Application Note AN-NIR-117

利用近外光分析煤炭中的水分、灰分、和物含量

Near-infrared spectroscopy (NIRS) offers results in seconds

Moisture, ash, fixed carbon, and volatile content are the most important parameters regarding coal analysis. The standard methods to measure these parameters involves combustion in special furnaces. Prior to combustion, the coal samples need to be pulverized and weighed. To determine the volatile content in coal, combustion needs to be performed under a controlled atmosphere of pure nitrogen at temperatures over 900 ° C.

Conventional methods used to determine the key quality parameters for coal samples are time consuming and, based on the nitrogen consumption, cost intensive. Near-infrared (NIR) spectroscopy is an excellent alternative method to simultaneously determine all four quality parameters in less than one minute without any sample preparation. This Application Note demonstrates that the Metrohm NIRS DS2500 Solid Analyzer operating in the visible and near-infrared spectral region (Vis-NIR) offers users an easier way to perform coal quality analysis.

EXPERIMENTAL EQUIPMENT

Different pulverized coal samples (n = 30) with a particle size of 0.2 mm were measured on the Metrohm NIRS DS2500 Solid Analyzer (**Figure 1**). All measurements on the DS2500 Solid Analyzer were performed in rotation using a large sample cup to average the subsample spectra. This sample setup reduces the influence of the particle size distribution of the coal particles. Data acquisition and prediction model development were performed with the software package Vision Air Complete.

Table 1. Hardware and software equipment overview.

Equipment	Article number
DS2500 Solid Analyzer	2.922.0010
DS2500 large sample cup	6.7402.050
Vision Air 2.0 Complete	6.6072.208

EXPERIMENTAL EQUIPMENT

Figure 1. Metrohm NIRS DS2500 Solid Analyzer with the DS2500 large sample cup for measuring coal samples in rotation.

All measured Vis-NIR spectra (Figure 2) were used to create a prediction model for quantification of the calibration models. The quality of the prediction model was evaluated using correlation diagrams which display a high correlation (R^2 > 0.89) between the Vis-NIR prediction and the reference methods for all parameters. The respective figures of merit (FOM) display the expected precision and confirm the feasibility during routine analysis (Figures 3–6).

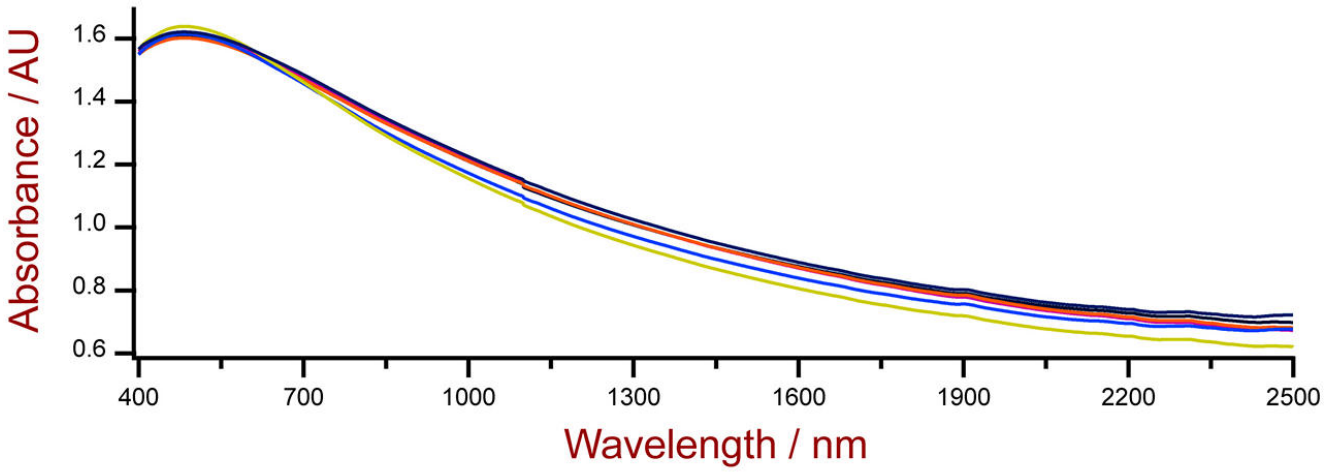

Figure 2. Selection of Vis-NIR spectra of coal samples analyzed on a DS2500 Solid Analyzer with the large sample cup.

RESULT ASH CONTENT

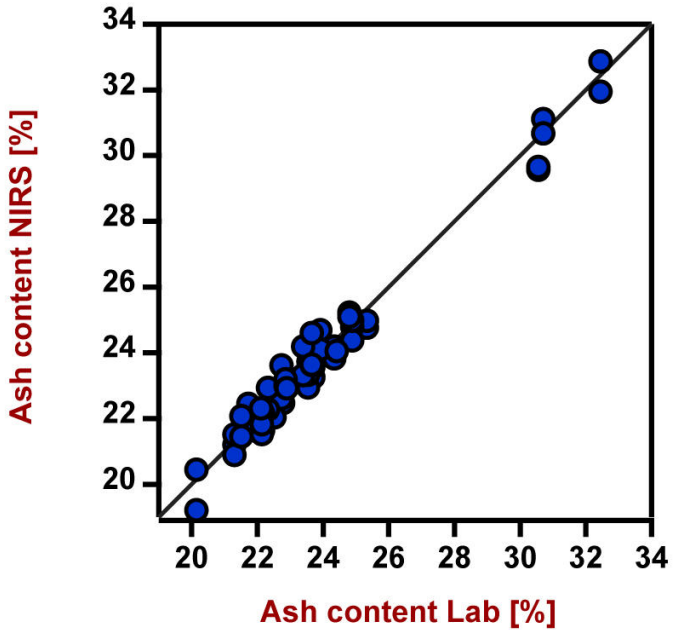

Figure 3. Correlation diagram and the respective figures of merit for the prediction of ash content in coal using a DS2500 Solid Analyzer. The lab value was evaluated according to ASTM D3174.

Figures of Merit	Value
R^2	0.973
Standard Error of Calibration	0.48%
Standard Error of Cross-Validation	0.73%

RESULT VOLATILE CONTENT

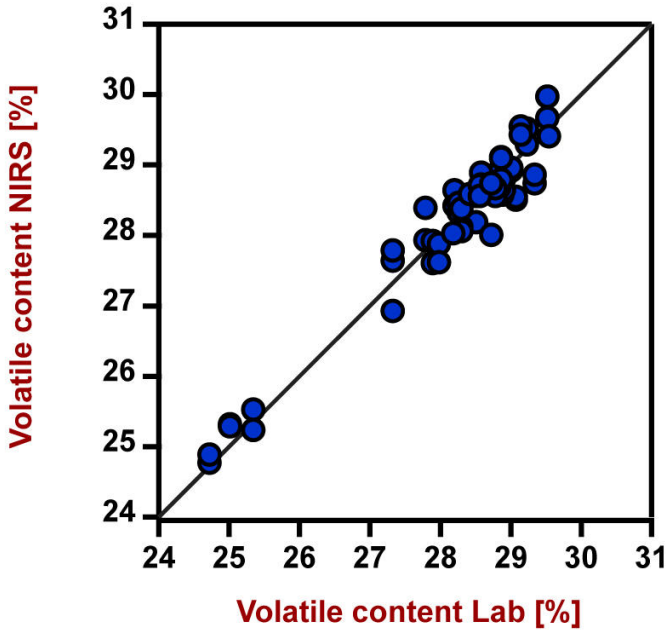

Figure 4. Correlation diagram and the respective figures of merit for the prediction of volatile content in coal using a DS2500 Solid Analyzer. The lab value was evaluated according to ASTM D3175.

Figures of Merit	Value
R^2	0.944
Standard Error of Calibration	0.29%
Standard Error of Cross-Validation	0.38%

RESULT FIXED CARBON CONTENT

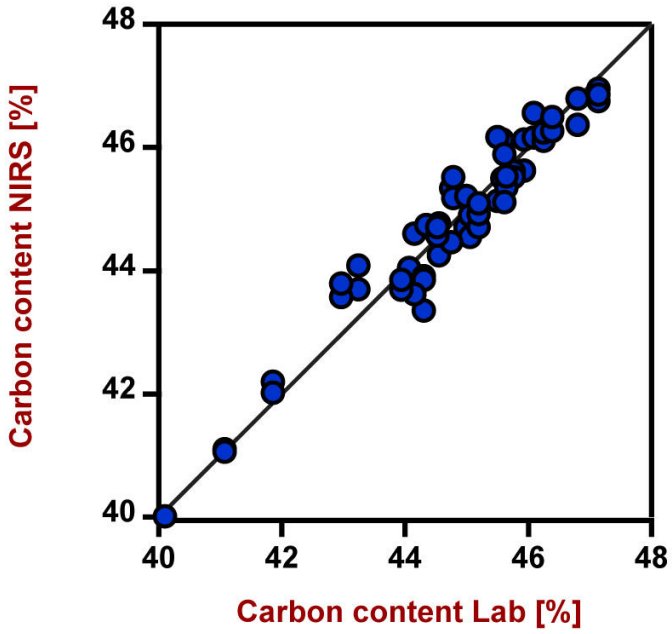

Figure 5. Correlation diagram and the respective figures of merit for the prediction of fixed carbon content in coal using a DS2500 Solid Analyzer. The lab value was evaluated according to ASTM D3172 (furnace combustion method).

Figures of Merit	Value
R^2	0.937
Standard Error of Calibration	0.40%
Standard Error of Cross-Validation	0.52%

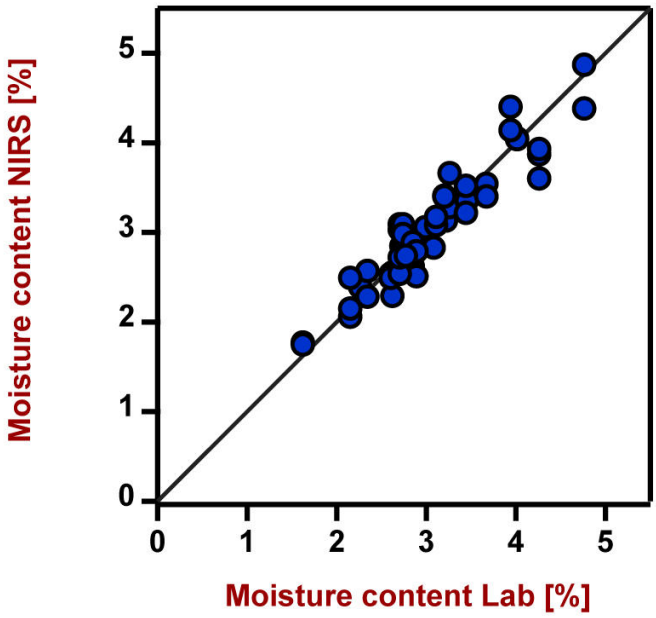

Figure 6. Correlation diagram and the respective figures of merit for the prediction of moisture content in coal using a DS2500 Solid Analyzer. The lab value was evaluated according to ASTM D3173 (furnace drying method).

Figures of Merit	Value
R^2	0.896
Standard Error of Calibration	0.23%
Standard Error of Cross-Validation	0.28%

CONCLUSION

This Application Note demonstrates the feasibility of the Metrohm NIRS DS2500 Solid Analyzer for the determination of ash, moisture, fixed carbon, and volatile content in coal. Vis-NIR spectroscopy enables fast determination (**Table 2**) without any sample preparation. In addition, the use of nitrogen gas is obsolete which reduces analysis cost.

Table 2. Time to result overview for different coal quality parameters using standard analysis methods.

Parameter	Method	Time to result
Ash content	Volatile matter furnace	1–2 h: grinding, weighing, combustion
Volatile content	Volatile matter furnace	0.5 h: grinding, weighing, combustion
Fixed carbon content	Volatile matter furnace	0.5 h: grinding, weighing, combustion
Moisture content	Volatile matter furnace	0.5 h: grinding, weighing, combustion

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CONFIGURATION

DS2500 Solid Analyzer

固的近外光,用于生境和室中的量。

DS2500 分析是的活解决方案,用于整个生程中的固体、乳膏和液体行常分析。其固的使 DS2500 Analyzer 分析不受灰、湿度、振和温度波的影,因此非常用于在劣的生境中使用。

DS2500 涵盖了从 400 到 2500 nm 的整个光范,并能在不到一分内提供准和可再的果。DS2500 Analyzer 足制行的要求,并由于操作便而能助用完成其日常工作任。

由于与匹配,附件可以承受任何具有挑性的品型,例如:粒料之的粗粒固体或乳膏之的半固体品,可得果。量固体的候,使用 MultiSample Cup 可以提高生率,可以自批量量多 9 个品。