Dealing with differing demands

ABB's Knowledge Based Solutions are successfully managing today's conflicting demands and priorities

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Dealing with differing demands

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The plant manager of the 21st century is confronted with disparate goals, which at a first sight seem to exclude each other. On the one hand, there is enormous pressure to increase profit and margins, while at the same time there is considerable public interest in sustainable and environmentally friendly usage of natural resources combined with the need to maintain product quality. In other words, plant owners and operators find themselves in a situation where they are pulled in many different directions simultaneously. Fast and optimal reactions to continuously changing conditions, while still meeting various and probably conflicting objectives, are crucial for survival.

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.

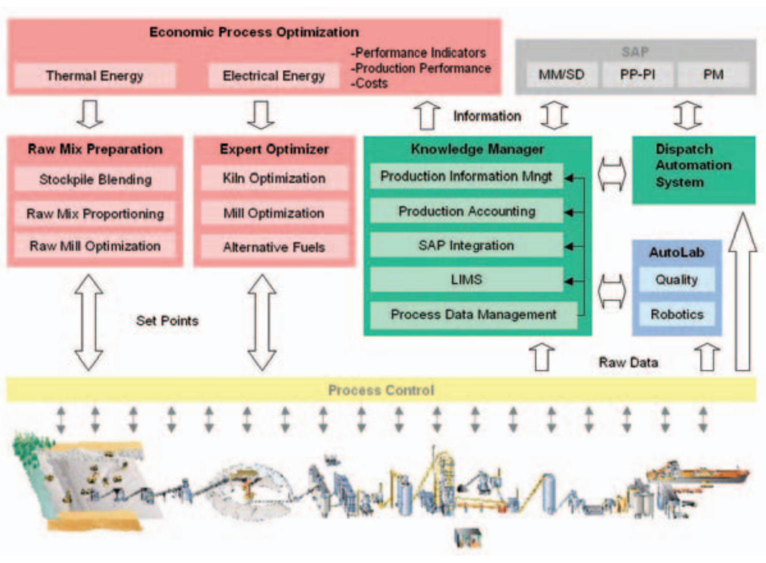
ABB has developed a state-of-the art Knowledge Based Solutions (KBS) product suite which is successfully managing the conflicting demands placed on plant managers and their team. The solutions suite is optimising the cement manufacturing process from beginning to end, reducing waste and optimising resources 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.

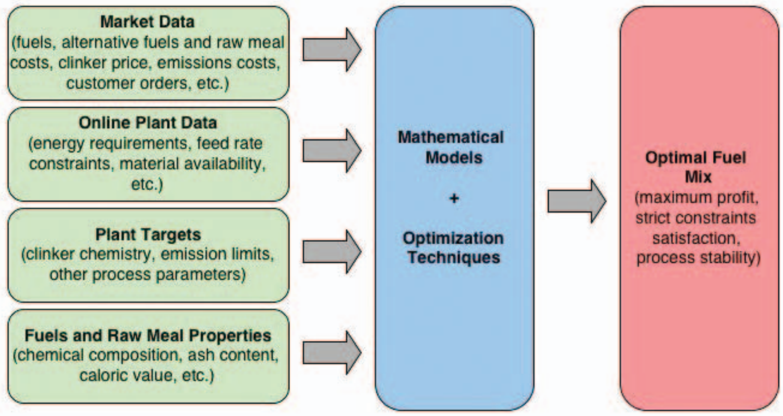
EO, built on the excellence of its predecessor LINKman, achieves stable and optimal kiln operation at a level that even the best operators are not able to match, 24 hours a day, seven days a week. The EO solution comprises both rule based control with modern tools like neural networks, fuzzy control 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

Figure 1: the ABB Knowledge Based Solutions product suite



system is reached, eg maximum speed of the ID fan, maximum tolerable underpressure 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.

Figure 2: optimisation data flow

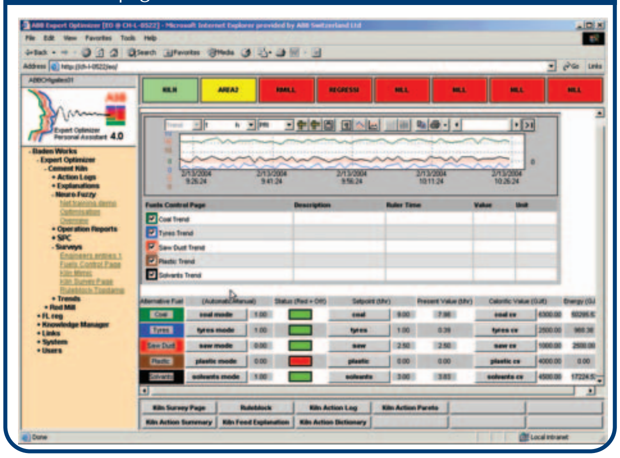


Focus on quality

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 on 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.

Fuel control page



Reducing costs

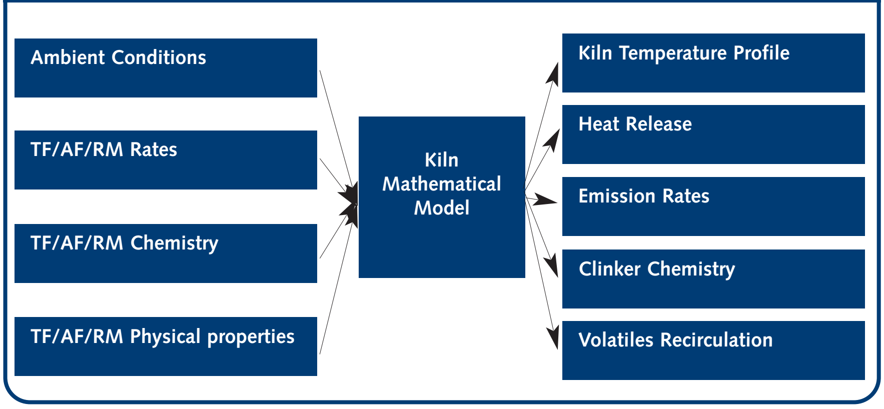
When production is operating at the right level for the market and quality targets are being achieved, demands which require flexible solutions still exist. Many options exist to reduce operating costs and optimise product price and margins. Often for economic reasons – in essence, to reduce fuel costs – 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

Figure 3. Kiln Model Input and Outputs



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, SO_2, 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.

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.

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