PrimeRun Evo: a new approach for energy saving and paper web stabilization in the drying section

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Introduction

The efficiency of a paper machine mainly depends on the good ability of paper web transfer through the drying section. Today, not a lot of attention is paid to the impact that a machine's runability in the drying section has on efficiency and energy savings. Suppliers are concentrated more or less entirely on the forces that provided even running, without taking optimization and energy consumption into consideration. The energy demand for runability of the paper machines are considered not important or even minor compared to the overall energy demand of the production process. As a result, many paper machines worldwide have been equipped with runability solutions ("boxes") that are very energy intensive. Sustainable development of paper machines should give more attention on optimizing runability solutions in the sense of decreasing material costs as well as energy consumption. Runability solution is not only the "box" that should be filled with as much air as possible ("to be sure") and left in the machine, but should be a tool for increasing efficiency and energy saving.

Sustainable development in paper making means continuously development of products and processes to make them more efficient, energy and cost acceptable and customer friendly. Usually some processes in papermaking like runability are obviously underestimated. The reason is lack of knowledge and ranking energy saving processes to "important and less important". The recently published book by Dr. Juha Leimu "The paper machine cylinder opening nip, LAP LAMBERT Academic Publishing" is actually showing the complexity of this subject.

Step-by-step is the key to success

The most widely used runability concepts for higher performance paper machines are based on controlling the web in free draw by including two main zones (Figure 01), which are separated by a sealing material. The zone 1 uses a high vacuum (release zone) for controlling the web after leaving the drying cylinder and a zone 2 uses low vacuum (stabilization zone) for controlling the web in the free draw between two cylinders in the single-tier drying configuration.

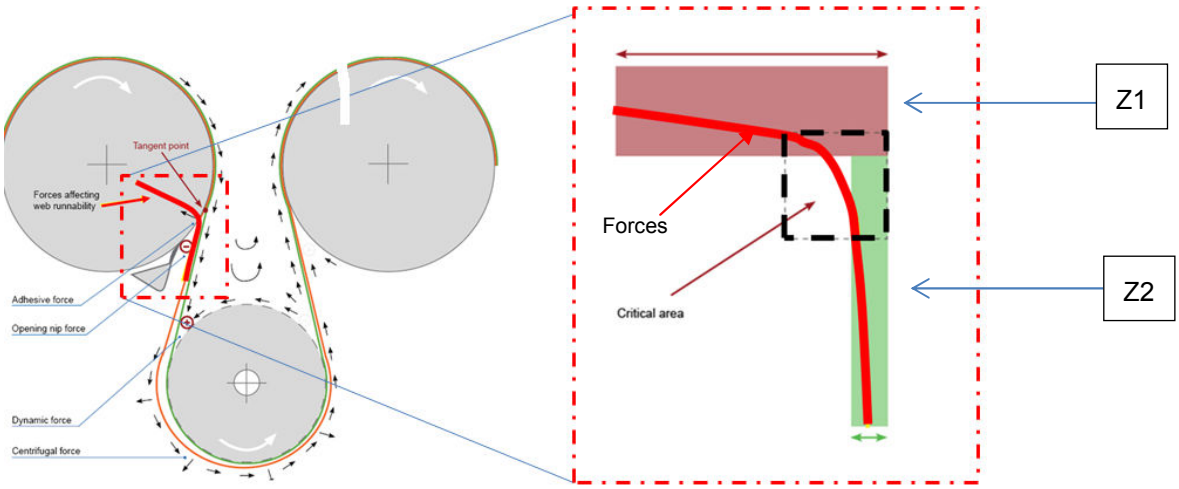

Figure 01: Forces that affect web behaviour

The two zone model solutions can cause high pressure differences between the zones as well as high fabric bending. Uncontrolled processes can cause mechanical damages of the sealing fabrics and instability of the web. The box performance is decreasing and energy consumption is increasing when mechanical damages occur.

Another issue is the high energy consumption to control web stability in solutions with creating indirect underpressure (ejector models). Andritz has considered both issues in the light of customer feedback and tried to offer customers an optimized solution that can provide good runability together with low energy consumption. The new runability solution, PrimeRun Evo, uses the operating principle of gradually reducing the vacuum applied in order to stabilize the web in the dryer pocket. (Figure 02)

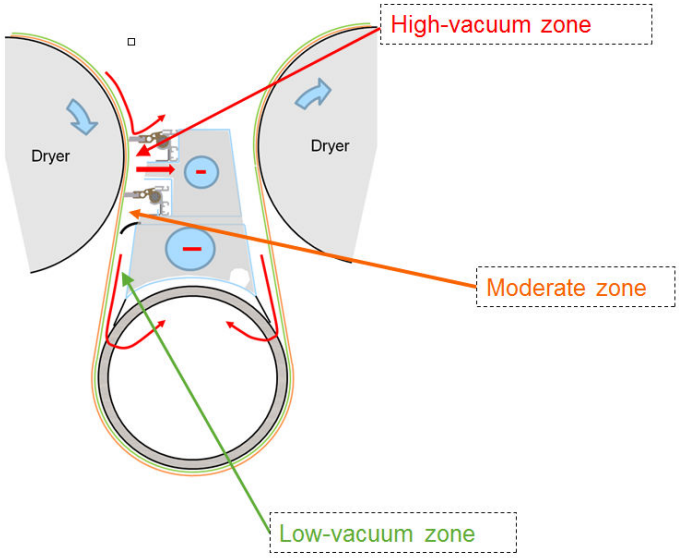

Figure 02: Working principle of three zone PrimeRun Evo model

The main principle of the new PrimeRun Evo runability solution is to divide the free draw (paper path from top drying cylinder to bottom Vac roll) into three different zones depending on the vacuum needed to neutralize the forces and stabilize the web. The negative forces on runability decrease in line with the distance from the opening nip (Figure 03).

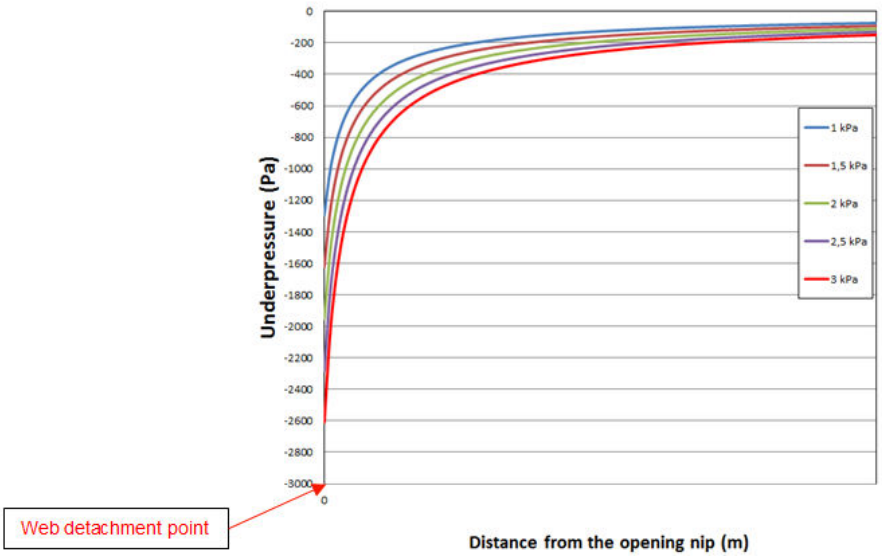

Figure 03: Underpressure distribution as a function of distance from the opening nip and box underpressure (Juha Leimu, The paper machine cylinder opening nip, LAP LAMBERT Academic Publishing)

At the same time when forces decrease the fabric bending is increasing with distance from the opening nip, (Figure 04). The optimization is needed to define boundary conditions for the high-underpressure release zone.

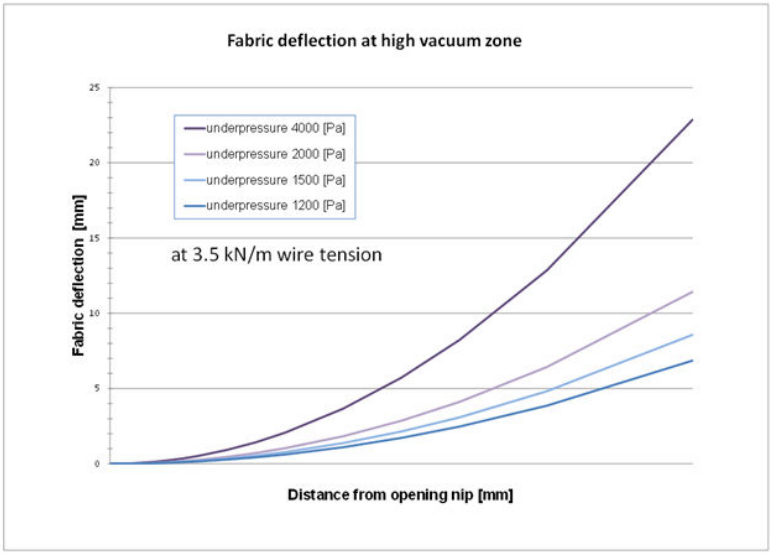

Figure 04: Fabric deflection at high vacuum zone

By gradually eliminating negative forces where they are weakest and restricting them to the zones of high vacuum, moderate vacuum and low vacuum, web stability can be better controlled and energy can be saved. With the principle of gradually reducing the vacuum, it is possible to support the web fully in the drying pocket and achieve good paper machine runability with less vacuum and lower consumption of air and energy.

CFD, (Computational Fluid Dynamics) analyses for different sealing models

The sealing's type and right position of the sealing are of the most importance for a good performance of the runability devices. Different sealing are on the market these days, to divide high release zone from low vacuum zone. In order to find the optimal solution for the three zones PrimeRun Evo runability box, a CFD for different sealing is simulated. Figure 05 is showing boundary conditions for CFD model.

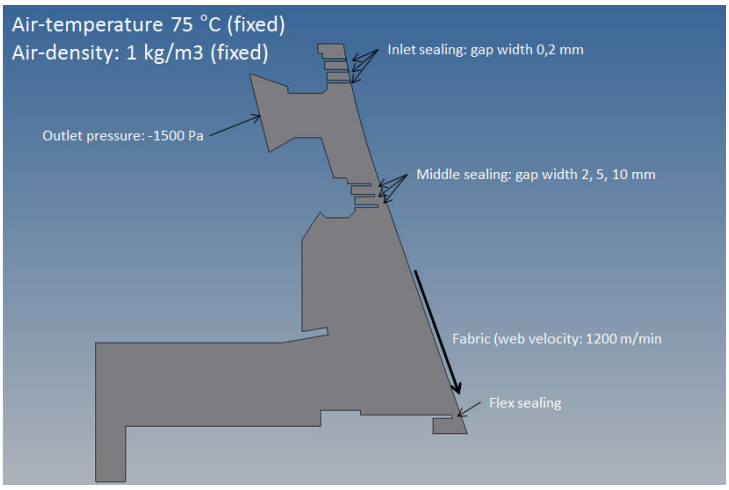

Figure 05: Boundary conditions for the three zone model

Two different sealing types have been used in the simulation. The first type is a labyrinth sealing with three Teflon slices; the second one is a single slice with different thicknesses. The results of the simulations are showing a strong influence on the pressure drop of the labyrinth sealing as a function of increasing distance from the fabric. At a distance higher than 2 mm the labyrinth sealing is losing function of partial pressure reduction and acts as one slice sealing. For the sealing with only one slice, the thickness of the slice sealing is playing a significant role. The results of the simulations are given in Figure 06.

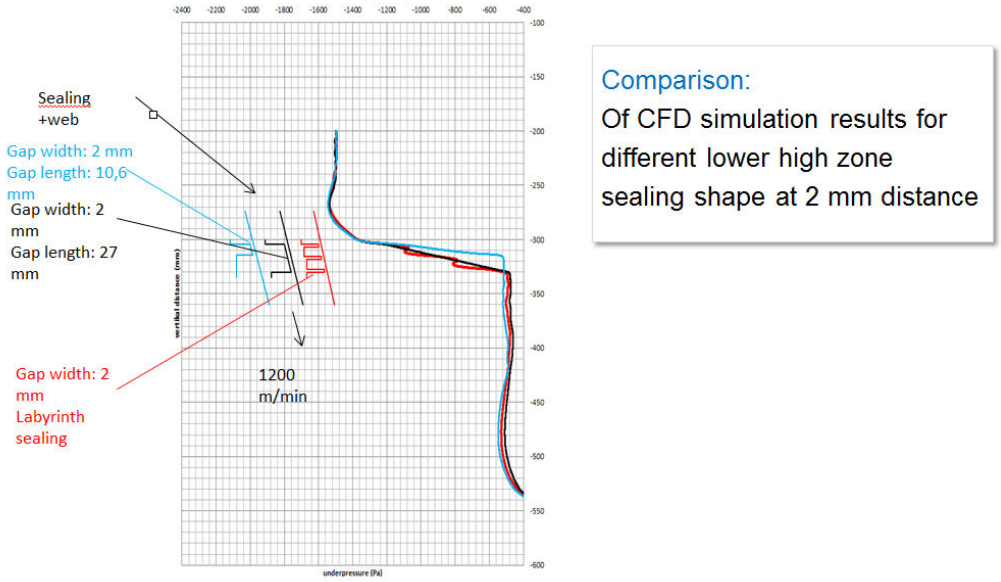

Figure 06. CFD simulation results for the three different sealing (labyrinth sealing with 3 slices, single sealing 10 mm and single sealing 27 mm width)

Profitability and energy savings

The results from industrial applications show that consumption of energy and air can be reduced by around 50%. (Figure 07)

The PrimeRun Evo concept is already successful in operation. Some of the benefits are:

- Speed increase achieved: +3,5%; potential to reach +5%
- Draw reduction from press to dryer section: -10% (at higher speed)
- Trend of down-time: no increase at higher speed
- Shorter time of grade change: -20%
- Fabric lifetime: unchanged

Figure 07 shows energy consumption and maintenance/spare parts costs comparison between the new PrimeRun Evo concept and two existing conventional systems used in paper industry. Base for the comparison is a system that has either highest energy consumption or maintenance/spare part costs.

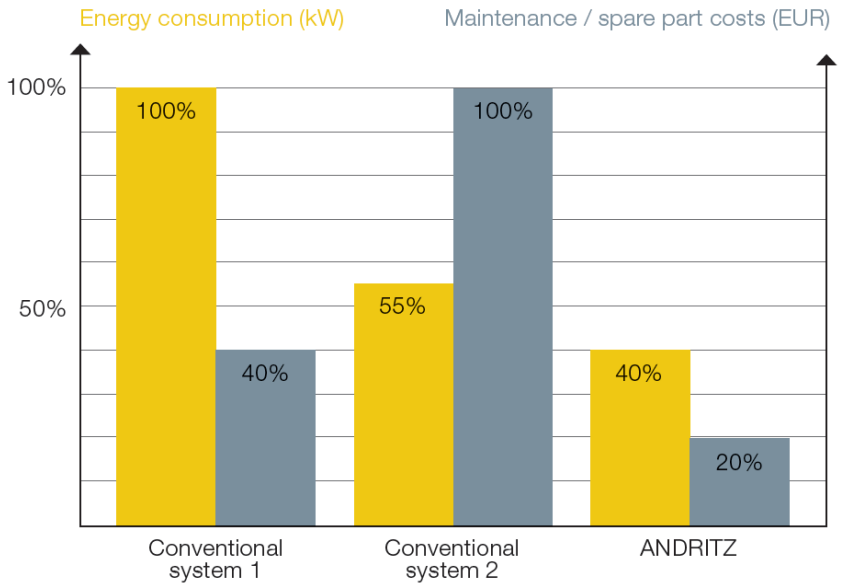

Figure 07: Energy consumption and maintenance/spare parts cost comparison

Conclusion

With the new generation of PrimeRun Evo runability solutions which are using gradual reduction of vacuum, new possibilities are emerging for good web control hand in hand with a reduction of energy consumption in paper machines. The PrimeRun Evo concept has been designed for universal use in new machines, for the rebuild concepts offered by ANDRITZ and also for all other machines on the market.

Literature

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