COVER STORY AND CONTENTS

Cover Story

The front cover shows ABB serving the cement manufacturing industry, which it has done since 1961 with turnkey installations, electrical equipment and automation systems. In 1990, ABB recognised the MES (Manufacturing Execution Systems) business area as a natural extension to its technology portfolio. Since then, ABB has provided added value solutions that are independent from the installed process control and automation platforms.

The main Centre of Excellence for MES in cement is based in Switzerland, but operates worldwide through a network of local organisations. ABB has gained extensive experience and deployable knowledge on production and quality management systems and production process optimisation solutions.

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Dealing with differing demands

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ABB details the kinds of pressures on today’s plant managers and describes the benefits of an integrated approach to management through process optimisation and flexible programming.
Dealing with differing demands

by Michelle Kiener, Ross Taylor, Dr Eduardo Gallestey, Clive Colbert, ABB, Switzerland

Operating successfully in such a changeable and demanding market requires tools that support the decision making process of key plant personnel. These tools must bring the plants to their optimal economic performance as given by the degrees of freedom left by the technological, environmental and contractual constraints. Further, in order to be successful they must work in real time and be fed with consistent and correct information at all times. Clearly, efficient performance information management systems are a precondition for successful implementation.

ABB has developed a state-of-the-art Knowledge Based Solutions (KBS) product suite which is successfully managing the conflicting demands placed on plant managers and their team. The solutions suite is optimising the cement manufacturing process from beginning to end, reducing waste and optimising resources by taking a fully integrated approach to the production process. From the beginning of the process where the Raw Mix Preparation (RMP) solution supplies the optimum blend to support process demands, through to the Dispatch Automation Solution (DAS), a fully integrated solution approach is able to optimise the process to meet conflicting process demands, time and time again in a tireless yet fully flexible style (see Figure 1).

Increasing production
Where the market conditions allow or encourage it, the priority for many managers is achieving the maximum possible production level from their process. Assuming that suitable resources are available to support an increase in production, many plants could be producing more than they are already. ABB’s Expert Optimizer (EO) is one part of the KBS suite that is assisting process owners and operators to increase production and therefore make even better use of their capital investment. EO, built on the excellence of its predecessor LINKman, achieves stable and optimal kiln operation at a level that even the best operators are not able to match, 24 hours a day, seven days a week. The EO solution comprises both rule based control with modern tools like neural networks, fuzzy control and Model Predictive Control (MPC) which optimise the kiln and mills while complying with the process constraints found in every plant. Running such a stable process allows operation with smaller tolerances. Being able to run closer to operating constraints enables EO to increase the amount of product that is produced, if the strategy is to optimise for maximum production. Experience has shown that a significant increase in production can be expected for kilns that previously had a lot of stops due to process problems such as cyclone clogging and formation of material rings. Furthermore, in cases where, in manual operation, the individual kiln installations were not already operated at their capacity limits, production can be enhanced by the high level control afforded by EO. This is done by automatically increasing the feed rate in small steps until the bottleneck in the system is reached, eg maximum speed of the ID fan, maximum tolerable.
under pressure at kiln inlet (dust cycles),
maximum thermal load of the clinker
cooler, etc. EO’s performance is very
satisfactory in cement plants as is revealed
by its strong reference record. Typical
production increases for a kiln being
optimised by EO are in the order of 2-5
per cent. A recent EO project, at Holcim’s
Ternate plant in Italy, saw a production
increase of eight per cent.

Focus on quality
If the demand is for product quality, an
integrated approach to process control is
the logical solution by making sure that
quality is optimised business wide, thereby
minimising waste and reducing costs. The
integration of the quality information with
process and production information is the
foundation for advanced optimisation of
key process parameters and clinker and
cement recipe management. The
Laboratory Information Management
System (LIMS) is a fully integrated part of
the ABB KBS suite. LIMS is designed to
manage the quality cycle from the routine
quality control tasks (supplied/incoming
material, raw material, clinker, fuel,
cement) in order to report on quality,
make criteria for decision making easily
accessible and transparent and to further
increase the plant personnel knowledge of
the process condition. It provides the
foundation for direct process and quality
control, for day-to-day management
decisions in production and for the long
term continuous improvement plans. It
includes functions like automatic and
manual data acquisition, data validation,
data consolidation, storage, calculations,
sample logging procedures, sample status
reports, work lists, standard and
compliance reporting features, easy to use
means for trending, graphing plus options
for SPC and statistical analysis
applications. Two main focuses in a
laboratory, information and workflow, are
supported.

A practical example of the benefit of an
integrated approach to quality is cement
strength forecasting. This is usually done
by the quality manager whose personal
experience is applied to regression analysis
for 1, 2, 3, 7, and 28 day strengths. After
the first day’s analysis, the 28 days’
strength is forecasted. This forecast is
based on the assumptions that the recipe
and fineness applied is exactly what has
been requested. In practice, these
assumptions are seldom fulfilled. There is
always some variation in the feeders and
fineness control leading to a different
strength. By using an integrated solution
the quality manager is now able to predict
the strength based on not only one
day’s value but also on key process
parameters like actual gypsum feed,
fineness, grinding aid, etc. Experience
shows that the model including process
variables gives much more accurate
results. The quality can
now be better
optimised by either
grinding the cement
coarser or by increasing
additives.

Reducing costs
When production is
operating at the right
level for the market and
quality targets are being
achieved, demands
which require flexible
solutions still exist.
Many options exist to
reduce operating costs and optimise
product price and margins. Often for
economic reasons – in essence, to reduce
fuel costs – waste fuels are increasingly
used in the cement industry and have
growing significance for operational
economics. The economic advantages of
waste fuels are especially important when
the plant is paid to burn waste material.

Often, waste fuels have variable
calorific values and are difficult to feed at
a constant rate. As a consequence of this,
the stability of the kiln is often reduced
when waste fuels are introduced and
production of good quality clinker
becomes more difficult. The use of an
additional EO module is, however, already
enabling more than 40 kilns worldwide to
burn waste fuels effectively. In cases
where environmental legislation plays a
part, complex logic can be required to
optimise the use of waste fuels for
reduced costs, while remaining within
emission and other environmental
constraints. Incorporation of the different
demands and process requirements are
optimised in the data flow as shown in
Figure 2.

However, since there is a strong need
for tools that offer optimal management
of the alternative and traditional fuels
involved in the kiln process, EO is being
further enhanced with an Economic
Process Optimisation (EPO) module that
brings economic performance to new
heights.

The EPO module gathers data from the
information management systems
(equipment, process, market, laboratory)
in order to calculate online the lowest cost
fuel mix that satisfies the process and
business constraints. The constraints to be
satisfied are numerous. Typically the most
important ones are
1. Heat balance,
2. Excess oxygen level,
3. Clinker chemistry,
4. Volatiles concentration,
5. Emission limits (CO₂, SO₂, NOx, etc.)
6. Maximum, minimum and speed of change constraints on actuators,
7. Operative constraints on fuel consumption,
8. Separate consideration of combustion process in precalciner and kiln,
9. Contracts (with customers or suppliers) to be satisfied at any cost.

The basic element of this algorithm is a dedicated kiln mathematical model which is used for Model Predictive Control (MPC). The mathematical model is able to estimate cooler, flame, burning zone, back end and preheater temperatures, kiln energy requirements, emission and volatiles levels, etc. The model parameters are tuned using a combination of neural networks and Kalman filtering techniques. Notably the optimisation algorithms are able to cope with both hard and soft constraints, which enhances robustness and reliability of the optimisation process. See Figure 3.

Figure 3. Kiln Model Input and Outputs

- Ambient Conditions
- TF/AF/RM Rates
- TF/AF/RM Chemistry
- TF/AF/RM Physical Properties

Kiln Mathematical Model

- Kiln Temperature Profile
- Heat Release
- Emission Rates
- Clinker Chemistry
- Volatiles Recirculation

Optimising fully integrated Knowledge Based Solutions for cost reduction strategies is currently saving ABB customers more than $100m per year.

**Conclusions**

The pressure for more profit and sustainability, increased production, reduced costs and maintained quality drives the trend towards truly integrated process optimisation. Taking a fully integrated approach to plant data integration, interpretation and action means that it is possible to respond proactively to the many competing and shifting demands that are placed on plant managers. Efficient, flexible and integrated software architectures together with more capable mathematical methods are putting suppliers like ABB in the position to help their customers to reach new levels of market responsiveness and performance. Plants running fully integrated but flexible solutions can be as flexible as the market. A change in priorities does not require a change in software or investment, solutions are simply provided by a change in strategy.