Almost every paper machine that has been operating for more than five years has one common need: produce an increasing number of quality tons of product at acceptable cost and at optimum machine efficiency. With recent market conditions, paper producers are rationalizing their production capacity, which subsequently means paper machines are forced to operate at production speeds above that of the original process parameters. Even if the machine is operating at design parameters, over time the machine itself will degrade in performance due to various mechanical and maintenance reasons.

Figure 1 describes what a machine manager faces as far as acceptable productivity over the life of the paper machine. Once the machine operates at or above original design specifications, consistent quality operation of the paper making process becomes more difficult over time.

One of the primary reasons for problems in increased quality paper machine operation is the inability of the wet end of the paper machine to deliver a sheet out of the press section that is sufficiently de-watered to allow the dryer section of the machine to effectively dry the sheet to required moisture levels with the available steam and condensate system.

A new technology developed by Nalco known as VELOX™ Technology for Dewatering Applications allows the sheet exiting the press section to increase solids up to two percent.

When VELOX technology was first introduced to the paper industry, the two major benefits of higher press solids were: 1) decreased energy consumption due to less steam to dry the sheet in the dryers and 2) higher machine speeds to take advantage of the additional steam capacity.

As referenced earlier, a paper machine manager has one primary concern when operating his paper machine—profitable tons out the door at acceptable quality and efficiency. In most cases, any steam savings realized when utilizing a press dewatering technology will be turned into speed or tonnage increases on the paper machine. If this speed increase is to help produce one of the manager’s higher basis weight grades run at speeds equal to his lighter weights on the machine, the likelihood of other efficiency problems occurring at the higher speed is probably low.

However, the paper machine will be operating at higher speeds than the heavier grade has achieved previously. Therefore, the machine manager will be looking very closely at any changes that may occur in the quality properties of the sheet itself. This is true because changes in items such as headbox stock delivery, foil angle drainage activity, vacuum drainage, press nip dwell times, uhle box dwell times, and
draw requirements can all have potentially serious consequences to the paper grade being produced at the higher speed. These items have to be considered and their effects weighed against the potential gain in tonnage for the grade.

The potential problems mentioned above are of greater concern if all grades produced on the paper machine are dryer-limited. Consequently, a press dewatering aid technology would conceivably allow operation of the paper machine at speeds higher than what machine crews have experienced. However, as can be seen in Figure 2, on a machine that is operating at 3,000 fpm (915 mpm) and is steam-limited 100 percent of the time, there is a potential to increase machine speed by 210 fpm (64 mpm). For even low incremental operating profit levels of $200/ton, this means a potential additional profit of $14 for each ton produced at the higher speed.

During economic times when additional paper machine production cannot be profitably marketed by the paper manufacturer, the other benefit using an enhanced press dewatering technology is to produce the same amount of tonnage off the machine at lower demand for steam. Depending on how the paper machine is financially responsible for the amount of steam used on the machine, the paper machine manager has to decide whether the cost of a dewatering aid program such as VELOX technology can be paid back with the potential steam savings that may be made available. Figure 3 illustrates the same production assumptions used above of 3,000 fpm (915 mpm), 100 percent of all grades being dryer-limited, and incremental profit of $200/ton produced. Considering only energy savings, the machine manager will only realize a profitability savings of $2.00/ton produced. For most paper machines, this, in itself, would not necessarily be a strong argument for the use of a dewatering aid technology.

On the other hand, any paper machine superintendent or manager cannot ignore the fact that VELOX technology can provide increased exiting press dryness. Consideration must be given to other potential benefits from the technology, which may not be as obvious as machine speed or energy savings. Depending on the grade being produced, design of the paper machine, speed of the paper machine, and type of furnish used, there are a number of other benefits that can affect the following parameters in a positive and profitable way:

- Increased first pass retention
- Lower tray solids
- Improved two-sidedness
- Increased porosity
- Higher drainage in the former
- Lower draws between the press and dryers
- Improved 2-sigma CD moisture
- Improved press clothing performance

### EFFECT OF PRESS DRYNESS ON MACHINE SPEED

<table>
<thead>
<tr>
<th>Speed (fpm)</th>
<th>% Dryness Change</th>
<th>$/ton*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000</td>
<td>0.00</td>
<td>$ –</td>
</tr>
<tr>
<td>3027</td>
<td>0.25</td>
<td>$1.75</td>
</tr>
<tr>
<td>3053</td>
<td>0.50</td>
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</tr>
<tr>
<td>3079</td>
<td>0.75</td>
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</tr>
<tr>
<td>3105</td>
<td>1.00</td>
<td>$7.00</td>
</tr>
<tr>
<td>3132</td>
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<tr>
<td>3158</td>
<td>1.50</td>
<td>$10.50</td>
</tr>
<tr>
<td>3184</td>
<td>1.75</td>
<td>$12.25</td>
</tr>
<tr>
<td>3210</td>
<td>2.00</td>
<td>$14.00</td>
</tr>
</tbody>
</table>

*Assuming 100% dryer limited paper machine, incremental operating profit of $200/ton and 3.5% drying efficiency gain.

Figure 2. An example of how to calculate potential incremental operating profit with increase in machine speed.

### EFFECT OF PRESS DRYNESS ON STEAM

<table>
<thead>
<tr>
<th>% Dryness Change</th>
<th>$/ton*</th>
<th>% Dryness Change</th>
<th>$/ton*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>$ –</td>
<td>1.25</td>
<td>$1.25</td>
</tr>
<tr>
<td>0.25</td>
<td>$0.25</td>
<td>1.5</td>
<td>$1.50</td>
</tr>
<tr>
<td>0.5</td>
<td>$0.50</td>
<td>1.75</td>
<td>$1.75</td>
</tr>
<tr>
<td>0.75</td>
<td>$0.75</td>
<td>2.0</td>
<td>$2.00</td>
</tr>
<tr>
<td>1.0</td>
<td>$1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Assuming 100% dryer limited paper machine, incremental operating profit of $200/ton and 3.5% drying efficiency gain.

Figure 3. An example of how to calculate incremental profit with steam savings only.

### FIRST PASS RETENTION (FPR)

As with any wet-end program, papermakers demand a balance among retention, formation and drainage to meet sheet specifications. With VELOX technology, both first pass retention (FPR) and first pass ash retention (FPAR) significantly increase. Consequently, tray solids are significantly reduced. Lower tray solids can result in a more effective microbiological program and savings can be realized in reduced microbiological chemicals.
Typically, when a paper machine has better ash and fiber retention, the formation of the sheet can deteriorate. If formation does worsen slightly, the forming section of the paper machine can be adjusted to either add more water to the stock flow, which will reduce headbox consistency or adjust the forming elements to reduce drainage pressure. Because VELOX technology will provide increased press dewatering, adding water or decreasing drainage will provide good formation improvement tools, but will not affect machine productivity. In most cases, after wet end adjustments, the final formation of the sheet is better than before VELOX technology is added to the system.

**IMPROVED TWO-SIDEDNESS**
Depending on the type of paper machine (fourdrinier, gap, hybrid, etc.), the improved FPR when using VELOX technology has resulted in improved sheet two-sidedness. Laboratory analysis of the sheets has repeatedly shown that there are large improvements in the filler distribution within the sheet. The result, for the papermaker, is a sheet that will accept coating and/or sizing more uniformly on both sides of the sheet. A more uniform application of coating and sizing provides a quality product with consistent performance on both sides of the sheet.

**POROSITY**
Even though there is higher ash retention in the sheet due to the use of VELOX technology, there is also an increase in sheet porosity. Increased porosity of the sheet may be due to the better adhesion of the micro-fines and fillers in the sheet to the fiber mat, which consequently will open up the sheet accordingly. On some machine grades, the increase in sheet porosity may not be desired. However, as with the increase in FPR and FPAR mentioned above, the existing retention aid and flocculant program can then be adjusted (in this case reduced) to adjust sheet porosity.

**INCREASED WET END DRAINAGE**
Even though VELOX technology is primarily a dewatering tool at the press section, there is also a varying amount of increased water removal through improved drainage in the forming section. Because a paper machine needs to increase solids in the sheet by more than three to five percent off the forming section to even realize one percent out of the press, it is unlikely that a sheet leaving the wet end at 18-21 percent dry content can increase this dry content by the six percent needed to reflect the two percent press solids improvement normally seen with VELOX technology. In most cases, the papermaker uses the increased wet end drainage to his advantage by adding more water, or reducing headbox consistency to improve formation and other sheet properties dependent on wet end drainage. The objective of the machine manager is to have the same sheet solids out of the forming section with the use of VELOX technology as before.

**BETTER DRAW CONTROL**
Concurrent with the increase in exiting press dryness, the sheet leaving the last nip, being dryer and stronger, is much easier to “peel” off the last press roll and transfer to the first dryer section. It is commonly accepted throughout industry that one percent increase in dryness after the last press will increase the wet-web tensile of the paperweb by 11-13 percent and will consequently reduce the steam demand in the dryer section by 3-4 percent.

The stronger, dryer sheet will release much more readily from the last press roll. The papermaker can now use less...
speed differential between the first dryer section and the press section. Less draw will result in a wider sheet entering the dryer section with less edge effects, edge cracks and breaks. Figure 4 illustrates the reduction of the draw between the press section and first dryer section on a paper machine running above 3,600 fpm (1100 mpm). The average draw reduction is almost eight percent.

Using the machine data shown in Figure 4, Figure 5 describes the profitability increase when reducing press and dry end machine breaks by just 9.46 minutes a day, which translates to approximately one break per day. The increase in profitability is over $1.31 per ton produced.

If, as referenced above, the paper machine manager cannot take advantage of speed increases, but only steam savings, adding the savings from break reduction to the energy savings creates more of a reason for a papermaker to implement a dewatering aid technology.

**IMPROVED CD VARIABILITY**

One of the biggest opportunities for a paper machine manager to improve his paper machine’s profitability is to reduce the average amount of fiber that he needs to use to produce his final product. Depending upon the type of former and press section, VELOX technology has repeatedly improved 2-sigma and 3-sigma values for the sheet being produced. The greatest improvements have been seen on fourdrinier and hybrid top wire machines. Modest profile improvements are still evident with gap formers—in one case, the 3-sigma improvement of both CD moisture and CD weight. These improvements were 13.4 percent moisture and 18.7 percent in weight. Depending on the value and furnish source used on the paper machine, these kind of CD variability improvements can dramatically improve the papermaker’s bottom line profit.

Because VELOX technology provides the opportunity for better FPR and FPAR performance, there are less fines and fillers in the sheet that can be removed by the pressing actions within the press section. This results in press felts that operate cleaner and the effective life of the press felts is extended. In other words, the press felt will remove the maximum amounts of water from the sheet for a longer period of time than the felt is running. The normal “falling off” of felt performance will be minimized and more tons of paper produced over the same life cycle of the felt.

In addition, VELOX technology will allow for improved felt designs which normally would have made the sheet run “wetter” to improve sheet properties such as sheet smoothness and appearance because VELOX will continue to effectively remove the necessary moisture from the sheet to maintain production specifications.

In conclusion, the obvious benefits of VELOX technology are higher machine speeds and energy savings. However, when the paper machine manager, papermaker, or superintendent is offered an increase of press dryness of up to two percent, he will be able to envision some or all of the machine runnability improvements seen in all cases. Because of constant requirements to push a paper machine to its limits, the offer of additional dryness provides the process buffers needed to improve overall machine efficiencies while maintaining sheet quality standards.

**TABLE: MACHINE RUNNABILITY**

<table>
<thead>
<tr>
<th>Location/Reason</th>
<th>Min./day $/ton BEFORE</th>
<th>Min./day $/ton AFTER</th>
<th>Profit Difference Min./day $/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press Breaks</td>
<td>2.10 $0.29</td>
<td>1.10 $0.15</td>
<td>1.00 $0.14</td>
</tr>
<tr>
<td>Main Section Breaks</td>
<td>19.06 $2.65</td>
<td>14.74 $2.05</td>
<td>4.32 $0.60</td>
</tr>
<tr>
<td>Fifth Section Breaks</td>
<td>0.42 $0.06</td>
<td>0.39 $0.05</td>
<td>0.03 $0.00</td>
</tr>
<tr>
<td>Reel/Cal Breaks</td>
<td>17.44 $2.42</td>
<td>13.33 $1.85</td>
<td>4.11 $0.57</td>
</tr>
<tr>
<td>Breaks Total</td>
<td>39.02 $5.42</td>
<td>29.56 $4.11</td>
<td>9.46 $1.31</td>
</tr>
</tbody>
</table>

Figure 5. An example of how to calculate additional profitability from break reduction.

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