

On-Line Porosity Analyzer For Optimization Of Paper And Board Production Processes

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ABSTRACT

The on-line porosity analyzers have in recent years become a practical tool for papermakers to maximize paper quality and production profitability. The PERMI, being a fast and reliable on-line porosity analyzer from ACA Systems Oy, helps papermakers to rapidly adjust all grades to specification and carry out fast paper grade changes. The monitoring of several paper grades can accurately and reliably be measured with only one single calibration. The very fast machine direction measurement enables a new kind of control of paper and paperboard processes. Paper quality variations in the machine direction can be reduced with greater ease when a fast real paper quality measurement is available. It is easier to track the root causes of faster variations (recipes, dosing of chemicals, screen cleanings, variation in deaerator vacuum and air content etc.) Naturally, this leads to better paper uniformity, not only in porosity but also in most of the other important quality characteristics. The refining of chemical pulp as well as the postrefining of mechanical pulp can be optimized for each paper grade in spite of quality changes in the incoming pulp. The process automation system (DCS) can be equipped with a closed loop control circuit to maintain the required porosity level. The potential to save energy and increase production is remarkable and the uniformity of paper quality improves noticeably. The dosing of paper chemicals (fixatives, retention aids, and defoamers) can be monitored and optimized so that a good combination of retention, formation and drainage, as well as better runnability on the machine, can be achieved. Overdosing and the costs of the chemicals can be reduced without any risks to the process operation. The vacuum levels in the wire section (foils, vacuum rolls, vacuum boxes) can be quickly adjusted in the grade changes and therefore a good formation and dewatering with lower energy costs can be achieved.

PERMI – THE NEW GENERATION POROSITY ANALYZER

The design criteria of the PERMI analyzers (Figure 1) were reliability, accuracy, fast measuring over the complete paper grade range, automatic cleaning and a durable sensing head. An important benefit is the grade independency. This brings the papermaker more reliable and accurate online readings, which help optimize machine setting, furnish mix and especially get faster grade changes with minimum broke.



Figure 1 Remote control box and measuring head

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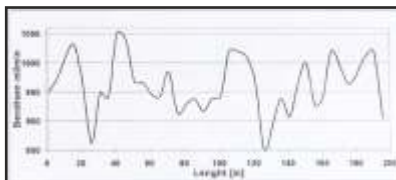


Figure 2 Example of a fast variation ($\pm 10\%$) in the machine direction

In Figure 2 a typical PERMI measurement of woodfree paper is presented. Variation of the porosity is $\pm 10\%$ during 10 s (or inside 200 m, with 20 m/s). With manual laboratory samples, taken from the top of a machine reel, the value can be 850 ml/min or 1050 ml/min or anything between those values.

ABOUT APPLICATIONS Fibre Quality and Refining

Normally, a higher content of long and thick fibres increases porosity. Especially in wood-containing papers, a higher content of long and thick softwood chemical pulp increases porosity. Porosity also increases when fibres are stiff and have thick cell walls and lumens are not collapsed. Fibre refining and addition of wet-end starch decrease porosity and increase fibre bonding and tensile strength.

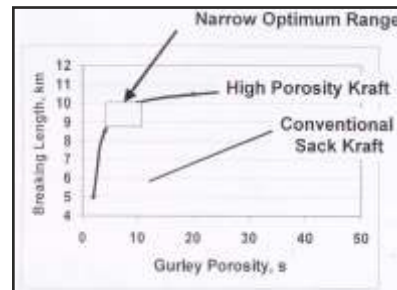


Figure 3. The optimum range of porosity is very narrow. With the on-line PERMI, it is possible to keep the paper quality inside this narrow window.

Fibre refining is normally controlled with net specific energy consumption by measuring mass flow and motor power. This would be quite a good system if the raw material (fibre) had no variation. However, in practice there can be great variations depending on the wood and fibre source and fluctuations in the pulping process.

A good example is a high porosity sack kraft paper, where the optimum window between strength and porosity is very narrow (Fig. 3).

Medium term variations

Most of the paper machines have scanning measurement and control of basis weight and moisture. The problem with these systems is that they can find and correct stable cross direction variation and long-term variation in the machine direction. The most problematic range for these controls is from 10 to 100 s. If paper machine speed is 20 m/s this is from 200 m to 2000 m in the length of paper.

A single point porosity measurement with PERMI has shown the usability to detect variations in this range, which is difficult to measure in a normal paper mill laboratory. A typical variation source for this range is the approach flow. The following variation sources are most common:

- Variation in consistency control and in furnish mix
- Poor mixing of thick stock, fillers and chemicals
- Deaeration control and air problems
- Cavitation in pumps, valves and pipes
- Washing cycles in screens
- Intermittent dosing of chemicals
- Sedimentation of fines and fillers

Porosity is, unlike basis weight, also a total quality measurement. In the basis weight, only variations before press section can be seen. On the contrary, porosity shows variations also in pressing, drying, surface sizing and calendering.

Control of Wire Section

The control of vacuums and dewatering in a modern gap former can be difficult. Especially a roll and blade gap former with loadable blades can be problematic. Vacuums in the forming roll and forming boxes affect formation but also the porosity and internal bond.

Normally, a better formation originating from fibres, decreases

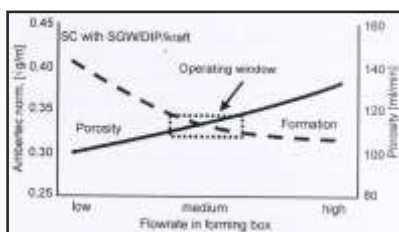


Figure 4. Too much vacuum in the forming boxes of a gap former increases porosity even if formation is better.

porosity. However, when vacuums are controlled in the wire section, better formation gives a higher porosity.

The PERMI porosity measurement facilitates fast adjustments in the wire section when grade, raw materials, retention or basis weight changes. Together with the new type of advanced formation measurement it is possible to decide, whether a change in porosity is originating from formation or not and what are the root causes of the formation changes.

Press Section and Porosity

The effect of the press section on porosity, bulk and internal bond is very interesting. It is well known that increased wet pressing reduces bulk and porosity and increases internal bond. However, more interesting may be the effect of press draw (speed difference) on paper properties and porosity.

When press draw increases, the web break frequency increases. Increasing press draw also increases paper porosity, thickness and bulk and reduces internal bond strength. If a high porosity paper is required, this is a very uneconomical way to increase porosity and bulk due to increased web break frequency.

On-line measurement of press drainage, steam consumption, press draw and porosity can tell several things of wet pressing.

CONCLUSIONS

The on-line porosity measurement is a new power tool for papermakers to better monitor and control the paper quality and to maximize the salable paper tonnage and production profitability. It has brought some new information capabilities like fast trend data from the porosity behavior during such process changes as grade changes, speed changes, furnish changes or other disturbances.

The key question of course is: Why should you measure porosity on-line? The following are good answers:

1. Paper porosity is a good general paper quality indicator, because it depends on so many other paper characteristics. A higher porosity correlates at least to the following properties:
 - Air permeability ↑
 - Tensile strength ↓
 - Size pick-up ↑

- Oil absorption ↑
- Formation ↓ (bad)
- Pin holes ↑
- Bulk ↑
- Opacity and filler content ↓↑
- Internal bond strength ↓

2. Paper porosity is a universal overall measurement of process stability because so many process variables have an effect on porosity:

- Fibre furnish
- Fibre refining
- Filler content
- Filler type
- Wet end starch
- Retention of fines and fillers
- Wire drainage and vacuums
- Air content in the stock
- Fibre flocculation
- Wet pressing and press draw
- Dryer draws and web shrinkage
- Fibre bonding
- Calendering

3. It is quite impossible to tune the process or make decisions about paper quality with only laboratory porosity measurements by taking samples from every machine reel in one to two hours interval. The main reason is that the variation of porosity in the machine direction is about ±10 %, which is at least ten times as high as the variation of controlled paper properties like basis weight or moisture (normally less than ±1 %). This high porosity variation can be reduced with the PERMI and a reliable average of the machine reel porosity can be reported to eliminate unnecessary quality rejets.

Literature

1. SC Papers, Voith Paper Machine Days in Salzburg, 2002
2. Metso brochure: Imageneering 12/2004, Paper Machine Dryer Sections