

Fast, Accurate, Robust Analysis of Multiple Elements in Steel by ICP-OES

Quality control of steel samples using the Chinese GB/T 20125-2006 method

Analyze elemental impurities in accordance with industry standard methods

Three steel certified reference materials (CRMs) were prepared for analysis according to the Standardization Administration of China GB/T 20125-2006 standard. Fourteen elements, including sulfur, phosphorus, nickel, and iron, were measured in microwave acid-digested steel samples using the Agilent 5800 Vertical Dual View (VDV) ICP-OES.

The 5800 ICP-OES was fitted with an AVS 7 sampling valve system and SPS 4 autosampler to improve sample throughput. Many steel-production quality control (QC) laboratories process hundreds of samples per day, so achieving high productivity with easy-to-use and reliable instrumentation is critical.

The 5800 ICP-OES also uses various tools that provide useful information on samples, methods, and the operational status of the instrument. IntelliQuant, IntelliQuant Screening, and Early Maintenance Feedback (EMF) improve data accuracy and reduce unscheduled downtime for maintenance, providing labs with greater confidence in the method and results.

Handling spectral interferences with effective techniques

Spectral interferences arising from stainless-steel sample matrices—especially line-rich iron—can impact the accuracy of the data for some analyte elements such as sulfur. The 5800 ICP-OES include freeform optics to enhance spectral resolution and advanced Vista Chip III detector that lowers detection limits. Agilent ICP Expert software includes the widest range of background correction techniques for ICP-OES, including Fitted Background Correction (FBC), Fast Automated Curve Fitting Technique (FACT), and off-peak background correction.

Finding the best wavelengths

IntelliQuant Screening was used for wavelength selection and to determine the approximate—semiquantitative—concentration of elements in some of the steel CRM digests, which was helpful for determining the concentrations of calibration standards. Figure 1 shows the IntelliQuant Screening results for As in the BCS-336 steel CRM. The IntelliQuant algorithm automatically identified 197.198 nm as the best As wavelength to use in the quantitative method, as indicated by the highest star rating and 'green' tick.

Element	Used	Flags	Wavelength	Rating	Concentration	Intensity	Background
As			188.980	*	221.63	1397.6	1686.5
			193.696	**	289.12	1707.8	1979.8
	✓		197.198	***	264.05	1167.8	2592.0
			228.812	**	193.97	605.7	3709.6

Figure 1. Selection of As wavelength using star ranking of lines in steel CRM.

Background and interference correction

To reduce the impact of spectral interferences arising from the steel sample matrices, different background correction methods were used. For elements where there were no direct overlaps, FBC was used. FBC is the simplest correction method, requiring no setup. For elements that were affected by more complex background signals, FACT was used. A 5000 mg/L Fe solution was used as a matrix in the FACT models.

Figure 2 shows a FACT model for Co 230.786 nm with corrections for Cr 230.752 nm, Ni 230.778 nm, Mo 230.798 nm, and Ni 230.817 nm. FACT has accurately modeled the interfering peaks and resolved the analyte signal, providing accurate results for Co.

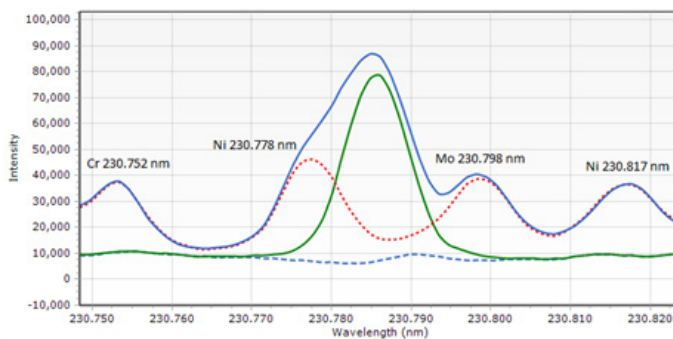


Figure 2. FACT model for Co 230.786 nm.

Robust and stable analyses

Analyzing samples with high levels of total dissolved solids, such as steel-digests, can affect instrument stability over long analytical runs. So, a robust sample introduction system and a high energy plasma are needed for reliable analysis of these sample-types. Also, the high iron content of steel can shorten the torch life. The vertical torch position of the 5800 provides excellent plasma robustness and long-term stability and ICP Expert software helps analysts schedule routine cleaning and maintenance using EMF indicators.

The long-term stability of this application was tested by analyzing 217 CRM samples over six hours by ICP-OES. A QC solution was measured after every 10 samples and the recoveries are shown in Figure 3. All measurements were within $\pm 10\%$ of the expected concentrations, demonstrating the excellent robustness and stability of the 5800 VDV ICP-OES for the analysis of high matrix steel sample digests over six hours.

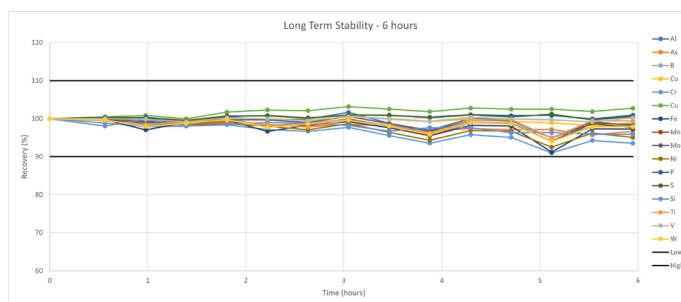


Figure 3. Stability of trace elements in a QC sample analyzed after each block of 10 steel digest samples over six hours.

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Find out more

Full details of this study can be found in [Agilent publication number 5994-4458EN](#)

