X-RAY FLUORESCENCE

S2 PUMA Series 2 for the Cement Industry

Reliable Process Control and Quality Monitoring
in All Steps of Cement Manufacturing

Innovation with Integrity

Optimized Processes and Best Product Quality Enabled by the S2 PUMA Series 2

The strength and durability of cement products make them one of the most important construction materials in the world. An increase in quality requirements has transformed the manufacture of cement into processes that are extremely complex. Out of raw materials with variable chemical and mineral compositions different cement products are produced with precisely specified properties.

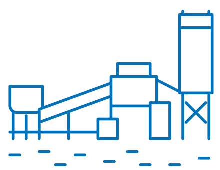
When it comes to quality, cement products have to fulfill highest requirements. To efficiently accomplish this, a constant product and process monitoring has to be applied from the time the raw mix is prepared, through clinker production, right to the mixing processes.

Cement Analysis With the S2 PUMA – Reliable, Precise, and Quick

For the analysis of raw materials, intermediate, and end products, the technique of X-ray fluorescence (XRF) analysis has established itself. With the help of this method the quality and quantity of components of mixtures can be quickly and reliably determined. For cement analysis in particular, Bruker offers an energy-dispersive X-ray spectrometer (EDXRF) in the form of a easy-to-use bench-top device: the S2 PUMA Series 2.

For typical analyses in the cement industry it is ideally configurable, and thanks to its robust construction it is just as suitable for use in the central lab as it is for use at the mill, the kiln, or at the filling location. Thanks to its user-friendly TouchControl™ interface, anybody can operate the system after minimal introduction.


Mining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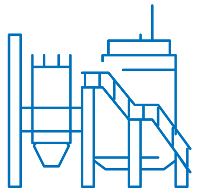
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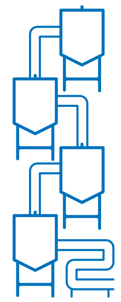
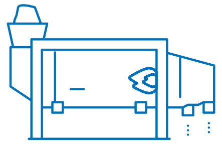

Cyclone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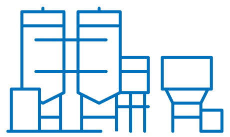
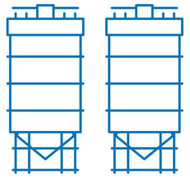
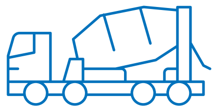

Cement Mill


Storage


Customers

Don't Leave Anything to Chance, Place Your Trust in First-Class Performance

The process and quality monitoring in the cement industry are very demanding on EDXRF: In addition to the range of concentrations of individual components, such as very high silicon and calcium concentrations, elements with low concentrations such as iron or sulfur have to be reliably determined. Moreover it is becoming increasingly important to analyze sodium or magnesium.

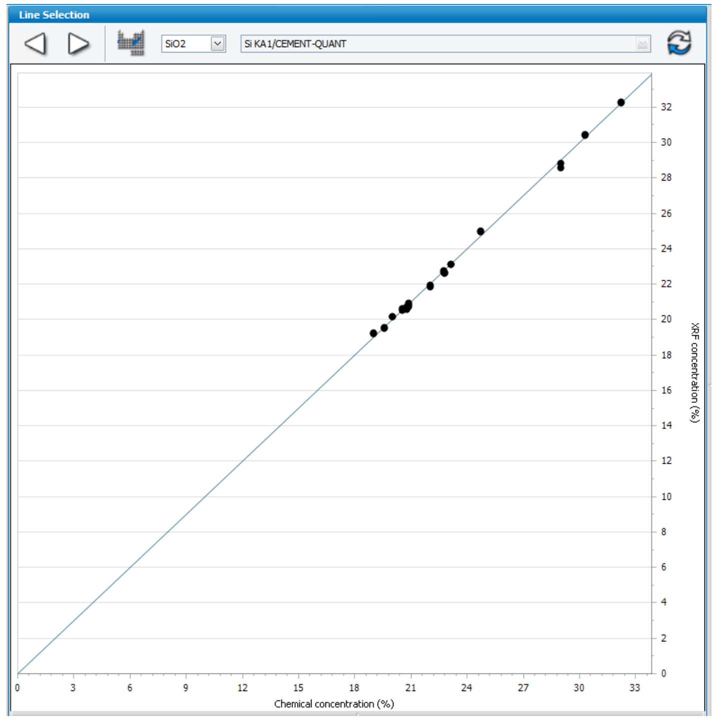
Even the preparation of the samples demands flexibility from analytical devices: Besides pressed pellets, fused beads are routine in cement analysis. So place your trust in a specialist that impresses with precision, speed, and long-term stability, whatever the analytical need may be: the S2 PUMA Series 2!

The Highest in Precision and Norm-compliance

In the cement industry the sample is fed to the device either directly as pressed pellet, or as fused bead.
Fused beads have the advantage of offering the most precise results across a large calibration range. With CEMENT-QUANT, Bruker offers a solution for calibration with fused beads that covers the manufacturing processes in cement plants, and also complies with the principles of good laboratory practice (GLP). This includes a check of device stability and a test of the reproducibility of the sample preparation in accordance with the international standards ASTM C114, and ISO 29581-2 / DIN EN 196-2. This way, based on international certified reference materials (CRM), the S2 PUMA Series 2 guarantees the norm-compliant analysis of all process materials in the cement industry, such as raw mix, clinker, and cement.

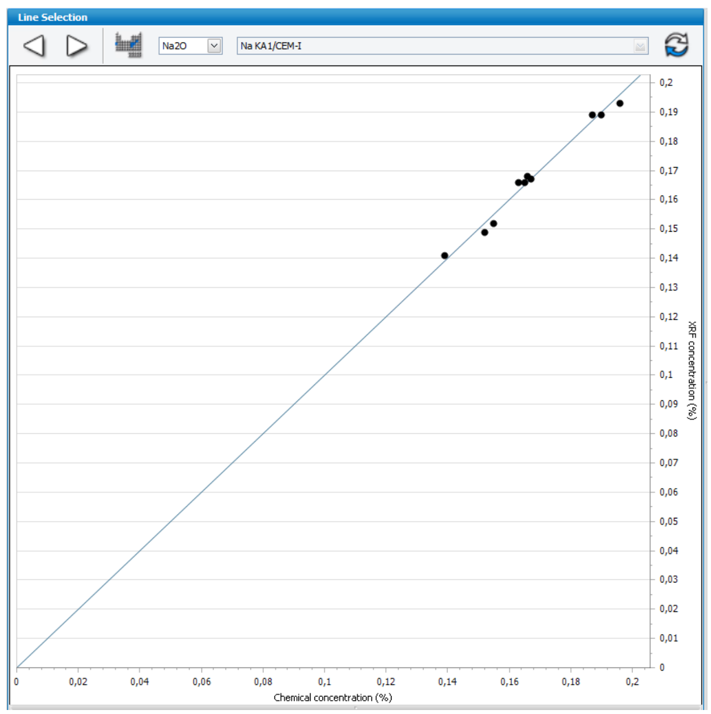
CEMENT-QUANT for S2 PUMA:

- Complete ready-to-analyze solution for calibration with fused beads
- Norm-compliant analysis of process materials in the cement industry, such as raw mix, clinker, and cement
- According to **ASTM C114-22**, and **ISO 29581-2 / DIN EN 196-2**



Preparation of samples as fused beads guarantees calibration over a wide range of concentrations (Figure 1). Typical data on the accuracy and repeatability achieved with fused beads is shown in Table 2. The total measurement time of a sample, including the time for sample handling, usually takes **less than 5 minutes**.

Figure 1
Fused bead calibration of SiO_2 of CEMENT-QUANT



Pressed Pellets Provide Precise Results in a Short Time for Fast Process Control

Preparing cement samples as pressed pellets offers two advantages: It takes less time and so it provides the necessary element information for process monitoring faster. Furthermore, pressed pellets are measured directly and undiluted, which improves the precision of the measurement with certain elements. Typical data on the accuracy and repeatability achieved with pressed pellets is shown in Table 3. The best kind of sample preparation depends on your respective processes and requirements – but with the S2 PUMA you always get precise results!

Figure 2
Na_2O calibration in pressed pellets in raw meal

Table 1 Measurement parameters for pressed pellets method

Elements	X-ray tube voltage [kV]	X-ray tube current [µA]	Filter	Measurement time [s]
Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Mn, Fe, Sr	20	Optimized for max. count rate	None	200

When it Comes to Data Quality, the S2 PUMA Guarantees Precision and Accuracy!

Best analytical results for fused beads and pressed pellets

The excellent analytical data for accuracy and repeatability demonstrate that the S2 PUMA fulfills the requirements of the cement industry. With CEMENT-QUANT, a solution tailormade for preparing fused beads, you comply with the needs of modern cement production. Regardless of the way the samples are prepared – whether your samples are prepared as fused beads or as pressed pellets – the S2 PUMA provides the best analytical results for quick and precise process monitoring.

Table 2 Accuracy and repeatability of 10 repeat measurements of a cement sample prepared as fused bead, measured with the CEMENT-QUANT. The S2 PUMA meets the requirements of ASTM C114-22, and ISO 29581-2 / DIN EN 196-2.

Measurement	Na_2O [%]	MgO [%]	Al_2O_3 [%]	SiO_2 [%]	P_2O_5 [%]	SO_3 [%]	K_2O [%]	CaO [%]	TiO_2 [%]	Mn_2O_3 [%]	Cr_2O_3 [%]	Fe_2O_3 [%]	SrO [%]
CEM_01	0.293	3.07	5.57	22.56	0.152	3.015	0.893	57.39	0.353	0.084	0.006	1.925	0.243
CEM_02	0.287	3.08	5.58	22.59	0.152	3.018	0.893	57.43	0.353	0.084	0.007	1.931	0.244
...	...	...	...	...	...	...	...	...	...	...	...	...	...
CEM_09	0.288	3.07	5.58	22.58	0.151	3.016	0.895	57.45	0.354	0.084	0.007	1.927	0.244
CEM_10	0.283	3.09	5.60	22.60	0.152	3.012	0.894	57.48	0.352	0.084	0.007	1.927	0.244
Mean value	0.287	3.08	5.59	22.59	0.152	3.015	0.893	57.44	0.354	0.084	0.006	1.928	0.244
Std. dev.	0.004	0.01	0.02	0.02	0.001	0.002	0.001	0.04	0.002	0.000	0.000	0.003	0.000
Ref. value	0.304	3.07	5.50	22.51	0.152	3.032	0.899	57.46	0.351	0.084	0.007	1.931	0.244
Diff. to ref. value	0.017	0.01	0.08	0.08	0.000	0.017	0.006	0.01	0.003	0.000	0.001	0.003	0.000

Table 3 Accuracy and repeatability for 10 repeat measurements of a raw meal sample as pressed pellet

Measurement	Na_2O [%]	MgO [%]	Al_2O_3 [%]	SiO_2 [%]	P_2O_5 [%]	SO_3 [%]	Cl [%]	K_2O [%]	CaO [%]	TiO_2 [%]	Mn_2O_3 [%]	Fe_2O_3 [%]	SrO [%]
RM_01	0.10	2.27	3.23	14.47	0.03	0.31	0.13	0.4	40.6	0.18	0.02	3.23	0.01
RM_02	0.12	2.20	3.22	14.42	0.02	0.32	0.13	0.4	40.55	0.18	0.02	3.21	0.02
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RM_09	0.12	2.26	3.24	14.45	0.01	0.32	0.13	0.40	40.64	0.17	0.02	3.22	0.01
RM_10	0.11	2.22	3.26	14.52	0.02	0.32	0.14	0.40	40.64	0.18	0.02	3.2	0.01
Mean value	0.11	2.22	3.25	14.48	0.02	0.32	0.13	0.40	40.62	0.17	0.02	3.22	0.01
Std. dev.	0.016	0.028	0.024	0.048	0.004	0.005	0.002	0.006	0.054	0.005	0.00	0.012	0.003
Ref. value	0.11	2.21	3.22	14.47	0.02	0.31	0.13	0.40	40.33	0.17	0.02	3.17	0.01
Diff. to ref. value	0.001	0.008	0.028	0.008	0.001	0.005	0.003	0.004	0.29	0.007	0.000	0.055	0.002

Technological Innovations as Key to the Best Results and Reliable Evaluation

The S2 PUMA provides you with a compact high performance device: Our HighSense™ technology comes with powerful 50 Watt X-ray performance. With its optimized optical X-ray tube and a state-of-the-art silicon-drift detector (SDD), it offers direct excitation of up to 50 kV. The HighSense™ XP detector is equipped with a high-transmission, ultra robust graphene window for unmatched light element sensitivity.

Particularly for the analysis of light elements with low-energy fluorescence the sensitivity of the measurement can be improved even more by a vacuum. The S2 PUMA is ideal for the analysis of cement samples: due to an optional vacuum pump no helium or nitrogen gas is required to flush the measurement chamber. Thus operating costs are reduced considerably by foregoing any auxiliary materials.

The S2 PUMA is offered in a range of different configurations. In cement analysis, the S2 PUMA Single, S2 PUMA XY Autochanger, and S2 PUMA Automation models are well-proven. Whereas the Single model is manually fed with one sample per measurement sequence, the S2 PUMA XY Autochanger can automatically measure up to 20 samples.

This makes it possible to analyze larger numbers of samples overnight. But new samples can be added at any time – even while the measurement process is running! For even higher automated throughput, it is possible to connect the S2 PUMA via conveyor belt or robot to an automated sample preparation.

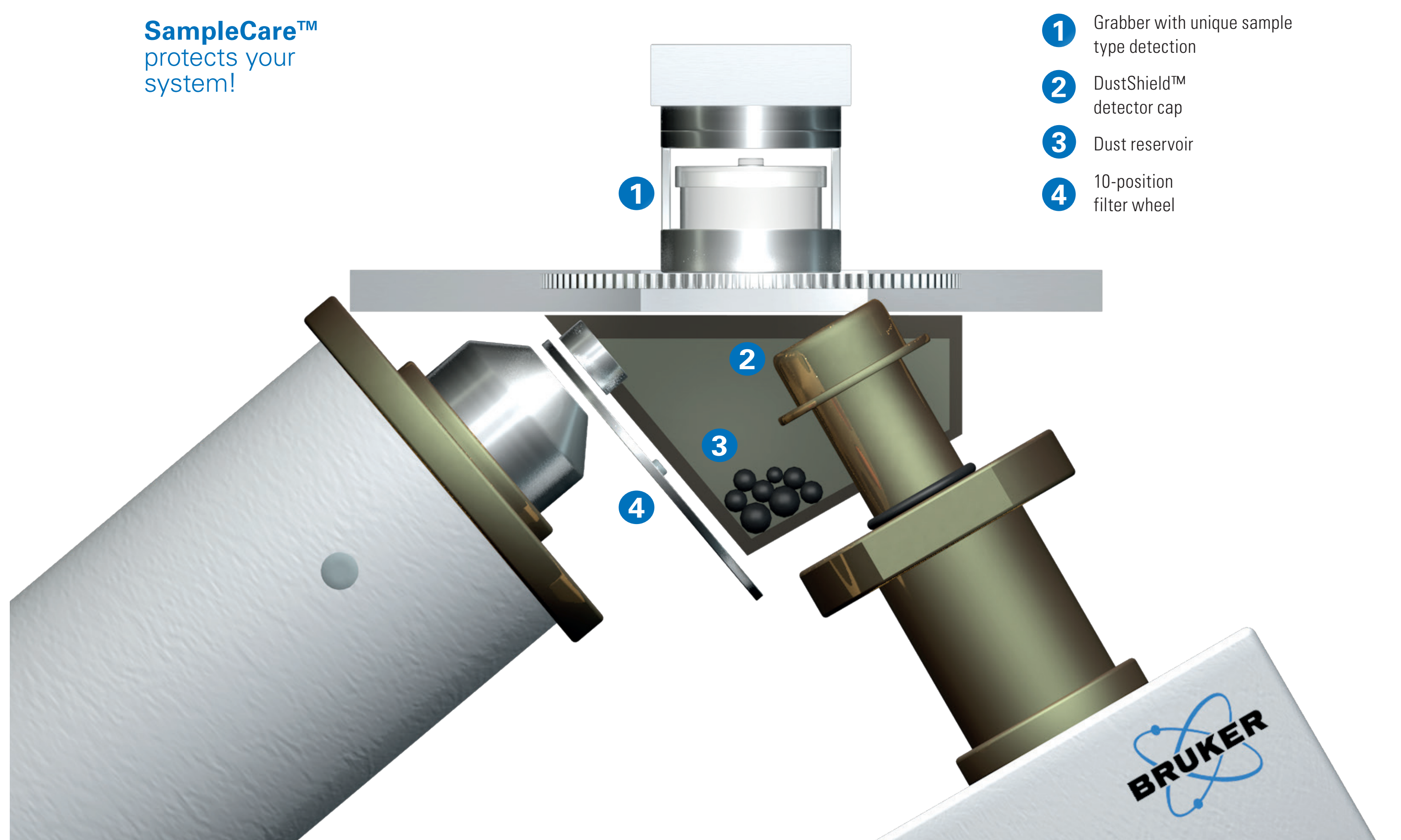
This way the **S2 PUMA Automation** ensures efficient process monitoring around the clock. That produces optimal and cost-efficient final products, while maintaining maximum process yield.

S2 PUMA – For Precise Analyses, Easy Operation, and Optimized Workflows

The S2 PUMA provides you with everything you need to monitor and optimize the entire process chain in cement manufacturing. The highest in analytical precision and repeatability in **accordance with ASTM C114-22.**

- **HighSense™ technology**: For high count rates and short measurement times.
- **HighSense™ XP detector**: For outstanding sensitivity even for light elements thanks to the with high-transmission, ultra-robust graphene window.
- **CEMENT-QUANT**: Bruker's out-of-the-box solution enabling precise, cost-saving, and GLP conform method setup.
- **SampleCare™**: Bruker's unique technology which protects important system components against dust and contamination, ensuring high instrument availability and easy maintenance
- **TouchControl™**: Enables stand-alone operation with the push of a button even in dusty environments.
- **SPECTRA.ELEMENTS**: Our spectrometer software makes data acquisition, analysis, and visualization of the results quick and easy

SampleCare™ protects your system!



Technical Data

Element range	Sodium to americium (Na – Am) Carbon to americium (C – Am) with light element detector
Concentration range	From ppm to 100 %
X-ray tube	10-position automatic filter changer for wide range elemental analysis
Detector	Silicon Drift Detector: Peltier cooled (no need for liquid nitrogen) with DustShield™; Available as HighSense™ and HighSense™ XP version, both with super-high count rates and excellent energy resolution
Collimator Masks*	For small spot analysis: 1, 3, 8, 12, 18, 23 and 28 mm
Sample Observation*	Integrated HD video camera, for exact sample positioning and documenting the measurement position of a sample
Atmosphere Mode	Air mode: For heavier elements in all sample types Helium mode*: Best performance for light elements in liquids and loose powders Nitrogen mode*: Cost-saving analysis of liquid samples Vacuum mode*: Enhanced light elements performance for stable samples and lowest cost of operation
TouchControl™	Integrated 12.1" TFT touchscreen, adjustable, multilingualuser interface, optional
Connectivity	Built-in Ethernet port RJ45, 3x USB ports for mouse, keyboard, printer
Power Requirements	100-240 V, 50/60 Hz, max. power consumption 600 VA
Sample Types	Loose powders, granules, solids, pressed pellets, fused beads, and liquids
Sample Rotation*	Spins all sample types and sizes for better measurement statistics with inhomogenous samples

	S2 PUMA Single	**S2 PUMA XY Autochanger**	**S2 PUMA Automation**
Sample Sizes	Up to 51.5 mm (2.03") Ø; Liquids and powders in liquid cups up to 50 ml	Up to 40 mm (1.56") Ø and 38 mm (1.49") height in sample holders with max. 200 g sample weight, or 51.5 mm Ø as sample ring; Liquids and powders in liquid cups up to 20 ml	Up to 40 mm (1.56") Ø and 38 mm (1.49") height in sample holders with max. 200 g sample weight, or 51.5 mm Ø as sample ring; Liquids and powders in liquid cups up to 20 ml
Sample Loader	Single position, manual loading	EasyLoad™ XY sample tray with 20-positions, removable; 2 fixed positions for QC samples; Grabber with automatic liquid sample detection	EasyLoad™ XY sample tray with 20-positions, removable; Grabber with automatic liquid sample detection; 2 fixed positions for QC samples; Interface to conveyer belt or robot arm link-up to sample preparation, including sample flipper
Dimensions (width x depth x height); **Weight**	67 x 71 x 37 cm; 87 kg (26.2 x 27.8 x 14.6"; 192 lbs)	67 x 71 x 61 cm; 108 kg (26.2 x 27.8 x 23.8"; 238 lbs)	67 x 71 x 57 cm; 132 kg (26.2 x 27.8 x 22.2"; 287 lbs)

* optional packages

TouchControl™, SampleCare™, EasyLoad™, HighSense™, and DustShield™ are trademarks of Bruker AXS Inc.

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