# Application of Near Infrared Spectroscopy for Rapid Characterization of Feedstock Material in Pulp and Paper Industry

Jan Skvaril, Konstantinos Kyprianidis, Anders Avelin, Monica Odlare, Erik Dahlquist

Mälardalen University - School of Business - Society and Engineering - Future Energy Center

**Topic:** Others

Pulp digesters can be continuous or batch reactors with significant residence time which are fed with woodchips and cooking chemicals. They deliver the pulp-fibers that are used in the production of paper, as well as black liquor that is combusted in the chemical recovery boiler. The possibility to measure what is happening inside the digester is limited. The most important quality properties of the feedstock material is content of lignin, which is being dissolved during the process, and related material reactivity. Pulp quality after the process is measured by Kappa number which is a measure of residual lignin in the pulp. One of the biggest challenges in pulp production process is the great variability in feedstock material properties. If the process is not adjusted by well-timed and appropriate operational control measures i.e. control of inlet and outlet flows and setting of the cooking recipe, it will result in the large variations in Kappa number, lower fiber quality or excess use of environmentally harmful cooking chemicals. This becomes particularly important during the swing between softwood and hardwood as part of meeting the final paper product quality requirements. Therefore, a rapid method that is capable of continuous feedstock material characterization is required. Near infrared (NIR) spectroscopy can be used for non-destructive characterization of the feedstock material. In this study, both Fourier transform and grating NIR spectrophotometers were used for NIR absorbance spectra acquisition. Each spectrum was recorded in the range between 700 and 2500 nm. During the calibration of spectra of various wood species with known lignin content, wood samples were placed on a tray so that the tray may move horizontally in a reciprocating manner underneath the sensor while maintaining the constant distance between the sensor and sample. This was done in order to simulate the movement of a real conveyor belt as used for transporting feedstock to the digester. In the on-line application the NIR meter is situated above the conveyor belt that wood up to the digester. Spectral data were pretreated with different methods such as normalization, scatter correction, smoothing, first and second derivative (Savitzky-Golay algorithm), selection of different spectral ranges and its combinations. Mathematical models to estimate lignin content were constructed using Partial Least Square Regression (PLS-R) and Principle component regression (PCR) statistical methods. Response data for model build-up were determined in the chemical laboratory according to standardized procedures including test repetitions. Different combinations of NIR instrument used, pre-treatment methods and statistical methods were evaluated in order to find the model with the best prediction performance. Results are promising and demonstrate that it is possible to characterize the lignin content and reactivity of the feedstock material by NIR spectrophotometers with reasonable prediction model performance. Improved prediction can be obtained if only selected spectral ranges are included as an input for statistical modelling; similarly using derivatives is better than using the raw spectrum. In the next step, developed statistical models for rapid lignin content prediction will be used as a feed-forward input for dynamic process control.

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