On-line sensors: exploring the trends

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The widespread use of on-line sensors has allowed mills to quickly correct defects and make quality decisions such as shipping by the gauge. This article provides a look at the past, present, and future of on-line sensor equipment.

With the introduction of more new and advanced on-line sensors in recent years, there is much interest in the reliability, testing, benefits from, and future of this equipment. While this article deals mainly with paper machine on-line gauging of product qualities such as basis weight, moisture, caliper, and other sheet properties, the concepts also apply to on-line sensors for the pulp mill and the paper mill stock prep and wet-end operations.

The on-line sensing equipment proliferation has helped spawn the Paper Machine Sensors Subcommittee of TAPPI's newest division, Process Control, Electical and Information (PCE&I). The current secretary of PCE&I, Keith Masters, was the founding chairman of the subcommittee. Masters reports that the subcommittee includes representatives of all the major on-line gauging suppliers, as well as many mills. The group's first accomplishment was a proposed TAPPI Technical Information Sheet recommending a standardized method for calculating the variance partition of scanning sensor data into its directional components. It is anticipated that this active and growing subcommittee will move to full committee status. The current chairman is Kevin Connolly of Mead.

Trends in on-line sensing

Continuing a steady growth in use since their introduction, on-line sensors have met widespread challenges in the past five years. In the pulp mill, new sensors are available for determinations such as kappa number, titratable alkali, measurement of conductivity, and pulp brightness. Flowmeters based on the Coriolis principle now read not only the mass flow of liquids and slurries, but also percent solids. In the paper mill, sensors have evolved for on-line sheet quality analysis of formation uniformity, smoothness, and strength. New improvements are being made constantly to sensors already on the market.

Sensor capabilities continue to be pushed to even greater results. "Faster, smarter, more accurate and reliable," reports Bruce Kopkin, general manager for Lippke Systems North America. Sensor packages can now traverse the sheet width at speeds up to 18 inches per second, presenting 1000 data point cross-sheet profiles simultaneously for each sensor.

Machine operators have come to expect instant action as a result of having on-line equipment. The faster they can receive information, the faster they can make a change to correct production problems.

"Papermakers see the value of on-line measurement, and want to take corrective action when a change occurs, rather than waiting for the results from the laboratory," said Keith Lantz, marketing manager for sensors and scanners for Measurex.

Ship by the gauge

The advent and development of on-line sensors has brought about a trend within mills. In the 1960s, as mills gained confidence in the accuracy and reliability of their on-line measurements, the question of conflicting quality control practices arose. Should the decision to ship or reject an entire reel be determined by an end-of-reel turn-up sample tested in the lab or by the continuously measuring on-line sensor? Gradually, more and more mills began using their on-line sensors for shipping desicions and reduced the frequency of lab tests for these parameters. Routine lab testing was still used by the mills for other properties. In packaging-grade mills, for example, the ship by the gauge method was accepted for basis weight and moisture, while strength tests, unavailable on-line, continued to be done in the lab for each reel.

Reference and verification methods

The question has been raised in some of TAPPI's 12 divisions whether to institute TAPPI test methods for use with on-line measurement devices. The Paper Machine Sensors Subcommittee is currently working on two items to clarify the use of on-line sensors in mills. The first is standardizing the method of readout so that measurements taken by sensors from different suppliers can be read the same. Secondly, the subcommittee is working on methods to verify that calibration and accuracy of on-line sensing equipment are correct. The advantage to having reference and verification methods would of course be that on-line measurements from different paper machines us-

ing different equipment could be compared. For mills, this would provide a standard.

The interest for reference methods evolves from the way on-line measurement often differs from laboratory test methods. For example, lab smoothness tests use various air leak methods, while on-line measurements of this property use optical principles. Results of each method are valid for practical use, but do not necessarily correlate with each other. Reference methods for on-line sensors would put laboratory and on-line methods on the same ground.

Manufacturers agree that reference methods for on-line sensing equipment could be helpful to them in proving the reliability of their equipment, which is already highly rated. Reference methods have to be examined for their appropriateness. For example, when on-line moisture sensors came into common use, the TAPPI test method for sheet moisture was revised to make sample handling procedures more stringent. However, there are no TAPPI test methods exclusively for on-line equipment yet.

Another big plus for mills is that reference and verification methods would provide the standardization needed for ISO 9000 requirements. Since properties measured by on-line equipment could be compared, a standard would allow mills to prove consistent quality easier, and lead to quicker certification.

Reliability and limitations

The trend of on-line sensors modifying the practice of lab testing of paper properties becomes more realistic as new improvements are introduced. Many mills still put their final trust in manual testing results from the lab. Mills also depend on lab tests when their customers are performing similar checks to verify quality of the products as received. For those tests that are performed on-line, the lab may check the results to back up the on-line equipment. Checking the on-line measurement by using the lab maintains the mill's confidence in the result, and thus the equipment. The mill is only limited by tests it cannot yet perform on-line, which guarantees the lab a place in the mill for some time to come. In other words, laboratory tests will remain necessary for those variables not measured on-line, and for comparison with lab tests done by the mill's customers.

Reliability of on-line testing equipment is verified regularly by most mills. Mill personnel also have access to detailed diagnostic information relating to the equipment, such as calibration verification and maintenance factors that maintain performance. Mills have added routine sensor verification programs in order that their ship by the gauge programs continue to be accurate. Today, many manufacturers of on-line equipment are exhibiting up-times near 100%.

"Most of today's sensors are the product of several generations of sensor products, and the processes and the environments in the paper industry are well understood," said Lantz.

According to Steve Sturm, principal measurement physicist for ABB Industrial Systems, mills don't always know how their on-line equipment should be operated and maintained. Uncalibrated and poorly maintained sensors seriously harm readings, and thus, reliability.

"If good statistical process control procedures are used to verify on-line instrument capability then users will find that on-line instruments can be relied upon," said Sturm.

The future

Mills can expect improvements in products already on the market. Coat weight sensors will continue to improve in their ability to compare not only coat weight, but also the ratio of components, such as titanium dioxide, clay, calcium carbonate, and latex binder. Eventually, this may lead to a binder migration sensor for quality optimization troubleshooting. Also, sensors for headbox jet velocity, accurate headbox consistency, and solids retention on the wire will be used to optimize sheet forming.

Suppliers continue to expand into more areas down the machine, such as finishing and inspection. Expect more on-line sensors to come about in the wet end and the pulp mill, too.

The only limitation for on-line sensors at this point seems to be price. On-line sensing equipment is not cheap to come by, but typically is found to be economically justified. Mills continually list benefits of on-line sensors as improvement in product quality, process efficiency, raw materials savings, and machine productivity.

Tappi Journal interviewed John W. Walkinshaw, professor, University of Lowell; Keith Lantz, marketing manager for sensors and scanners, Measurex; Chuck Veal, vice president, Chemtrac Systems; Bruce Kopkin, general manager, Lippke Systems North America; Keith Masters, application consultant, Honeywell; and Steve Sturm, principal measurement physicist, ABB Industrial Systems for this article. Many of their responses were incorporated into the body of this article.

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