Expertly boosting output

Clinker production increases by as much as 8% at a Holcim Group plant

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More stringent market requirements on costs, quality, environmental legislation and the increasingly competitive market situation puts energy intensive industry under pressure to leverage its asset management, increasing profitability. Furthermore, globalisation influences the industry leading to the implied requirement for optimisation of resources and production facilities. In this context, advanced process control and optimisation systems are helping the modern cement and mining industry in its quest for higher profitability. This paper reports on a project carried out at Holcim Italia's Ternate plant by ABB Switzerland and tells of the main difficulties the plant set out to overcome and the goals achieved.

An ABB OptimizeIT Expert Optimizer system was implemented on the Kiln and Cooler at the Ternate plant of Holcim Italia SpA. Ternate is located in Northern Italy close to lake Maggiore approximately 60km north of Milan.

Kiln line no 3 at Ternate was designed and erected by Polysius in 1992 and consists of a three tyre kiln with an inline goose-neck precalciner, a five-stage preheater and a chlorine by-pass that was commissioned in September 2004. The grate cooler is also a Polysius design consisting of three grates and nine fans; it has been updated by installing an IKN fixed inlet. The raw mill extracts gasses from the kiln system exhaust and returns the used gasses at the bottom of the cooling tower, starting and stopping of the raw mill does not disturb the kiln system.

Holcim Italia's Ternate plant

The nominal capacity of the kiln line is 2600tpd, and the thermal energy consumption is around 3300kJ/kg clinker. Despite the five-stage preheater, the outlet gas temperature is in excess of 350°C, this temperature falls as the feed rate gets close to the maximum feed rate. The kiln feed chemistry is variable due to:

- complex preblending and raw mill bins feeding systems
- no possibility of correcting low LSF in the raw milling circuit (because of only two feeding bins: Prehomo and clay)
- unsatisfactory performance of the homogenisation silo
- kiln dust return during direct operation

Holcim Italia's Ternate plant

The kiln system is fired with multiple fuels. Petcoke is the main fuel; Heavy Fuel Oil can be used for the main burner but in practice is only used for warming up. There are also four alternative fuels collectively known as AFRs. AFRs are sometimes off, the main reasons for this are as follows:

- low storage capacity at the plant so that these fuels run out when there is no delivery for more than two days
- lack of alternative fuels availability on the market
- handling problems, for example, the conveying system blocks up
- conditions required by the environmental permit not met, for example, required instrumentation out of service for maintenance.

The AFR stoppages change both the quality of the flame in the kiln and the Lime Saturation Factor (LSF) of the clinker. Although burning alternate fuels is an economic necessity they create both operational and quality problems that have to be dealt with and installing Expert Optimizer was one of the methods used to restore stability to the process.

Expert Optimizer project

The project at Ternate followed the normal schedule of an Expert Optimizer project, this has been described many times before and is therefore not repeated here.

ABB's OptimizeIT Expert Optimizer was installed at the factory and the primary commissioning commenced in March 2004. The Expert Optimizer server software was installed on a Dell server and interfaced to the Siemens S7 PLCs by use of the Microsoft OPC technology. Initially the quality data from the plant quality system was not available automatically but later this data was read via the PLC. Direct reading would also have been possible but as the data was also required for the MMI the route via the PLC was deemed to be the best one. With Expert Optimizer the user interface is a web browser[ii] and so no special operator station is required although it was decided to install a dedicated PC so that the operator can see the interface at all times without having to swap between applications.

The introduction of a high-level control system could have been a culture shock for the operators so to prevent operator resistance they were involved in the project from an early stage. The project goals (mentioned above) were communicated to them and they were given basic training before the commissioning started and on the job training during the commissioning. Italian documentation was also prepared. As a result the operators soon felt able to take ownership of the system and treated it as

Figure 1: monthly clinker production as percentage of maximum achieved production

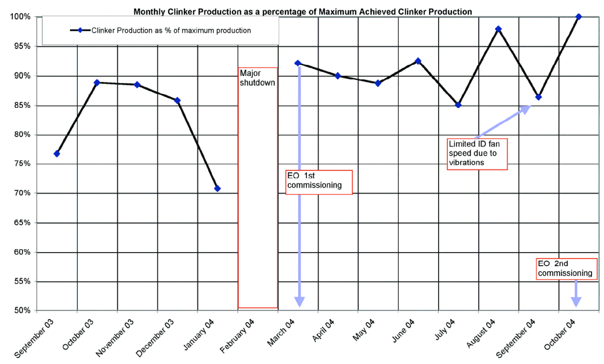
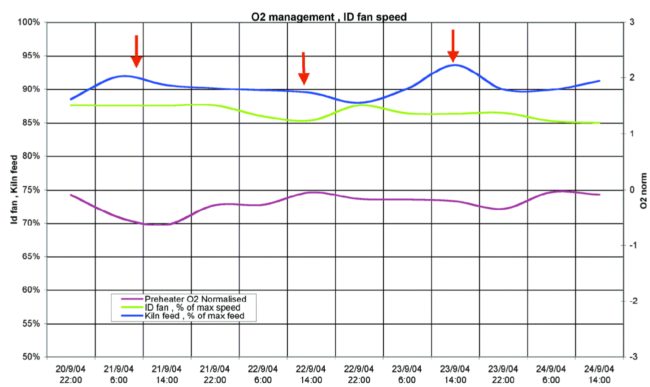


Figure 2: operation in September 2004 with ID fan vibration



a labour saving tool. The confidence of the operators is shown by on line times of more than 95 per cent in the first months of operation. Watching the Expert Optimizer actions has been good training for the kiln operators: changing feed and fuels were not common for the Ternate operators who used to set the feed at the target and drastically increase/decrease fuels and decrease the kiln speed when the kiln was cold/hot. They can now see that this was contributing to the kiln instability.

To correctly operate the process it is necessary to (a) correctly understand what the instrumentation is saying about the process and (b) have the correct targets to operate the process in the optimum manner. Utilising the skills and knowledge of the engineers and the operators, the key parameters on this kiln were determined to be:

Burning zone temperature (BZT). This is the predictor of product quality, if the BZT is low we expect that the clinker will be insufficiently burnt and if the BZT is high we expect the clinker will be over burnt. At Ternate there are three possible measures of BZT: NOx, IST Scanning Pyrometer, and Kiln main drive hydraulic pressure. Interpretation of these signals was not easy due to instability of the kiln coating and the variable position of the burning zone, however combining the knowledge of the operators, process engineer and ABB engineer allowed a good solution to be found.

Precalciner temperature (PCT). The bottom stage material temperature was found to be the best indication of calcination. Hot meal is sampled automatically every three hours and calcination degree is used as a feed back for PCT. For some unknown reason the bottom stage gas temperature is not a good calcination indicator often showing a different trend to the other temperatures around the process. Stable calcination is an important factor for stable kiln operation.

Kiln Inlet Oxygen and CO. Operation at the correct Kiln Oxygen and CO levels is very important to prevent reduced clinker and to reduce build up in the preheater tower.

Preheater Oxygen and CO. Available at the preheater outlet and at stage three. The analyser at stage three is not really reliable due to false air and so the preheater outlet analyser is normally used. Operation at the correct System Oxygen level is very important to achieving maximum output.

Fuel Management

In Expert Optimizer fuels are divided into two classes:

- a master fuel – this is a fuel that Expert Optimizer adjusts in response to the energy requirements of the strategy
- a secondary fuel - this is a fuel where Expert Optimizer does not send a setpoint but responds to changes made elsewhere.

The master fuel is adjusted by Expert Optimizer to ensure that sufficient energy is supplied to the process at all times. The changes made respond both to the temperature of the process and any changes to the supply of secondary fuels.

Where multiple fuels are in use the problem of managing the fuels to meet constraints such as operating cost, emissions, chemistry etc is not a trivial problem and operators are generally not very good at this. Mathematical solutions are now available and offer the prospect of taking the management of alternative fuels to a new level[iii].

Chemistry and quality

The chemistry of the clinker is variable partly due to the variable kiln feed chemistry described above and partly due to the AFR. The animal meal has a particularly important influence here with the LSF decreasing by around one point when the animal meal is shut down. Due to this variable LSF, operating the kiln with a fixed Freelime target could cause the process to be overheated when the LSF is high and to be operated too cold when the LSF is low. In order to counteract this problem Ternate people wanted to operate the kiln with a variable free-lime target according to the LSF of

Figure 3: Average and Standard Deviation of C3S

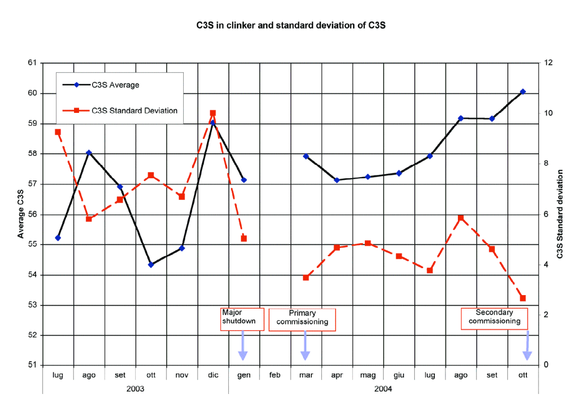
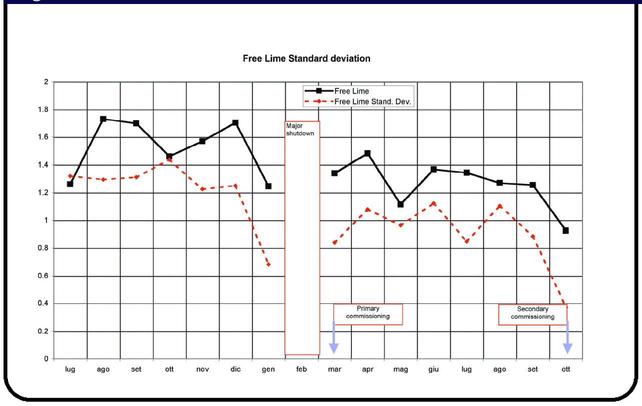


Figure 4: – Freelime Standard deviation



the clinker. This strategy is only possible because the clinker is automatically sampled and analysed each hour. The LSF is determined by XRF and the Freelime is determined by XRD using the Rietveld method, a method that results in a fully quantitative real phase determination.

When the plant quality system is under maintenance or has a fault it queues samples so for this reason only results with a timestamp less than two hours old are acted upon by Expert Optimizer. On each valid sample Expert Optimizer determines the appropriate Freelime target and compares this with the actual value before adjusting the kiln operating targets to optimise the operation. If no valid results are received then Expert Optimizer simply continues to use the last set of operating targets.

Results after six months

Bottom stage cyclones blockages have been one of the main operational problems over the last few years. Since the installation of Expert Optimizer these have been avoided due to better control of the calcination and of the kiln oxygen.

Improvement in refractory lifetime cannot yet be estimated, however, the kiln shell temperature profile shows more stable coating and a more constant temperature. This should lead to better refractory life.

Expert Optimizer will always attempt to reach the maximum production. In September 2004, the kiln had to operate the kiln at reduced output because of ID fan vibrations. Due to high market demand it was not possible to stop the kiln to fix this until the end of the month. During this period Expert Optimizer helped to keep the production rate high. In Figure 2, the red arrows show periods when Expert Optimizer was able to increase the feed because of the good control of the oxygen, we do not expect that the average output would have been so high if managed by the kiln operator.

From a quality point of view the Expert Optimizer lead to a continuous improvement of the absolute value and standard deviation of the C3S.

The standard deviation of the Freelime was also reduced, see Figure 4.

Of course when evaluating the results, the on-going program of optimisation of the kiln should be also be considered. Expert Optimizer is a part of the continuous improvement efforts of Ternate and is a tool that will continue to be used to help operate in the most cost effective way.

Conclusions

In this paper ABB and Holcim Italia reported on a project carried out at a plant in the north of Italy. The main difficulties to overcome were

- variability of feed chemistry
- high usage of alternative fuels
- plant process stability.

The benefits achieved are shown in Table 1.

This project shows that ABB's Expert Optimizer continues to produce value for our customers. It depicts Expert Optimizer as a proven but innovative product, which can boost plant productivity and profit while ensuring satisfaction of the process and environmental constraints. The control strategy produced with Expert Optimizer is able to be supported by the engineers on site and provides the opportunity to easily test and incorporate new ideas, thus it supports the continuous improvement efforts at Ternate.

References

i Expertly Controlled by D Clark, World Cement, January 2002

ii New possibilities of kiln control by R Taylor and M O'Grady-Hills, ZKG September 2002

iii Optimising the kiln fuel mix by E Gallestey, C Colbert, D Clark & M Mound, International Cement Review, February 2004.

Table 1: benefits achieved

	Average of four months before Expert Optimizer	Average of six months with Expert Optimizer	change
Output	85%	92%	8%
C3S	56.45%	58.24%	3.2%
C3S Standard deviation	7.17%	4.28%	-40.3%
Freelime	1.54%	1.26%	18.2%
Freelime standard deviation	1.18	0.9%	-25.7%

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