

Online Porosity Measurement enables Refining and Grade Change Control



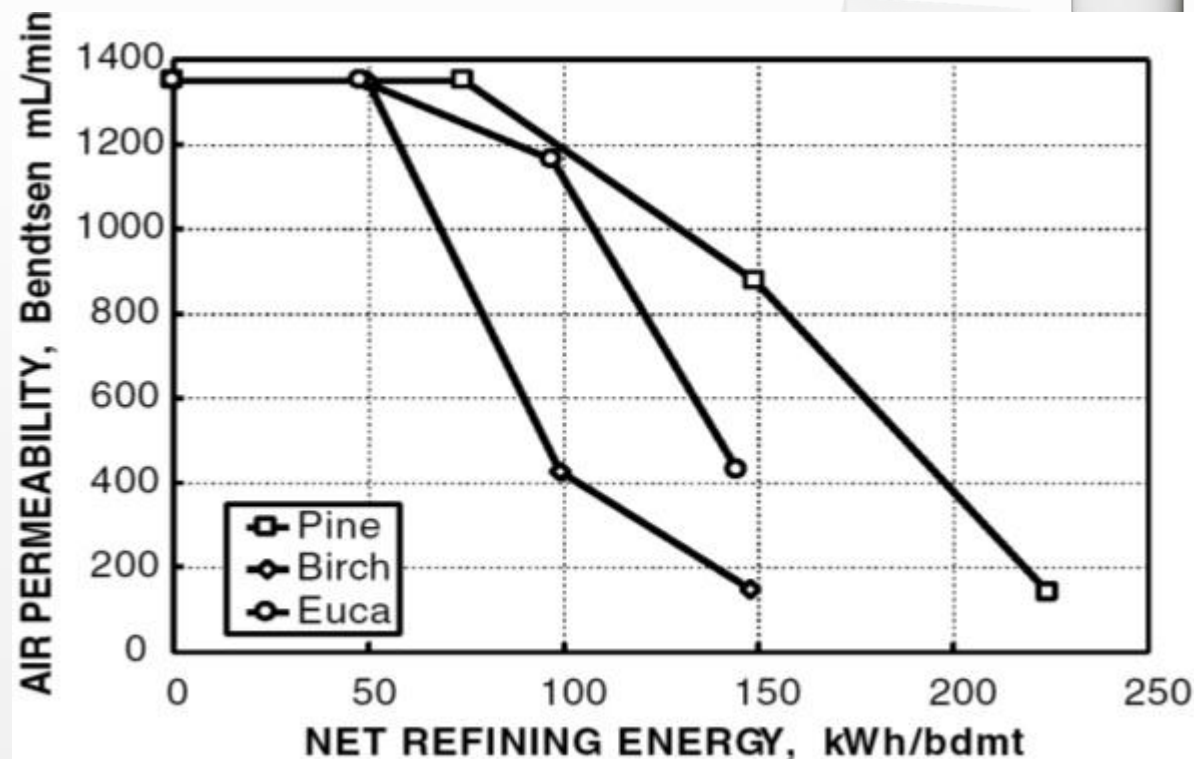
“Porosity is the best indicator for the balance of pulp quality and machine settings”



Refining and Porosity



- 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.

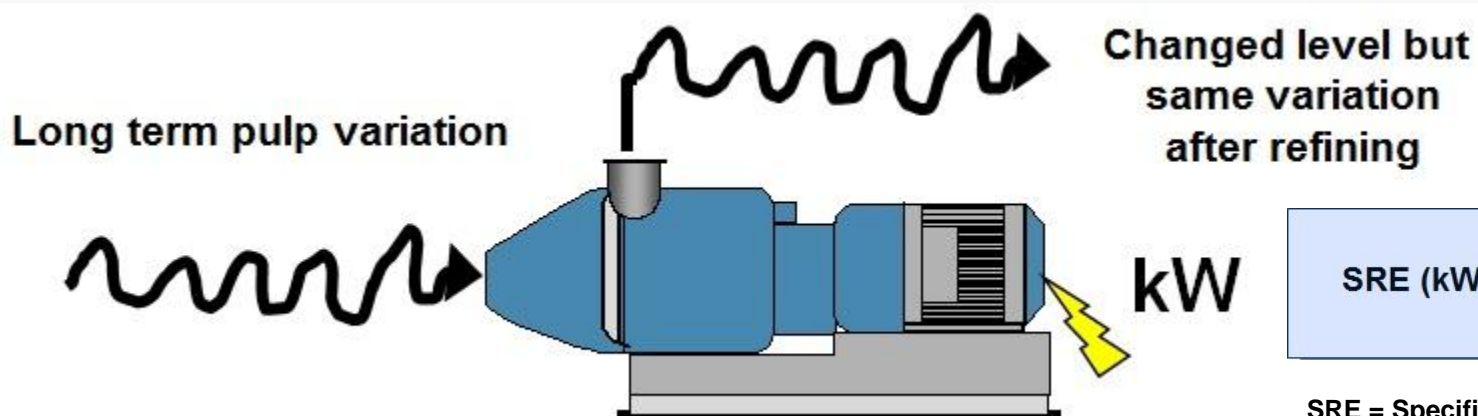


Lumiainen, J., Refining of chemical pulp, Papermaking Science and Technology, Book 8, Stock Preparation and Wet End, Paulapuro, H. (Ed.), Fapet, Jyväskylä, CD-Rom (v.11.01).

Refining and Porosity



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



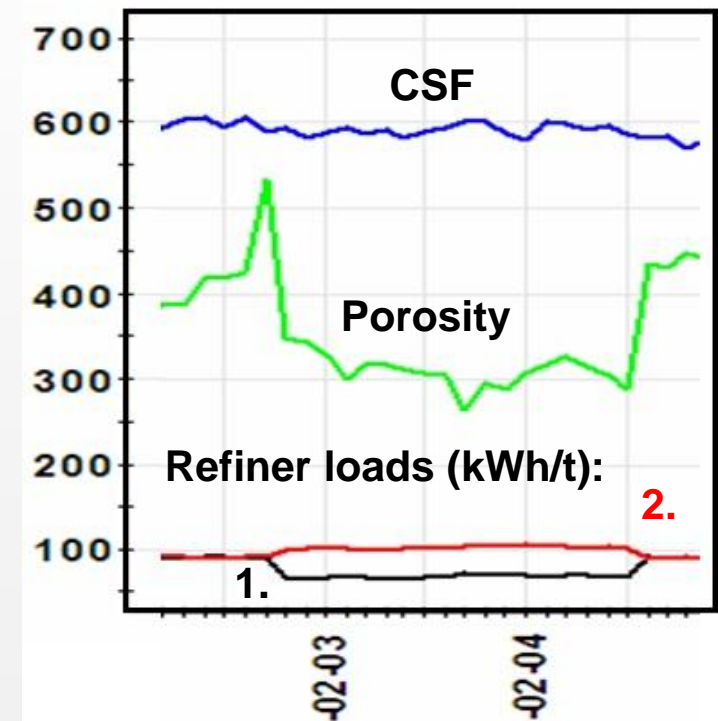
$$\text{SRE (kWh/t)} = \frac{P_e \text{ (kW)} = P_t \text{ (kW)} - P_o \text{ (kW)}}{m \text{ (t/h)}}$$

SRE = Specific Refining Energy
Pe = Effective Power, Pt = Total Power, Po = Idle Power
m = Fibre flow (Bone Dry)

Refining and Porosity

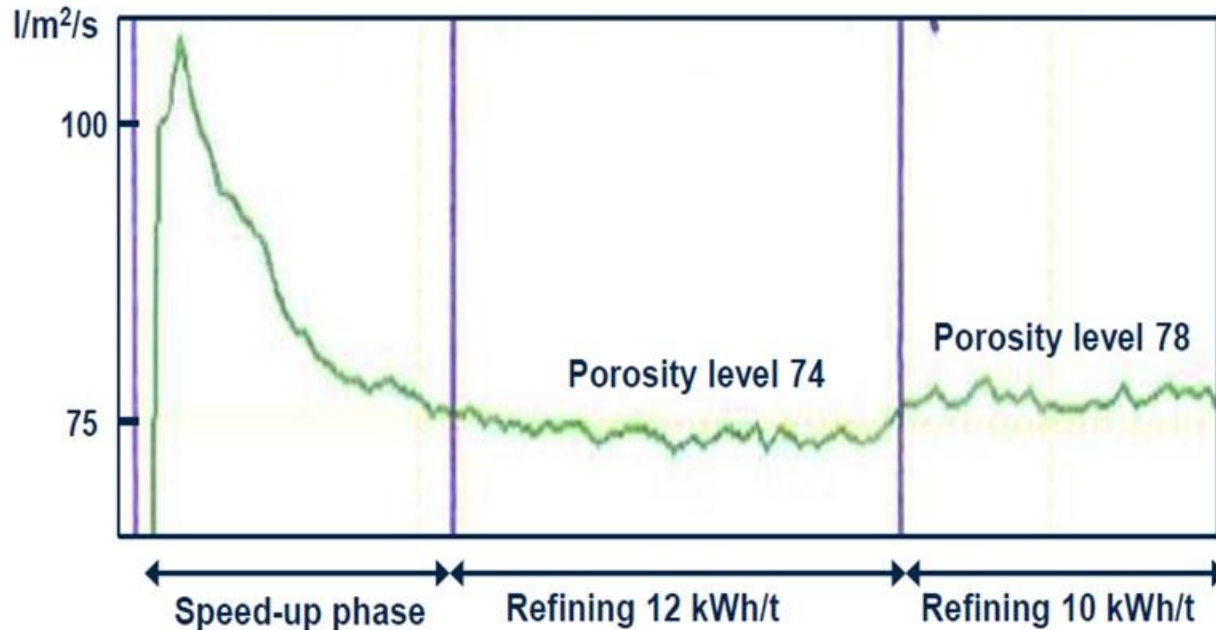


- Freeness, porosity and refining
 - It has been interesting to note that the load distribution between two softwood kraft refiners in series has effect on porosity.
 - Specific energy consumption (SEC) in the first refiner was reduced as much as it was increased in the second refiner.
 - Total SEC was constant as well as freeness (CSF). However, paper porosity decreased about 25%. This shows that CSF control cannot be correct in all situations.
 - It seems that only fines content has effect on freeness while also internal fibrillation of fibres and fibre flexibility have effect on porosity.



Refining and Porosity

- Example of filter paper machine

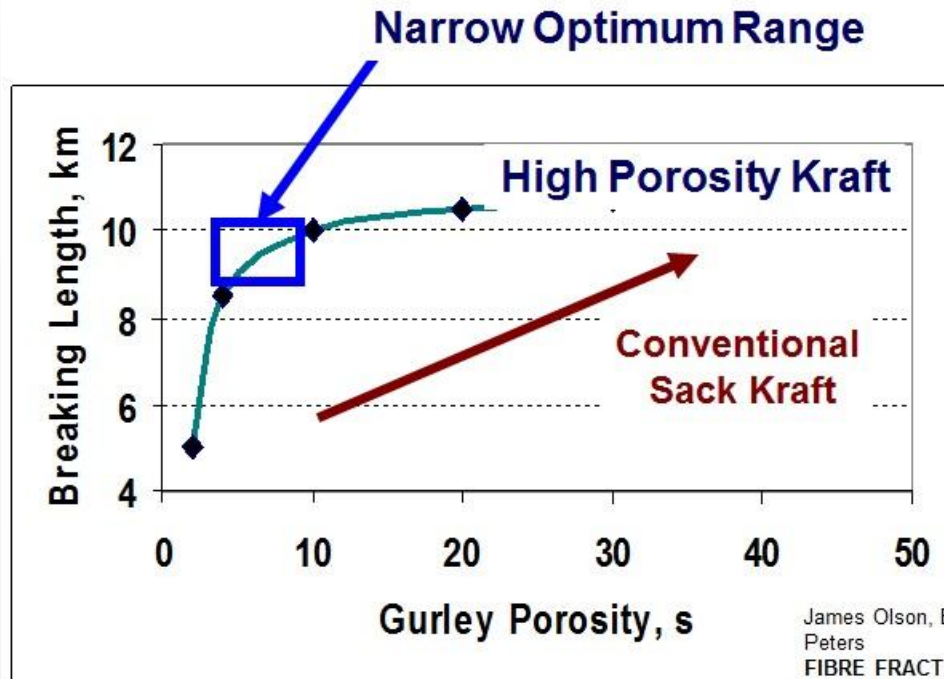


A very small change in refining control can be clearly seen in the porosity measurement. The units of porosity numbers are $l/m^2/s$.



Refining and Porosity

- High porosity sack kraft paper



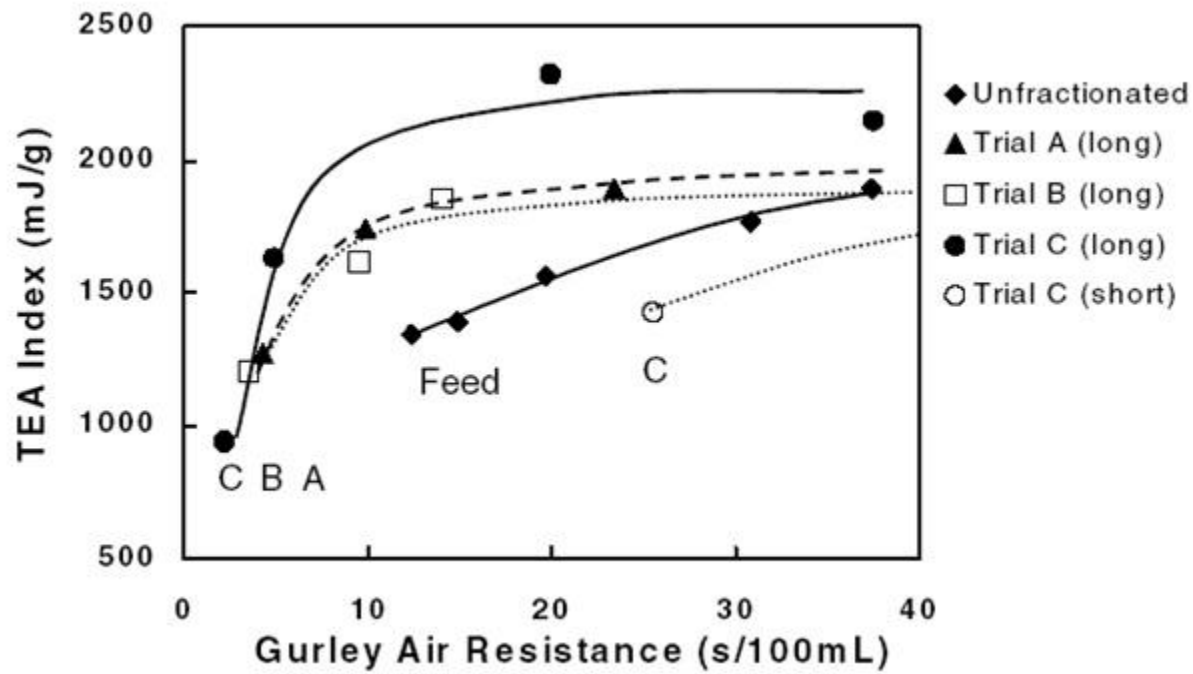
James Olson, Bruce Allison, Tim Friesen and Christine Peters
FIBRE FRACTIONATION FOR HIGH POROSITY SACK KRAFT PAPER
Tappi Journal, June 2001

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

Refining and Porosity



■ TEA and Refining

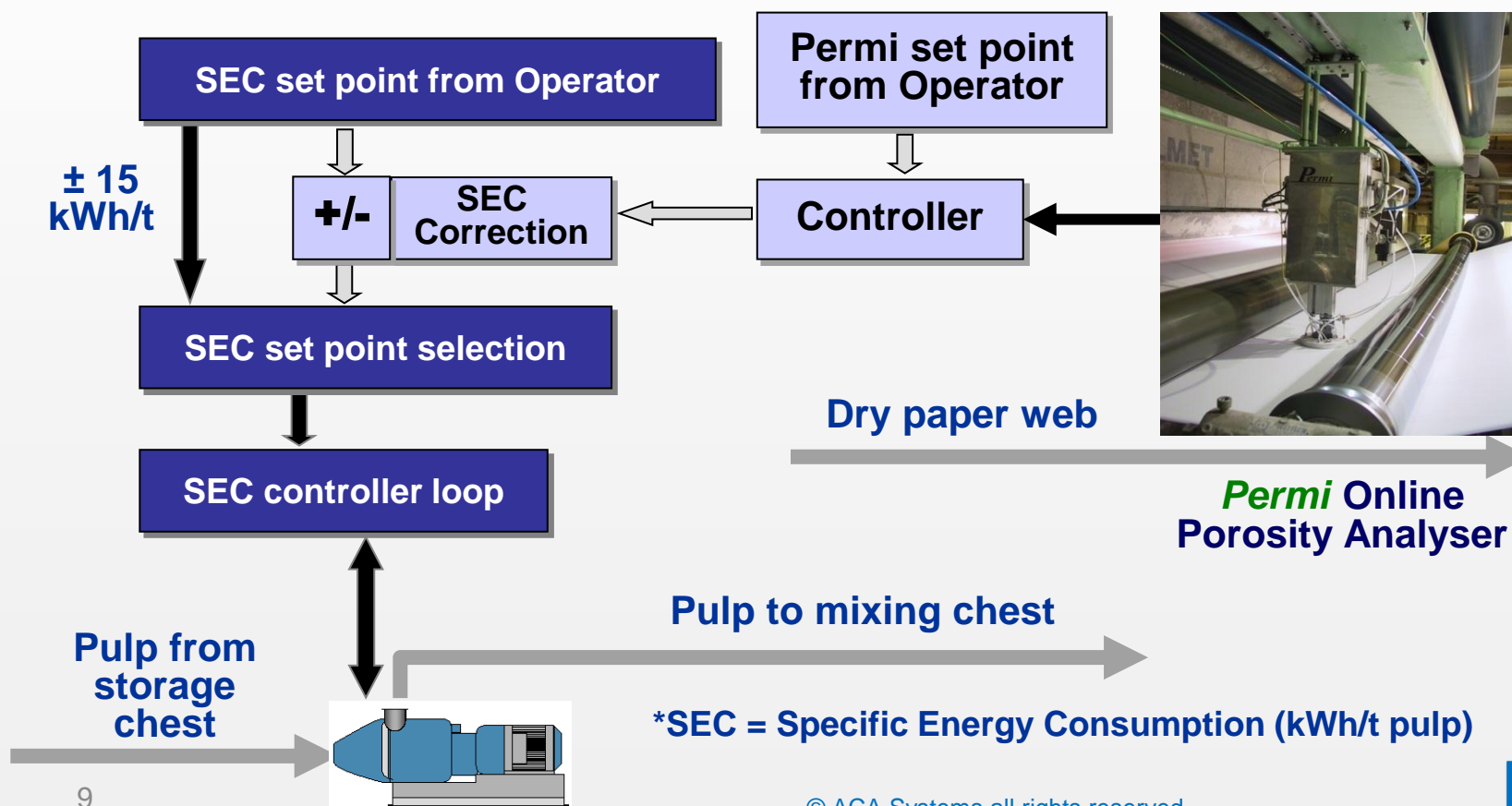


- Refining is always a compromise between porosity and strength properties.
- Quick filling of valve sacks require Gurley porosity between 5 and 10 seconds. This is the range, where TEA (Tensile Energy Absorption) and tensile drop very fast.
- It is important to have a good control on porosity to be able to make these grades with acceptable combination of the critical properties.

Refining and Porosity



- Feedback Porosity for SEC* control



Permi
supervisory
predictive
control can give
remote set-point
to SEC-control
about 6 times
per hour or
faster

*SEC = Specific Energy Consumption (kWh/t pulp)

Refining and Porosity



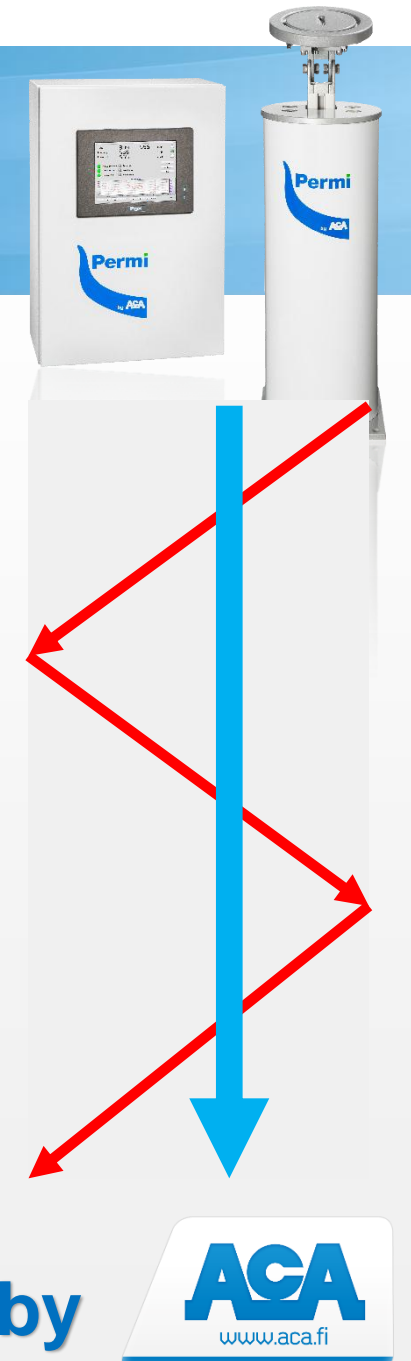
■ Refining control with porosity

- In series refining fibres are stiffer in the first refiner. If the load is too high, fibre cutting and fines formation will increase. This decreases freeness and drainage on the wire.
- In the second (and third refiner) fibres are more flexible and specific edge load can be higher without fibre cutting and fines formation. However, internal fibrillation will advance more and more flexible fibres compensate the binding power of fibre fines.
- Same porosity can be achieved with higher CSF when using increased loading order. Total energy can be saved, drainage on the wire is increased and lower headbox consistency can be used to get better formation even if the fibres are longer and paper strength is better.
- Loading shares between refiners is only one example how online porosity can be utilised to optimise refining. This would not be possible by using freeness measurement, which mostly reflects fines content.

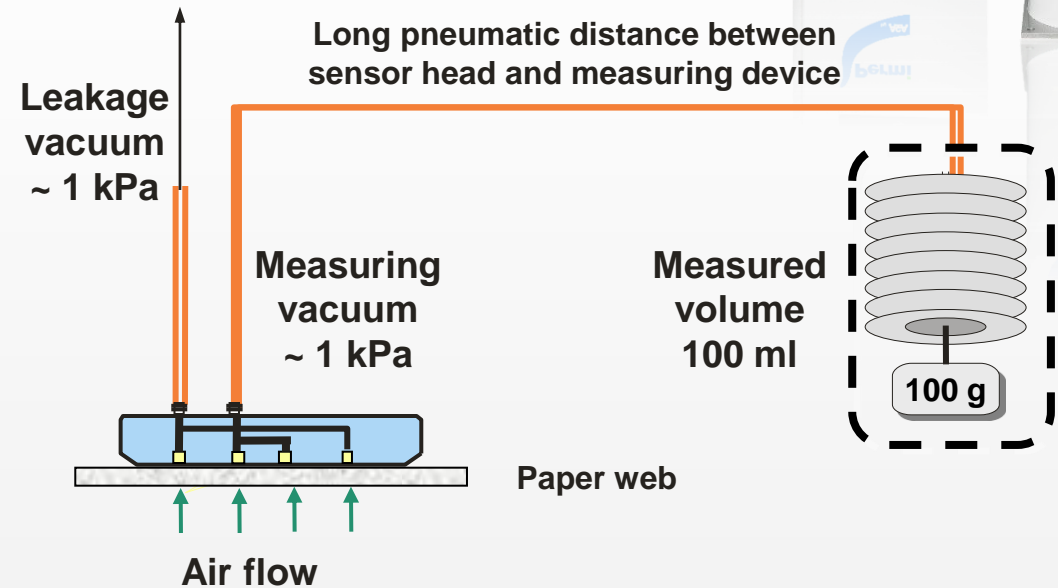
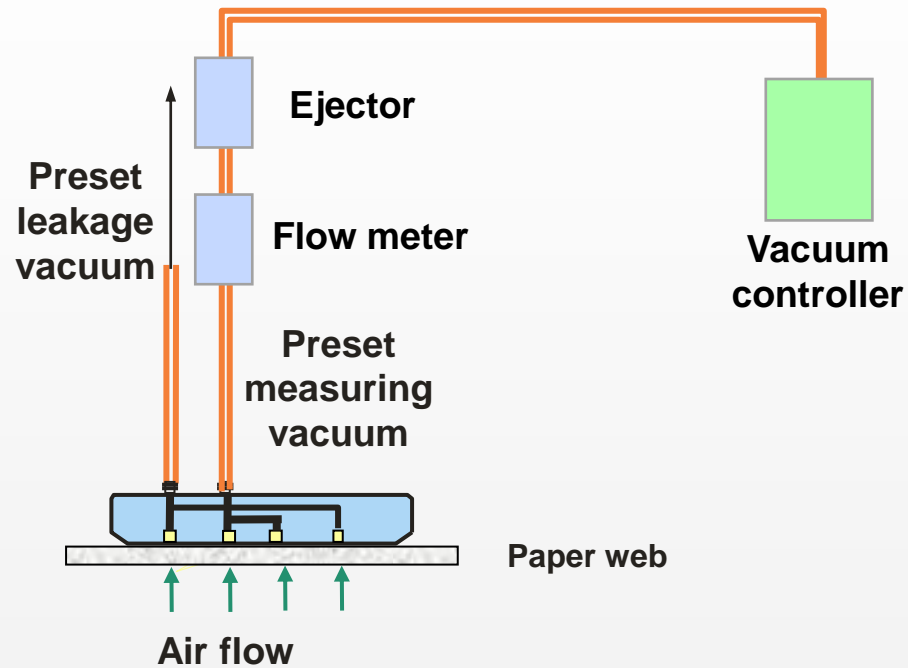
Porosity and grade changes

■ 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.



Porosity and grade changes



PERMI measures air flow continuously!

Conventional porosity analyzers measure time

Porosity and grade changes



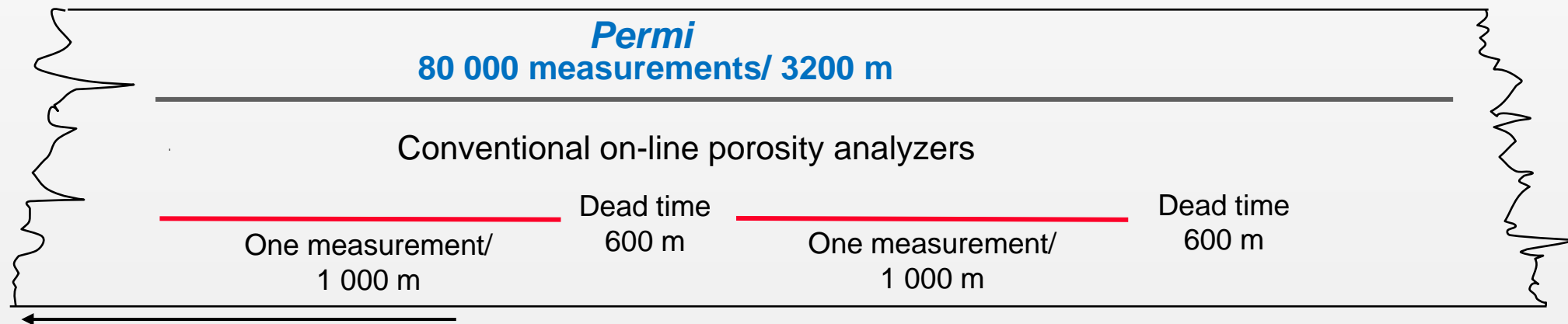
■ Comparison Permi vs. conventional on-line porosity analyzers

Permi

- **One measurement 2 ms - 0,04 m**
- **Continuous measurement**
- **80 000 measurements - 3200 m**

Conventional on-line porosity analyzers

- One measurement 50 s - 1000 m
- Dead time 30 s - 600 m
- Two (2) measurements - 3200 m



Web speed 1 200 m/min, Porosity 50 Gs

Users' Experiences



- Energy savings up to 10 Kwh/ton with better control of refining.
- 100 000 euros savings/a when chemical (retention and defoaming agent) proportioning was optimized by Permi.
- Increase from 576 ton/day up to 648 ton/day (12,5 %!) in production of paper board when the proportion of fines was optimized by Permi (if drying is a bottleneck).
- 15 % average shortening in grade changes.

Users' Experiences



- Permi On-Line Porosity Analyzer gives us very reliable online information for controlling the refiners, and the fines content in our furnish. It has helped us optimize the paper quality and mechanical fiber treatment consistently, and save energy in refining.
- The online information provided by Permi – together with some other activities - has also helped us shorten grade change time by 15 - 20 %.

- Mill Manager Juha Kovanen, Savon Sellu, Finland

Thank You for Your Attention

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