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Dynamic three-dimensional Nip Impulse Measurement enables real-time Insight of Nip Conditions

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Three-dimensional measurement of the dynamic press nip impulse enables the optimization of press nip performance. This three-dimensional knowledge is critical to simultaneously maintain cross machine quality and improve pressing effectiveness.

Paper machine operators have long recognized the detrimental effects of cross machine nip pressure profile variations and have used tools such as roll crowns, biased loading, and crown compensating rolls to improve nip profile uniformity and avoid these detrimental effects. To make informed decisions and effectively use these profiling tools to compensate for nip variations, the machine operator must first have accurate feedback regarding nip conditions. Embedded sensor systems have been developed to provide the best feedback possible: cross machine, dynamic, real time data.

While the desired cross machine profile maintains quality, the machine direction profile controls pressing effectiveness. The varying machine direction pressure profile between nipped rolls has several characteristics that determine the effectiveness of the nip. 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. Not only are these characteristics important when considered independently, but the combination of peak pressure and nip width offers additional insight. An increase in nip pressure is an example of a situation where the combined knowledge is beneficial. By itself, an increase in nip pressure may be difficult to interpret. It may indicate a linear load increase but it could just as easily indicate a stiffness increase in the system composed of the roll cover, felt, and paper mat. A system modulus increase can occur from events such as cover grinding, cover hardening, felt compaction, and increased paper web fluid content. By simultaneously knowing the peak pressure and nip width, the operator can discern the source of the change and work to accommodate it.

Shoe press nips as well have opportunities for optimization. While the shoe press nip width is defined, the machine direction profile may vary and affects performance. Unlike the nearly symmetrical shape of a roll pressure pulse, the shoe press profile is asymmetrical and may contain multiple localized pressure peaks. An incorrect roll diameter or felt calliper may lead to these inefficiencies. Some shoe presses have the capability to control the pressure ramp rate and machine direction location of the peak pressure. Embedded sensor systems have been developed for shoe press mating rolls to identify these inefficiencies.

From a practical point of view, every paper machine contains a pressing environment comprised of many interrelated factors. These factors include but are not limited to: nip pressure, dwell time, nip impulse, felt and roll void volume, Uhle box capacity, nip and Uhle box dewatering, doctors and cleaning systems. The proper combination of roll cover and paper machine clothing design is critical to the success of

dewatering the sheet in the press section. The press section must be considered as a whole and not only as a conglomeration of individual press nips. Through the selection of the right cover and press clothing properties, the papermaker ensures that the press section sees the correct combination of incremental and peak pressures dependent upon paper grade and press design.

Each grade of paper produced has a signature pressing environment in which an optimized peak pressure range has been established. Knowing this range of optimized peak pressures the SMART 5.0 nip width system will be utilized as a practical engineering tool to ensure the press section continues to operate within this designed peak pressure range. In the past, prior to the invention of SMART technology, this was possible only through analytical modelling based on inputs from the roll cover, clothing, and machine parameters. With SMART 5.0 the papermaker will be able to determine in real time under dynamic operating conditions whether the press nip is performing at peak optimization levels by observing the peak pressure output range as a function of nip width.

This paper describes a breakthrough embedded sensor system with the ability to measure the nip width of a roll cover, which to date has not been accomplished. This is a significant breakthrough in dynamic nip measurement because it paves the way for real time engineered nip solutions. This information is utilized to engineer a press nip through the use of a mathematical model based upon nip width, pressure, and application experience.

While previous state of the art embedded systems provided the ability to embed sensors in every roll cover material and application throughout the paper machine, the newest generation now allows intelligent usage of machine direction nip width data, which leads to the ability to optimize the press section for sustainable, continuous paper machine efficiency.