New Developments in Roll Cover Embedded Systems

Latest innovations in SMART® Technology measure multiple nips and MD nip width, even on shoe presses.

By Eric J. Gustafson

Paper producers have used embedded sensor technology in roll covers for several years to improve process efficiency. Initially, these systems were sparsely used, but in just a few short years they have become commonplace with many mills employing multiple systems to monitor different parts of their process. This rapid growth is a testament to the value derived from these systems.

Armed with accurate, real-time nip performance knowledge, operators can adjust operating parameters and make corrections. These systems have quickly identified improper cover crowns, biased loading, and uneven roll cover wear resulting in reduced costs through extended cover and clothing life, reduced downtime, lower raw material consumption, and reduced energy costs. Embedded sensor technology is field-proven and providing documented results.

THE EVOLUTION OF EMBEDDED SENSOR TECHNOLOGY

Advanced embedded systems now have the capability to include double-nipped applications and machine direction pressure measurement. Previous versions would not perform in covers with two mating rolls — a critical application. Clusters of rolls deployed in paper making machinery create challenging interactions between the various rolls in the cluster. These interactions must be managed for efficient performance. The stiffness, crown, vacuum level, clothing tension, and loading of each roll affect the deflection of every other roll in the cluster. For this reason, irregular loading problems originating from roll clusters are often difficult to diagnose and resolve.

Advanced embedded systems now also provide machine direction data. Three-dimensional measurement of press nip impulses enables the total optimization of nip performance. This three-dimensional nip knowledge is essential to simultaneously maintain cross machine quality and improve pressing effectiveness.

DOUBLE NIPPED APPLICATIONS

Two supercalender applications illustrate the double nipped capabilities. The first application is employed in a machine producing coated paper with the sensors embedded in a Genesis AP composite supercalender roll cover loaded to 315 – 385 kN/m (1800 – 2200 pli). The SMART® roll has run in all three covered positions of this stack (**see Figure 1**).

The mill's production process suffered from three recurring problems: hard edges on the calender reel, impression defect at the tending side quarter point, and a loading bias that frequently required higher drive side actuator loading.

With the embedded sensor system installed in the top covered roll position, it monitors the pressure profile of Nip 1 and Nip 2 — the first two nips the paper passes in the stack. **Figure 2** shows two profiles of Nip 2. The profile labeled "Swim Roll – No Crown" shows high loads at the sheet edges that occur with uniform hydraulic pressure across the queen roll. By reducing the crown in the queen roll, the mill is able to decrease the edge loading and flatten the profile as shown by the blue line labeled "Swim Roll – Crowned". The mill uses this feedback with the crown-adjust feature to control the hard edges and build a uniform reel.

The sheet impression defect occurred at the front quarter

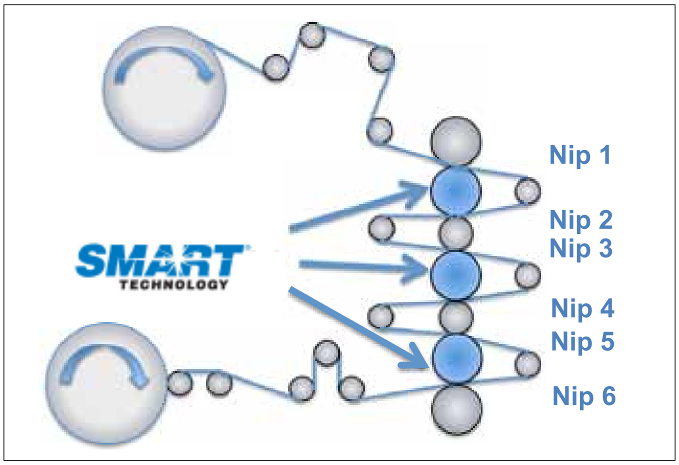

Figure 1

point. This defect could be seen in the paper but was not easily felt. Diagnosing its source from the cluster of calender rolls was challenging. By installing SMART technology in the bottom covered position, the mill was able to monitor the profile of Nip 5 and Nip 6. **Figure 3** shows synchronous pressure profiles of these two nips. A single embedded sensor array measured the profiles shown in Figure 3. This single array measured a localized low load region corresponding to the recurring paper impression defect. This localized low load region appears in Nip 5 but not in Nip 6 despite being synchronously measured by the same sensor array. Once the defect's origin was identified, the mill ground the questionable roll, eliminating off-grade paper and reducing waste.

A third issue for this calender is a load bias. Typically, the drive side must be loaded more than the tending side to produce a uniform profile. This condition, however, can change during machine operation. Without profile feedback, the mill must use reel spool hardness measurements as the log builds to recognize a correction is required.

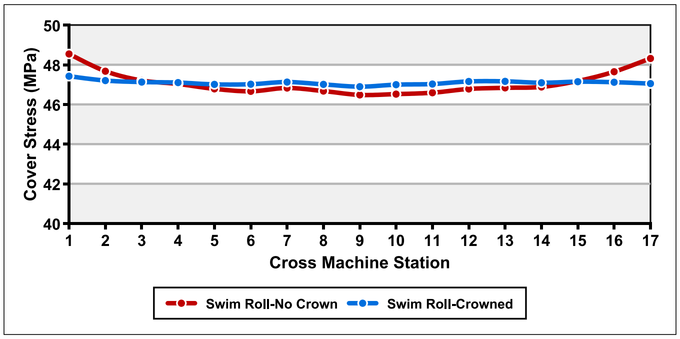

Figure 2

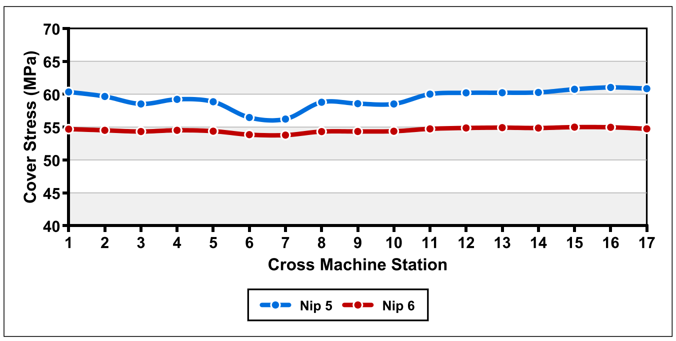

Figure 3

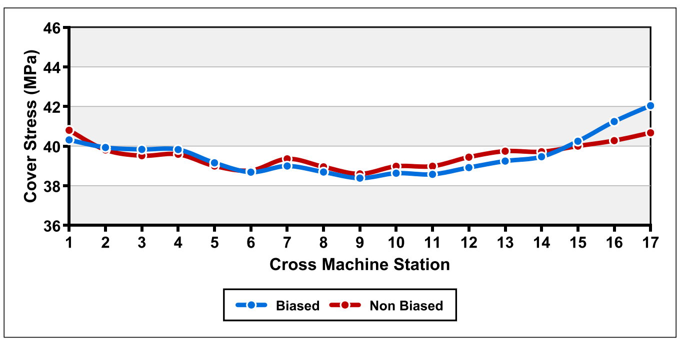

Figure 4

SMART technology provides instant feedback. As an example, **Figure 4** shows two pressure profiles measured in Nip 1 less than 24 hours apart. Both profiles show an under-crowned loading condition intentionally used to control hard edges. The profile labeled "Biased", however, shows a bias load in addition to the under crowned condition. The end-to-end pressure difference of the unbiased profile is 0.3% while the end-to-end difference of the biased load is 4.2%.

With instantaneous profile feedback, operators can easily control the reel build. Prior to using embedded technology, the mill measured the reel hardness profile by hand with a portable meter. This process created a feedback delay as the hard ends could not be detected until a certain amount of off-caliper paper was wound. Then the operator would over compensate the loading on the yet-to-be-wound paper to compensate for the paper that had already been wound. With the embedded system's instantaneous feedback, the mill omits the feedback delay, has better control, and can more efficiently build the spool. Waste caused by winding defects is reduced.

The second application is employed on a machine producing wood-free coated paper at 685 mpm (2,250 fpm). Sensors are embedded in a Stowe Woodward Genesis XT calender roll cover loaded to 360 kN/m (1750 pli). With the composite covered SMART roll located in the fourth position, which is the bottom double finisher, it can simultaneously measure its nip to the cotton roll above it and its nip to the metal roll below it (**see Figure 5**). Along with the pressure profile, the embedded system monitors the standard deviation of the pressure loading.

Cotton rolls require frequent maintenance because their surface degrades and requires refurbishment. The SMART roll cover detects this degradation by means of an increased standard deviation in the pressure profile. **Figure 6** shows the coefficient of variation versus time for the cotton/composite nip and the metal/composite nip. COV is used in this analysis to eliminate the load levels between these two nips. The data show that the cotton/composite nip pressure varies slightly more than the metal/composite nip throughout the run, but

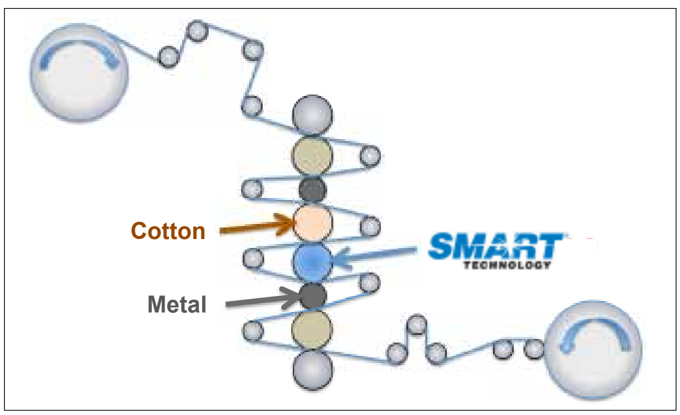

Figure 5

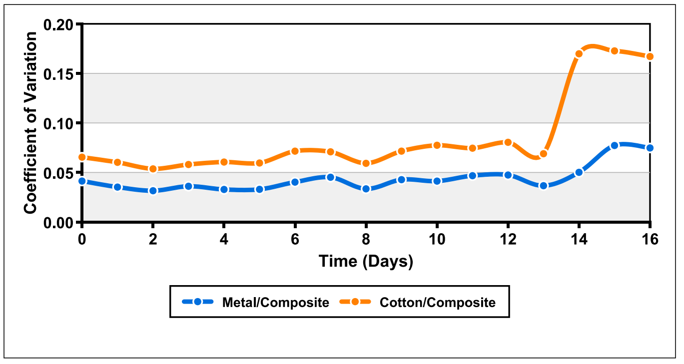

Figure 6

as the run time approaches a couple weeks, the COV for the cotton/composite nip rises dramatically. This degradation is not gradual, but progresses rapidly once started. The effects of the degrading cotton roll also adversely affect the metal/composite nip as its COV rises simultaneously, albeit not to the level of the cotton/composite nip.

This finding enables the mill to use the embedded system to monitor the performance of the cotton calender rolls and to efficiently plan their removal for refurbishment.

THREE DIMENSIONAL DATA

While the desired cross machine profile maintains quality, the machine direction profile determines pressing effectiveness. The machine direction pressure profile between nipped rolls has several characteristics that determine the nip effectiveness. One characteristic is the peak pressure. If the peak pressure is too high for a given paper grade or position within a machine, sheet crushing, sheet densification, felt compaction, and other non-desirable effects occur.

A second characteristic of the machine direction pressure profile is its width — the nip width. Nip width is an important dewatering parameter for many paper grades. When considered together, these two characteristics can provide additional insight. For example, an observed increase in nip pressure could be an indication of a load increase or it could be an indication of a system (cover, clothing, paper web, etc.) stiffness change. By considering the corresponding nip width change, the observer can be certain of the cause.

For the first time, SMART 5.0 provides functionality to measure and report the shape of the impulse curve in real time. **Figure 7** shows an example from a size press nip. The combined peak and nip width increase confirm a load increase on the tending end.

Shoe press nips also have opportunities for optimization. While the shoe press nip width is defined, the machine direction profile may vary and affect performance. Unlike the nearly symmetrical shape of a roll pressure pulse, the shoe press pulse is asymmetrical and may contain multiple localized pressure peaks. An improper fit between the roll diameter, clothing caliper, and shoe arc may lead to these inefficiencies.

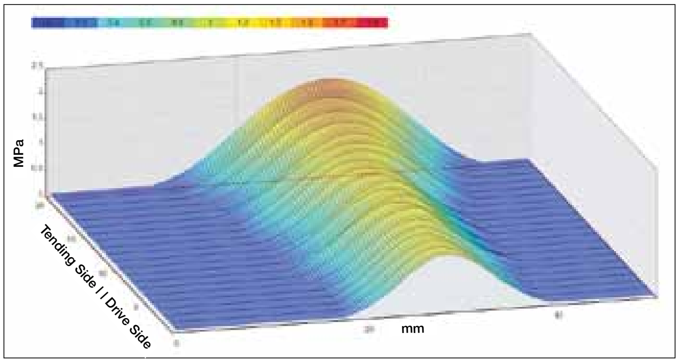

Figure 7

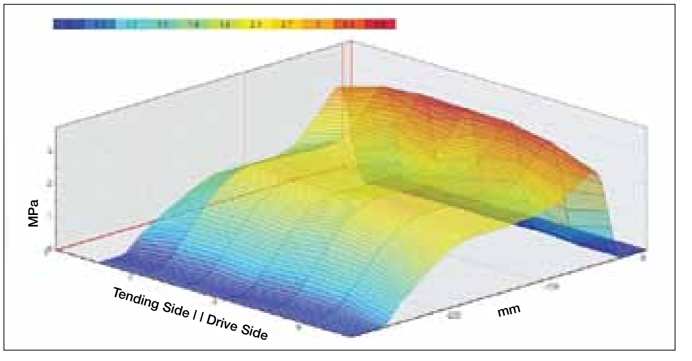

Figure 8

Some shoe presses are equipped to control the pressure ramp rate and machine direction location of the peak pressure.

SMART 5.0 embedded sensor systems have been deployed for shoe press mating rolls to identify these inefficiencies. One such system was installed in a board machine shoe press running 1000 mpm. The nominal press load is 875 kN/m. **Figure 8** is a plot of the data collected from this system.

The plot shows a slight drop in pressure on the tending side. In the machine direction, the pressure ramp is not excessive showing a peak near the trailing edge of the shoe. The lack of a localized peak near the shoe center and the lack of dual peaks at the entrance and exit of the shoe indicate the roll diameter, machine clothing, and shoe arc are compatible.

SUMMARY

With over 325 SMART Technology orders around the world, this unique system has already delivered millions of dollars of documented savings. Now this technology has made the next technological breakthrough with SMART 5.0. These enhanced systems can distinguish between the two pressure profiles on covers with two rolls mated against them and can provide three dimensional pressure mapping for pressing applications. Further capability enhancements for SMART Technology are already underway.

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