Cement plant operators, in addition to the perennial challenge of maintaining throughput and strict quality control during high-volume production, must also constantly ensure their operations are as sustainable as possible.

Reducing unnecessary additive overdosing in industrial emissions control makes sound business sense, boosting productivity, reducing costly equipment downtime, and ensuring compliance with local and global environmental regulations.

For cement producers, that means controlling sulfur dioxide (SO₂) emissions and hydrate consumption to avoid limit violations. Digital solutions such as ABB Ability™ Expert Optimizer – underpinned by advanced process control (APC) – are designed to stabilise and optimise production processes for increased output, lower fuel consumption, longer refractory life, and improved, more consistent quality.

As any seasoned cement manufacturer will explain, varying properties in the feed and fuel sources make manual optimisation challenging. Manual operators also vary in their control performance.

Manufacturers need, therefore, to find a way to standardise their optimisation strategy to minimise shift-to-shift variations and human workload, freeing up operators to focus on more pressing tasks.

This is where the APC software comes in, handling complex multivariable processes to constantly tweak the production process into an optimum state – and keep it there for as long as possible.

Confidence and control around hydrate dosing and SO₂
The challenge is confidence and controllability around SO₂ and CO₂ emissions. The latest APC solutions give cement operators both by ensuring parameters are monitored and met.

Managing hydrate consumption is key. Hydrate is added to bring SO₂ down; in the past dosing took place unnecessarily to run SO₂ at a lower level, leading to costly waste. Now, ABB Ability Expert Optimizer automatically increases or reduces the dosing, helping to minimise plant consumption by around 10% overall.

Ryan Koorts and Gregor Schuetz, ABB, show how advanced digital solutions can stabilise and optimise production processes for increased output, lower fuel consumption, longer refractory life, and improved, more consistent quality.
In terms of sustainability, APC platforms can also be used to reduce a cement plant’s CO₂ footprint by maximising the use of alternative fuels. Previously, operators were forced to juggle alternative fuels including tyres, animal meal and rubbish, and instead would often resort to traditional fuels like coal for greater certainty.

Now, this assurance comes from Industry 4.0 solutions. They can be used to lower CO₂ emissions, which is better for the environment and means cement customers are able to hit ‘go green’ targets in the countries where they operate.

ABB Ability Expert Optimizer, for example, uses model predictive control and analytics, allowing predictions to be made based on past control actions for accurate and consistent system decisions.

**Cement industry applications**

The rotary cement kiln process is intrinsically unstable. The control strategy involves maintaining a given temperature profile along the kiln and good burning conditions, combined with the lowest possible energy consumption, taking in constraints such as the amount of air in the exhaust gases.

Actuators are kiln speed, energy input, air and feed, while the process parameters to be controlled are temperature in the kiln front (or specially built soft sensor), temperature at the kiln inlet, and oxygen in the gases travelling through the system. The potential usage of alternative fuels means the control strategy may also need to calculate the optimal fuel mix for the given conditions.

ABB Ability Expert Optimizer – part of the ABB Ability portfolio of digitally connected products and services – combines APC technologies with the company’s industry expertise to stabilise the process and then maximise profitability, enabling a higher level of automation and optimisation of rotary cement kilns and mills, alternative fuel management and material blending.

Off-the-shelf control modules with preconfigured strategies ensure rapid implementation, and this is complemented by new software innovations such as key performance indicator monitoring, artificial intelligence (AI) and machine learning (ML) to facilitate soft sensors like cement strength prediction.

In addition, hardware helps provide milling insights, allowing previously unmeasurable information such as vibration data to be converted into controllable analytics and optimised by the APC system.

**CEMEX case study**

A control system is crucial to any cement plant, regulating the plant’s stability and the quality of product delivered. ABB Ability Expert Optimizer tackles the complexity of cement processes by minimising the effect of variability in feed and fuel sources, and driving maximum profitability.

The installation topology allows the solution to be deployed both in the ABB Ability System 800xA control system and in third party control systems, making it applicable to any type of control system set-up.

The ABB system is employed on the raw material preparation, mills and kiln in Rüdersdorf, Germany. Recently an additional application was introduced to reduce SO₂ emission variability, and hydrate overdosing and consumption, enabling the plant owner CEMEX to hit operating targets and reduce emission violations to zero.

The controller reduced operator workload by automatically optimising the short-term exhaust SO₂ target based on the current

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The CEMEX plant located in Rüdersdorf, Germany, is already utilising the ABB Ability Expert Optimizer.

The ABB Ability Expert Optimizer combines APC technologies to stabilise processes and maximise profitability.
The operator can select one of two optimisation modes – ‘normal’ or ‘aggressive’ – based on whether they want to target the daily average below the limit at the end of the day or within the next 30 minutes. ABB Ability Expert Optimizer then automatically adjusts the multiple feeder points of lime hydrate to ensure the SO₂ and HCl targets are strictly met.

The results are tangible. After a year, the system minimised standard deviation, significantly reduced the deviation around the operating target for daily SO₂ emissions, and helped reduce plant hydrate consumption by 11%. Operator utilisation of the emissions controller is 91%.

This final statistic is indicative of a growing confidence in process industries around digital solutions. In 2021, humans still have the ultimate power, but ABB develops functions so that the operator receives the information they need, and they also know what the APC is doing in the background.

**RCCPL case study**

In India, ABB is helping RCCPL, a subsidiary of Birla Corporation, to boost production, minimise its carbon footprint and reduce fuel consumption at its 3.9 million tpy greenfield plant in the state of Maharashtra – which incorporates a 40 MW captive power plant and a 10.60 MW heat recovery system – using ABB Ability Expert Optimizer and additional digital technologies to control, stabilise and optimise the cement plant’s industrial processes.

The ABB digital solutions and electrification products will be integrated with ABB Ability™ System 800xA, a distributed control, electrical control and safety system as well as a collaboration enabler with the capacity to improve engineering efficiency, operator performance and asset utilisation.

In Maharashtra, the system will use linear and non-linear model predictive control and neural networks to manage critical plant components, identifying the best operating conditions to maximise output and immediately detecting deviations among various processes in cement production. This is backed by the remote ABB Ability Collaborative Operations Centre from which experts monitor and can help retune the system remotely for new process conditions.

Early involvement in the project’s development was key, allowing for a holistic approach to the design of the complete system, culminating in the launch of the Collaborative Operations Centre in India that provides operations support to RCCPL during the post-commissioning life cycle.

This emphasis on involving the technology supplier from the outset of a cement automation project, and on collaboration between all project stakeholders – including the sharing of real time process information – is set to accelerate in 2021, resulting in more efficient and sustainable operations.

**The future of digitalisation**

More and better-quality data – gathered directly from connected equipment and processes or from soft sensor models – is the cornerstone of a smart cement plant. The future of APC lies in leveraging advances in artificial intelligence and machine learning that make it easier to not only provide additional variables to optimisation but to also help in sustaining the benefits of the controllers via adaptive re-modelling and tuning.

While operators already collect granular data from their plants to benchmark productivity, they are not yet leveraging it to confront process optimisation challenges that have not yet been addressed.

To this end, ABB is developing instrumentation that offers deeper insights into what is happening in the production process. These innovations include devices that attach to the mill wirelessly with a very small footprint and provide milling or grinding information that previously was unmeasurable.

Online vibration sensor analytics, in conjunction with ABB Ability Expert Optimizer, can be used to control and improve grinding conditions. For example, cement mill level and grinding angle variability are reduced by targeting operating regions within set constraints, improving overall grinding efficiency. The tools and technology are now available to better tackle the challenge of ‘what is going on inside the mill?’

The aim is to provide operators with the information they need to make more informed decisions; for example, do they want to use APC to control the production process or take over manually?

Companies such as ABB, in collaboration with original equipment manufacturers (OEMs) and manufacturers, are committed to continue pushing the boundaries of digitalisation to the benefit of all cement industry stakeholders.