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Quick mineralogical quantification of blended cement

Aeris
Cement edition

Introduction
One of the key elements of reducing CO_2 emissions during cement production is to reduce the clinker-to-cement ratio by replacing clinker with supplementary cementitious materials (SCMs). The amount of SCMs in cement can go up to several tens of percent. This drastically reduces the carbon footprint per kilogram and also reduces fuel consumption. What is more, many of these blended cements have better properties than Ordinary Portland Cement (OPC).

Essential for the production of these cements is the careful blending of the SCMs into the cement mix. As SCMs have many elements in common with the clinker, direct mineralogical probing by X-ray diffraction is the only way to obtain the necessary information for controlling and guaranteeing good SCM feed. This information can also be used to benchmark against cement classification norms like EN-197, ASTM C150, ASTM C595 and ASTM C1157.

The Cement edition of Aeris is the first benchtop X-ray diffractometer designed for process control and quality assurance in a cement plant. In this data sheet we show typical results from a phase quantification of blended cements along with the repeatability of these results.

Experimental
In order to show the capabilities of the Cement edition of Aeris two types of blended cements were analyzed:
1) a blended cement containing both fly ash and slag;
2) a pozzolan cement.

The measurement time was 10 minutes, followed by automatic phase quantification. Each sample was measured 15 times in order to judge the repeatability of the analysis chain.

Summary

When producing blended cements, direct mineralogical probing with X-ray diffraction is essential for correct and accurate control of the SCM feed into the cement mix. The Cement edition of Aeris is an easy-to-use benchtop X-ray diffractometer and the first that is automatable and fully suited for process control.

In this data sheet we show that quantification results of the phases in blended cements are both accurate and precise, showing that the Cement edition of Aeris is a perfect quality assurance tool for these innovative cements.

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Result and discussion

Figures 1 and 2 show the quantitative results of the fly ash/slag cement and the pozzolan, respectively. The usual cement phases are quantified along with SCMs. Note that slag, fly ash and pozzolan themselves contain many phases, but are quantified as a whole [1].

The results of the phase concentrations of both cements are also presented in Table 1. The standard deviations of the repeatability of all phases are well below 1 wt%, making the analyses with Aeris well-suited for process control.

[1] N. Scarlett and I. Madsen, "*Quantification of phases with partial or no known crystal structure*," Powder Diffr., vol. 21, pp. 278-284, 2006.

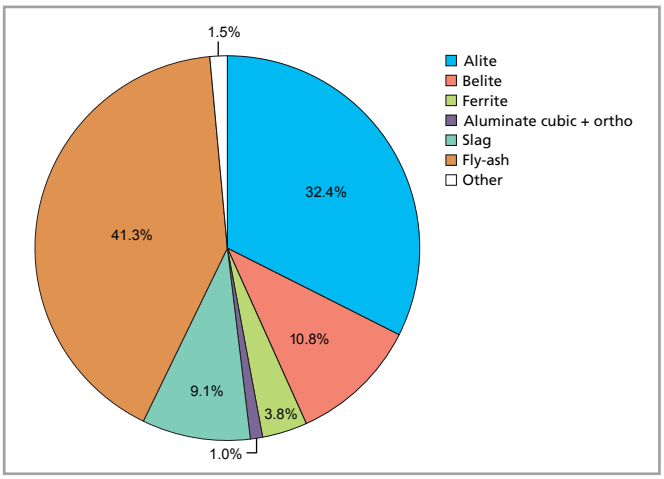

Figure 1. Phase concentrations of cement containing both slag and fly ash

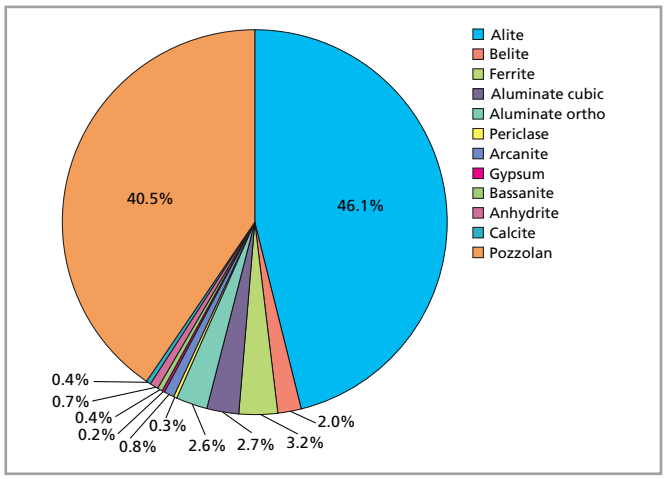

Figure 2. Phase concentrations of a pozzolan cement

Table 1 Repeatability at 1σ of the fly-ash/slag and pozzolan cement. Values are in wt-%.

Fly-ash/slag	Alite	Belite	Ferrite	Aluminate cubic	Aluminate ortho	Free lime	Portlandite	Periclase	Arcanite	Gypsum	Bassanite	Anhydrite	Calcite	Fly-ash	Slag
Mean	32.4	10.8	3.79	0.60	0.43	0	1.00	0.13	0	0.08	0.01	0.09	0.15	41.4	9.1
Standard deviation	0.3	0.1	0.04	0.03	0.03	0	0.04	0.03	0	0.02	0.02	0.02	0.03	0.4	0.8
Pozzolan	**Alite**	**Belite**	**Ferrite**	**Aluminate cubic**	**Aluminate ortho**	**Free lime**	**Portlandite**	**Periclase**	**Arcanite**	**Gypsum**	**Bassanite**	**Anhydrite**	**Calcite**	**Pozzolan**	
Mean	46.1	1.97	3.25	2.68	2.64	0	0	0.29	0.85	0.214	0.43	0.70	0.382	40.5	
Standard deviation	0.4	0.07	0.03	0.04	0.03	0	0	0.02	0.05	0.007	0.02	0.02	0.009	0.6	

Conclusions

The presented results show the Cement edition of Aeris to be a fast and precise analysis tool for full mineralogical phase analysis. It is the first benchtop XRD instrument designed for demanding industrial process control requirements. The Cement edition of Aeris is perfectly suited for quality assurance of blended cements.

Global and near

PANalytical B.V.
Lelyweg 1, 7602 EA Almelo
P.O. Box 13, 7600 AA Almelo
The Netherlands
T +31 (0) 546 534 444
F +31 (0) 546 534 598
info@panalytical.com
www.panalytical.com

Regional sales offices
Americas
T +1 508 647 1100
F +1 508 647 1115

Europe, Middle East, Africa
T +31 (0) 546 834 444
F +31 (0) 546 834 499

Asia Pacific
T +65 6741 2868
F +65 6741 2166