

Advanced Control for the Cement Industry

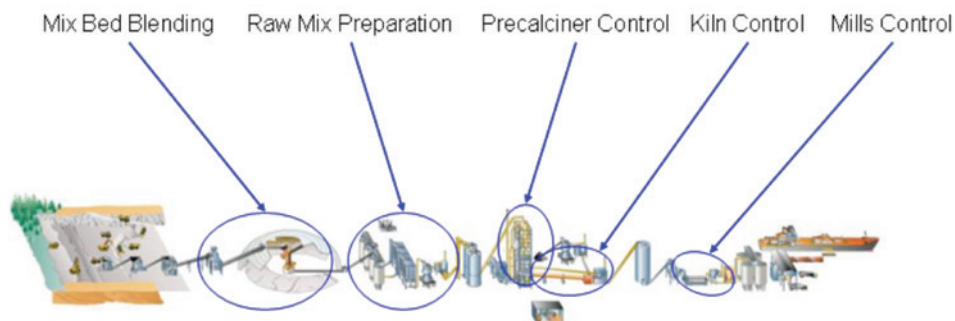
The cement industry of the 21st century is confronted with disparate goals that at first glance seem to conflict. For example, the enormous pressure to increase profit and margins is juxtaposed against the considerable public interest in the sustainable and environmentally friendly use of natural resources. In other words, plant operators find themselves in a situation where they need to react fast and optimally to continuously changing conditions while still meeting various, and probably conflicting, objectives. Thus, there is a need for tools that bring the plants to their optimal economic performance allowed by technological, environmental, and contractual constraints. From a technological standpoint, these tools are related to mathematical programming: optimization subject to constraints. The cpmPlus Expert Optimizer (EO) was developed to address these challenges, in particular for cement plants.

Solution Overview

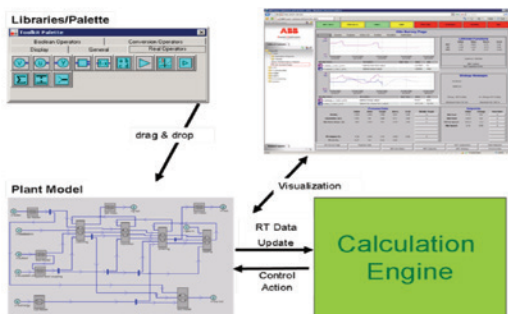
Over many years, a variety of strategies for control and optimization of key industrial processes have been developed and implemented in EO, with particular focus on control and optimization in the cement industry:

- Raw materials blending
- Vertical mills for raw meal grinding
- Calciners and rotary kilns
- Vertical and ball mills for cement grinding

The technology has been deployed in cement plants worldwide. Most installations have been made in blending, kiln, and grinding operations. More than 45 blending systems, 195 rotary kilns, and 90 ball mills have been commissioned by the ABB team in recent years.



cpmPlus Expert Optimizer applications scope in the cement industry



Energy Efficiency and CO₂ Reduction

The cpmPlus Expert Optimizer is a generic platform for development of advanced process control solutions at ABB. It is primarily designed for closed-loop control, optimization, and scheduling of industrial processes, although it can also be used for open-loop decision support applications. When this platform is used, the problems described above can be attacked with techniques such as model predictive control (MPC) in its mixed logical dynamical (MLD) systems formulation, which includes Boolean variables and logical constraints.

For ease of use, the technology has been embedded in a graphical modeling toolkit that allows maximal flexibility during model and cost function design while hiding the mathematical complexity from the user.

$$\begin{aligned} x(t+1) &= Ax(t) + B_1u(t) + B_2\delta(t) + B_3z(t) \\ y(t) &= Cx(t) + D_1u(t) + D_2\delta(t) + D_3z(t) \\ E_2\delta(t) + E_3z(t) &\leq E_1u(t) + E_4x(t) + E_5 \end{aligned}$$

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Global Fuels Award, 2008

In 2008, the cpmPlus Expert Optimizer received the "Global Fuels Award for most innovative technology leading to electrical energy savings." The award was granted by the Global Fuels 2008 conference in London.

Selected Success Stories

Switzerland: Material Blending at Untervaz

The Untervaz plant wanted to reduce raw mix quality variability, reduce the associated material costs, and increase the useful lifetime of the quarry. This would also allow the plant to have better process parameters in the kiln, getting closer to clinker quality targets, increasing production, and reducing the risk of process disruptions. In March 2007, ABB extended Untervaz's Expert Optimizer to include ABB's Raw Mix Preparation (RMP) solution. The technologies used are MPC and MLD systems. The benefits achieved by the installation are that raw mix quality variability has been reduced by 20% and kiln process variability has also been reduced. New daily clinker production records have been achieved in the time since RMP has been online.

Germany: Precalciner With Alternative Fuels at Lägerdorf

The Lägerdorf plant wanted to increase alternative fuels utilization, get closer to optimal calcination conditions, and reduce the risk of process disruption. In August 2006, ABB successfully installed Expert Optimizer, encompassing a Precalciner Temperature (PCT) control solution, on the calciner at Lägerdorf. The technologies used are MPC and MLD. The installation achieved a dramatic increase in the use of alternative fuels. Furthermore, it was possible to reduce temperature variability, bring the precalciner average temperature toward optimal values, and reduce the risk of cyclone blockages.

Italy: Cement Grinding at Guidonia

Buzzi Unicem wanted a solution for its Guidonia plant that would increase the productivity of its cement grinding system, consisting of three mills. ABB installed Expert Optimizer on the mills at the Guidonia plant between December 2006 and January 2007. The EO team overcame the challenges at the Guidonia plant by applying the MPC approach together with a tailor-made parameter adaptation and process supervision procedure. The benefits are better grinding process parameters and operation closer to process constraints. The specific energy consumption was reduced by as much as 5%.

Turkey: Full Process Optimization at Adana

Adana Cement Industry Inc. operates four separate clinker production lines, two coal mills, and five cement mills at its Adana plant. Over a period of a few months in 2010 the company deployed Expert Optimizer to several kilns, mills, coolers, and calciners. The strategies were based on model predictive control and achieved runtime factors of over 90% while reaching the targeted improvements in energy efficiency and production.