# SURVIVAL TECHNIQUES: EXTENDING THE LIFE OF PRESS FABRICS

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***SUPPLIERS OF FELT CLEANING COMPOUNDS DISCUSS SURVIVING COMPETITIVELY AMID CHALLENGES FROM INNOVATIONS IN PRESS FABRICS AND DESIGN AND PROCESS CHANGES IN AND AROUND THE SHOE PRESS.***

"*To extend the life and performance characteristics of this fine press fabric, clean and condition regularly.*" It is an implied label on every press fabric purchased by a paper mill. But just like that favorite pair of blue jeans where the seat and knees are the first to show wear, press fabrics have spots that wear faster than others. The most challenging area for suppliers of felt cleaning compounds is around the shoe press, where felts run faster and suffer a greater degree of compaction. With this in mind, *TAPPI JOURNAL* invited the Sustaining Members listed as suppliers of felt cleaning compounds in the *TAPPI Directory* to tell us what it takes to stay alive competitively while challenged with innovations from press fabric manufacture's and design and process changes in and around the shoe press. These suppliers also tackle questions related to recycled fiber and stickies, speeding up grade changes, and the future for enzymes.

Respondents included **Ernie Young**, senior applications engineer, *BetzDearborn Paper Process Group,* Jacksonville, FL; **Chris Perry**, product manager, papermaking technologies, *Buckman Laboratories*, Memphis, TN; **Satish Salgar**, technical director, *Constant Laboratories*, Montreal, PQ, Canada; **Gary L. Baker**, field technical director, *DuBois Paper Technologies*, Cincinnati, OH; **William "Bill" Smith**, senior technical consultant, paper lab, *ECC International*, Greenville, SC; and **Kristin Roziewski**, technical specialist, *Houghton International*, Valley Forge, PA.

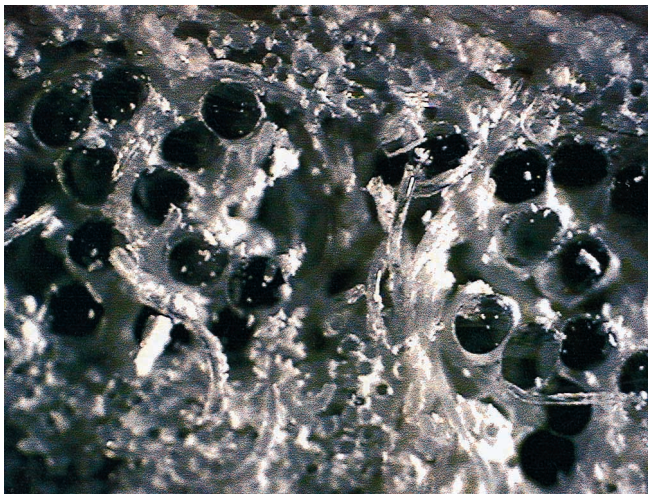
**TJ: What are the biggest challenges in the shoe press area?**

*BetzDearborn:* The greatest challenge in the shoe press area continues to be maintaining the original design characteristics of the shoe press felt for as long as it is economically feasible under high press loading conditions. The high press loads contribute to increased compaction, filling, and wear.

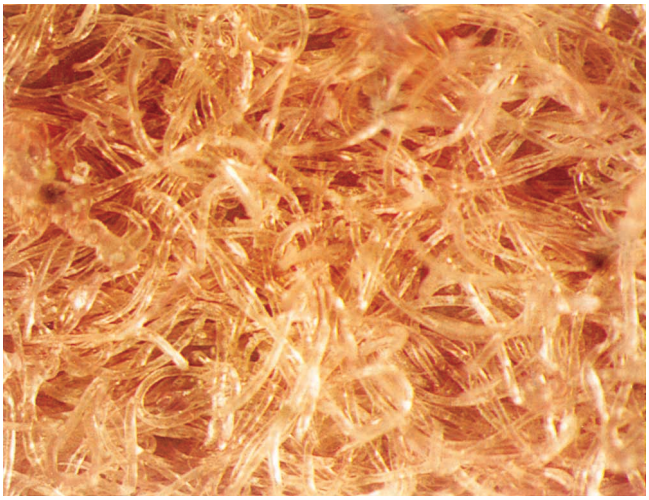
Today's multilayered laminated press felts are custom designed by position to provide compaction resistance features. These help keep the felt void volume open during normal machine operations. For both mechanical and chemical conditioning systems, the greatest challenges are controlling felt void volume filling by contaminants under high nip loadings and increased recycled fiber usage in high temperature press sections. Recent developments in this field make it likely that shoe pressing will be used more in printing and writing and non-brown grades.

Lighter basis-weight fine paper, lightweight coated, and newsprint grades are not as forgiving to the presence of contaminants in the felt structure as are heavier-weight brown paper grades. Obtaining good sheet opacity and printability with fine paper, newsprint, and premium coated grades using shoe presses requires a clean, debris-free felt and press section. It is even more critical that original felt design characteristics are maintained, through proper mechanical and chemical conditioning, to avoid rewet, sheet defects, press breaks, crushing, sheet stealing, and sheet drop off.

*Constant Laboratories:* It is important to perform a thorough analysis of the fabric in order to determine the type of deposit present. With today's high-speed paper machines and complex wet-end chemistry, deposit control becomes of critical importance.



*Light micrograph of a cross-section of a press felt with PCC filling. (Courtesy of ECC International).*



*Photomicrograph of a clean wet press felt. (Courtesy of DuBois Paper Technology).*

*Buckman Laboratories:* The effective use of the shoe press has already been proven on board grades, and the industry will begin to see more shoe pressing on machines producing lighter-weight grades including newsprint. The objective will still be to produce a sheet that has good printability and opacity, but the optimal fabric design has to be in place.

Because newsprint production typically involves a percentage of deinked pulp, contamination of the fabric occurs and presents a hurdle. The use of recycled fibers requires changes in wet-end chemistry and the press section is most always affected. As water loops continue to close, recirculating elements and contaminants in the water may cause filling and corrosion problems. The fabrics have a high tendency to compact in the shoe press, so any contaminants present will pose a threat to keeping shoe press fabrics open and clean. If the mechanical aspects are aligned and maintained, using chemicals to clean the felts can be reduced.

*ECC International:* For linerboard applications, one of the early successful uses of the shoe press, there are almost always two press fabrics: a top and a bottom fabric creating a "double-felted" nip. These press fabrics are high in weight, multilayered, and designed to carry water to the Uhle boxes. Even though the intensity of forces acting on the press fabrics is reduced somewhat by the wide nip and resultant moderate "psi," there is a long residence time in the nip, compared with the situation where a press consisting of two hard covered rolls is running at a high pli.

The greatest challenge in the past has been to keep the press fabrics clean. The long residence time in the nip forces the water-borne contaminants in the sheet into the press fabrics. If they are allowed to build up there, the felts lose their ability to take water. The situation is complicated by the fact that these press fabrics may have four or more base layers. A successful strategy is to apply a continuous conditioning solution to the inside of the felt run just after the press nip. Application is typically through a stationary fan shower, although oscillation of this shower will increase the effectiveness of the chemical solution by creating a more uniform distribution. Use of hot water, travel of the felt over roll to work the solution in, and proper Uhle box design all contribute to effectiveness.

The cross-sectional view of a press fabric (above left photo) taken with a light microscope illustrates the problem with base layer entrapment. In this particular case, the felt filling is precipitated calcium carbonate (PCC). Whether the entrained solids are pitch, resin, size, clay, PCC, or latex glue residues, to name a few, the challenge is to prevent their buildup. Both felt design and conditioning programs are essential elements for success.

Also remember that build-up of chemicals and minerals can be minimized through a strong retention program, which may translate into a reduced requirement for felt conditioners. To optimize the press section, it is important to consider all wet end options at the same time.

*DuBois*: One of the greatest challenges for shoe presses is maintaining maximum dewatering of press felts, through proper cleaning and felt conditioning. To better appreciate this, one must first realize that water is the vehicle by which soils are transported from the web, through the press felts, press rolls, etc. Water removal from the sheet in a press nip is a function of the "press impulse." The press impulse is defined, according to Pikulik and Pye, as the product of the average pressure and dwell time in the nip. Since shoe presses were developed as a result of this relationship, taking advantage of higher linear loads, dewatering rates were maximized.

Likewise, soil transport must be maximized or else felt filling and subsequent dewatering will occur at relatively rapid rates. If soil removal is not uniform within the felt, sheet properties can vary accordingly.

**TJ: Papermakers want versatility and are striving to make grade changes on the same machine faster than ever. What kind of challenges does this present to you as a supplier of felt cleaning systems?**

*BetzDearborn:* The type of grade change will determine if modifications to the cleaning and conditioning program are required. Significant changes in basis weight, furnish, wet-end additives, and process changes might affect drainage and water removal in the wet end. Typically, heavier grades will require increased water and contaminant removal through the felt structure. This might require a modification in the chemical product feedrate, the type of product used, or both. If color changes are made, batch on-the-fly washing should be done at reel turn-up, and down-batch washing should be instituted just before color change. Batch-wash chemicals can remove dyes from the felt, transfer them to the sheet, and result in off-quality color paper during batch washes.

*Houghton International:* Automated cleaning systems so cleaning can be done on the fly, without operator involvement, will allow for faster grade changes.

*Buckman Laboratories:* The mechanical cleaning aspects of the press section is essential for optimal press-section efficiency. Alternating among acid, neutral, and alkaline washes might be required, and this type of program needs to be monitored and applied correctly. As furnishes and wet-end chemistry change, the specialty chemicals supplier always needs to pay close attention to reduce risk to his customer. Maintaining the proper feed rates via reliable feed equipment, providing accurate product recommendations, and being responsive to the daily operations of that shoe press will help the papermaker most. In today's business climate, the supplier must first determine what the "problem" is costing the papermaker. Often, the cost of the chemical program and the cost associated with changes made to the mechanical cleaning aspects of the shoe press are small, compared with the cost of the problem.

*ECC International:* Grade changes involve drastic changes in pulp types, and filler level swings, and color changes require that special attention be paid to press clothing. One of the strategies used successfully is to conduct an on-the-run batch cleaning during grade changes. This can be done without taking the sheet off the reel, if felts are cleaned one at a time with proper dosages of cleaners. Frequently these cleaners consist of alkaline and sequestering components in concentrations designed to remove clay, pitch, fines and alkaline-soluble materials. In other cases, controlled concentrations of acid batch cleaners can address PCC buildups and acid-reducible crystalline solids.

A note of caution: the alkaline and acid batch cleaners are stronger in alkalinity or acidity than continuous cleaners. They provide a shock treatment and are not formulated to be run continuously or too often. Excessive use can lead to yarn damage and reduce the ability of press fabrics to handle water.

*DuBois:* Felt cleaning systems that provide on-demand application of various cleaning regimes ranging from continuous, to either on-the-fly batch washing, downtime batch washing of press felts, or both, with one or more cleaning products addresses this problem. A PLC-controlled system can be programmed to optimize any condition or desired felt cleaning procedure. It offers the ability to interface with a mill's DCS system and can therefore offer on-line optimization to account for grade changes accordingly. These systems eliminate the need for chemical handling and the environmental concern of misapplication of chemical.

*Constant Laboratories:* We strive to recommend well-adapted fabric conditioners since paper web formation then becomes critical for paper manufacturing. This may require interchangeable shower bars as grade changes dictate.

**TJ: How are you keeping pace with all the innovations in felt materials and design? Are any new designs proving to be easier to clean and showing better wear characteristics? What differences in requirements might there be between seamed vs. seamless fabrics?**

*Houghton International:* The newer synthetic fibers used make cleaning the felt easier since they are more resistant to chemical attack and show less wear. The membrane fabrics that are just now being tested by the felt suppliers should realize even better and easier felt cleaning. Due to the demands of the industry to not have any marks in the felt, the felt suppliers have done a very good job of meeting these demands with seamed felts. From a cleaning standpoint, there is no difference in the requirements to clean the seamed felts vs. the seamless felts.

*Buckman Laboratories:* Achieving lower sheet moisture content, while maintaining sheet uniformity and sheet properties, is the ultimate goal. Laminated felts with specific batt design are essential. Designing the felt for a specific machine and grade will help to keep the felt open and running clean longer. Coarseness and the batt-to-base ratios are design characteristics required to keep pace with the shoe press development. Felt suppliers will design felts that are easier to clean, especially as furnishes and fiber mat characteristics change.

*ECC International:* Mutual cooperation between the clothing manufacturer and the cleaning-compound supplier results in better clothing performance for the papermaker who needs both proper designs for his applications and the tools to maintain the initial functionality of the press fabric over its useful life.

Both the base yarns and the batt fiber used in modern press fabrics are produced from nylon in almost all cases. Extrusion technology, heat setting, and fiber plant process and quality control have advanced over the past few years. As a result, today's nylon yarns are superior to the ones introduced to the paper industry years ago.

The biggest step-change in press fabric technology for the shoe press has been the seamed felt. These multilayered felts are constructed using monofilament base yarns, exclusively for the machine direction and in most cases for the cross-direction. The monofilament construction makes these press fabrics easier to clean than multifilament base constructions. Remember, however, that these four- and five-layer felts are on the high side of the weight range; i.e., 5–6 oz/ft$^2$.

One of the interesting developments to watch as the shoe press is introduced to the fine-paper industry is how press fabrics will have to be altered to prevent sheet surface marking by the outer base layers. This is a potential problem in the latter stages of the press fabric's life. One strategy is to reduce the yarn size for the layers near the face (or sheet) side of the felt, producing a smoother, more planar surface. This design might be more difficult to keep clean than the current press fabrics.

*DuBois:* The chief design characteristic affecting cleaning technology is that of multilayered felts. Triplex and quad-layer felts generally function as better "filters" for retaining soils. The cleaning chemistry required for these dense felts has become more sophisticated; so has the art of their application, through knowledge of proper cleaning shower placements and water loading and balances.

Some felt designs with new fiber developments and weaves are running longer while performing better. But felt life is subject to so many variables, such as showering, cleaning programs, roll maintenance, and press nip loadings, that it is still too early to determine exact benefits. We are interested in seeing how effectively the new synthetic fibers repel or resist macro-soils and stickies contamination.

Regarding seamed vs. seamless press fabrics, DuBois essentially sees no differences in felt performance or cleaning approach.

*BetzDearborn:* BetzDearborn works closely with felt manufacturers and paper mill personnel, to better understand the design characteristics of the felts and how they perform on machines, and continues to develop new technology to assist in maintaining the available void volume. Laboratory tests are conducted using the latest synthetic materials to determine which chemistry and products are most effective at preventing and removing contaminants in felts. When washing a seamed felt, it is extremely critical in preventing seam damage that a thorough rinse is applied to remove any residual caustic.

No new challenges have been noticed recently with synthetic fibers.

*Constant Laboratories:* We have noticed that new synthetic fabric technologies have extended service life from 1–8 weeks if a proper chemical conditioning program is in place.

**TJ: What measures have you taken to deal with the increased use of recycled fiber in the furnish (e.g., stickies)?**

*Constant Laboratories:* Increased use of recycled fiber in the furnish results in a high percentage of stickies and other contaminates. On the basis of a thorough analysis of these deposits, our R&D department formulates fabric cleaners which minimize environmental impact and maximize operator health and safety.

*Buckman Laboratories:* It is critical to know where discharge from the Uhle box ends up. As water loops continue to close, we will see the reuse of more and more Uhle box and suction box discharge. Hopefully, the discharge will be cleaned to some extent. Stickies and other contaminants will pose a problem relative to felt filling. A consistent cleaning program will help. Solvent-based products certainly are effective. However, with the strict monitoring of VOCs, it is the supplier's role to provide products to the papermakers that are effective but do not contribute significant environmental impact. Solvent-based products, incorporating exempt or lower VOCs, are becoming a trend. Better yet, treating the source of the problem (before the press section) is the ideal method,

and should at least be considered first.

*ECC International:* Almost all of the shoe press installations in the containerboard industry are on machines running from 20–50%, or even higher quantities, of old corrugated containers (OCC), mixed waste, news, or a combination.

One of the most successful ways to prevent press-fabric buildup of recovered paper contaminants, such as latex and self-sealing adhesives (SBRs), is to set up a continuous felt conditioning program using solvent-emulsion formulated cleaners. These emulsions are most successful when applied very hot, 160–190° F, through fan showers located on the inside of the felt. Needle showers on the face side of a 5–6 oz/ft$^2$ heavy, multilayered press fabric do not penetrate to the base, at reasonable operating pressures.

Many OCC systems employ thermal dispersion of the stock, which "melts" wax from the surfaces of vegetable and meat containers. This wax remains in a dispersed state until the temperature in the water in which it is dispersed cools. In many cases, this occurs in press fabrics carrying sheet water away from the nip. This perfect "hydrophobe" coats yarns and resists transverse water flow. Even at low percentages of press fabric weight, wax can cause severe problems. Most successful programs to combat this problem involve using hot cleaning solutions. Good emulsification is also important to prevent reoccurrence of the problem, if water off of the press section is reused in the process.

*BetzDearborn:* Optimization of mechanical cleaning and screening is the first step in BetzDearborn's approach to stickies control in the felts. Back-system stabilization of contaminant particle size is often a viable treatment measure for increased recycled fiber usage. Stickies can be prevented from filling felts by means of solubilization and wetting while being removed at the Uhle box. By passivating the felts to prevent deposition of stickies, a change in the surface affinity of the fiber towards stickies occurs and the contaminants are emulsified for removal at the Uhle box.

*Houghton International:* Stickies will build up in the water system until it can no longer hold any more and they deposit out, usually on the wire or felt. The stickies are removed from the system by having them go out with the sheet. The sticky particle then needs to be rendered nontacky so that it will not stick to the forming fabric. Houghton International's approach is to apply a chemical treatment to the recycled fiber before it reaches the paper machine to encapsulate the stickies particles so they are no longer tacky. Good mechanical cleaning and screening of the recycled fiber is very important, as well as a felt cleaning/maintenance program.

*DuBois:* It is important to match the correct cleaning chemistry with soil types. Formulated press felt cleaners with detergent systems comprised of emulsifiers, polyalcohol solvents, detackifiers, dispersants, and anti-redeposition aids are particularly effective in removing stickies. However, it is not enough to keep the felts clean. The suction press rolls, grooved rolls, Uhle box lips, and other press elements must be kept clean to maximize water removal, prevent sheet imperfections, and avoid felt shedding.

**TJ: Are you seeing any change in performance of your products because of decreased use of water at some mills? How about the water quality?**

*ECC International:* Water quality is at the center of paper machine operations. Low hardness, low dissolved and suspended solids, chlorine-free, sterile and neutral mill water allows: (1) selection of a broad range of chemical cleaning compounds with few compatibility issues; (2) heating of chemical cleaning solutions without scaling, i.e., calcium carbonate formation; and (3) operation of shower nozzles without plugging or slime buildup.

Unfortunately, this water is rarely available, which means that the successful press fabric cleaning program must take all of the above factors into account. Treatment of process water with chelants, adjustments of pH, and filtration for removal of suspended solids are some of the strategies used to develop successful programs where water quality is an issue.

Showers on the press clothing represent a large share of the fresh water used on the paper machine. The only way to "close up" the mill is to eliminate fresh water flows or uses. In-plant process water clarifiers are being used today, and their use will be further expanded in the future. This presents major challenges to the chemist faced with developing strategies to convert this high solids (TDS) water into an effective cleaning solution.

*BetzDearborn:* As mills close up, white water is reused and fresh water usage is decreased. This results in an increase in cycle-up of felt filling contaminants that would previously have been discharged. A challenge for closed white water machines using secondary fiber is to find a nonsolvent-based solution to control recycled fiber contaminants. Solvents could also cycle-up in a closed system and aggravate the stickies problem. Felt passivation programs have been very successful at reducing solvent use.

If white water is used, it should be screened and fil-

tered to prevent large particles from plugging nozzles and felt void volumes. Many mills are using oxidizers to treat the fresh water for microbiological control. Free residuals of oxidizers could lead to felt fiber damage, felt hair shedding, and sheet quality problems.

*Houghton International:* Although mills are trying to reduce the amount of fresh water used, the felt cleaning showers should continue to remain on fresh water. Filtering recovered mill water does not provide the quality of water needed in the cleaning showers.

*DuBois:* Water quality has always varied across North America, according to fresh water source, seasonal changes, degree of mill closure, and the type of water filtration or treatment of recycled water. Our felt cleaners and conditions are formulated to negate the deleterious effects of water hardness ions, transition metal ions, high dissolved solids and even many organic constituents. However, most recently we have experienced machine systems which are "totally" closing the press section water cycle. Press filtrates are being captured, filtered, and then recycled for wet-end use, instead of being sewered. This type of closure dictates the chemistry used in formulating cleaners to overcome concentration increases in dissolved calcium, magnesium, aluminum, etc., along with the type of procedure used to effectively clean felts.

*Constant Laboratories:* With today's closed-water-loop pulp and paper operations, the use of biodegradable fabric cleaners and conditioners is very important. Clarified and recirculated water must be of good quality for chemical showers.

**TJ: What, if any, role will enzymes play in your product mix?**

*Buckman Laboratories:* Enzymes are certainly playing a big role in R&D of products for several types of applications in the pulp and paper industry, and are being used successfully for starch system boilouts and for other cleaning applications. Various enzymes have been found effective to clean felts. If an enzyme can be used in place of caustic or acid, and the cost can be justified, then the use of an enzyme may be the best product choice.

*ECC International:* Enzymes selectively change the structure of large, naturally occurring molecules such as lignin and cellulose. They will have many interesting roles in the paper industry. However, the dynamics of press fabrics make them less promising here than in other areas such as mechanical pulp pitch control. The reason for this is that enzymes require more time to react than is generally available.

*BetzDearborn:* Research using enzymes to improve dewatering characteristics of recovered paper appears promising. Current research is being conducted to pursue applications using enzymes as general deposit and microbiological control mechanisms. Felt cleaning and press section optimization need to be viewed in the context of the entire papermaking system. The current state of research indicates that enzymes are better suited to wet-end addition rather than direct application to the press felts.

*Houghton International:* Enzymes are still not a part of cleaner formulations. The dwell time of the cleaner on the fabric is not great enough for the enzymes to do their job. The use of some solvent, caustic, or acid would still be needed in cleaner formulations so any enzymes considered would have to be active in this environment. The high pH or solvent concentrations that are used will denature or deactivate most enzymes; those that would be effective in the cleaner environment are still too cost prohibitive to be used.

*DuBois:* Since DuBois was founded in 1920 as a soap company, we have maintained expertise in cleaning chemistry to date with the newest technologies including enzyme cleaners. However, for press felt cleaning (and machine cleaning as well), we see limited practical application for enzymes, due to the short duration of dwell time of cleaners in the press section. Since enzymes are also substrate specific, complex soils accumulation due to water system closure and recycled fiber use also make enzyme cleaning less likely to be effective. Instead, we see enzyme use in the fiber prep areas for pitch control, pulping aids, pulp bleaching assistance and in the waste-water treatment areas, along with our bioremediation programs.

*Constant Laboratories:* Our biotechnology research group continually evaluates enzymes and their potential for fabric cleaners. These products are at an early stage of development.

**TJ: What tools/reports can a papermaker expect from a supplier to justify investments in a felt cleaning program?**

*Constant Laboratories:* As a supplier of felt-cleaning specialty chemicals, it is very important for us to have thorough analysis of white water, shower water, and fabric deposits.

***A lab technician prepares the wet press felt for physical testing. (Courtesy of DuBois Paper Technology).***

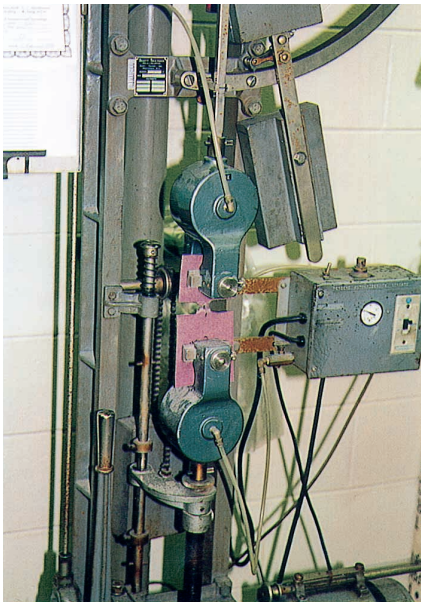
Results of these analyses will guide us in our fabric cleaning program recommendations.

*ECC International:* Felt cleaning programs consist of the mill capital commitment to pumps, piping, flow meters, showers, Uhle boxes, DCS tie-ins, etc. Cleaning chemicals represent a recurring expense that is a part of the direct cost of making a ton of paper. To justify this expense, the papermaker must either reduce other direct costs, such as dryer steam requirements, or produce more paper, which generally reduces all of his direct costs except materials.

Some of the reports which the mill generates related to these factors include: grade-related tons/h; grade-related lb steam/lb paper; wet-end breaks, minutes/week or day; reject and broke experience; unscheduled downtime related to press clothing; and felt life.

Some of the reports that ECC International provides the papermaker include: water permeability, measured on-line; Uhle box and press save-all pan weir flow patterns; Uhle box vacuum patterns; chemical cleaner/conditioner cost per ton; and laboratory reports on felts removed from the paper machine detailing the chemical nature of the contamination in the felt, caliper, weight loss, air permeability, etc.

*BetzDearborn:* A good monitoring program and service report should provide qualitative data that demonstrate the performance and effectiveness of the felt cleaning program. The supplier and papermaker should have clear performance objectives and criteria for success (CFS). The tools and monitoring program should track boundaries related to the CFS as well as other key factors that will affect performance of the press section. Typical measurements taken, and instruments used, include: FeltPerm®, Scanpro®, or PressTuner®; Uhle box vacuums, Huyck-Smyth porosities, felt analysis, and grab samples.



***Tensile strength testing helps to identify unusual felt wear patterns. (Courtesy of DuBois Paper Technology).***

The TAPPI Technical Information Sheet, TIS 0404-19, provides a good summary of tools and procedures for monitoring press section performance.

*Houghton International:* The supplier should know the mill system well enough to provide valuable product and application recommendations. A machine survey including a water balance and felt extractions should be part of a practical approach to a felt cleaning program. The cleaning program should provide tangible results, such as extended felt life or increased production, that can be equated to dollar savings or earnings. The use of an instrument such as the FeltPerm® can provide immediate results on the effectiveness of the cleaner in removing contaminants and improving the profile. Data should be taken by the supplier over the life of the felt to fully equate the dollar value of the program.

*DuBois:* Papermakers rely upon service companies to implement and monitor the felt cleaning programs and expect to receive detailed reports from their vender/service companies with regard to both press performance and product performance. It is not enough to perform the felt cleaning alone. Press performance must be monitored, analyzed, recorded and discussed with mill staff in order to correlate efficacy with machine runnability, sheet quality and determination of program ROI. This is extremely critical in the development of new grades, varied wet-end operation, or influences from environmental and safety regulations.

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