Article 7
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Case Studies in Improving Your Chip Supply

Rotary Debarking - A Process Description

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Rotary debarking has fast become a preferred method for multiple stem continuous feed wood debarking and processing for forest industries. Variants of this 20-year-old technology are being recognized as a viable alternative to single stem debarking methods used in some processes such as sawmills. The adjustable and positive nature of the debarking action coupled with a simple design produces the benefits of clean stems and low maintenance costs.

The term rotary debarking is commonly used to describe a log debarking device that uses a stationary bin where rotating shafts protrude along the bottom or sides. These shafts are fitted with a variety of tooling that provides controlled agitation of the wood fiber in the bin. As the shafts turn, the action of the tooling abrades the wood and creates cuts, fissures or weak points in the bark. Stem to stem contact rubs the bark from the wood, as does the continued action of the shafts and tooling. The logs circulate in the bin until the bark is adequately removed.

Debarking frozen wood can be extremely difficult – even non-existent in drum debarkers – without first preconditioning the log to lower the required direct mechanical or passive log-on-log energy input requirement.

Rotary debarkers, however, are an improvement over traditional drum debarking. Rotary debarkers use tooling to increase abrasion. They also allow an increase in rotor speeds while bin loading is simultaneously increased. These factors all contribute to the increased energy required in more difficult debarking situations. (See Table 1.)

The rotary debarking process is dry and no effluent treatment or water source is required. Occasionally, though, a minimal water spray is used to control dust. Footprints are shorter as no deicing or conditioning decks are required. Rotary debarking installations will see a savings in reduced maintenance costs when compared to a drum/deicing deck combination. (See Table 2 summarizing “typical” drum characteristics.)

With a history of straight line low maintenance costs compared to the exponential rise in operating costs for drums as they near the end of their useful life, rotary debarking makes a considerable and positive impact on return on investment calculations (ROI).

In addition, rotary debarkers are able to use more of the fiber that is otherwise left behind in the field. Where, historically, small diameter tops and rat tails have been left in the forest by topping at 75 to 100 mm, this fraction of the raw material source can now be delivered to the facility and the fiber effectively debarked (with no noticeable rise in debarking costs per unit).

Long term studies have indicated an ability to increase fiber utilization by 10 to 15% without harvesting any additional fiber when employing rotary debarkers and a well-designed forest harvesting practices format. This, again, can have a dramatic and positive impact on ROI calculations.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>EFFECT OF FREEZING ON DEBARKING EFFICIENCY</th>
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<tbody>
<tr>
<td>• Green aspen unfrozen requires 50#s/square inch energy input.</td>
<td></td>
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<tr>
<td>• Green aspen at 0 degrees Celsius requires 115#s/square inch.</td>
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<tr>
<td>• Green aspen at –5 degrees Celsius requires 280#s/square inch.</td>
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<tr>
<td>• Green aspen at –65 degrees Celsius requires 480#s/square inch.</td>
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<tr>
<td>• Appears that the energy input increase required to remove bark from frozen aspen flattens at –80 degrees Celsius.</td>
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<tr>
<td>• Similar, though not identical, effects can be seen in other species.</td>
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Rotary debarker designs

There are two basic designs of rotary debarkers, one is the closed bottom (CB) and the other is the open bottom live floor (OBLF). While they share a number of characteristics, each is unique.

CB rotary debarking is the original improvement over drum debarking technology, while OBLF rotary debarking is an improvement on CB rotary debarking itself. OBLF rotary debarking has recently been incorporated into discharge batch (DB) stem management with increased benefits.

DB rotary debarking has the potential to have as large an impact on debarking technology as rotary debarking has had on drum debarking technology.

CB rotary debarking technology was developed for and applied to initial markets in Asia. In its early form it consisted of two rotors intruding into the bottom of a static bin. A transfer plate is fitted between the rotors to create a closed space between the rotors. Tooling in the form of staggered prominent cutters is mounted on the surface of a smooth shaft that sweeps through slots cut into fingerplates stationed on either side of the rotor assembly. The rotors are mounted in the bottom of the bin in such a way as to rotate the logs and lift them from one side to the other. The entire bin is declined so that the wood even-

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TABLE 2

DEBARKING IN DRUMS USING SOME FORM OF ENERGY TRANSFER TO ASSIST BARKING EFFICIENCY

Effective debarking of dried or frozen wood can become almost impossible in drums without some significant form of energy transfer.

Three methods are used to assist drum debarking

- Wet debarking
- Log washing and de-icing
- Steam treatment

Heating water with steam is very costly due to the large quantities required as well as the loss to condensate. Separation of water from bark is elaborate and expensive if bark is to be used for fuel.

A degree of pulping takes place in wet debarking producing large quantities of small fibers as well as dissolving a number of inherent organic compounds increasing BOD and toxicity of the debarker effluent ... requires treatment.

A wet system is not attractive from a maintenance aspect.

Log washing systems use from 1500 to 3000 gallons of water per cord.

Water should not exceed 120°F to prevent excessive fogging and slime and must be warmer than 80°F to be effective.

Washing and de-icing are not considered the most effective method to promote bark removal in very cold weather as the frozen log rapidly absorbs the heat introduced outside the drum.

In late 1987 the cost of steam treatment (operational) was placed at up to $0.25/m³ SUB for steam and a condensate loss of 30L/m³ SUB – these costs are noticeably higher today.

Steam injection at maximum rates will increase bark moisture content by 25% requiring use of bark presses to allow burning.

In dried-on aspen bark, however, the water acts like a lubricant and decreases barking efficiency.

- Adequate pH control is required to prevent drum shell corrosion.
- A combination of steam and wet debarking conversion is the cost capital-intensive approach beyond the cost of the drums.
- Conversion to wet debarking is second.
- Steam injection into drums is third.
- Steam with log washing is fourth.
continued,

Rotary Debarking – A Process Description

usually migrates to the low end and passes out of the machine.

Some CB rotary debarkers include a third rotor, or larger diameter rotors, to increase bin width and capacity in a shorter footprint. This is a relatively simple principle to embrace: increased bin size with adequate rotor-to-fiber interaction and sufficient consistent stem movement increases capacity.

More demanding debarking can be achieved with stationary cutters on the sidewall and finger-plates. Recently, sharp cutting plates have been used that are air-bag extendable and mounted to the bottom transfer plate. These have been added to some CB debarkers. These use a previously underutilized area of the bin to increase efficiency.

In another application, a sidewall mounted ‘return’ rotor was added to CB debarkers with limited success. CB rotary debarkers have a tendency to be limited in the fill depth that can be adequately agitated. As such, the return rotor typically has little contact with the fiber charge and no noticeable benefits.

CB rotary debarkers are typically fed with an “over the side, parallel to the rotor” delivery of logs to the low rotor side of the module.

They are very effective in small diameter and crooked material where the log-on-log action can cleanly debark the interior of the crooks and sweeps. The same debarker, however, has difficulty rotating large diameter stems when they are introduced with smaller diameter stems. Large stems in such a blend have a tendency to strand themselves on the inter-rotor static plate. The smaller stems, even when agitated by the rotors, do not have the necessary mass to move the larger static log.

With CB rotaries, the infrequent cutter arrangement can lead to patchy debarking of the stem during initial stages and ultimately higher white wood losses. In order to reach your cleanliness levels, the stems needs to be retained for a longer period so the abraders can make contact with the remaining bark. During that process, areas that have already been debarked come into return contact with the abraders and thus you have higher white wood losses.

Further, the prominent cutter profile leads to high stem point pressure and increased chance of breakage in smaller diameters. Where the loading is excessive, the abrader tool can impart stresses that exceed the strength of the stem itself, resulting in fracturing or breaking.

Abraders can be replaced seasonally, if needed, to control their aggression and some adjustment can be obtained by varying loading and rotor rpm. However, tall, sharp abraders can have a noticeable negative impact on the stems, resulting in breakage and poor log surface finish. In some processes, such as ground wood pulp or OSB broken stems below optimum length, the efficiency of the grinder or strander is negatively impacted. Further, it is well known that in traditional chipping applications the production of pins and fines is related to the number of ends the chipper sees – more ends are present with broken stems.

CB rotary debarkers require feed and fill level consistency and a certain level of operator attention and skill to achieve optimum performance. Once the correct level of fill and the appropriate dwell time are achieved, a constant infeed and discharge rate will promote the ability of the debarker to provide a continuous supply of fiber cleaned to specification.

CB rotary debarkers have a maximum stem length that is typically restricted to around 7 meters. At those lengths crooked stems may have a tendency to knit and tie together, resulting in loss of charge rotation and no debarking. Also, it leaves the stems susceptible to white wood losses due to gouging and chunking.

This is not as severe a problem in straighter softwood stems but traditionally stem lengths, even in this straighter, more uniform diet, are capped at or around 7 meters.

CB rotary debarkers use a vertical
discharge gate. When stems below 2.4-meter length are being processed the gate is quite effective. However, the gate loses the ability to control stem flow as longer lengths are introduced. When long stems are being processed, the gate is typically kept at or near the full down position (or not included in the design). Longer stems crossing a raised gate as they are discharged from the debarker result in loss of contact with the rotors and a corresponding loss of agitation and rotation. Care must be given to the selection of the incline slope of the bin. Where stem characteristics are uniform this slope selection can be made quite readily. However, where stem characteristics and wood profiles are variable, a satisfactory compromise is often difficult to achieve.

As this style of debarking is applied to large capacities, another phenomenon is noted. To achieve the desired cleanliness and throughput levels of the facility, the debarker's length may reach 36 meters. While this is satisfactory in the more difficult season when debarking is more easily accomplished, the long lengths result in a preponderance of high white wood losses. Once easily debarked wood has been rapidly cleaned in a short section of the overall system, the debarker merely becomes an aggressive conveying system to move the logs to the discharge. Parallel shorter systems are employed to address this undesirable characteristic.

Open Bottom Live Floor (OBLF) rotary debarking embraces the core characteristics of CB rotaries with some noted innovations to address deficiencies. Developed in the cold climates of northern Canada with an emphasis on unconventional fiber recovery and frozen wood processing, the effectiveness of the process became apparent and was quickly applied to conventional debarking applications.

OBLF rotaries can be described as three or more rotors intruding into a static bin with no transfer plates between the rotors, hence the “live floor” designation. The rotors possess elements which function like interleaving discs when rotated to retain fiber hence they are open bottom. Each successively higher placed rotor turns faster which prevents pull through of good material. The rotors are placed on a more noticeable incline than are the rotors in CB rotaries.

Rotors disc elements are fitted with a high frequency of abrader blocks and, when compared to earlier closed bottom rotaries, may have as many as three times the tip incidence. Each disc carries a specific throat – the distance from the top of the abrader block to the top of the ring that carries the abrader block – and is arranged on the rotor to form a helix or spiral.

The discs are placed on the rotor shaft to produce an interface with the adjacent rotor's discs. The discs can vary in diameter to provide the desired slot length to pass the finer bark chunks and particles. Rotor core tubes withstand the high stress levels present in the bin bottom and meet the demands of specific or severe applications.

Tooling can be generic in nature or specific to the application and may or may not be at a constant radius from the centre of the tube.

The rotors are driven to agitate and tumble the fiber. Typically the debarker is placed on an incline and the wood moves towards the lowest end. During the travel, the rotating disc abraders bruise the bark and create a weak point at the bark-to-fiber interface where the rubbing of log on log can complete the bark removal process.

Stationary cutters can be placed on the sidewall and fingerplates to assist in difficult debarking conditions, although they are typically not required.

Feed arrangements for OB debarkers are varied but similar to the
closed bottom design. Logs can be fed over the side with logs parallel to the rotor, conveyed in from the end above the rotor bed, conveyed in slightly above at the central rotor height, or fed by mobile log yard handling equipment.

OBLF rotaries are dry debarkers and do not require de-icing or thawing of frozen wood. They process small diameter and crooked stems with high efficiency and low white wood losses. The live motion floor virtually eliminates plugging or jamming of errant fiber in the debarker bin. The live floor and interleaving arrangement provides material transfer hand off from rotor to rotor. This style of rotary debarker can effectively handle increased loading depths. With a high number of debarker abrader discs and tips, the stems do not see undue high specific point pressure and stem breakage is minimal.

The increased loading provides a rise in stem to abrader point pressure over a very short length which encourages bark to fiber bond failure and provides high debarking capacity in much smaller footprints than conventional CB rotaries. An indicator of the effectiveness of this technology is the simultaneous stem surface debarking which provides reduced white wood losses while achieving an enhanced stem surface condition.

This style of debarker also enjoys low maintenance costs and the high tip count reduces the wear rate which greatly extends the required machine maintenance window.

While the cost per processed unit in both CB and OBLF rotaries is similar, OBLFs require less frequent maintenance.

Replaceable or fixed tooling is available for OBLF rotaries. In addition, scheduled downtimes can often be avoided as the machine’s needs can easily be met while the machine is idle during process interruptions.

The reduced footprint this technology offers makes it particularly suitable for fully portable and bush debarking applications.

OBLF rotaries have a footprint 60 to 70% that of CB rotaries to reach the same production and cleanliness rates where stem length is not the determining factor.

The live floor design allows OB debarkers to handle large diameter stems. There are systems debarking stems up to 1000 mm in diameter – the downstream chipper being the limiting factor.

The improved efficiency of OBLF rotary debarkers allows the processing of stems which are the full length of the module, with systems running stems of up to 9 metres. Even longer applications appear to be possible where the wood is relatively straight. In general, if long stem material can be debarked in a drum, it can be more effectively and economically debarked with this technology.

An advantage of employing OBLF rotaries in place of dry-drum long-stem debarking is that the unit can be top loaded, eliminating the need for long-stem infeed systems. Where infeed systems are selected to optimize mobile yard equipment capacities, the infeed system can be installed such that the stems are delivered over the low-rotor sidewall parallel to the rotors.

Usually they run the butt end first as it ‘steers’ the log. However, in side discharge batch systems inserting one charge one way and the next the other way helps increase capacity, as described below.
A vertical traveling discharge gate has limited effectiveness when the stem is more than about 2.4 meters long. OB rotaries in a continuous feed format with long stems are sensitive to the effects of incline angle. Some machines have been installed with an “active slope” feature where the machine’s inclination can be adjusted during operation to suit variations in the feed quality or performance requirements.

Discharge Batch (DB) rotary debarking was introduced in late 2002 and is expected to have a considerable impact on the industry. In 2015 Acrowood introduced the Bottom Discharge Batch (BDB) rotary debarker to replaced the older SDB to reduce handling costs and negate issues of the side discharge design. A natural development of the OBLF debarker’s ability to accept high loading and long stems, a BDB debarker with an OBLF will (depending on local circumstances) require a footprint of only about 30% of a conventional OB continuous feed debarker and about 20% of the footprint of a CB rotary debarker to reach the same performance.

A predetermined volumetric wood charge of 5m³ to 30m³ solid wood equivalent is placed into the debarker bin by deck, cradle loader with a pre-staged charge or by suitably sized wheeled equipment. The goal is to fill the machine in the short-est possible time to maximize the number of cycles or batches per hour.

After loading, the rotor action is started. The abraders bruise the bark to initiate debarking, and the rubbing of log on log completes bark removal. This is the most effective application of rotary debarking. The high loading weights and the high incidence of generic or specific tooling lead to dwell times that range from 90 to 120 seconds in green unfrozen wood, to a typical maximum of 800 seconds when very difficult frozen and/or dormant fiber is processed.

BDB live floor open bottom rotary debarkers are installed with no slope. When the desired level of cleanliness is achieved, the rotors are stopped, the side discharge gate is opened and/or raised and the rotors turned in reverse to quickly discharge the cleaned material. The stems fall in an aligned and collated form, into a bunk or onto a deck in 6 to 8 seconds. The machine can be recharged immediately and the process repeated.

Downstream of the debarker, clean wood stems can either be processed in their batch format by feeding directly into a receiving chamber such as a strander infeed, or can be converted to a true continuous feed by employing log loaders, wave feeders or other metering and singulating devices that are well accepted by the industry.

BDB debarkers offer all the advantages of closed and open bottom rotary debarking which include dry debarking, no requirement for deicing or thawing of frozen fiber, and the ability to handle small diameter stems in a random length or cut-to-length format. They increase fiber utilization while achieving low white wood losses due to the debarking process itself. Stem surface quality is excellent because the debark-ing dwell period can be precisely controlled, either visually, via PLC timer, or with automated visual assessment technology.

Unlike conventional continuous feed rotaries there is virtually no stem end contact with the debarking elements. This has been shown to increase fiber recovery in sawmills where this approach is used in place of ring debarkers, and when used in pulp and paper or OSB facilities the reduction in pins and fines will be beneficial.

Large diameter and long stems can be processed efficiently in debarkers like these. The broad performance capabilities and improvements of the Bottom Discharge Batch rotary debarker allow it to be applied to the entire wood processing industry from sawmills through to high capacity multiple stem debarking applications.

Acrowood Corporation