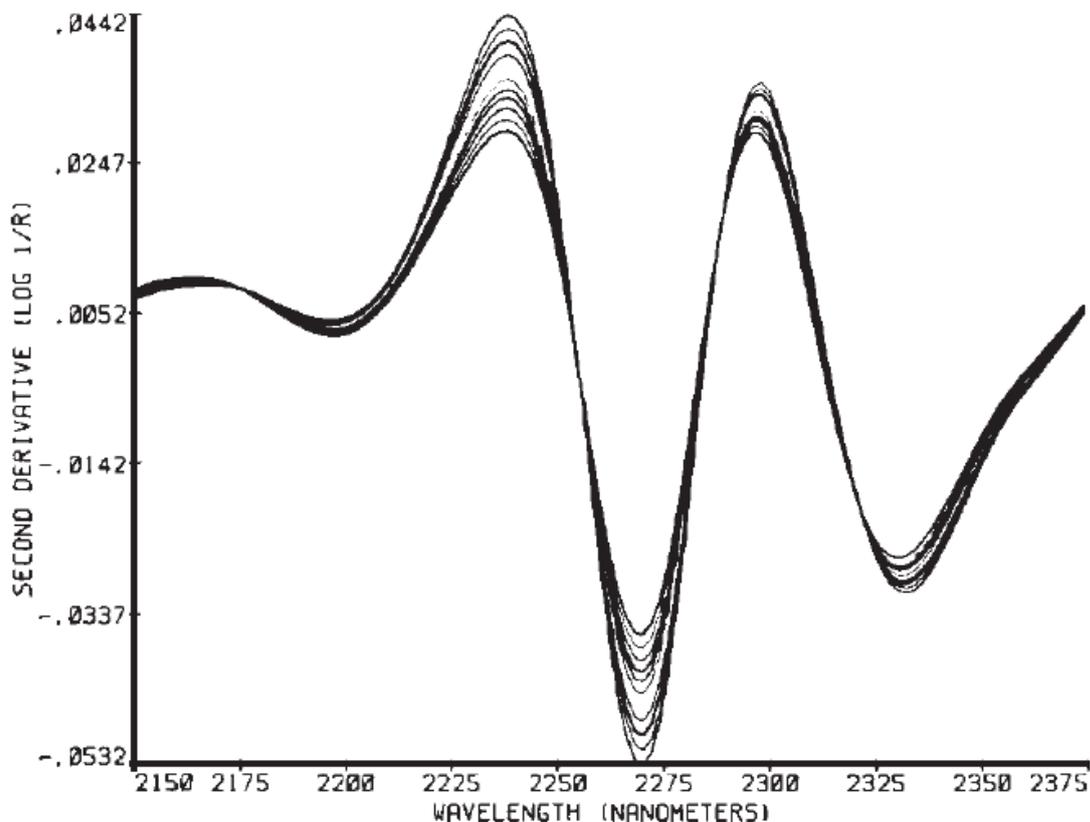


Determination of hardwood/softwood content in wood products by near-infrared spectroscopy



Near-infrared spectroscopy is ideally suited to monitor the hardwood and softwood content in pulp and paper products. The herein described method bases on the fact that the changes in hardwood and softwood content are reflected in the intensity of cellulose absorption bands in the NIR spectrum. A linear least-squares regression on second derivative spectra provided results that show a very good correlation with lab methods. Fast analysis time (< 1 min) allows manufacturing processes to be controlled on a real-time basis.

Method description

Introduction

The characteristics of paper and other wood products are affected by the components in the original wood pulp, such as the relative amounts of hardwood and softwood fibers. Hardwood and softwood fibers differ in their length and width, which affects the strength and pliability of the products made from wood pulp. Presently, the determination of hardwood to softwood ratio is performed using microscopy, which requires a highly trained microscopist, and is a tedious and time-consuming analysis. The length and width of the fibers is how the microscopist differentiates the hardwood and softwood fibers.

A rapid analysis for hardwood/softwood content for pulp and paper products, which does not require highly trained personnel would be very beneficial for quality control. Near-infrared (NIR) spectroscopy is one such method.

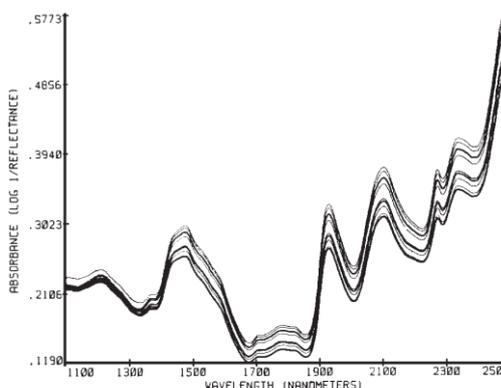
Experimental

NIR spectra of several paperboard samples were measured using a Foss NIRSystems Model 6500 in reflectance mode from 1100 to 2500 nm. Since this instrument is not available anymore, the NIRS XDS RapidContent Analyzer is recommended. The samples were cut into two inch strips and placed into an elongated sample cell with a foam backing to insure an even sample contact with the cell window. The NIR scans were co-averaged as the cell moved through the NIR beam to minimize the effects due to sample inhomogeneities. Ten paperboard samples ranging from 0 to 100% softwood were analyzed.

Results and discussion

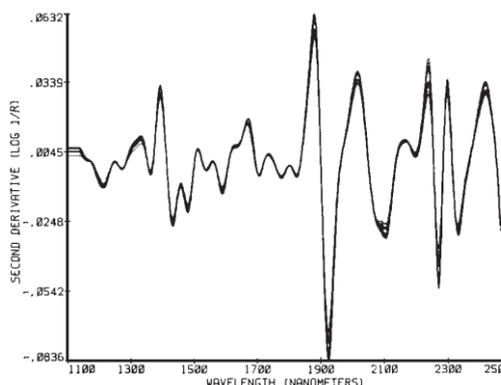
The absorbance spectra (log 1/R) for the ten calibration samples are shown in Figure 1. The baseline varies due to differences in the amount of NIR radiation reflected by the samples, and is a significant source of error if left uncorrected. By conversion of the spectra to the second derivative, the baseline variations can be minimized as shown in Figure 2. This treatment obviates surface texture variations and allows investigation of chemical content of the samples. (The second derivative math treatment inverts absorption peak maxima to second derivative peak minima with positive lobes on either side.)

Figure 1
Hard/Softwood Paper Samples

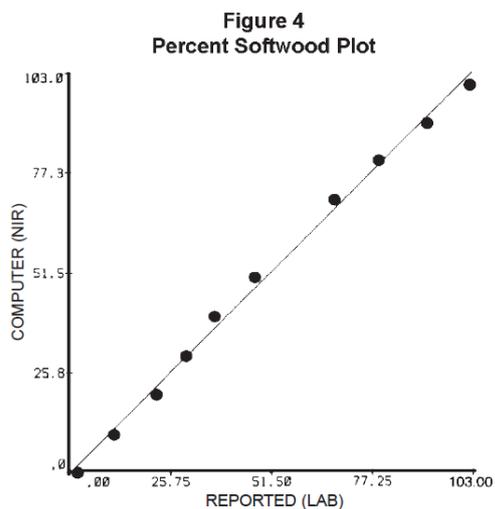
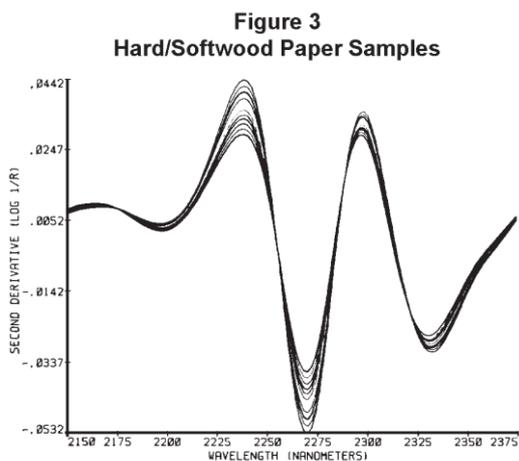


From Figure 2, it is evident that all absorption bands in the NIR spectrum change in intensity as the hardwood/softwood content changes. This suggests that the variation in the fiber length and width causes the penetration depth of the NIR beam to change. As the penetration depth increases, all absorbance bands in the spectrum increase in intensity. Since there are no major chemical differences between hardwood and softwood fibers, the change in penetration depth should be useful in monitoring hardwood/softwood content. The most logical wavelength to use would be one due to an absorption band for the major constituent in these samples (cellulose).

Figure 2
Hard/Softwood Paper Samples



Method description



To demonstrate the ability to quantitatively determine softwood content in these hardwood/softwood paperboards, a linear least-squares regression was performed at 2274 nm. This wavelength band, shown in Figure 3, is attributed to absorptions of cellulose. A correlation (R) of -0.998 and a standard error of calibration (SEC) of 2.1% were obtained. A scatter plot of NIR calculated vs. laboratory reported results is shown in Figure 4. An excellent correlation is observed between the NIR and lab method for the analysis of softwood content.

Conclusions

NIR spectroscopy offers a method for determination of hardwood/softwood content in wood products. Fast analysis time (less than one minute) allows processes to be controlled on a real-time basis, minimizing out of specification products and assuring quality products.

Other Applications

Other applications of NIR spectroscopy for the pulp and paper industry that have been successful include lignin content in pulp (see AN-NIR-8), resin uptake, kaolin treatment, additives in paper, as well as coatings, waxes, adhesives, moisture and chemical treatments in various paper products.