A New Generation Online System for Standardised Pulp Quality Monitoring

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What is the purpose of pulp quality testing? One main purpose is to predict the final product potential from wet pulp properties. If we know the impact from the pulp properties on the final product then we can optimise and control the process for best economy. But what shall we measure to characterise pulp quality? And what technique is useful in a reliable online quality testing system?

One way to measure pulp quality covering both chemical and mechanical pulps is a 6-star approach;

- Fibre length and deformations (Shape/Curl, kink)
- Cross section properties (Width, Coarseness)
- Bonding; (CSF/SR, strength test of sheet or optical test)

Fig. 1: L&W Pulp Tester

- Chemical composition (soft-sensor from NIR spectra)
- Optical properties (Brightness, Whiteness, Colour, Fluorescence, Estimated Residual Ink)
- Cleanliness (Vessel Cells, Shives)

This concept is substantiated in the online automatic laboratory for testing of pulp – L&W Pulp Tester (figure 1). A central unit is fed from samplers distributed in the mill. A sample preparation unit adjusts the consistency of the sample and distribute pulp samples to different included modules. Wet samples are fed to standard tests for freeness (CSF/SR), fibre morphology (length, width, shape, kink, fines, vessel cells, shives) and to a sheet former and dry sheets are then analysed with respect to optical properties (Brightness, whiteness, fluorescence, color and Erik), NIR spectra and burst strength.

All measurements from the image analysis based laboratory analyser (L&W Fiber Tester) are included. Coarseness is new, as a completely automatic measurement, which allows for high repeatability and improve the potential for development of predictive pulp strength models. A separate shive analyser is available for better statistics in this measure.

True consistency is calculated from a dried and weighted pulp pad. A pulp sample with known volume is taken from the process. The weight of a completely dry pulp pad of a known part of this sample is measured. True process consistency is used to replace manual testing of process consistency, to calibrate inline consistency transmitters and to calculate material flow for allocation of chemicals and energy (quota systems). Observe that optical and mechanical consistency transmitters don't give true consistency values! They have to be calibrated from time to time.

Standard CSF/SR are automatic versions of the laboratory standard equipment measured with correct consistency and temperature compensation.

Since CSF and SR are well-established methods a lot of process experience relates to these measurement values. It has shown to be difficult to model the measurements mathematically from other non-standard measuring devices. Frequent calibration work is avoided by using the standards.

Optical properties are measured from a completely dry pressed sheet. Almost all facilities from the laboratory standard instruments are included.

The pulp strength can sometimes change due to change in chemical composition without measurable changes in the geometrical fibre properties. One way to detect such effects is by using NIR-spectra. Models are then developed with multivariate data analysis methods. This require considerable modelling work. Another way may be to measure sheet strength of a pad to get complementary information of the bonding for modelling of sheet properties.

BASIC REQUIREMENTS FOR ONLINE ANALYSERS

For an online pulp quality analyser the reliability is very important. Reliability is the ability of a device or system to perform a required function under stated conditions for a specified period of time. Required function is reached if people can trust in measured data. This is reached if measured properties are close to international standards and need less calibration. Since calibration of online units has been regarded as a major problem we have used methods close to or exactly following the standards in order to increase the reliability of data. It is also an advantage if known engineering scales are used for the measured parameters.

The sensors also have to be stable and have good repeatability. Repeatability tests are standard procedures for ac-

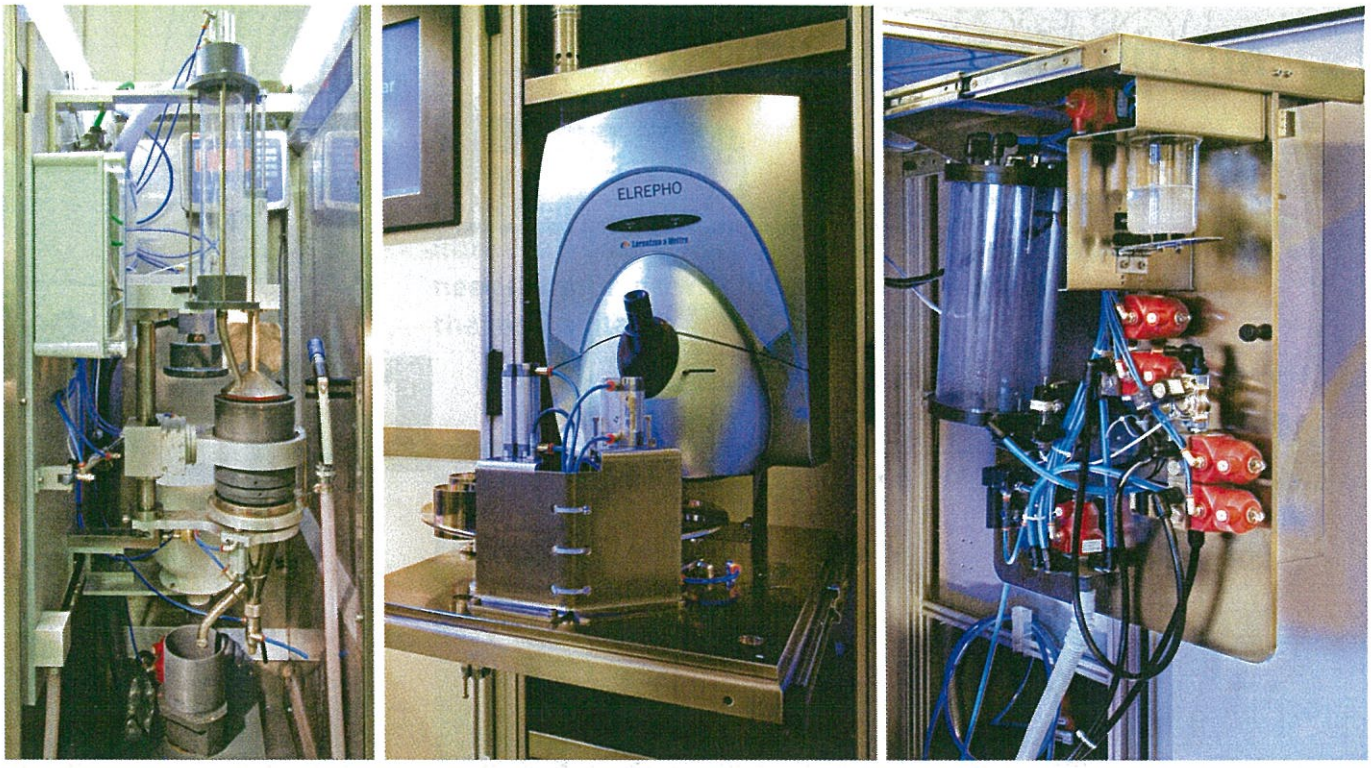

Fig. 2: Modules from left to right; SR, Optical properties unit and Fibre Morphology.

ceptance of new instruments.

All coefficients of variations are low. Coarseness is better than what is often reached with manual tests. For vessel cells the variations are commonly slightly higher due to worse statistics. Fewer vessel cells than fibres are commonly counted. If we count 900 vessel cells the statistical caused standard deviation will dominate the error and is about 3 %.

The experience from the past is that the reliability of complex online sensors and analysers is critical for acceptance of the new instruments. The data must be available when needed and this has to be reached with limited maintenance work and costs. You have to use good and tested components. Advanced automatic cleaning systems are a must. A critical device for high uptime is the sampling.

The robust and simple samplers are designed with a cutting edge, which prevent the sampler to jam. The sampler sticks into the pipe in order not to measure pipe edge effects. The sample is diluted directly at the sampling point and transported at low consistency in separate tubes to the tester.

The measurement frequency is very limited with manual tests as illustrated in table 2. They generate more of historical data. An automatic system measures frequently and with a system based on 6 samplers complete data can be reported every 30 minutes. Single point measurements can report every 5 minute. If faster response time is required an inline fibre quality transmitter is available and can report every minute and even faster than that.

Important are;

- high trust in data;
  according to standards, automatic calibration
- high uptime;
  automatic cleaning, proven components and robust design
- measurement frequency

	SW mean	SW CoV%	HW mean	HW CoV%
Length	2.233 mm	0.45	0.879 mm	0.37
Width	31.3 µm	0.17	22.2 µm	0.32
Shape	82.3 %	0.15	87.2 %	0.10
Fines	4.6 %	2.05	2.4 %	2.13
Coarseness	166 µg/m	1.84	87.5 µg/m	0.87
Kinks	0.741 1/mm	0.79	0.92 1/mm	0.85
Vessels cells/g	-	-	9233 no/g	3
Brightness	90 (ISO)	0.08	90 (ISO)	0.02
CSF	79.8 (TM)	2.3	620	0.37
SR	19.1 brown	0.42	15.8	0.76

Table 1. Typical examples of repeatability in L&W Pulp Tester

INTEGRATED PULP AND PAPER QUALITY MONITORING AND CONTROL

With automatic pulp quality testing the data can be integrated in the DCS and QCS systems for monitoring together with other process data and for control purposes. Measurements of final paper quality in an at-line profiler is very common today. It will be as common with online pulp quality data integrated in these systems. This type of system monitoring process data in real time gives an excel-

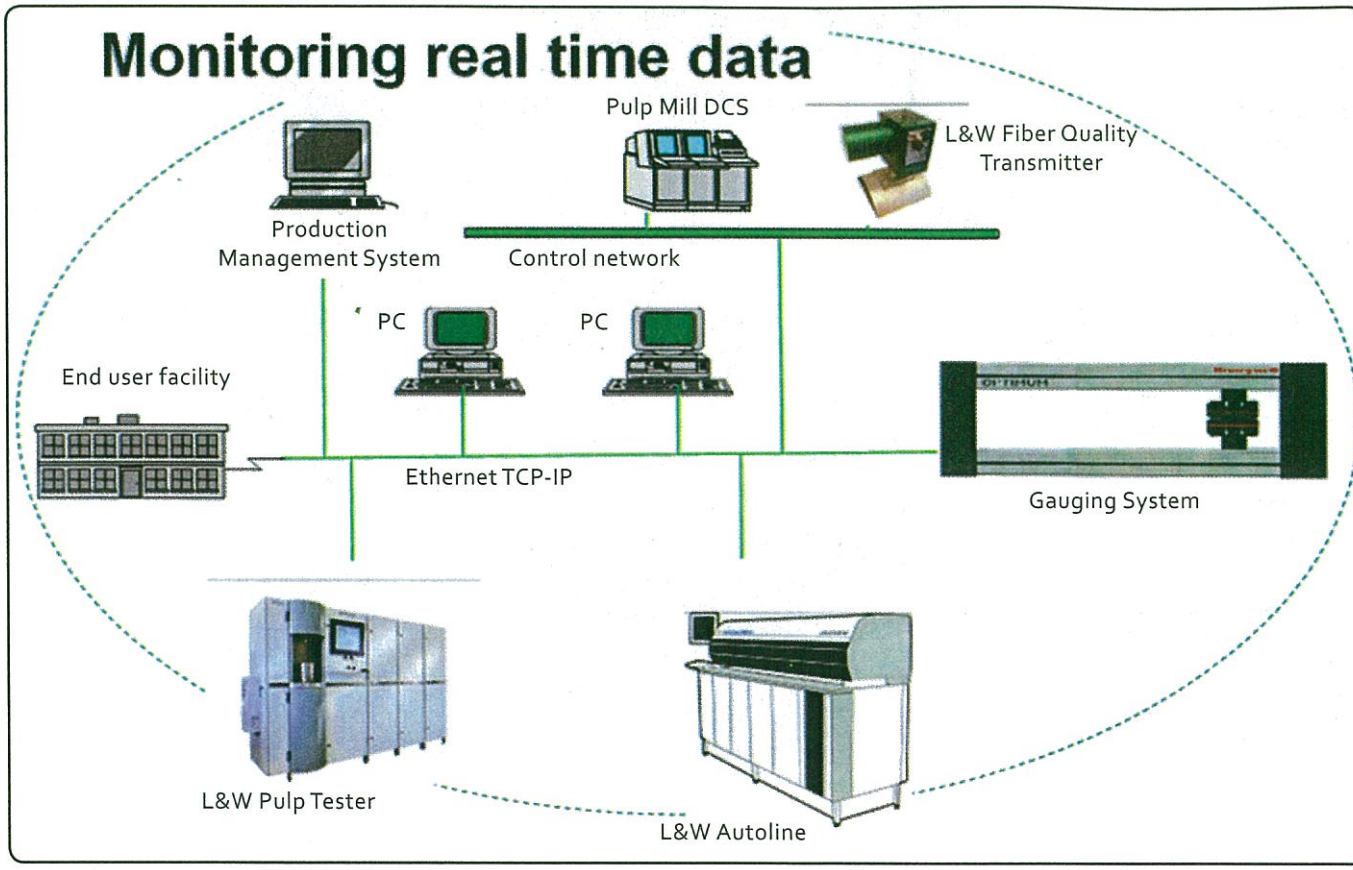

Fig. 3: A quality control system including automatic pulp quality and final paper quality testing systems.

lent possibility for optimization of the process.

BENEFITS OF MEASURING:

Mechanical pulp

Optimisation and control of pulp quality based on frequent pulp quality analysis save refiner energy consumption and give fast return on invested capital. Optimal settings of a dozen of parameters are not possible without relevant measurements.

Chemical pulp

On-line measurement of final pulp quality makes frequent testing of pulp quality possible. Deviations in delivered pulp quality (claims) are avoided. The quality is guaranteed. Control of grade changes alone can pay for a system. Control of brightness saves chemicals and guarantees brightness levels.

Recycled pulp and deinked pulp (DIP)

More than 50% of produced pulp worldwide today is recycled pulp. Most important of the process is to remove other material than fibres, to minimise fibre losses and to increase the whiteness. In order to maintain pulp quality in for example recycled pulp and DIP production it is important to measure consistency, optical properties, ERIC 950 (for residual ink), and fibre properties for optimisation of mixing of raw material or if fractionation is applied in the mill.

Paper machine stock preparation

Freeness is used for optimisation and control of refiners in stock preparation. In this process fibre deformations also can be optimised as well as the pulp blend for each grade. A uniform pulp quality minimises breaks and deviations from the quality targets, and optimises the paper machine (in terms of energy, production and quality).

Handsheets	Less than 1 test/day
Other manual wet tests	Less than a few per shift
Online automatic laboratory	One every fifth minute.
Inline transmitter	Every minute at each position

Table 2. Measurement frequency of pulp quality

SUMMARY

L&W Pulp Tester is an online automatic wet lab for pulp quality and stock preparation. It operates according to standards for established properties and it uses the latest optical technique as well.

It is designed to cover pulp quality for different pulps and it combines different techniques in order to get a solid base for modeling of sheet properties, which are difficult to measure directly in this kind of systems.

Unique features are:

- Process consistency based on weight
- Coarseness
- Standard CSF, SR
- Standard Brightness, Colour etc
- Standard fibre length
- Conform to L&W single instruments and profiler (Autoline) PA