ANDRITZ Küsters
Technical paper: Paper and board production

Comparison of internal and external profiling systems to control cross-direction (CD) thickness profile

Author: Hans-Josef Reiners of ANDRITZ Küsters

1. EXTERNAL PROFILING

The operating principle requires a heating unit that exposes specific areas of a roll to thermal energy. When the roll rotates during production, a ring of metal heated to a very high temperature is generated. The resulting thermal expansion increases the diameter of the roll in the specific area. As a result, the gap between the two mating rolls at this point will narrow slightly, causing densification of the web. By including many heating elements, it is possible to influence the cross-direction thickness profile of a web passing through the roll gap.

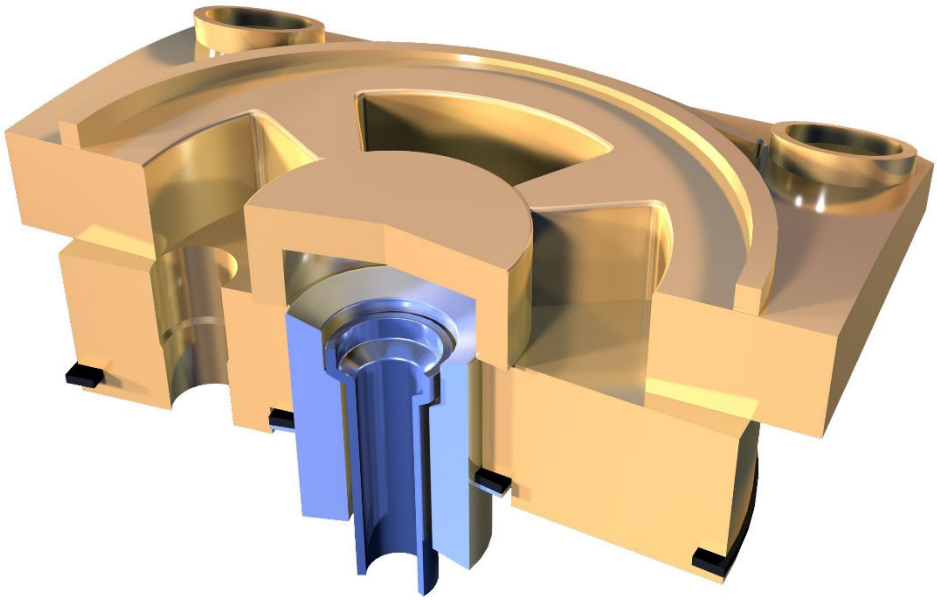
2. INTERNAL PROFILING

*Prime*Roll MHV by ANDRITZ

Unlike the indirect mode of operation described above, an internal profiling system acts directly on the roll shell, adjusting the shape of the roll by means of hydraulic pressure. A row of pistons is arranged in a line, pointing in the direction of the nip. When the rotating roll shell reaches a piston, this piston can deflect the roll shell in the direction of the nip.

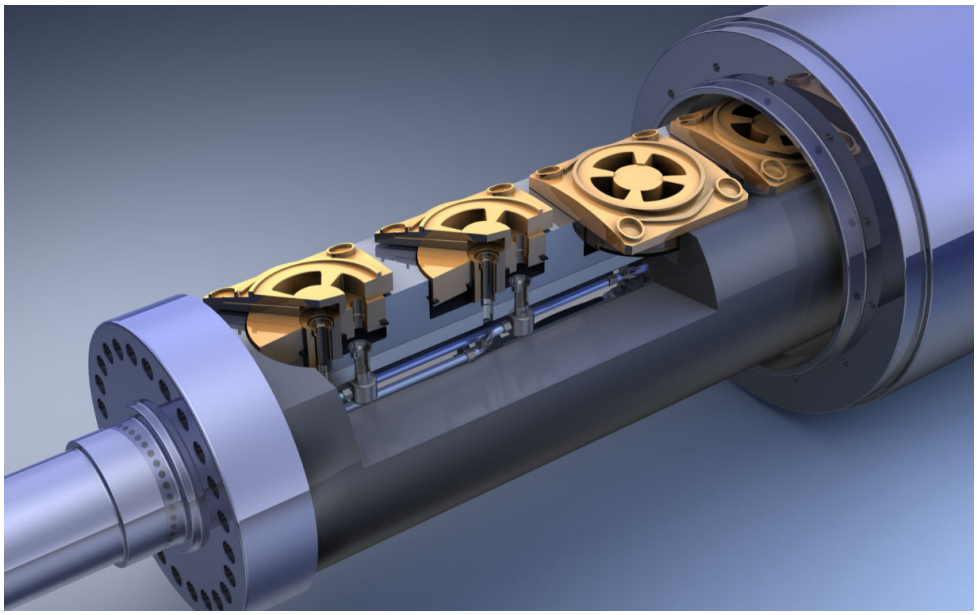
The degree of deflection can be defined separately by hydraulic pressure for each piston in the row. A control system that can be connected to the Quality Control System (QCS) calculates the values needed. Thus, a correction of the CD thickness profile is achieved either in a closed-loop procedure or manually, depending on the requirements of the operators.

There are various systems on the market to retract the roll shell from the nip, thus widening the gap between the mating rolls and allowing thicker material to pass through.



Single MHV element inside *Prime*Roll

ANDRITZ balances the piston pressure against pressure from a ring chamber, a competitor uses one additional row of counter-pistons pointing 180° away from the nip, while another competitor uses two additional rows of pistons pointing plus and minus 120° away from the nip, respectively. To reduce the control effort for the overall system, some pistons in non-critical areas may be connected to one supply line only, i.e. these pistons can be operated in groups.



Single element-controlled *Prime*Roll MHV technology by ANDRITZ to create state-of-the-art CD profiles.

DECISIVE PARAMETERS

The ultimate goal is to improve the 2-sigma, cross-direction thickness profile. Any interfering influences stem from upstream production processes, like the headbox, press or coating section. The best approach would be to eliminate the problems there, however, the restrictions within the production line may not allow this.

MINIMUM SETTING WIDTH OF THE PROFILING SYSTEM

Sometimes the thickness deviations are located close to each other; in this special case, the minimum setting width of the CD profiling system should be small. For both internal and external profiling systems, there are certain limiting factors to be considered. External systems have constraints for their electric heating unit. The more thickness deviations have to be balanced, the more heating elements have to be combined. Each heating element has a certain effect, which means that several elements must be connected in order to achieve a greater impact. This jeopardizes resolution as there are

no sharp boundaries between the single elements; each element will have some minor influence on the neighboring zones.

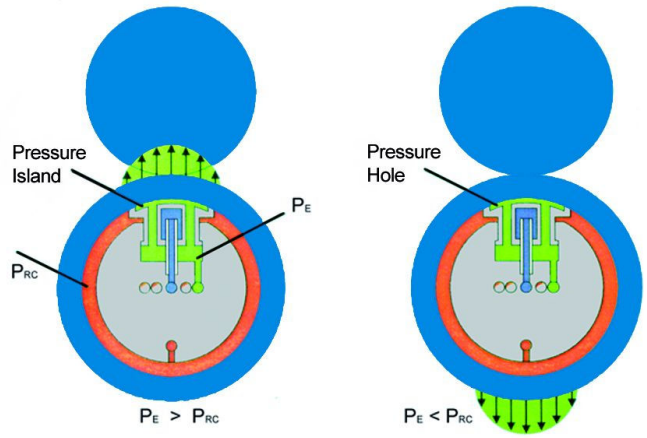
With internal profiling systems, it is tempting to take the diameter of the pistons or the distance between two pistons as the minimum response width. However, adding neighboring pistons to the control system in both directions is state of the art for all suppliers. Accordingly, the minimum setting is less than the distance between the pistons.

Moreover, compressibility of the web and the tendency to expand after compression are important values for the papermaker. Hence, the right scale to measure the paper quality is not the diameter of the pistons but the expected 2-sigma value at the pope reel.

NUMBER OF PISTONS

The mere number of pistons is easy to compare. However, it goes without saying that only the pistons pointing in the direction of the nip should be counted. There are systems available on the market that also use pistons pointing away from the nip. These pistons are used to retract the shell from the nip and open the gap between the rolls at this point. This approach supports the roll shell twice during one revolution (at 0° and 180°), with some elements pointing at the nip and others pointing in the opposite direction. The ANDRITZ method uses a ring chamber and hence, no counter-pistons are needed, whereas the previous approach causes ovalization of the roll shell, which results in bending stress and increases the required drive capacity. For the sake of completeness, it is important to mention that there are also systems available that split the force between two counter-cylinders retracting the shell from the nip. This approach reduces negative ovalization of the roll shell slightly because the roll shell is supported every 120°. However, ovalization is still experienced.

The ring chamber supports the shell continuously round the entire circumference, and only the area of the pistons is separated from the pressure in the ring chamber in order to control the paper profile.



*Prime*Roll MHV principle

Higher pressure deflects the roll shell in nip direction (P_E>P_{RC}), whereas lower pressure retracts the roll shell (P_E<P_{RC}).

Hence, the number of pistons is not helpful in comparing the effectiveness of internal profiling systems. The expected 2-sigma value at the pope reel is the better scale for this purpose.

It is also important to mention that increasing the number of pistons results in a smaller piston diameter, so less force can be applied to deflect the roll shell and this, in turn, diminishes the desired effect. Hence, the pistons must have a certain diameter to allow sufficient deflection of the thick roll shell, and this diameter is provided with the well-proven ANDRITZ method.

PRODUCT QUALITY

Following the laws of physics, the most prominent parameters for calendering are nip load and temperature. One of these critical parameters, the temperature, is used by the external profiling system as the actuator. Subsequently, the web suffers from an uneven CD temperature profile. This can have an impact on quality, and glossy streaks may

appear. As a result, the negative effects must be weighed up against the lower investment costs.

RESPONSE TIME

Depending on the mode of operation of the OCS systems, the scanners move across the web while it is running at production speed. The scan shows a zig-zag pattern. For any deviation in machine direction, the respective position must be measured several times. This itself requires a certain amount of time. In addition, the external profiling systems also need time to heat up. In contrast, internal profiling systems have, by their very nature, a fast response time. The hydraulic pressure is changed, and this has an immediate impact on the shape of the roll shell.

ENERGY CONSIDERATIONS

External profiling systems are cooled by the web as it travels through the nip. In order to maintain the required roll profile, heating energy must be supplied to the system continuously. Internal profiling systems require less energy because the roll shell profile is generated more effectively.

For further information, please contact us at paperfinishing@andritz.com.