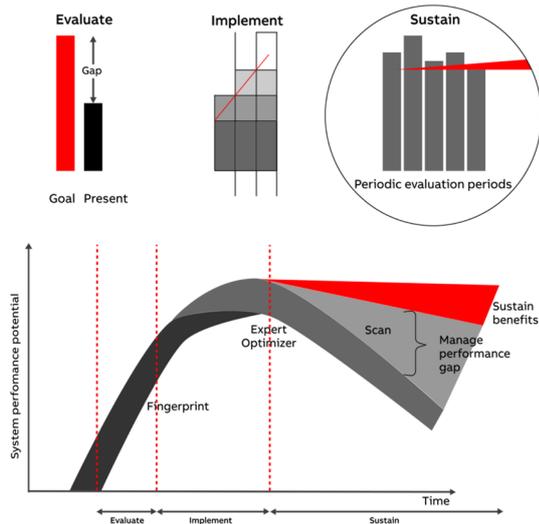


à digital foundation

Ryan Koorts and Luis Domínguez, ABB, discuss how advanced process control and analytics can deliver real benefits to cement producers.

Delivering high-quality products, while keeping production costs low and plant efficiency high, is an ongoing challenge for all process industries. Cement manufacturers face these challenges daily and the drive for improved efficiency cannot undercut the stability of the production process. While many in the industry and

technology circles talk about the potential of Big Data and digital technologies, do these deliver tangible benefits? This article will discuss how advanced process control (APC) and related optimisation strategies can help cement manufacturers to reap the real efficiency benefits of digital technology, without sacrificing stability or quality.



Performance optimisation for mining (PRISE).

Cement manufacturers are under increasing pressure to optimise their operations and get the very most out of the resources they have, all while increasing production. This is true across all heavy industries and industry in general. However, there are some specific areas unique to cement production that offer opportunities for improvement by deploying APC. These include kiln operation, alternative fuel use, mills, and blending.

Kiln optimisation

The kiln process is intrinsically unstable and influenced by long time delays and large disturbances. The process needs to be stabilised in order to yield its best performance. This article will discuss how APC will help achieve this stability.

Alternative fuel management

Burning alternative fuels can lead to instability in the clinker manufacturing process. APC can control, mix, and monitor rates of alternative fuels to ensure consistent burning, while also ensuring that the kiln does not become unstable due to changes in fuel calorific value.

Mill optimisation

Grinding makes up a large portion of the electrical energy consumed in a plant, meaning that the efficiency of grinding operations has a big influence on overall energy costs. APC can optimise the grinding circuit to increase throughput and secure consistent output quality, while also lowering energy consumption.

Material blending

Stable and correctly proportioned raw meal is essential for energy-efficient clinker production. Cement blended at the right proportions is essential to ensure that specifications are met and a quality product is delivered to end-customers.

Implementing APC can positively impact both raw material and the cement blending processes.

APC and analytics technology at the forefront of digitalisation

ABB's advanced process control and analytics (APCA) technology helps to improve these aspects of cement manufacturing. ABB's APCA technology suite comprises a set of tools, both online and offline, that allow the deployment of advanced controllers and analytic models. This provides monitoring, predictive analytics, and closed loop control capabilities at the device, edge, and cloud to ensure real-time operational efficiencies. It also helps process and energy industries to optimise operations by using emergent technologies – such as the cloud, data analytics, visualisation, and advanced modelling algorithms – as part of the disruptive change offered by the Internet of Things. It extracts knowledge from existing data in the plant and uses that for detailed analysis, in order to arrive at the best course of action to improve specific processes.

The evolution of knowledge acquisition, creation, and transfer ability gives those that use APCA technology the power to make improvements in operational scheduling, as well as the ability to make predictions and estimations about process performance, even in the absence of reliable measurement data. APCA technology truly helps the user to make sense of the available data and provides the computing tools that use this data to make significant improvements in resource use, equipment performance, and product throughput, yield, and quality.

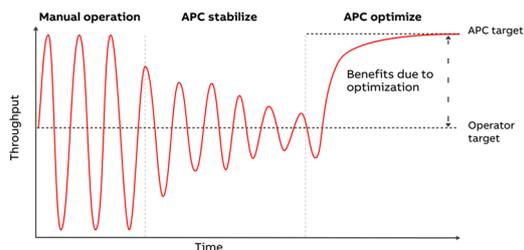
Commercially available solution

The ABB Ability™ Expert Optimizer (EO) is an APCA solution for controlling, stabilising, and optimising cement and mining processes. Incorporating state-of-the-art optimisation and analytics technologies, the software enables a plant to automatically make the best operational decisions accurately and consistently.

Manual operators vary in their control performance. ABB's Ability EO standardises the optimisation strategy to minimise both shift-to-shift variations and human workload. This frees up operators to focus on more pressing tasks. EO for cement combines APCA technologies with ABB's extensive industry expertise, stabilising the process and maximising profitability.

Working with existing control infrastructure

EO employs fuzzy logic, as well as model predictive control and state estimation strategies, which use either linear or non-linear mathematical models of industrial processes and smart algorithms to estimate unmeasured



Stabilise then optimise.

states and control process variables. EO helps cement and mining industries attain operational and financial targets by increasing throughput and yield whilst reducing consumables, such as energy usage.

The EO can work in standalone or be integrated into the distributed control system ABB Ability 800xA, thus allowing industry users to benefit from the system's distributed resource allocation, redundancy, and communication, as well as the intrinsic cybersecurity infrastructure of this modern distributed control system.

Leveraging process data

The client's applications data is leveraged with modelling and controller design tasks and analysis carried out in EO's modelling environment before deploying the solutions. Users can import large data sets and perform advanced data processing tasks, such as resampling, interpolation, and filtering, in addition to open and closed-loop simulations. These capabilities deliver true operational advantages.

Analytics

One problem control engineers often face is the need to infer data from missing measurements or infer backup data for unreliable measurements. In these cases, analytic models can be deduced from either first principles or process data. Analytic models supported by EO include: graphical (first principles), linear regression, nonlinear regression, principal component analysis, artificial neural networks, and support vector machines. Users can test various models and choose the one with either the best fit or performance statistic, thereby leveraging state-of-the-art advanced analytics.

With the included diagnostics tool, users can analyse the performance of deployed controllers by visualising the controller actions history from log files. Estimated values of the process variables and the quality of predictions can be compared with the data received from the plant, thus allowing control engineers to easily troubleshoot abnormal situations.

Real benefits delivered

A number of cement producers that implemented this solution have achieved significant process

improvements, in terms of overall efficiency, energy use, product consistency, and product throughput.

A cement customer in Italy that recently commissioned EO applications covering the pre-calciner, kiln, cooler, and NO_x saw the following results:

- A 40% reduction in litric variation.
- A 17.3% reduction in litric weight toward target constraint.
- Up to 40% reduction in grid pressure variation.
- A 30% reduction in pre-calciner temperature variation.
- A 6.2° increase in pre-calciner temperature toward target constraint.
- The utilisation of coal reduced by 58% by the substitution of alternative fuels.

In Brazil, EO applications that covered the process from raw milling to cement milling delivered an average overall productivity increase of 4%. Specific improvements include the following:

- A 62% reduction in the variation of raw mill power.
- A 60% reduction in the variation of raw mill bed depth.
- A 24% reduction in the variation of kiln motor load.
- A 27% reduction in free lime variation.
- A 16% reduction in litre weight variation.
- A 5% reduction in burning zone temperature variation.
- A reduction in the consumption of grinding media in ball mill.

In Turkey, an EO kiln application delivered significant benefits for a major cement manufacturer from day one. It increased feed by over 3 tph, while also reducing specific energy by 20 kcal/kg. This result was achieved with an EO utilisation factor of over 95%.

Conclusion

The use of the ABB Ability EO for cement offers enormous potential for process improvements in many areas. As EO continues to advance with new features and state-of-the-art technologies, the benefits are increased. The system, with cement industry experience and expertise, offers customers a solid digital foundation with forward-thinking (scalable) APC solutions and services that improve operations even as a business changes and grows. ■

About the authors

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