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ACA Permi Online Porosity Analyzer for Optimization of Paper Production Process, and Calendering control by ACA RoQ Roll Hardness Profiler.

Jyrki Laari, ACA Systems Oy

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System configuration, online porosity analyzer



Control Unit



Measuring Unit

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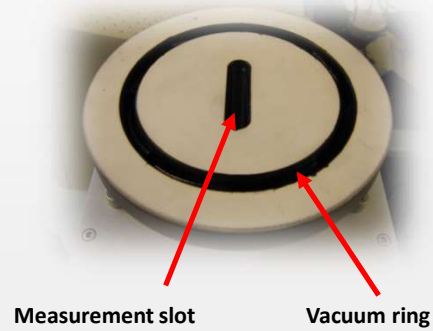
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Measuring head

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- Durable and low friction coating against paper web.
- Outer vacuum ring with a separate vacuum control prevents errors caused by the air pressure from the moving web.
- Using the optimised sensor geometry PERMI can recalculate several porosity values according to different standards.
- Grade independent.
- Accurate online readings, which help optimise machine setting, furnish mix and especially get faster grade changes with minimum broke.



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Installation pictures

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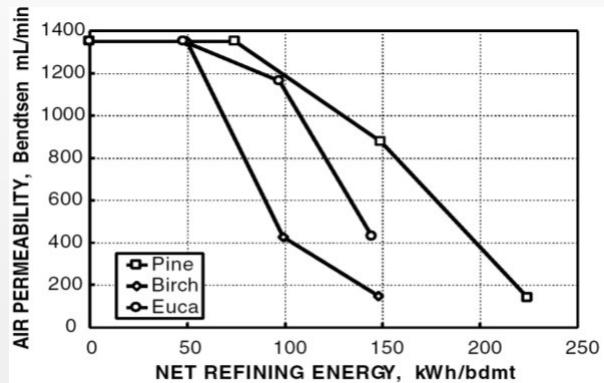
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Refining and Porosity

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- Adding refining energy will decrease the size and number of pores in the paper.
- Fiber network tightening in the refining is based in the increase of fines content and fiber bonded area, thus resulting in a lower air permeability level.



Lumiainen, J., Refining of chemical pulp, Papermaking Science and Technology, Book 8, Stock Preparation and Wet End, Paulapuro, H. (Ed.), Fapet, Jyväskylä, CD-Rom (v.11.01).

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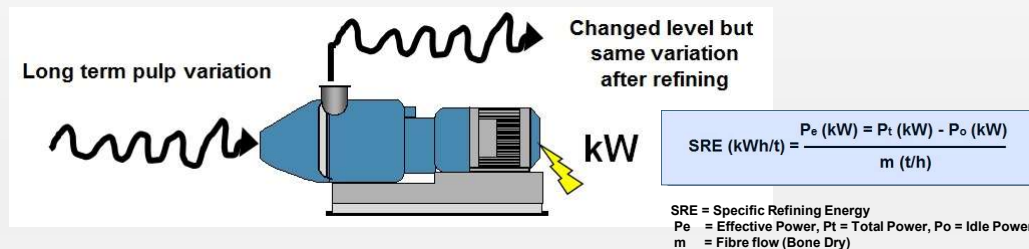
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Refining and Porosity

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- Conventional Control of Refining
 - SRE control of refiners cannot decrease pulp quality variations
- With on-line porosity measurement this can be corrected!



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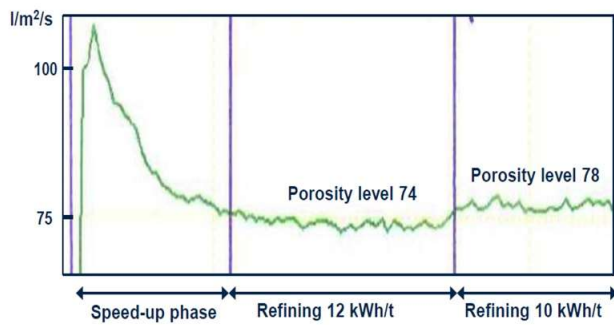
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Refining and Porosity

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Example of filter paper machine



A very small change in refining control can be clearly seen in the porosity measurement. The units of porosity numbers are $\text{l/m}^2/\text{s}$.

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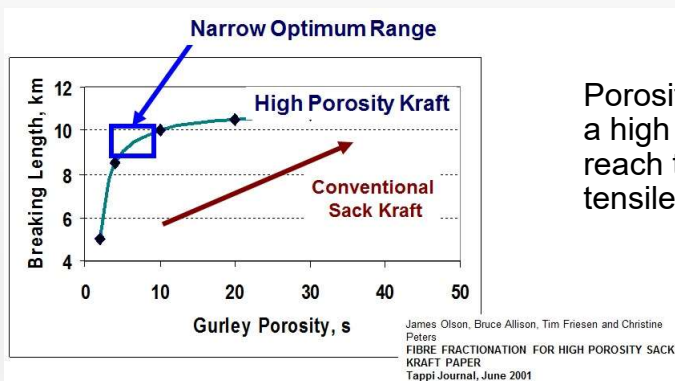
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Refining and Porosity

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High porosity sack kraft paper



Porosity control must be accurate for a high porosity sack kraft paper to reach the optimal combination of tensile strength and porosity.

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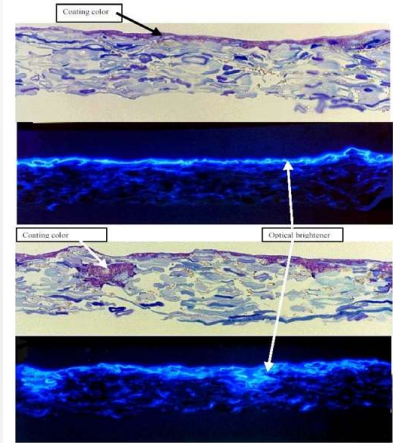
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Coating and Paper Porosity

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■ Porosity and Coating Coverage



- Dense sheet – small penetration of coating color and good coating coverage and gloss.
- Porous sheet – deep penetration of coating color and poor coating coverage and gloss. Misting problems in film coating.

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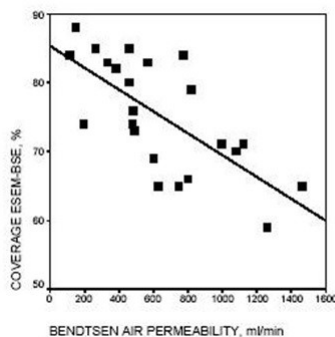
Forsström et al. TAPPI Coating Conference, 2002
<http://www.kcl.fi/news/link12004/link12004s4.html> ACA Systems all rights reserved



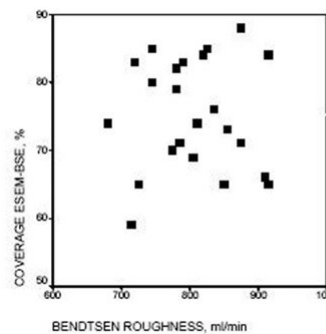
Coating and Paper Porosity

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■ Coating Coverage in Film Coating



Rsq = 0.4870



Rsq = 0.0000

U. Forsström et al. Tappi Coating Conference, 2002
<http://www.kcl.fi/news/link12004/link12004s4.html>

- Due to nip pressure coating coverage depends on porosity not on roughness.

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Total Process Control with Porosity

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■ Constant porosity – Consistent quality

- Papermakers know that final porosity of cigarette, filter and sack papers is very important but also printability and runnability properties of printing papers correlate well with final paper porosity.
- Most on-line instruments measure and control only one paper property. In addition to final paper porosity, which is an important property for some paper grades, Permi is a universal analyzer of paper quality for most paper grades due to the fact that almost all process parameters have a clear effect on porosity.
- On the other hand, porosity correlates with almost all physical paper properties. If porosity is constant, paper process performs well and paper quality is consistent.

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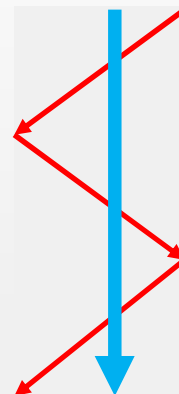


Total Process Control with Porosity

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■ Advantages of single-point measurement

- A normal scanner covers only a tiny fraction of the web area. With a scan speed of 0.5 m/s, web width of 10 m and web speed of 25 m/s web travels 500 m during one scan. It is impossible to separate cross directional and machine directional variations from a scanned measurement. However, there are separate CD and MD controls, which cannot work very well in the wavelength range of 1 to 100 seconds.
- This range is the most common problematic area related to variations in the approach flow and short circulation of the paper machine. These variations are mainly fluctuations in stock consistency but there can be other sources of variation like raw material mixture, fines content or chemical condition of the stock.
- With a fast Permi porosity analyzer it is possible to improve the process so that basis weight and moisture controls work better and the fast peak-to-peak variation, which cannot be seen in the scanner measurement, is lower and thus runnability is better.



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Calendering control by roll hardness measurement



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Calendering control

- Calendering is typically controlled based on online caliper measurement.
- The required accuracy of online caliper measurement is very demanding.
- In cross direction profile less than 0.5 micrometer caliper variations can cause problems especially with thin and dense paper grades like SC and LWC.

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Benefits of hardness measurement

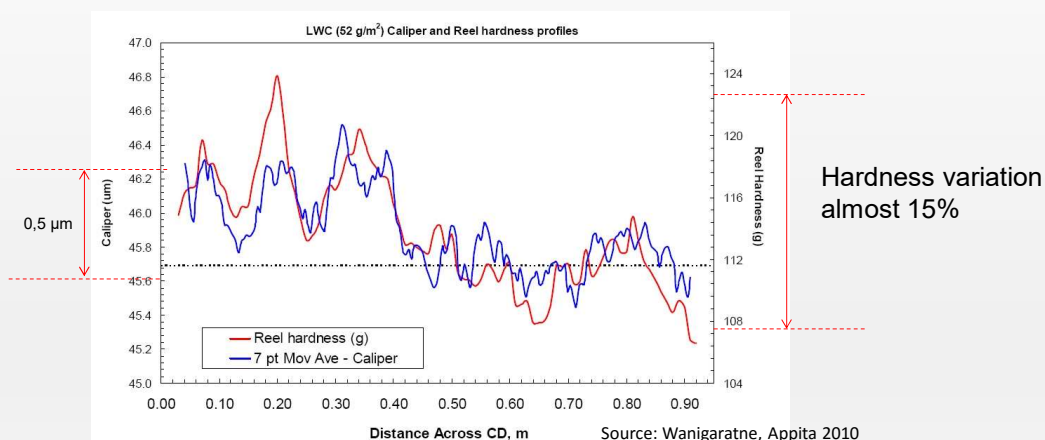
- Reeling is a cumulative process where paper layers are set on top of each other.
- Defects like CD profile variation are magnified in paper roll.
- Good control of CD profiles is extremely important for successful reeling.
- Hardness measurement is very sensitive profile measurement. There can be thousands, sometimes even tens of thousands layers in a roll. Microscopic differences in CD profile can add up to big variations.

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Hardness vs. Caliper

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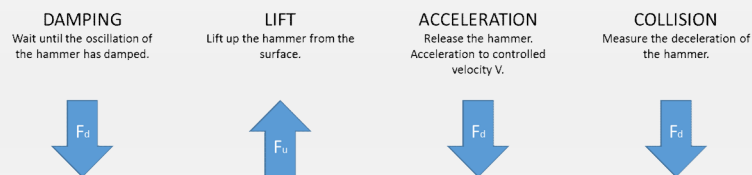
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Roll hardness measurement, new technology

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- Hammer hits to the surface of the paper roll maximum 50 times per second.
- From every hit there is measured deceleration (g), which is used as a hardness unit.
- Hitting force is controlled real time for every hit individually → excellent repeatability and reproducibility of the measurement.
- Distance counter reads the distance by 1 mm accuracy.
- Results are displayed as high resolution hardness profiles on integrated touch screen right after measurement.



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Roll hardness measurement, new technology

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- Measurement data is saved as text files to the flash memory of the device.
- Data is identified by barcode information or time stamp.
- Data is transferred by USB connection or wirelessly by WiFi connection to mill wide system.

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Roll hardness measurement, example video

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<http://youtu.be/lx9BP9Gcdzw>



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Calendering control based on hardness

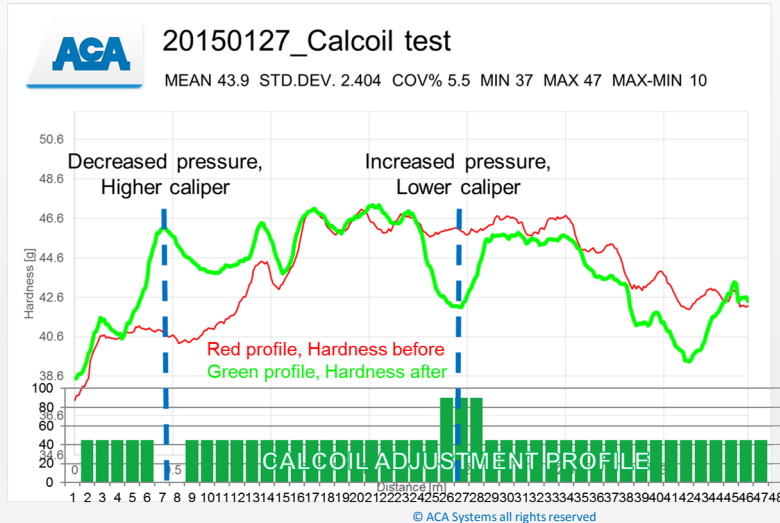
- Hardness profile is measured from the parent reel right after it is finished.
- Data is transferred to automation system.
- New control profile is calculated for calendering control system.
- Can be done automatically using closed-loop control or changes are accepted manually by the operator.

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Bump test with calcoil profiling system

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Key benefits of calendaring control by ACA RoQ hardness measurement

- Better and more accurate profile control.
- Improved runnability.
- Less breaks and reeling problems on a winder.
- Less rejected customer rolls, better production efficiency.
- Better customer rolls quality and less customer complaints.

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