated chips were then fed to a pressurized refiner (OVP20) and refined at 2.1 bar (g) to freeness levels of approximately 600 ml CSF using around 800-1,000 kwh/bdt. The refined pulp was collected in plastic bags after passing the refiner.

Table 2 shows the pulp characteristics for the two raw materials after impregnation. These two pulps were used in the laboratory bleaching trials and bleached in one or two stages as described in the text below. Chemical charges and process conditions in the laboratory bleaching trials can be seen in Table 3.

![Table 1. Raw material testing](image)

<table>
<thead>
<tr>
<th>Units</th>
<th>Chinese poplar</th>
<th>Eucalyptus urophylla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood basic density</td>
<td>kg/m³</td>
<td>382</td>
</tr>
<tr>
<td>Wood brightness</td>
<td>% ISO</td>
<td>36.0</td>
</tr>
<tr>
<td>Dry content</td>
<td>%</td>
<td>54.9</td>
</tr>
<tr>
<td>Bark content</td>
<td>%</td>
<td>2.13</td>
</tr>
<tr>
<td>Lignin</td>
<td>%</td>
<td>25.2</td>
</tr>
<tr>
<td>DCM</td>
<td>%</td>
<td>0.54</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/kg</td>
<td>8.1</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/kg</td>
<td>398</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/kg</td>
<td>114</td>
</tr>
</tbody>
</table>

Table 2. Pulp characteristics after impregnation and refining

<table>
<thead>
<tr>
<th>Units</th>
<th>Chinese poplar</th>
<th>Eucalyptus urophylla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific energy</td>
<td>kWh/BDT</td>
<td>805</td>
</tr>
<tr>
<td>Freeness</td>
<td>ml CSF</td>
<td>642</td>
</tr>
<tr>
<td>Bulk</td>
<td>m³/kg</td>
<td>3.8</td>
</tr>
<tr>
<td>Tensile index</td>
<td>Nm/g</td>
<td>8.5</td>
</tr>
<tr>
<td>Brightness</td>
<td>% ISO</td>
<td>62.5</td>
</tr>
</tbody>
</table>
adjust consistency, were mixed together. Just before the chemicals were mixed into the pulp, peroxide was added to the bleach liquor. The bleach liquor was then mixed into a 10 g pulp sample by hand for 1-2 minutes at room temperature. The pulp was then put into a tempered water bath at the specified bleaching temperature and time. After bleaching, some liquor was squeezed out from the pulp and analyzed for residual peroxide and final pH. The pulp was then diluted with 1 liter of milli-Q quality water to stop the bleaching reactions. Four 2g brightness sheets were then made according to ISO 3688:1999. Brightness was measured with Elrepho 2000 according to ISO 2470:1999.

In the two-stage process, the pulp from the first stage \( P_{MC} \) bleaching was diluted after bleaching to 8% consistency with 70°C Milli-Q water. The pulp was then dewatered in a Buchner funnel followed by centrifugation to over 30% consistency. This procedure simulates the effect of the press stage between the \( P_{MC} \) and \( P_{HC} \) bleach stage.

### Results and discussion

#### Single-stage (\( P_{HC} \)) bleaching

**Figure 11** shows the result from bleaching in a single stage (\( P_{HC} \)). At each peroxide level, the pulp was alkali optimized to find the highest brightness that could be reached for a given peroxide charge.

The brightness of the pulps after impregnation was 62.5% ISO for Chinese poplar and 50.5% ISO for eucalyptus urophylla. As can be seen, reaching brightness levels of over 80% ISO for both pulps is possible, but the peroxide charge, especially for eucalyptus, is very high (>50 kg/t) if the brightness target is over 80% ISO. Reaching a brightness of 83-85% ISO in a single stage bleaching process is impossible for any of these pulps, at least if peroxide charge levels are to be kept at reasonable levels.

#### Two stage (\( P_{MC}P_{HC} \)) bleaching

To simulate a two-stage bleaching process in the laboratory, the pulp is first bleached at medium consistency followed by a
washing stage. Alkali optimization is then made in the second stage for evaluating both brightness and residual peroxide with a varying charge of alkali (Figure 12).

The result from bleaching Chinese poplar in two stages can be seen in Figure 13, which shows the effect of alkali optimization in the second bleaching stage on both brightness and residual peroxide. Reaching a brightness level as high as 85% ISO was possible with a peroxide charge in the second stage of 50 kg/t. In this case, the 20 kg/t peroxide that was charged in the first stage is available as residual peroxide from the second stage.

This means that in mill-scale operation no fresh peroxide is needed in the first stage. Utilizing the residual peroxide after the P_{HC} stage is obviously not possible in a process with only a single bleaching stage.

In Tables 4a and 4b, the bleaching result from a single stage process (P_{HC}) is compared with the result from the two stage (P_{MC}P_{HC}) bleaching process. In a two-stage bleaching process, the brightness is at least

<table>
<thead>
<tr>
<th>Chinese poplar</th>
<th>Units</th>
<th>P_{HC}</th>
<th>P_{MC}P_{HC}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First bleach stage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H_{2}O_{2} charge (kg/t)</td>
<td>50</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td>NaOH charge (kg/t)</td>
<td>35</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>H_{2}O_{2} consumed (kg/t)</td>
<td>33.4</td>
<td>47.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Brightness (% ISO)</td>
<td>82.0</td>
<td>83.5</td>
<td>73.3</td>
</tr>
<tr>
<td><strong>Second bleach stage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H_{2}O_{2} charge (kg/t)</td>
<td></td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>NaOH charge (kg/t)</td>
<td></td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>H_{2}O_{2} consumed (kg/t)</td>
<td></td>
<td>16.6</td>
<td>20.7</td>
</tr>
<tr>
<td>Total H_{2}O_{2} consumed (kg/t)</td>
<td>33.4</td>
<td>47.5</td>
<td>23.7</td>
</tr>
<tr>
<td>Final Brightness (% ISO)</td>
<td>82.0</td>
<td>83.5</td>
<td>81.5</td>
</tr>
</tbody>
</table>

*Table 4a. Comparison between single stage (P_{HC}) and two-stage (P_{MC}P_{HC}) bleaching of Chinese poplar. Chemical charges in the impregnation (30 kg/t H_{2}O_{2} and 30 kg/t NaOH) are not included in these numbers. Brightness after impregnation was 62.5% ISO for Chinese poplar.*
2% ISO higher at a given peroxide charge in the PHC stage. Compared at the same brightness level, this corresponds to a potential saving in peroxide of 10-20 kg/t depending on the brightness target.

When bleaching eucalyptus, it was possible to reach almost the same brightness levels as with the Chinese poplar, in spite of the alkali charge being the same in chip impregnation. Tables 4a and 4b show the brightness development for single stage (PHC) and two-stage (PMCPHC) bleaching. A brightness of over 84% ISO can be reached in two-stage bleaching with a correct split of NaOH charge between the two bleaching stages. For single-stage bleaching, reaching a brightness level of over 82% ISO is not possible without excessive use of peroxide.

Adding as much peroxide as possible in the second stage is clearly advantageous. In the second stage, the pulp is better washed due to the wash press between the first and second bleaching stages. This results in lower metal ion content in the pulp as well as lower levels of detrimental substances from the refining stage. Bleaching directly after the refiner in mill scale limits the bleaching consistency at higher peroxide doses.

**Conclusions of two-stage bleaching for maximum CTMP brightness**

The study clearly shows that for brightness levels above 80% ISO, two-stage peroxide bleaching (PMCPHC) is the best and most flexible process solution for pulps produced from Chinese poplar and eucalyptus. Production costs can be reduced by as much as 15% at high brightness levels (Table 5, next page). With the two-stage process, it is also possible to produce pulp with brightness levels as high as 85% ISO.
Better overall pulp washing would also result in a cleaner pulp and/or the possibility of closing water loops. Better water management would reduce the overall need for fresh water, which can reduce production costs. These are some of the benefits of the two-stage bleaching process.

**Table 5. Production cost reduction**

<table>
<thead>
<tr>
<th>Brightness</th>
<th>( P_{HC} )</th>
<th>( P_{MC P_{HC}} )</th>
<th>Reduced production cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>75% ISO</td>
<td>35-45 kg/t</td>
<td>40-45 kg/t</td>
<td>0%</td>
</tr>
<tr>
<td>80% ISO</td>
<td>50-55 kg/t</td>
<td>60-65 kg/t</td>
<td>-10%</td>
</tr>
<tr>
<td>83% ISO</td>
<td>60-70 kg/t</td>
<td>80-85 kg/t</td>
<td>-15%</td>
</tr>
<tr>
<td>85% ISO</td>
<td>Not possible</td>
<td>65-75 kg/t</td>
<td></td>
</tr>
</tbody>
</table>

**Eucalyptus urophylla**

<table>
<thead>
<tr>
<th>Brightness</th>
<th>( P_{HC} )</th>
<th>( P_{MC P_{HC}} )</th>
<th>Reduced production cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>75% ISO</td>
<td>40-45 kg/t</td>
<td>45-50 kg/t</td>
<td>0%</td>
</tr>
<tr>
<td>80% ISO</td>
<td>50-60 kg/t</td>
<td>65-70 kg/t</td>
<td>-10%</td>
</tr>
<tr>
<td>83% ISO</td>
<td>65-75 kg/t</td>
<td>90-95 kg/t</td>
<td>-17%</td>
</tr>
<tr>
<td>84.5% ISO</td>
<td>Not possible</td>
<td>70-80 kg/t</td>
<td></td>
</tr>
</tbody>
</table>

**New OptiThick DF disc filter provides many operational benefits**

Valmet’s new OptiThick DF disc filter (Figure 14) brings a new level of performance and dependability to stock thickening in pulp and paper mills. Disc filters are commonly used in paper mills as savealls for the recovery of fiber and filler and for the clarification of whitewater. Modern disc filter savealls now produce clear and super-clear filtrates for stock dilution and machine showers that minimize freshwater use.

Petteri Riivari, Valmet’s Dewatering Equipment Product Manager (Figure 15), sums up: "In designing the new OptiThick DF, we paid special attention to increasing operational capacity through accurate dimensioning while simultaneously maintaining the high filtrate quality."

**How it works**

The OptiThick DF disc filter consists of filtration discs attached to a hollow center shaft which rotates partially submerged in the vat. A vacuum applied to the shaft via a barometric dropleg causes a
fiber mat or cake to form on the disc, which traps the fibers and fines while letting the filtrate pass through. As the disc rotates, the cake increases in thickness and increasingly clearer filtrate is sucked through it and divided into separate flows by a special valve at the end of the shaft. The filtration capacity and cleanliness of the filtrate are determined by the sweetener stock available, the vacuum level, the white water solids content and the pulp cake thickness. Several features of the new OptiThick design have improved efficiency and reliability, as well as simplifying maintenance and service procedures (Figure 16).

**Increased capacity without compromising quality**

The increased capacity of the OptiThick DF is the result of several design features, including good shaft flow characteristics, optimum internal volumes and filtrate valve selection. The small internal volumes of the disc sectors, shaft and filtrate valve provide a faster response and ensure the best possible filtrate quality, even at faster rotational speeds. The tightly sealed gaskets in the vertical drop leg prevent leakages and maintain the optimum vacuum in the shaft and disc sectors.

Another major factor in the capacity of a disc filter is air in the feed stock. "Just 1% additional air in the stock can require two extra discs in the larger filters to achieve the same production rate, with a corresponding increase in investment and operating cost. The OptiThick inlet box has been flow-modeled to ensure an even distribution of pulp and smooth flow for better cake formation (Figure 17) and filtrate quality," explains Petteri Riivari.

**Simple sector mounting**

OptiThick DF sectors feature the industry standard, open-grid design, but their mounting on the shaft is unique. Mounting rods, slotted to hold the sectors, are clamped to hollow feet that are welded to the central shaft. They maintain perfect alignment (Figure 18), enabling a tight seal between the hollow foot and sector base. The welded foot eliminates the traditional bolt-on foot and gasket between the foot and the shaft that can lead to vacuum loss from a poor sector to the center shaft connection. In the event of mechanical damage to a sector mounting rod, replacement is much easier, bolts are pre-attached to the rod clamp, and no loose parts (gaskets, mounting plates or bolts) that can be accidentally dropped into the vat are needed.

**Maintenance-friendly design features**

Large doors in the filter hood give generous access to the sectors. The rigid construction of the inlet chutes in which each disk rotates reduces any possibility of bending and resultant damage.

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**OptiThick DF benefits**

- High level of reliability
- Improved capacity
- Increased performance
- Excellent flow
- Cleaner filtrates
- Easier operations and maintenance

*Figure 16. Benefits of implementing the OptiThick DF filter*

*Figure 17. Excellent "cake" formation provides better-quality filtrate.*

*Figure 18. Sectors are mounted on feet that are welded to the central shaft and maintain perfect alignment, enabling a tight seal to the sector base.*

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to the sectors. The 20 sectors per disk are easy to replace, sliding in and out on the mounting rods with a simple securing system to hold them in place. The sectors themselves feature zip-on polypropylene filter bags and positive O-ring sealing at the sector base. The hood also has smaller inspection hatches for safer visual examination. Unlike some designs, the shaft bearing on the valve side is outside the vat, which means it can be serviced without opening the disc filter.

Successful start-up
The first OptiThick DF installation took place as part of Valmet’s delivery of a complete tissue production line to Industrie Cartarie Tronchetti (ICT) in Montargis, France. Producing 70,000 tons a year of high-quality facial, toilet and towel grades, the production line is optimized to enhance final product quality and save energy. Start-up was in July 2011.

WavStar – the disc filter capacity booster
Valmet’s WavStar filter bag (Figure 19) is suitable for all kinds of disc filter sectors, including the new OptiThick DF disc filter. The secret of WavStar lies in its unique fabric corrugation. The solution increases the sector surface by 29%, enhancing capacity by 10 to 25%. The corrugation also facilitates filter cake removal.

The key benefits of this disc filter bag are:
- High capacity
- High pulp discharge consistency
- Improved filtrate quality
- Cost-effective retrofit
- Easy maintenance and service

WavStar ensures high runnability and performance even in the toughest conditions.

TwinRoll Evolution – raising the standards
Ever since its launch in 2009, orders for the TwinRoll Evolution wash press have been pouring in: 66 presses of type TRPE have been sold and 18 of them are already in operation.

Better washing performance, more capacity and numerous features
When the TwinRoll Evolution was being developed, the aim was to create a press that was the same size as earlier twin-roll presses, but with significantly higher capacity and the ability to cover a wider range regarding inlet consistency of the pulp. In addition, all the good qualities that made previous generations of the twin-roll press industry best-sellers would be retained.

The results so far have been good. The machine also has a number of unique features, such as variable nip control, which makes it possible to change the distance between the rolls during operation. This is extremely useful when the machine needs to be trimmed or when major production changes have to be made.
The TwinRoll Evolution’s availability is high. The machine has been running without much supervision after start-up at several mills.

Another feature is the Rotoformer, a new pulp inlet arrangement, which is also now available for upgrades of earlier twin-roll presses.

When compared with previous generations of presses, a great visual and functional difference of the TwinRoll Evolution (Figure 20) is the movable flaps on the frame. These flaps can be opened for maintenance and they provide full access to the machine’s interior, which means the need for platforms around the machine is reduced, simplifying the installation and saving space.

Successful TwinRoll Evolution startup

One of the latest TwinRoll Evolution start-ups was in January 2012 at Mondi Richards Bay in South Africa. Here they have a long experience of presses, with a number of older models of various makes installed at the mill. After a few weeks of operation Pieter Mans, Fiber Line Business Unit Manager, confirmed that "our new Evolution press is the most user-friendly press we have, and unlike our older generation presses we experienced no blockages."

Valmet’s personnel who were on site during start-up verify that everything went really well process-wise. The equipment functioned as promised. "We started to run 1,600 tonnes at start-up, and then quickly switched to 2,000 tonnes. This is impressive, as presses previously needed to be stopped in order to manually adjust the nip at a production change. Being able to easily change the nip during operation is an incredible advantage," says Thomas Hellström, SR Electrical & Instrument Manager from Valmet. The press at Mondi Richards Bay is dimensioned for production of 2,300 tonnes per day but is prepared for an upgrade to 3,000 tonnes, which the mill intends to run in the future.

The delivery projects follow one after another. The presses for Suzano Imperatriz in Maranhão, Brazil are currently being erected in Brazil. Three presses in the United States have recently started up at Weyerhaeuser mills in Columbus, MS and Longview, WA. With the latest TwinRoll Evolution press, with all its new features and benefits, Valmet has taken dewatering and washing to a whole new level, and raised the standards in press washing.

RotoFormer - The No. 1 performance upgrade for your TwinRoll press

RotoFormer was originally developed for TwinRoll Evolution, the latest generation of TwinRoll presses from Valmet. Now this new pulp inlet device is available for upgrading the DPA, DPB and TRP TwinRoll presses.

Upgrading to RotoFormer yields a number of benefits. The increased vat angle of the press and improved pulp distribution and formation provide significantly greater capacity for a broad range of inlet
consistencies while delivering greater washing efficiency. Upgrading to RotoFormer also minimizes the risk of plugging in the inlet device.

RotoFormer consists of a pulp inlet box and a rotating screw. The inlet box is open toward the roll surface. The screw maintains the flow of the pulp in the inlet box and its function is to distribute and form the pulp for optimal consistency and throughput.

The special design of RotoFormer allows a pulp feed consistency between 3% and 11%, enabling capacity increases of up to 30%.

An upgrade includes RotoFormer, a new and improved spray pipe, longitudinal air seals and upgraded air pressurized end seals for presses with water adjusted end seals (Figure 21).

**Easy to upgrade to RotoFormer**

RotoFormer is easy to install (Figure 23). It is bolted to existing holes on the press. Almost no modifications are needed for the DPB and TRPB presses, but some adjustments of the vat are necessary for the DPA and TRPA presses.

Installation takes approximately three days for the DPB and TRPB presses, and five days for the DPA and TRPA presses. The main press drive and the pre-breaker drive may need to be upgraded to handle a capacity increase.

**Summary**

Possibilities exist to reduce refining energy while increasing production rate by process optimization and refiner segment design. New segment innovations such as AttackBar are suitable for heavy-wear conditions. Two-stage ($P_{mcp\,HC}$) peroxide bleaching of CTMP can reduce production costs while producing brightness levels of 85% ISO or more for CTMP produced from Chinese raw materials.
RotoFormer is an easily installed upgrade to improve DPA, DPB and TRP TwinRoll press performance. The popular TwinRoll Evolution wash press provides better washing performance, more capacity and several other benefits. The OptiThick DF disc filter and WavStar filter bag provide several stock thickening benefits, including improved reliability, capacity and performance.

*This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.*

*Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.*

*We are committed to moving our customers' performance forward.*