

Measurement of Moisture and Caffeine in Coffee

Key Words

- Near Infrared
- NIR
- Spectra-Quad
- Coffee
- Moisture
- Caffeine

Thermo Industrial Solutions Note

Introduction

In the production of coffee, the monitoring and control of moisture and caffeine are critical. The control of processing steps such as roasting and grinding are dependent upon the moisture content of the whole beans (*figure 1*). In ground coffee, product quality and shelf life are dependent on moisture content. By controlling moisture, coffee producers are able to save money by using less energy and resources. Caffeine is generally measured in the final ground product to ensure the product complies with label claims.

Moisture and caffeine can be continuously measured online in real-time using the Spectra-Quad™ Online Moisture and Constituent Analyzer from Thermo Electron (*figure 2*). The Spectra-Quad uses a measurement technique, based on Near Infrared (NIR) light absorption. It is a non-contact, non-destructive and non-hazardous method. The sensor illuminates the sample with NIR light at a wavelength that the constituent of interest such as moisture or caffeine, absorbs. The light is very low intensity and does not heat or damage the sample. The sensor measures the reflected light. The more moisture or caffeine present the more light that is absorbed and the less reflected. The reflected light is inversely proportional to the amount of the constituent in the coffee.



figure 2 – Spectra-Quad NIR Sensor

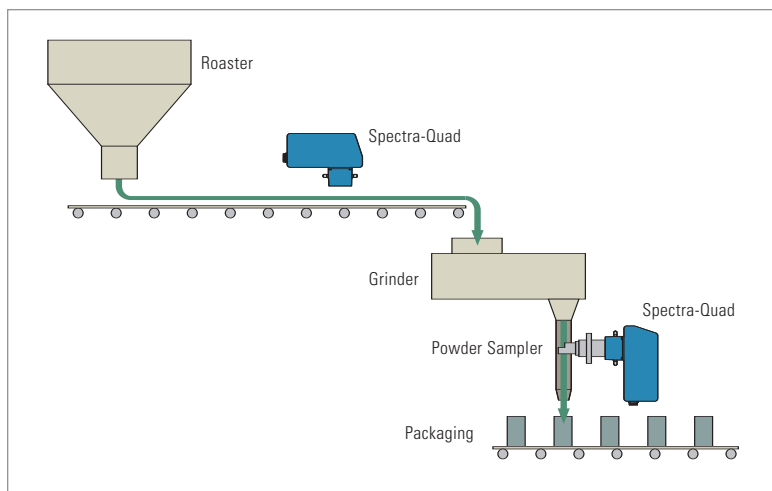


figure 1 – Coffee production process

Sensor Location

Two process locations were selected for monitoring moisture; one after the roaster, the other after the grinder prior to packaging. The Spectra-Quad is mounted over the conveyer carrying the whole roasted coffee beans. It is configured with the wavelengths best suited to measure moisture in whole beans. Using a 4-20 mA output, the moisture measurement of the whole beans is used to control water dosing prior to transport to the grinder.

A second Spectra-Quad NIR sensor equipped with the powder sampler option was located after the grinder in the closed pneumatic transport system. The powder sampler has a cup like design that catches the ground coffee. After the analysis is complete, the cup is emptied by a puff of air. The powder sampler's sanitary stainless steel design is easy-to-install, and has no moving parts. The Spectra-Quad is configured to measure moisture and caffeine simultaneously in ground coffee. The results from the Spectra-Quad are used to control moisture in the final product and to verify the product is within specification.

Calibration

The Spectra-Quad NIR sensors were calibrated using five or more samples of whole and ground coffees that cover the expected range for moisture and caffeine. The samples are analyzed using a laboratory reference method and by the Spectra-Quad. The laboratory reference method for moisture is loss on drying and for caffeine is Liquid Chromatography (LC). A linear regression is performed using the laboratory and Spectra-Quad values. The result is a calibration equation that can be used to predict the moisture or caffeine content of in process samples. The data used to generate the calibrations for moisture in whole beans, moisture in ground coffee and caffeine in ground coffee are presented in *tables 1, 2 and 3 respectively*.

The goodness of the calibration or its ability to accurately predict the constituent concentration is described by the correlation coefficient, which is a decimal value between 0 and 1. A perfect calibration is described by a correlation coefficient of 1. Therefore, the closer the correlation coefficient is to the value of one the better the calibration. The correlation

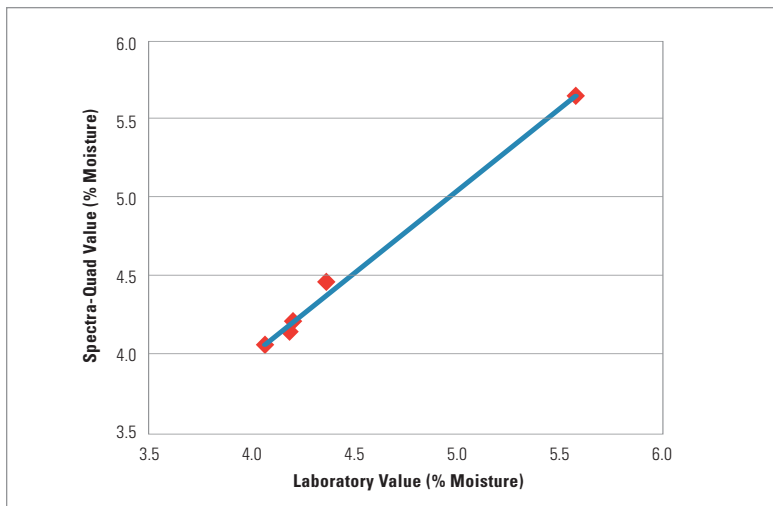


figure 3 – Calibration Plot for Moisture in Ground Coffee

coefficient is presented for each of the data sets. The results can also be represented graphically by plotting the laboratory results against the Spectra-Quad readings. The straight line on the graph represents the result of the linear regression. The calibration plot for the moisture in ground coffee analysis is presented in *figure 3*.

Conclusions

Coffee producers are able to monitor moisture and caffeine at multiple locations in their process with the Spectra-Quad Online Moisture and Constituent Analyzer. The Spectra-Quad provides the flexibility needed to analyze both whole beans and ground coffee. The moisture concentration is used to control the process resulting in improved efficiency and reduced costs. The caffeine content is monitored to verify the product meets label claims.

Other Applications in the Food Industry

The Spectra-Quad can also be applied to the measurement of moisture in many other food products including snack foods, flours, cookies, dairy products and cereals.

Laboratory Value (% Moisture)	Spectra-Quad Value (% Moisture)
4.81	4.76
4.80	4.82
5.08	5.03
5.33	5.38
5.55	5.50
5.60	5.64

table 1 – Moisture in Whole Beans
(Correlation Coefficient: 0.995)

Laboratory Value (% Moisture)	Spectra-Quad Value (% Moisture)
4.06	4.06
4.18	4.14
4.20	4.20
4.36	4.46
5.57	5.65

table 2 – Moisture in Ground Coffee
(Correlation Coefficient: 0.997)

Laboratory Value (% Caffeine)	Spectra-Quad Value (% Caffeine)
0.04	0.01
0.28	0.25
0.51	0.48
0.74	0.67
0.97	0.85
1.08	1.11

table 3 – Caffeine in Ground Coffee
(Correlation Coefficient: 0.992)

For More Information

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