APPLICATION NOTE - 16

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LAB-X5000

LAB-X5000 for the rapid process and quality control of minerals

INTRODUCTION

Silica (silicon dioxide SiO_2) sand is one of the most abundant industrial raw material on the surface of the Earth. It is used in many industries, such as metal production (for foundry casting moulds), hydraulic fracturing, ceramics and glass making. The use and price of silica sand are linked to its purity. Contents of iron oxide (Fe_2O_3) and impurities such as aluminium oxide (Al_2O_3) and titanium oxide (TiO_2) need to be controlled as they impart physical properties to the final product.

Ball clay has high plasticity and good white-fired colour, and it is commonly used in the production of ceramic sanitaryware and tableware. Its resistance to high temperatures also makes it an ideal component in the fabrication of kiln insulation bricks and electrical porcelain insulators.

Kaolin (China clay) is primarily used in the paper industry. As a coating or a filler, its white colour and fine particle size improve the appearance of paper and its printability.

In the production and use of minerals and ceramics, quality control includes the chemical analysis of raw materials and final products. Traditional analysis techniques include atomic absorption spectrometry (AAS), and inductively coupled plasma spectrometry (ICP). Both involve lengthy chemical preparation that demands a high degree of skill. In contrast, X-ray fluorescence (XRF) spectrometry is one of the simplest techniques for analysis in minerals extraction facilities because the sample preparation is simple, and the analysis is fast. Hitachi High-Tech have a long and highly respected reputation within the minerals industry with instruments such as the Lab-X3000 series, Twin-X and X-Supreme providing simple to use, accurate, cost-effective and dependable benchtop energy-dispersive XRF (EDXRF) analysis round the clock.

MINERALS ANALYSIS MADE EASY

Now with the Hitachi High-Tech LAB-X5000 EDXRF analyser, the analysis of sand and clay couldn't be easier. Routine analysis is carried out by placing a pressed minerals pellet into a sample holder, placing the holder in the LAB-X's analysis port, and pressing a button to start the measurement. Results are available in minutes on the large, industrial LCD touch screen, showing the contents for all key oxides.

The combination of a high-resolution detector and optimised calibration parameters ensure that you get results you can trust. For this application, the LAB-X is equipped with a sample spinner to compensate for residual sample heterogeneity and deliver repeatable results. For most analyses, built-in atmospheric compensation delivers reliable analysis without the need for helium or vacuum purge, minimising the cost per analysis while retaining optimum stability. Helium is used only when strictly necessary, for example when measuring low levels of light elements such as Na, Mg and Al.

Users can set-up a QC routine with concentration targets and lower and upper limits for each key element; the displayed control charts clearly show if the test is in control.

With up to 100,000 results stored on the analyser itself, operators can view new and old results easily, print them on the integrated printer for a hard-copy record, download them on a USB memory device, and even upload them to our ExTOPE Connect cloud service to manage them remotely. With the LAB-X connected to WiFi, the results are uploaded to your cloud account automatically, so you do not need to be near the analyser to access your data.

Clear results display

SAMPLE PREPARATION

For precise and accurate multi-element analysis, it is essential to prepare the samples to meet the high standards of production control that are the norm in the minerals industry. This means grinding a powder sample in a swing mill. A grinding additive can be used to prevent the sample clogging the mill and to help it bind into a pellet. The best type of additive is one available as tablets of precise weight so that only the sample needs weighing. Hitachi High-Tech supply one that has been used in the minerals industry for many years (Part Number 10005278). The resultant fine mixture is formed into a strong pellet (usually 40mm diameter) by compression in a die using a hydraulic press. Operators then fit the pellet into a pellet holder (Part Number 10001316), place it in the LAB-X's analysis port, and press the Start button on the analyser.


Pressed pellet in pellet holder


Starting the analysis

PERFORMANCE AND RESULTS

The data shown in this section highlights the typical performance that the LAB-X delivers. For each mineral type, an empirical calibration was created by measuring a series of assayed production samples to establish the relationship between the oxides' contents and their X-ray signal. The calibrations used the pre-defined parameters included in the LAB-X5000 Minerals package (pre-loaded in the analyser).

The limits of detection were calculated from the results of ten repeat measurement of a blank sample (SiO_2), and the precision from the results of 10 repeats of samples containing elements at the mid-range concentration levels.

Table 1 also highlights the difference in performance when measuring samples as ground powders and as pressed pellets.

Table 1: Typical calibration performance for low Fe_2O_3 in silica sand (air path)

Sample form	Concentration range (mg/kg)	Standard error of calibration (mg/kg)	Guaranteed limit of detection (3σ) (mg/kg)	Limit of quantification (10σ) (mg/kg)	Mid-range precision (95% confidence) (mg/kg)	Analysis time (seconds)
Ground powders	2 – 900	20	9	20	15	60
		20	4	9	7	300
Pressed pellets	2 – 900	8	7	16	7	60
		8	3	7	3	300

Table 2: Typical calibration performance for the rapid multi-element analysis of low-TiO_2 silica sand – Pressed pellets (Helium path)

Analyte	Calibration range (% m/m)	Standard error of calibration (% m/m)	Guaranteed limit of detection (3σ) (% m/m)	Limit of quantification (10σ) (% m/m)	Mid-range precision (95% confidence) (% m/m)	Analysis time (seconds)
Al_2O_3	0.18 – 0.27	0.006	0.005	0.010	0.003	200
SiO_2	99.2 – 99.8	0.03	n/a	n/a	0.02	
K_2O	0.002 – 0.064	0.0014	0.0020	0.0045	0.0016	
CaO	0.000 – 0.022	0.0013	0.0011	0.0025	0.0012	
TiO_2	0.027 – 0.092	0.0072	0.0018	0.0040	0.0011	
Fe_2O_3	0.04 – 0.45	0.012	0.001	0.003	0.001	

Table 3: Typical calibration performance for the rapid multi-element analysis of high-TiO_2 silica sand – Pressed pellets (Helium path)

Analyte	Calibration range (% m/m)	Standard error of calibration (% m/m)	Guaranteed limit of detection (3σ) (% m/m)	Limit of quantification (10σ) (% m/m)	Mid-range precision (95% confidence) (% m/m)	Analysis time (seconds)
Al_2O_3	0.17 – 0.37	0.027	0.007	0.024	0.005	200
SiO_2	98.4 – 99.5	0.30	n/a	n/a	0.02	
K_2O	0.002 – 0.064	0.0014	0.0020	0.0040	0.0023	
CaO	0.000 – 0.022	0.0013	0.001	0.002	0.001	
TiO_2	0.16 – 0.29	0.014	0.002	0.003	0.003	
Fe_2O_3	0.10 – 0.95	0.020	0.002	0.004	0.002	

Table 4: Typical calibration performance for the rapid multi-element analysis of ball clay (Helium path)

Analyte	Calibration range (% m/m)	Standard error of calibration (% m/m)	Guaranteed limit of detection (3σ) (% m/m)	Limit of quantification (10σ) (% m/m)	Mid-range precision (95% confidence) (% m/m)	Analysis time (seconds)
Na_2O	0.25 – 0.44	0.038	0.009	0.019	0.006	180
MgO	0.33 – 0.68	0.011	0.018	0.040	0.011	
Al_2O_3	13.1 – 26.1	0.66	n/a	n/a	0.03	
SiO_2	55.2 – 78.7	1.49	n/a	n/a	0.21	
K_2O	1.37 – 2.38	0.059	0.008	0.017	0.006	
CaO	0.05 – 0.31	0.006	0.002	0.005	0.003	
TiO_2	1.17 – 1.89	0.051	0.001	0.003	0.009	
Fe_2O_3	0.75 – 1.37	0.018	0.002	0.005	0.002	

SUMMARY

Once calibrated, Hitachi High-Tech's LAB-X5000 provides reliable minerals analysis, enabling operators to make process decisions fast. Its ease of use and ruggedness make it an ideal tool at the quarry QC laboratory, delivering results within minutes for maximum productivity.

Visit **www.hitachi-hightech.com/hha** for more information.

ORDERING INFORMATION

The minimum required for this application is:

- LAB-X5000 Minerals package, which includes: the analyser with sample spinner and Helium purge, user manual (on USB memory device), pre-loaded method parameters and method sheets (calibration instructions), setting up samples, pressed pellet holders and a consumables pack.

Optional:

- Grinding/binding pellets, bag of approximately 5000, Part Number 10005278

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