



SUPERIOR CHEMICAL CONTROL FOR THE CEMENT INDUSTRY

QCX/BlendExpert™

CHALLENGES IN CEMENT PRODUCTION

Cement producers face many challenges which QCX/BlendExpert helps them overcome.

Competitiveness relies upon obtaining good quality products at low cost

- QCX/BlendExpert optimises raw material blending to meet peak quality targets.
- The upshot is reduced fuel consumption and stable kiln operation.
- This, in turn, leads to less thermal stress on kiln parts, such as lining, resulting in fewer and shorter kiln stops.

Total capex is limited for new plants

- Tight control of raw material blending negates the requirement for expensive blending silos. Silos can be considered storage buffers only and this dramatically reduces the need for capital expenditure.
- QCX/BlendExpert also compensates for poor functioning blending silos on existing plants.

Skilled technicians are limited, with high staff turn-over rates

- QCX/BlendExpert is a world class control system, meaning the complex task of controlling varying raw material qualities is no longer manual.
- QCX/BlendExpert boasts a simple and intuitive user interface, making it easy for operators to use.

Pressures to reduce CO2 and other emissions from cement production

- Alternative fuels are becoming an increasingly important option for cement plants to reduce their CO2 footprint.
- With QCX/BlendExpert kiln operation is more stable and this enables stricter control of emissions. In addition, the use of alternative fuels, without jeopardising clinker quality, opens new possibilities for many cement plants.



RESULTS ACHIEVED

Local conditions are an important factor when comparing data from different plants. These include:

- Fluctuating raw material quality.
- Blending efficiency before and after the raw mill.
- Material handling problems.

What may be considered poor control performance figures at one plant with 'easy' raw materials, could be considered excellent performance at a plant with more difficult conditions.

Selection of samplers and analysers is very much specific to the individual cement plant. So is prediction of the achievable control performance.

While high frequency online analysers can result in improved control performance, automatic sampling and sample preparation result in more accurate and precise analysis. By integrating these analysis techniques QCX/BlendExpert delivers the vital link to attain substantial quality improvements.

FLSmidth Cement has continuously demonstrated that QCX/BlendExpert provides considerable control improvements compared to manual set point control. QCX/BlendExpert has a proven track record of maximizing performance improvements.

Quality improvement

Previous versions of QCX/BlendExpert software performed well.

However, with the new V8 software, cement producers have seen a reduction of lime saturation factor (LSF) standard deviation of 60% compared to earlier versions.

Auto correction of the online analyser

Some plants trust their online analyser to provide correct analysis, however this is not always the case.

QCX/BlendExpert advanced process modelling takes all material process delays into equation and comparison between the quick online analyser results with the more correct analysis from the laboratory XRF.

Dynamic bias correction of the online analyser is based on this. This bias correction significantly enhances the value of the online analysis.

Maximum use of alternative fuels

Alternative fuels are becoming important for most cement plants.

Using by-products provides waste management options that can be economically viable, regionally available and environmentally sound.

Some alternative fuels generate chemical constituents, such as alkalis or chlorides, that must be considered in the equations when designing the chemical targets of the cement.

QCX/BlendExpert is designed to handle these important factors.

Less homogenising requirements

When engineering a cement line, eliminating or reducing the size of the homogenising equipment is often an important factor. This puts added pressure on blending the raw materials.

QCX/BlendExpert proves that it's possible to operate a cement line with a direct feed from the quarry to the mill or from the mill to the kiln.

This feature is effective when an existing homogenising silo is not functioning well and not blending to the desired factor.

No need for sampling and analysis of raw material

The raw material estimator has proven to be as accurate as the physical samples taken from the raw materials, thus eliminating the need for this manual process.

History

For more than 50 years, FLSmidth Cement has been a pioneer in high-level expert systems designed specifically for cement applications.

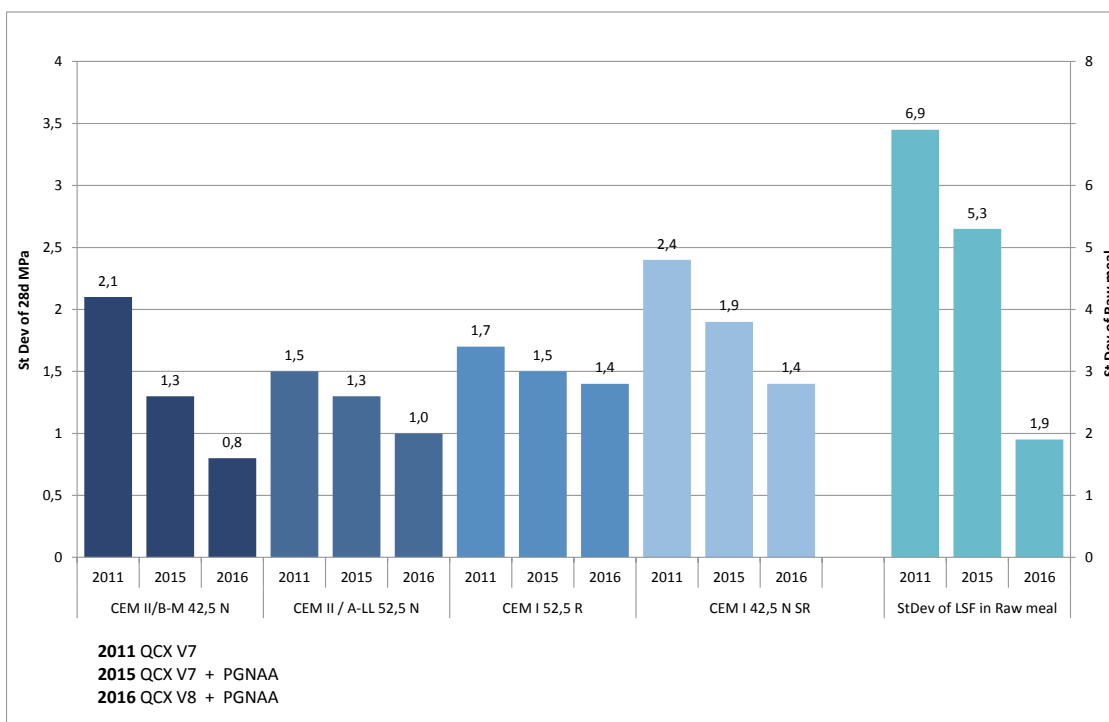
The new QCX/BlendExpert solution is the ninth generation of the software and is based on FLSmidth Cement's vast automation experience.

This is evidenced by more than 700 quality control (QCX) systems being successfully installed worldwide.

It's designed by FLSmidth Cement's international team of quality experts using the latest control technologies, such as modelbased predictive control, which, together with today's powerful PC processors, enables very complex process simulations and corresponding estimations.

PROVEN LABORATORY SOFTWARE FOR CEMENT PLANTS

Reliable and robust laboratory software that meets the needs of your cement plant



Results from Finsementi Lappeenranta plant in Finland. The graph shows clinker strength for 4 different cement types as well as to the far right the std.dev. of LSF in the raw meal after the mill. The first bars for each instance (2011 values) represents operation with QCX/ AutoSampling and QCX/BlendExpert v7. The second bar (2015 values) represents operation with QCX/ AutoSampling and QCX/BlendExpert v7 and a PGNAA before the raw mill. The third bar (2016 values) represents operation with QCX/ AutoSampling and a PGNAA before the raw mill and QCX/BlendExpert V8. Considerable improvements were achieved with the new QCX software.

WHAT IS QCX/BLENDEXPERT?

QCX/BlendExpert is an advanced software solution, which, through chemical analysis results, controls:

- Blending of raw material feed to stockpiles: BlendExpert Pile
- Blending of raw materials and additives to raw mills: BlendExpert Raw Mill
- Blending of raw materials to Mills: Raw mills and Cement mills

The QCX/BlendExpert suite of applications support quality optimization from quarry to delivered cement. Optimising quality control starts with correct automated sampling, sample preparation and X-ray analysis, which ensures a reliable and accurate chemical evaluation.

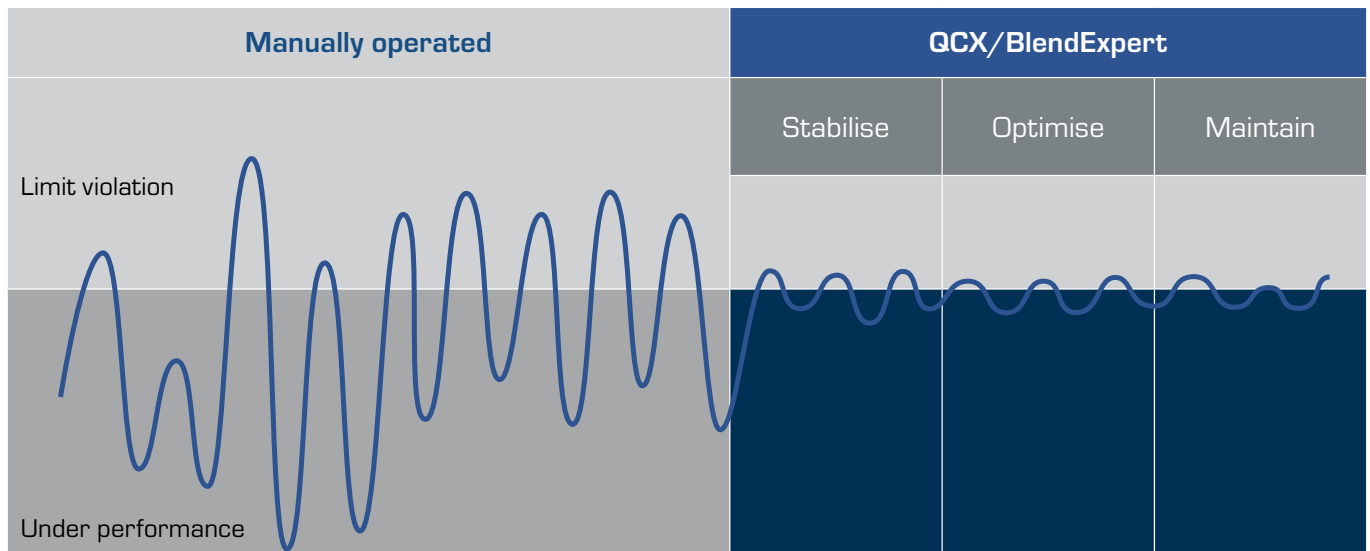
This can be combined with online analysis instrumentation which provides very frequent, however less accurate, data. Using a sophisticated mathematical toolbox and specialised application algorithms, QCX/BlendExpert continuously performs complex

analysis of the chemical conditions and, based on these results, adjusts the set-point of material and additive feeders.

Rapid complex calculations, which take chemistry, tonnages and price, among many other factors into the equation, enable QCX/BlendExpert to adjust the feeders more frequently and reliably than any human operator.

The software can be installed on a standard PC, physical or virtual, stand alone or on top of another QCX system. While QCX/BlendExpert is part of FLSmidth Cement's suite of QCX solutions, such as QCX/AutoSampling and QCX/RoboLab, it is still compatible with most other plant control and quality control systems.

QCX/BlendExpert – Mill can be configured for any number, type and make of mills. In addition, mill and stockpile mix control schemes can be combined in one system.



QCX/BlendExpert consists of several software modules and is part of FLSmidth Cement's QCX suite of products which also includes QCX/AutoSampling and QCX/RoboLab.



QCX/BLENDEXPERT™ – MILL APPLICATION: RAW MILL & CEMENT MILL



Based on the analysis of the material stream, QCX/BlendExpert –Mill continuously integrates material tonnage and chemical analysis results and compares the expected raw meal quality with the defined quality target.

The calculated feeder set-points are automatically implemented via the general plant control system. Taking into account target chemistry, chemical constraints, process limitations and material costs, QCX/BlendExpert will always strive to produce the desired chemical product quality with minimum product quality variance.

The software can be configured for any number of raw mills and/or cement mills, and be based on any analysis technique (whether in the laboratory or online) or in any combination of analysers.

Online accounting

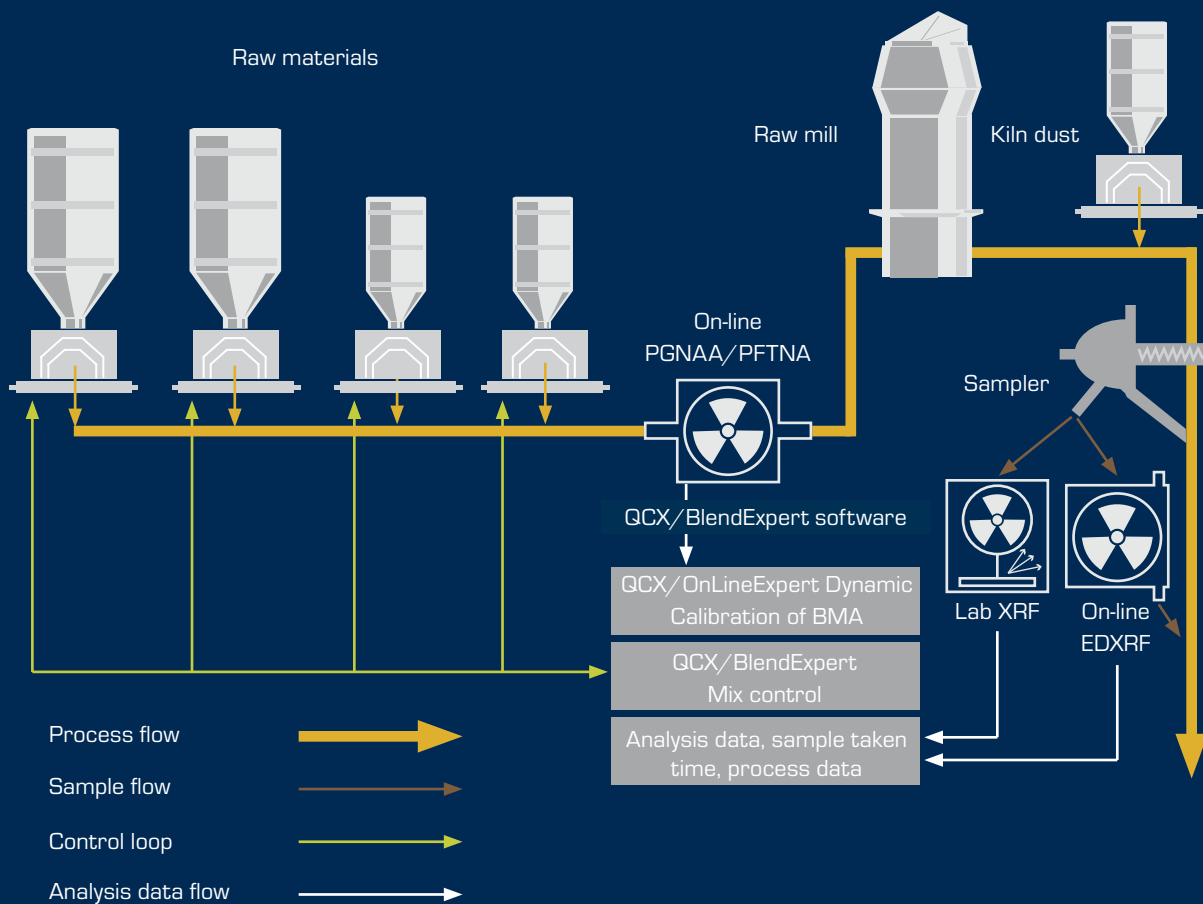
The online accounting of individual raw material feed streams and other relevant materials, such as dust, coal, ash, fly ash, alkali and bypass, is based on weigh feeder signals and depicted in the below diagram.

It demonstrates how QCX/BlendExpert can operate with laboratory XRF results only, or in a combination of laboratory XRF and online analyses incorporating all results in the control algorithms.

This single loop control enhances the control accuracy as it makes use of the speed of online analysis together with the accuracy of a laboratory XRF.

Quality control based on both XRF and XRD results

QCX/BlendExpert – Mill (raw mill and cement mill) can perform quality control based on analysis from both XRF and XRD thereby it is also optimized for Cement mill control.



Raw material estimation

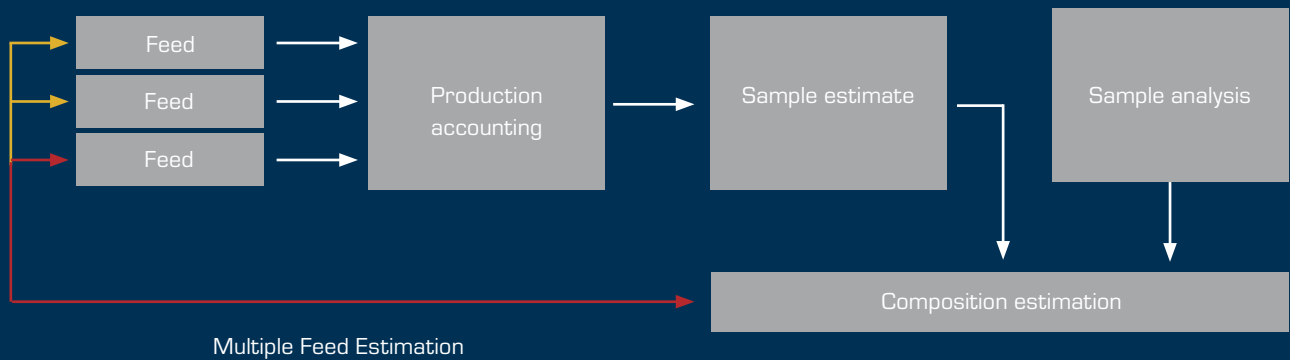
QCX/BlendExpert raw material estimation provides a reliable assessment of the chemistry in the feeders at any given time.

This feature saves time and money as it eliminates the need for physical sampling, sample preparation and analysis of raw materials – a labor-intensive job conducted regularly on many cement plants.

The combination of the mathematical toolbox, the process modelling and the estimators in QCX/BlendExpert ensures that the raw meal composition is constantly and consistently estimated.

Changes in the material compositions are estimated as they happen, so there is no need to wait for a physical sample which is usually only available once per shift.

The model behind the estimator takes into account expected variations in the concentrations, concentration constraints and accuracy of the analysis methods employed. The process is modelled in the diagram below:



Automatic feeder offset correction

QCX/BlendExpert software ensures automatic correction of feeders and will detect and correct potential feeder offsets. This unique feature contributes to improved overall chemical control performance.

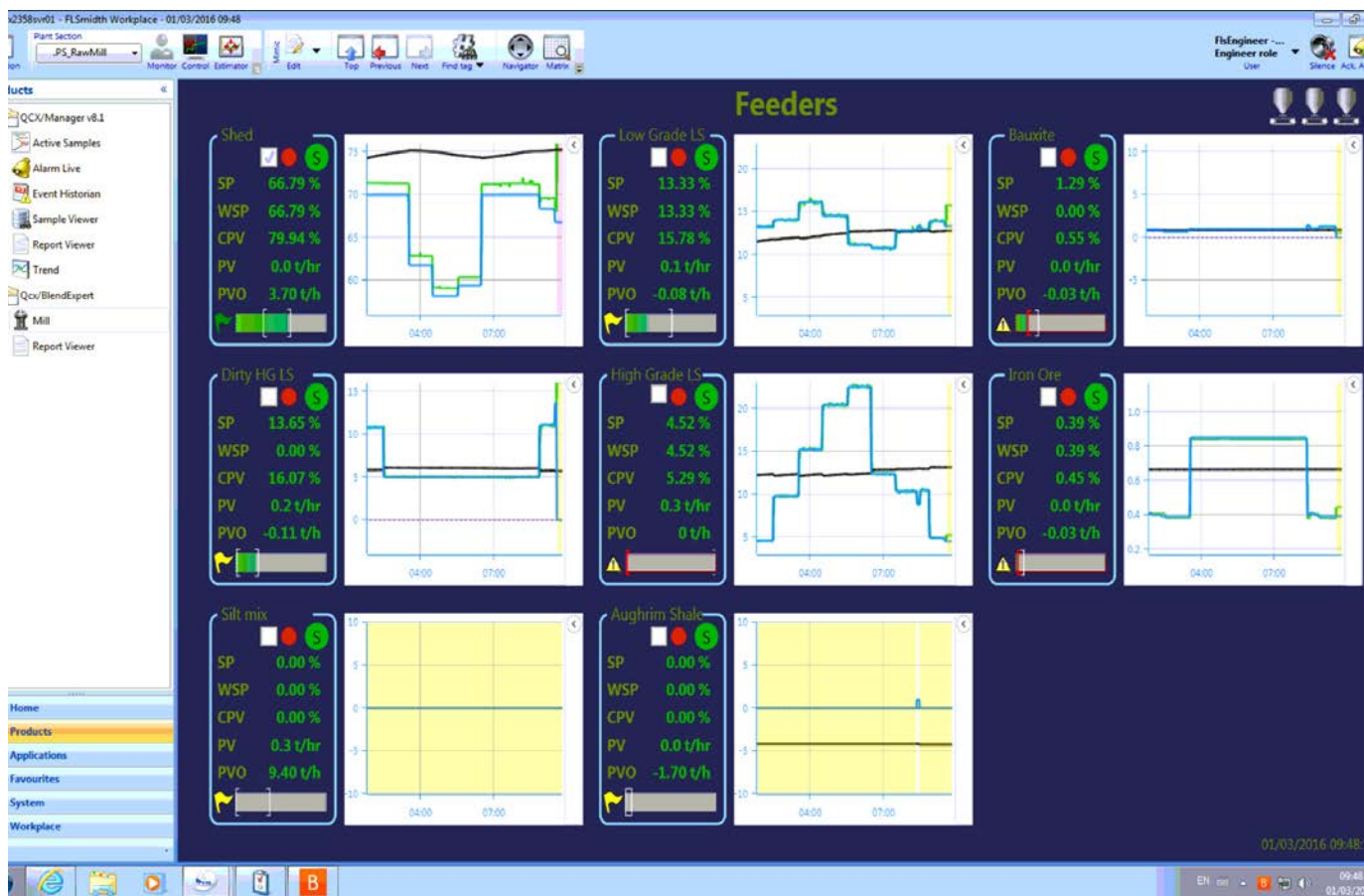
Automatic handling of feeder starvation

If a feeder is in starvation, QCX/BlendExpert estimates whether it can still reach its target in this condition. If it cannot reach all targets (if it's losing a degree of freedom), it will, according to control philosophy, jeopardise the target(s) which are least important to the overall clinker quality, for example, alumina module (AIM).

Multiple materials per feeder

In order to meet the demands of modern plant conditions, where material types can rapidly change, QCX/ BlendExpert software can operate with multiple materials per feeder.

This results in a fast, flexible and responsive system, with minimal operator intervention, when faced with varying materialtypes. The diagram below is a screen shot of the status of the various raw material and additive feeders.



Feeder overview

1. Tracking of whether the feeder set-point is within the feeder limits
2. Tracking of how well the feeders react to set-point changes
3. Indication of: Feeder set-point, Working set-point, calculated process value, process value and process value offset.

QCX/BLENDEXPERT™ – PILE APPLICATION

The 9th generation of the QCX/BlendExpert-Pile is a software package that greatly enhances the ability of achieving the desired chemistry on a stockpile – thereby saving money throughout the production process. It combines powerful mathematical accounting and optimisation algorithms with advanced modelling of material position.

Based on the analysis of the material stream, QCX/BlendExpert – Pile continuously integrates material tonnage and chemical analysis results to ensure the stockpile is always on the defined quality target.

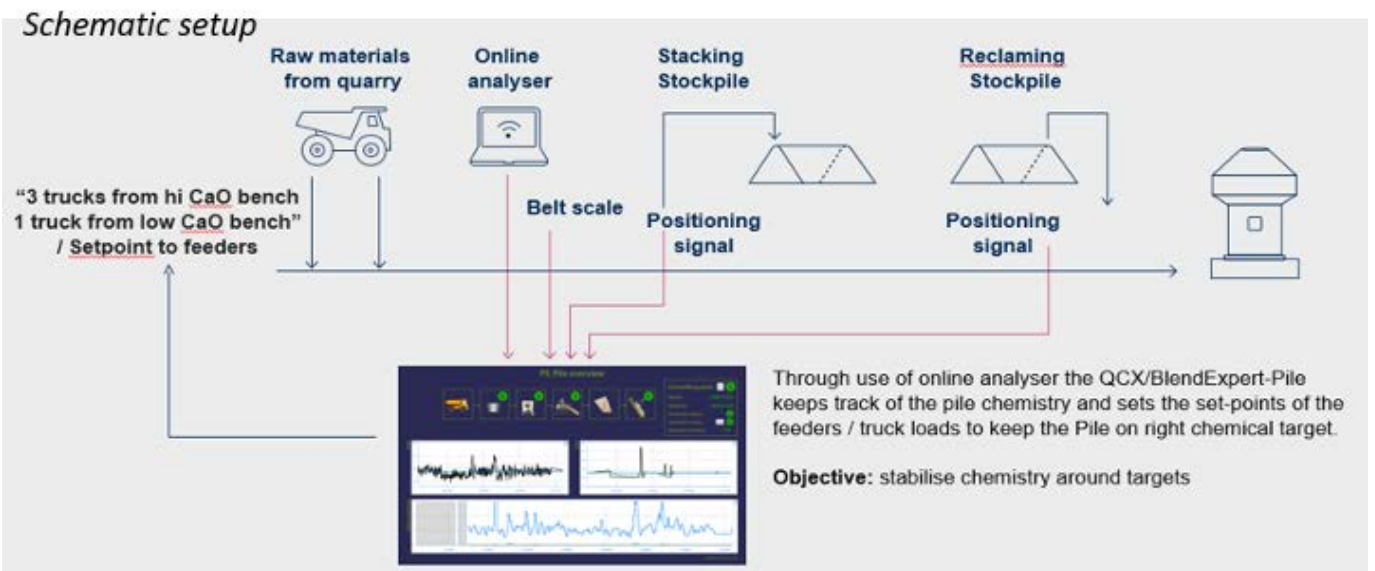
QCX/BlendExpert Pile provides a visualization of the stockpile chemistry in a flexible 2D and 3D model which shows the mass and chemical content of your stock pile at any given position.

Based on the on-line PGNAA analysis of raw material from the crusher QCX/BlendExpert-Pile software continuously integrates the raw material chemistry, tonnage and position while informing the quarry master about actions to keep the pile on the right quality target.

The QCX/BlendExpert-Pile can control longitudinal and circular stockpiles and offers an unmatched flexibility in terms of supporting a wide range of process lay-outs:

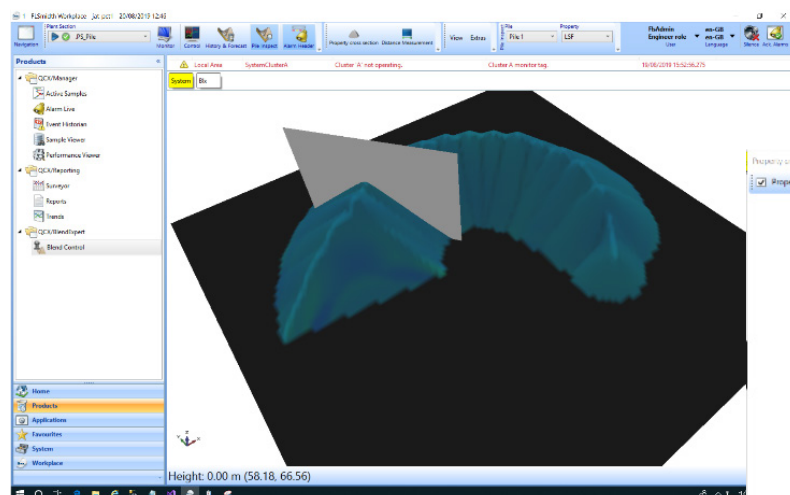
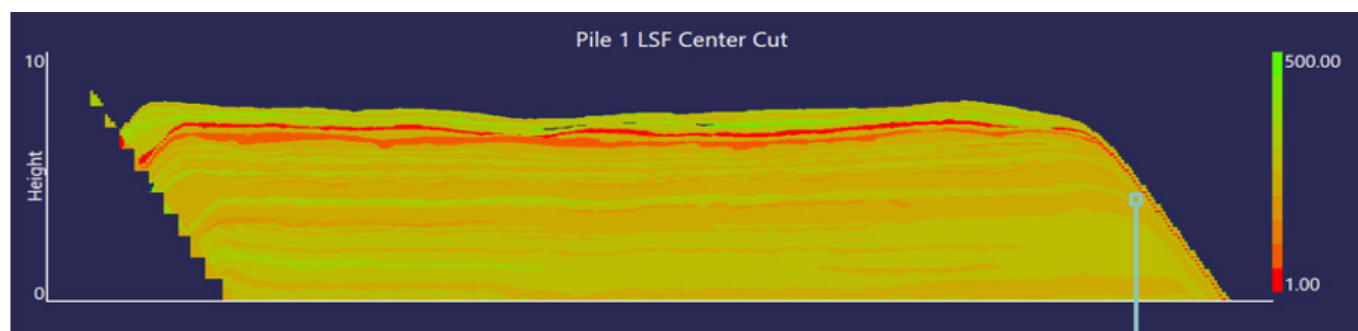
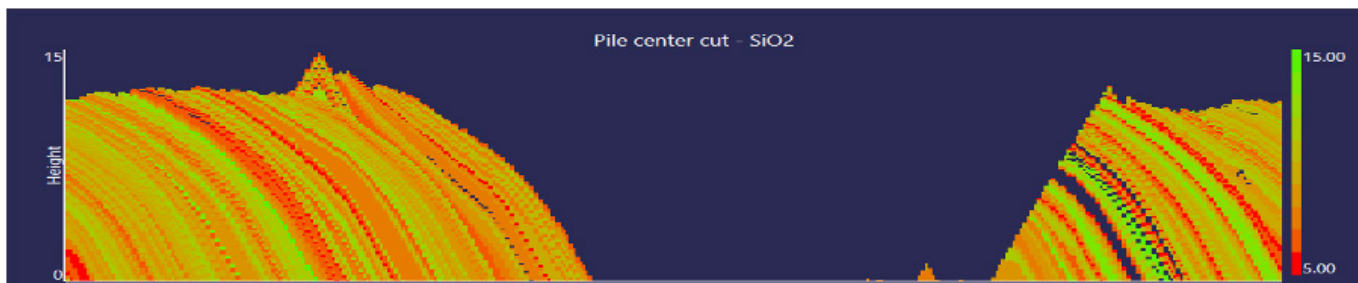
- Unlimited number of raw materials per crusher
- Several crushers feeding material to the PGNAA analyser
- Stacking in one of “n” defined piles

To get optimum value from the software it is recommended to have positioning signals on stacker and reclaimers – only through exact information on positions the software can model the composition in the pile with chemistry of the material down to 50*50 cm voxels. For circular pile system it is a requirement to have positions signals available.

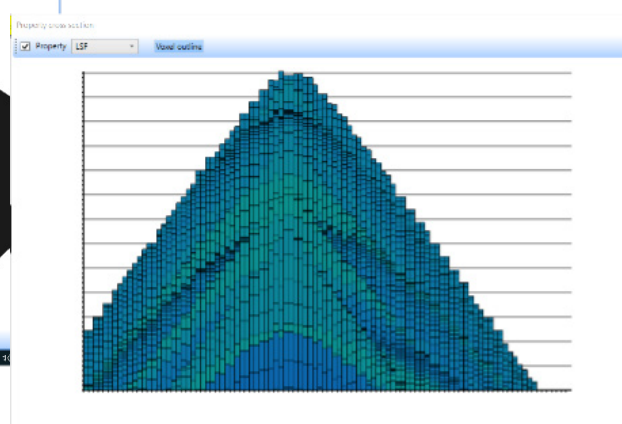


3D and 2D visualization

The chemistry of the stacked material in the pile can be visualized in trends, 2D and 3D views giving a very easy understanding of the distrution of the pile content and stacking patterns.



Examples of 2D visualization of a circular pile system and a longitudinal pile system. Chemistry is illustrated in colours and gives a clear view of the chemical distribution within the pile system.



Controller tuning, history and forecast

The QCX/BlendExpert Pile have the control tuning feature available as in the raw mill application, furthermore a history and forecast of stacked and reclaimed material is available making it easy for the operator get get an overview of the pile chemistry.

Feedforward from QCX/BlendExpert pile to QCX/BlendExpert Mill

The FLSmidth Cement optimization quality control software are linked so the estimation of the reclaimed material from the pile application can be linked to the raw mill application providing the end user with a full combined solution. This can also help reduce the quality issues often associated with pile end cones.

QCX/ONLINEEXPERT

To maximise the benefits of online analysers, it's necessary to implement a high-level control system such as QCX/BlendExpert. It integrates the online analysis data stream with the less frequent, but more accurate, central laboratory XRF results to produce accurate process chemistry data.

The QCX/OnlineExpert software module handles data from a range of online analysers, such as PGNAA, PFTNAA, NIR and ArcTech.

Apart from the communication driver to the online analyser, the software module handles the important function of automatic bias compensation and sample aggregation .

Through the OnlineExpert user interface the end user can view both raw and BIAS corrected data as well as rolling averages and statistical data combined with trends.

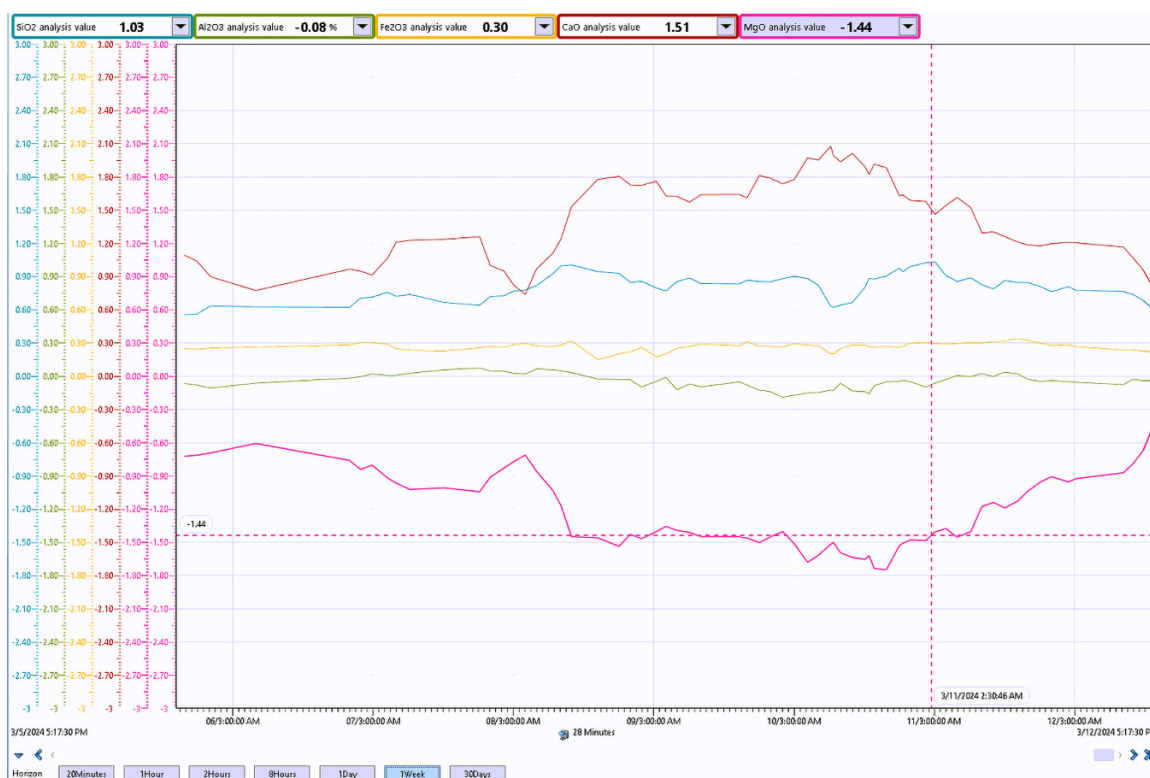
Dynamic bias compensation of PGNAA/ PFTNAA/NIR/ArcTech

While a mix control application based solely on online analysis will provide fast and frequent (however less accurate) control performance, QCX/BlendExpert offers a unique function where the results from both the online analysis and laboratory XRF spectrometer are used in a single control loop.

QCX/BlendExpert calculates the bias compensation of the online analyser dynamically. This means that every analysis from the online analyser is verified against the more accurate chemistry obtained by the laboratory analysis.

This calculation takes into account all delays and material additions which occurred from when the material passed the online analyser, to when the reference sample was taken.

Below is a QCX/BlendExpert graph showing the results of the dynamic calibration of a PGNAA. CaO proves to be off target with considerable variations. However, this does not affect the QCX/ BlendExpert controls as it accounts for the bias associated with every sample analysed by the PGNAA.



REPORTING, TRENDING AND ALARM HANDLING

Reporting

QCX/BlendExpert is designed to operate together with QCX/Reporting. This module generates the required reports for shift, day, month and chemical performance.

It offers approximately two years of data storage capacity and manages all reports as well as trend curves. The extensive and flexible report generation and graphic presentation facilities provide:

- Configuration of general QA reports.
- Configuration of customer specific reports
- Auto-generation of reports.
- Automatic scheduling of reports
- Report availability on the QCX website
- Report availability via email.

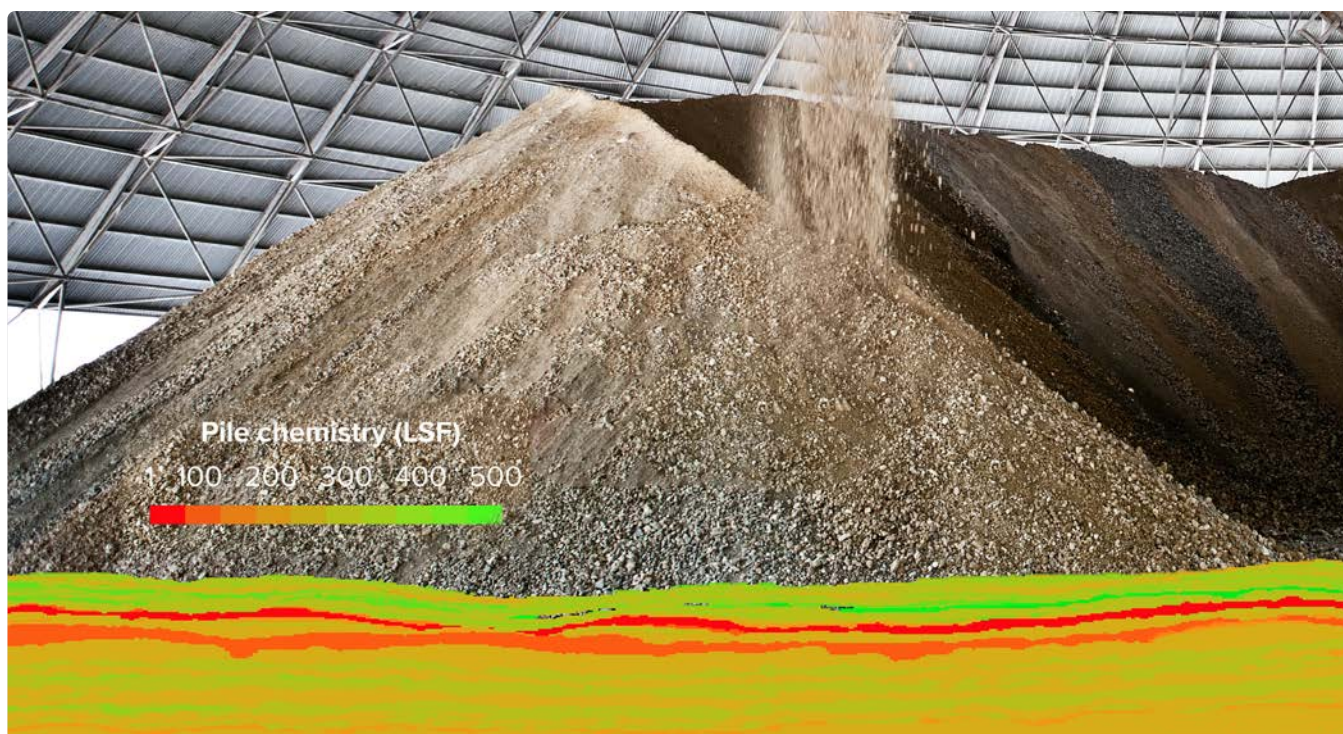
- Configuration of trend packages.
- Fast trending chemical results
- Trending up to 10 sample analyses in one view.

Alarm handling

Sampling, analysis or equipment alarms and non-critical events are logged in order for the laboratory personnel to keep track of 'bad' samples and other important events, such as maintenance scheduling.

Event historian

An event historian keeps track of alarms and events. The live event lists and historical events are tracked and recorded. This record is useful should there be discussion regarding events or alarms or a need to review them.



FLSMIDTH CEMENT'S EIGHT-STEP IMPLEMENTATION PROCESS

EIGHT STEPS TO A SUCCESSFUL QUALITY CONTROL SOLUTION

FLSMIDTH CEMENT'S EIGHT-STEP IMPLEMENTATION PROCESS

1. Project planning: An FLSmidth Cement project manager prepares a start-to-finish strategy.
2. Client process interviews: FLSmidth Cement engineer interview the client regarding the blending control strategy and process model.
3. Application design and process strategy review: FLSmidth Cement designs the right solution based on the site interviews.
4. Primary system commissioning: Commissioning is completed and the system is implemented and monitored onsite.
5. Operator and super-user training: FLSmidth Cement representatives train operators in the new system.
6. Remote monitoring and fine-tuning: As the final part of commissioning, FLSmidth Cement makes small adjustments to the system remotely – this requires an internet connection to the system.
7. After sales service: After commissioning is complete, FLSmidth Cement transitions the project to the service phase.
8. Establishing long-term support: FLSmidth Cement can support the system with software updates and ensure that it runs as efficiently as possible.

When FLSmidth Cement initiates an advanced control project, a dedicated project manager is assigned to coordinate all activities over the lifetime of the project.

As the main contact for the plant, the project manager is involved in the implementation process right from the start, providing the plant with a clear and detailed project plan that contains key deadlines, project meetings and more.

For solutions to operate reliably and efficiently, it needs to be implemented correctly. FLSmidth Cement's eight-step implementation model provides the professional support necessary to ensure the system meets all requirements and expectations.

FLSMIDTH CEMENT

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