Increasing Yield and Quality of Low-temperature, Low-alkali Kraft Cooks with Microwave Pretreatment

Minimizing the Effect of Variations in Fiber Sources Prior to Pulping

Approximately half of the energy and chemicals used to pulp wood are required to drive reaction chemicals into the center of the thin wood chips during pulping. Microwave pretreatment is an energy-efficient, environmentally-friendly technology which transports chemicals into wood chips. In addition to directly reducing the energy required to pulp wood, microwave pretreatment decreases the natural gas required to operate the lime kiln by decreasing process chemical use and recycle by up to 40%. Microwave pretreatment also permits pulp mills to significantly increase the rate of pulp production. Successful implementation of microwave pretreatment technology will be of significant value in both reducing the energy density and emissions of domestic pulp mills and in increasing the amount of pulp that can be produced by larger, more efficient mills.

The project team showed that, by opening the cellular microstructures of wood, microwave pretreatment could permit pulping chemicals to pass easily into even large sections (4 inch long X 4 inch diameter) of hardwoods. The project team has demonstrated that, for both hardwood and softwood chips, microwave pretreatment can decrease both H-factor and chemicals required to pulp hardwoods and soft woods by greater than 40% with acceptable quality (kappa, handsheets) and yield.

Benefits for Our Industry and Our Nation

Microwave pretreatment improves both economic and environmental performance. Yield and throughput within existing kraft pulp mills is improved by 40% due in part to a 40% reduction in pulping chemical usage; elimination of “bottlenecks” in lime kiln and recovery boiler; and lowered processing time. Improved environmental performance is seen in a 40% reduction in natural gas use and reduction of wood losses associated with oversized chips.

Applications in Our Nation’s Industry

Microwave pretreatment technology will be applicable to kraft, soda, sulfite, and other chemical pulping processes. It is estimated the market for this retrofit technology will be up to 75 percent of chemical pulping mills.

The broken bordered pits of pretreated pine (left) and untreated pine (right). Microwaves generate steam pressure inside the wood, which breaks pit membranes and vessel cell walls, thereby enhancing the wood’s permeability to chemicals and process liquors.
**Project Description**

To develop a proof-of-concept demonstration of a microwave/RF pretreatment process that improves productivity, cost-competitiveness, and energy expenditure in conventional kraft pulping mills.

**Barriers**

Major barriers to be overcome include:

- Developing methods and technology for decreasing pulping chemicals, process time and energy, and cost required to produce a requisite amount of pulp;
- Enabling production levels and quality meeting company and customer quality while meeting acceptable economics and energy balances
- Meeting applicable requirements: International, federal, state, and local standards for environmental, safety, operating, emissions, and permitted frequency
- Finding an adequate scale-up mill demonstration site and transitioning the microwave/RF pretreatment technology from the lab to a mass-producing industrial location

**Pathways**

The objectives of this project will be achieved through (1) developing methods to improve pulp production efficiency; (2) systematic study to determine relationships between microwave parameters and wood product yield and quality; and (3) developing the data required to transfer the technology to both the forest products industry and manufacturers of large industrial microwave/RF systems;

**Progress and Milestones**

- Complete preliminary small digester experiments evaluating low-temperature and low-cooking-chemicals pulping (Completed)
- Evaluate softwood and hardwood cooks with larger test facility (Completed)
- Complete microwave pretreatment tests of logs (Completed)
- Complete handsheet and bleaching tests (Completed)
- Select demonstration site and complete tests to verify microwave/RF pretreatment in an industrial setting

**Commercialization**

Communications and Power Industries, a project partner and international manufacturer of industrial RF and microwave generators and related industrial process equipment, has a goal of development of microwave/RF pretreatment systems (generators and applicators) which can be retrofit directly into existing Kraft and soda-anthraquinone pulp mills (80% of the U.S. pulping) to increase throughput, yield, and energy efficiency while minimizing chemical use. It is likely that microwave pretreatment can also be adapted for use in sulfite and chemithermomechanical pulping mills, although these are a much smaller fraction of the pulping industry.

**Project Partners**

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- Consolidated Papers, Inc.
  Wisconsin Rapids, WI
- Potlatch R&D Center
  Cloquet, MN
- Weyerhaeuser
  Tacoma, WA

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