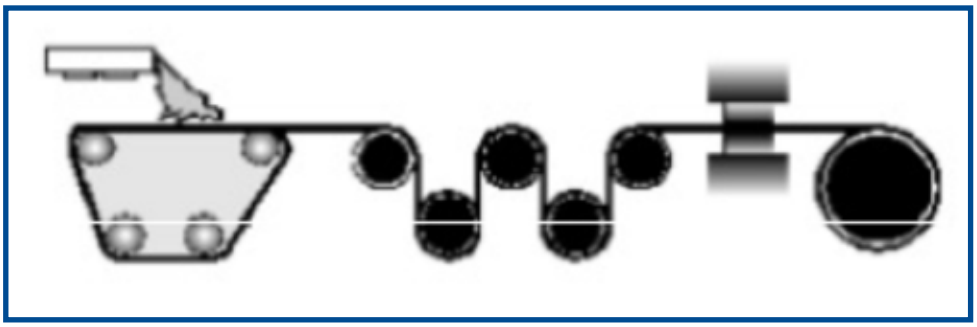
On-machine Ultrasonic Sensors For Paper Stiffness

Stiffness Will Reduce Industry's Costs by Improving First Quality, Saving Fiber and Energy, and Increasing Production

As much as 5 percent of the paper produced each year is considered sub-standard and requires repulping and remanufacturing to improve its mechanical properties and strength. The availability of on-line sensors that measure these parameters during production would quickly signal a drop in paper quality and minimize substandard product. It is known that the velocity of ultrasound can be used to determine various mechanical properties of paper—for example, the square of ultrasonic velocity is proportional to paper stiffness. Technology that measures the transit time of ultrasound through the thickness direction (ZD) of a moving paper web is being developed by the Institute of Paper Science and Technology (IPST), with funding from the Department of Energy's Office of Industrial Technologies (OIT).

Successful implementation of ultrasonic velocity instrumentation will allow the manufacturing process to be controlled to stiffness targets rather than basis weight targets. This will provide more effective use of raw materials, conserve energy, and produce products with improved uniformity and performance. Additional energy savings will accrue because of optimal use of energy during refining and because product uniformity will lead to improved energy efficiency during converting processes.



Measurement of paper quality before the reel will permit increased use of recycled fibers.

Benefits for Our Industry and Our Nation

- Avoids repulping and remanufacturing costs
- Decreases moisture entering the dryer
- Decreases water use and wastewater discharges
- Allows use of a higher percentage of recycled fiber than in standard operations
- Reduces the amount of fiber required
- Enhances the uniform appearance and performance of the product
- Improves the efficiency of subsequent converting processes
- Avoids the "hidden waste" of lost fiber quality during drying and rewetting

Applications in Our Nation's Industry

The new technology is available to manufacturers of paper products. While it is applicable to most lines of paper, it is especially useful in producing strong packaging paper and paperboard.

Project Description

Goal: To develop sensors and instrumentation to measure the velocity of ultrasound in the in-plane and thickness direction (ZD) of the paper web as it is being made on the paper machine.

IPST and the Herty Foundation developed and tested pilot-scale prototype units for measuring both in-plane and out-of-plane (z-plane) ultrasonic velocity. Full-scale proof-of-principle units were verified at IPST and Herty, and then demonstrated on a linerboard paper machine at a Georgia-Pacific mill in Cedar Springs, Georgia. Testing in a commercial production environment demonstrated the practical application and benefits of the technology and will establish the confidence required to proceed to commercialization of the technology.

Results

- Successfully demonstrated the out-of-plane (ZD) ultrasonic technology based on fluid-filled wheels containing ultrasonic transducers on a commercial paper machine.
- Demonstrated the sensitivity of on-machine ZD measurements to refining and calendaring.
- On-machine ZD measurements correlate well with laboratory measurement of the paper properties. For #69 linerboard, the correlation of ZD transit time with plybond and with ZDT (Z-direction tensile or internal bond strength) was greater than 0.8 (R squared)
- Concluded that the display of ZD data to the operator as a time trend and/or a contour map of scan-by-scan cross-web profiles should provide constant visibility of product status and early warning of process upsets. This would help the operator maintain stable operation of the paper machine and make efficient process adjustments through grade changes.

Project Partners

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The Herty Foundation
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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

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