

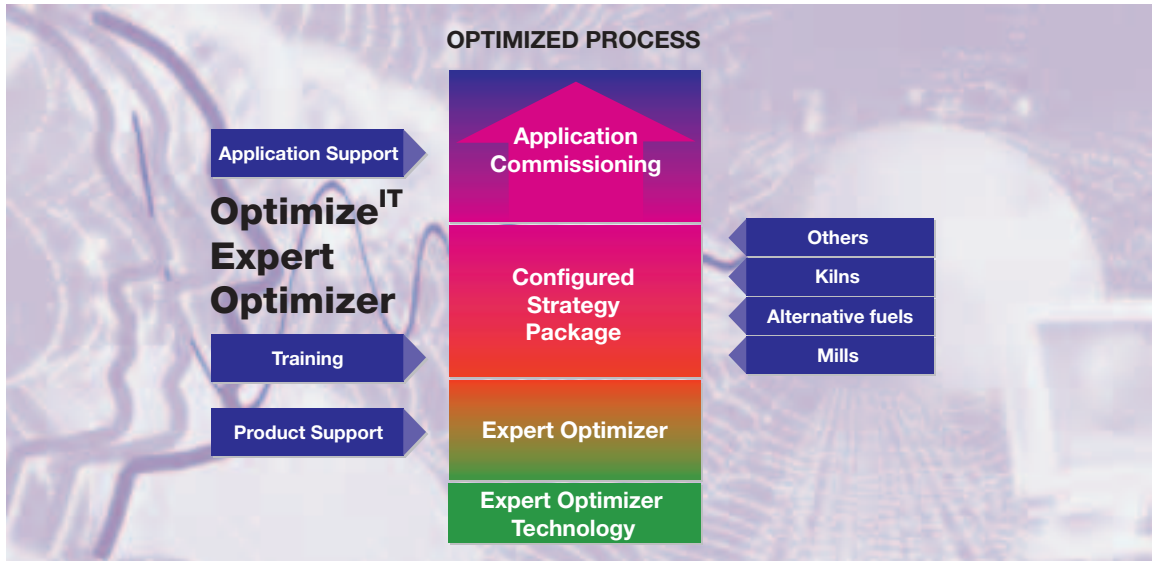
# Industrial<sup>IT</sup>: Optimization for the Cement Industry

Optimize<sup>IT</sup> Expert Optimizer



**ABB**

# Optimize<sup>IT</sup> Expert Optimizer



**The cement industry faces increasing pressure for more stringent requirements on profitability, product quality, legislation on emission control and an increasingly competitive market situation. Optimize<sup>IT</sup> Expert Optimizer – an expert control system – will help you reach these goals.**

## What is Expert Optimizer

Optimize<sup>IT</sup> Expert Optimizer is a hybrid intelligent-system product developed by ABB. Part of its wide optimization suite, it is primarily designed for expert closed-loop process control and optimization of industrial processes, but can also be used for decision-support applications.

Hybrid intelligent systems are not a substitute for plant DCS or PLC systems. Rather, they are a high level supervisor for supplying setpoints to the lower layer of control systems. Our hybrid intelligent system, the Optimize<sup>IT</sup> Expert Optimizer possesses human-like knowledge within specific domain. Adapting itself and learning in changing environments, it makes decisions and takes actions.

## Why Expert Optimizer

Its primary objective is to achieve continuous process optimization and thereby improve the plant's overall performance. Hence its advantage as a graphical engineering and programming environment, used to control and optimize

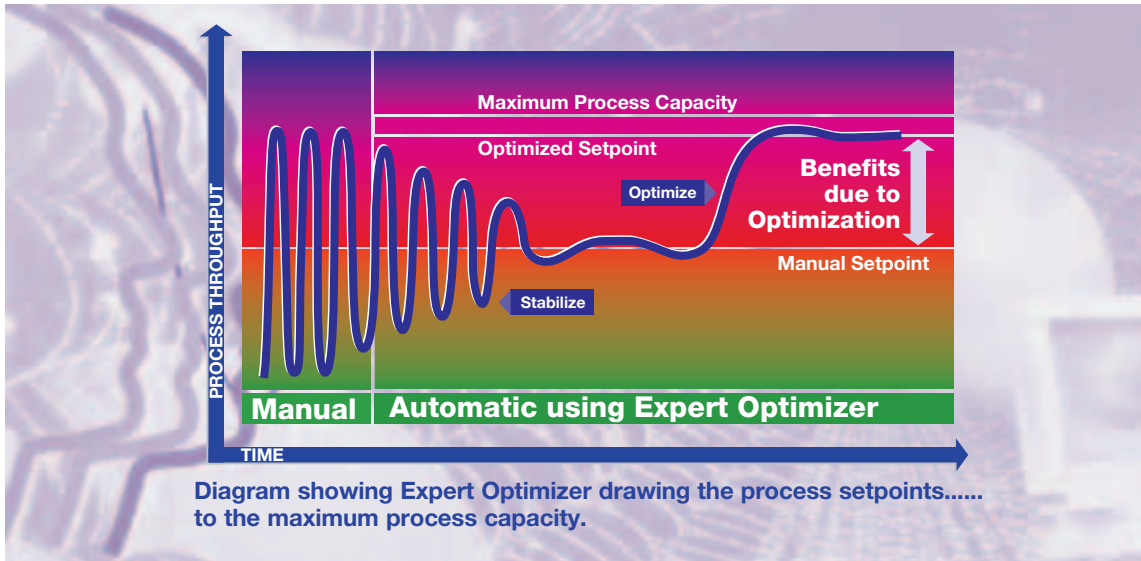
- Kilns
- Mills
- Alternative fuels

with a combination of proven and advanced control techniques. Optimize<sup>IT</sup> Expert Optimizer adds value to the operational performance by bringing the process closer to its operational limits.

In coordinating the setpoints of the different parts of the process, and immediately detecting deviations among the different parts of the mine operation, Optimize<sup>IT</sup> Expert Optimizer is a key tool for all – plant performance, it helps plant management reach enterprise profitability and sustainability goals.

## Tangible Benefits

- Increased profits (5%–10%)
- Increased production (3%–10%)
- Energy savings (3%–7%)
- More stable product quality (10%–20%)



### How does Optimize<sup>IT</sup> Expert Optimizer work

Complex real-world problems require intelligent systems that form partnerships with different control design methods. Thus, the Optimize<sup>IT</sup> Expert Optimizer provides a comprehensive variety of advanced control techniques for appropriate strategy development. Coupled with the graphical engineering environment, this ensures fast development and implementation with low cost system maintenance.

Process behavior is often well-known to experts. The expert knows and understands the forces acting on the process. This allows him to build a detailed relationship, able to link process output and inputs. For this reason, our core control strategy consists of multi-variable fuzzy ruleblocks,

neural networks, and model-based control. Optimize<sup>IT</sup> Expert Optimizer has successfully applied this technique and achieves more than 2 million hours, run-time in closed loop control every year.

As today, Expert Optimizer is controlling more than 260 processes worldwide. It is saving more than \$100 million to our customers, year after year.

**Combination of proven advanced control techniques and deep process knowledge guarantees the system success.**

### Optimize<sup>IT</sup> Expert Optimizer provides: unmatched performance

- Tirelessly supervises desired process parameters
- Unchallenged reaction speed
- Consistently takes the best decision
- Executes many small changes as opposed to few large changes
- Immediately recognizes abnormal conditions and acts accordingly

# Cement Kiln Optimization



**Expert Optimizer optimizes the cement kiln process. To achieve this however, its stabilization must occur before manipulated variables are driven to its constraints.**

## Meet your quality targets by maximizing your kiln throughput – How? By using Expert Optimizer

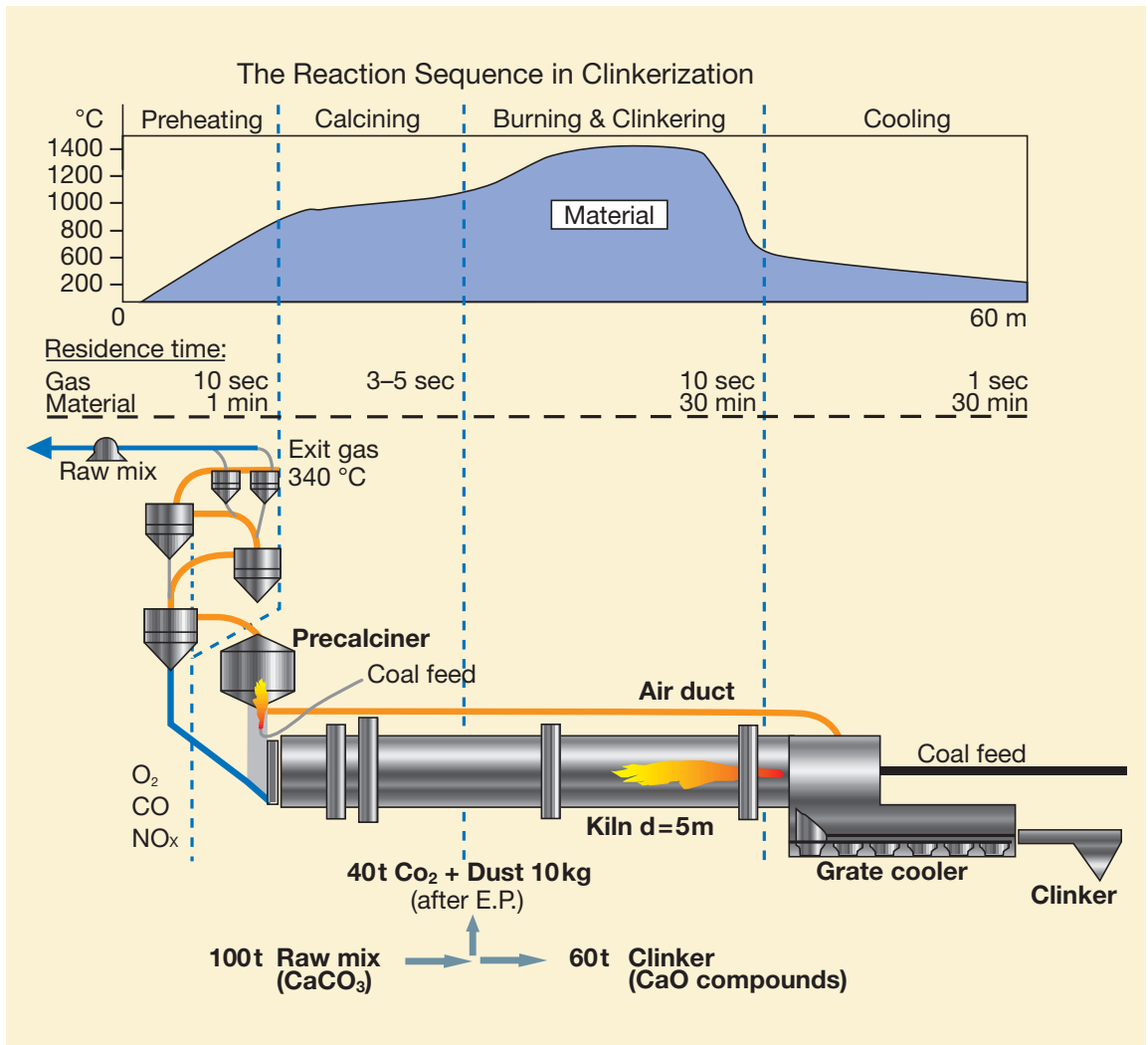
Controlling a cement rotary kiln is a very difficult task. The process is intrinsically unstable and there are long time delays and large perturbations acting on it. Only a perfect mix of experience, deep knowledge, mathematical techniques and state-of-the-art software can achieve optimal behaviour over long periods of time. Expert Optimizer is a system tailored for these needs.

### Optimize<sup>IT</sup> Expert Optimizer controls a kiln by:

- Checking for abnormal conditions, prioritizing their importance and taking special actions to bring the process back to normal.
- Using various of control techniques to maintain process stability.
- Once the process is stabilized, make numerous small changes to drive the process closer and closer to the process constraints.

The potential benefits a user can expect to achieve by installing Expert Optimizer can be assessed on the basis that performance will improve from that of an average operator to that of a best operator performing at its optimum for 24 hours a day, every day.

BENEFITS	SPECIFICATIONS
Quantifiable process benefits	<ul style="list-style-type: none"> <li>• Increased output (3%–10%)</li> <li>• Lower fuel consumption (3%–7%)</li> <li>• Longer refractory life (10%–15%)</li> <li>• Better and more consistent quality (10%–20%)</li> </ul>



The presence of both exothermic and endothermic chemical reactions makes the cement kiln process unstable. This means that achieving an ideal temperature profile through the kiln is essential to meet expectations on process stability

and performance. Expert Optimizer can solve this problem. It has been applied to the cement kiln process more than 170 times in 15 years, achieving an impressive record of performance and savings and creating value to for our customers.

**Expert Optimizer has been applied to the cement kiln process more than 170 times, creating value for our customers.**

BENEFITS	SPECIFICATIONS
<p><b>Benefits</b></p>	<ul style="list-style-type: none"> <li>Control strategy focused on business objectives</li> <li>Lower plant maintenance costs through improved run times</li> <li>Control of plant emissions to meet environmental legislation</li> <li>Consistent control of the process, eliminating shift-to-shift variations</li> <li>Enhancement of kiln-specific knowledge</li> </ul>

# Alternative Fuels Optimization



**Cement industry kilns are increasingly burning waste fuels to capitalize on the cost benefits offered by alternative fuels and hazardous materials.**

**“Use Optimize<sup>IT</sup> Expert Optimizer to burn alternative fuels and increase profitability.”**

Burning alternative fuels can lead to instability in the clinker manufacturing process.

Expert Optimizer controls the mixing of alternative fuels to ensure consistent burning, while making sure the kiln does not become unstable through changes in calorific values of the fuels.

Normally Expert Optimizer is designed to allow the kiln to use the minimum amount of thermal energy. But if the cement manufacturer's goal is to dispose of the alternative fuels, then the Expert Optimizer strategy can automatically be adjusted to maximize the burning of such fuels thus saving the customer money. Expert Optimizer has the ability to control the combustion of different fuels simultaneously.

Users must however meet stringent monitoring and control policies established by environmental agencies before burning any alternative fuels.

The Expert Optimizer Alternative Fuels Control Module is approved by environmental agencies in North America and Europe.

The system ensures that best practices are used at all times, while avoiding shift-to-shift variations and reducing operating costs without destabilizing the process.

BENEFITS	SPECIFICATIONS
<p><b>Benefits</b></p>	<ul style="list-style-type: none"> <li>• Increased usage of alternative fuels (5%–20%)</li> <li>• More stable product quality (10%–20%)</li> <li>• Reduced fuel costs (5%–20%)</li> <li>• Lower maintenance costs and fewer pollution emissions (5%–20%)</li> </ul>

# Emission Optimization



**“Use Optimize<sup>IT</sup> Expert Optimizer to limit the impact on the environment.”**

**Optimize<sup>IT</sup> Expert Optimizer reduces cement manufacturers' emissions in three distinct areas:**

- The burning of cement clinker in rotary kilns is controlled more efficiently, thus reducing the energy requirements of the process. This reduction in the energy consumption reduces the quantity of alternative exhausts emitted into the atmosphere.
- The kiln process runs at much lower temperature, which reduces the amount of NO<sub>x</sub> formed in the flame. The effectiveness of Expert Optimizer as a tool to reduce NO<sub>x</sub> emissions has been recognized in the form of an environmental award presented to ABB by the British government.
- Cement industry kilns are increasingly burning alternative fuels to capitalize on the cost benefits offered by alternative fuels and hazardous materials. Moreover, the CO<sub>2</sub> emissions produced by these fuels do not influence the enterprise environmental balance. Expert Optimizer helps to achieve the process stability needed to maximize the usage of these fuels.

**The kiln optimization strategy focuses on reducing NO<sub>x</sub> emissions while still maintaining the correct level of thermal energy.**

BENEFITS	SPECIFICATIONS
Benefits	<ul style="list-style-type: none"> <li>• Efficient control reduces energy requirements</li> <li>• Lower burning temperature reduces amount of NO<sub>x</sub> formed in the flame</li> <li>• Expert Optimizer is recognized by environmental authorities as the best available technology for the burning of alternative fuels.</li> </ul>

# Grinding Optimization



**Expert Optimizer has been successfully applied in more than 90 mills, to optimize milling operations.**

## “Use Expert Optimizer to improve profit via larger throughput and lower power consumption”

### Optimize<sup>IT</sup> Expert Optimizer benefits the cement mill operations in four ways:

- More consistent quality (grade).  
The continual monitoring of the mill loading and the adjustment of the feed and separator results in reduced variations in cement grade. This has the added benefit of a more consistent product quality. The control strategy is designed to respond to disturbances in the process but still achieve quality consistency.
- Increased output.  
By continually monitoring both the loading of the mill and the balance of material flows through the system, it is possible to identify situations when the feed to the mill and the output can be increased. Increased output over extended periods of time has been observed on mills controlled by Expert Optimizer.

- Reduced power consumption.  
This important saving is a result of the softer clinker produced by a kiln controlled by Expert Optimizer. The control strategy is able to make optimum use of the available mill capacity and improve the production rate.
- Reduced consumption of grinding media.  
As a result of the softer clinker produced in kilns controlled by Expert Optimizer the consumption of grinding media is reduced.

The main benefits of Expert Optimizer Controlling the grinding circuit of a raw mill are an increase in output and a reduction in power consumption.

BENEFITS	SPECIFICATIONS
<b>Cement mills</b>	<ul style="list-style-type: none"> <li>• Production increase (3%–10%)</li> <li>• Power saving, (3%–7%)</li> </ul>
<b>Raw mills</b>	<ul style="list-style-type: none"> <li>• Production increase (3%–10%)</li> <li>• Power saving (3%–7%)</li> </ul>



# Overall Plant Economic Process Optimization



**“Use Expert Optimizer to increase your economic performance through plant wide coordination of operational targets.”**

## **Optimize<sup>IT</sup> Expert Optimizer and the quest for overall economic performance**

Continuous operating performance and high profit margins are the major concerns in the cement industry. Plant management systems are expected to reinforce and conform to these requirements. The use of advanced intelligent systems like Optimize<sup>IT</sup> Expert Optimizer as a decision support tool can reduce costs, optimize investment and create a shorter payback by processing the information available and suggesting decisions. Production efficiency is reached via the integration of process, production, market, and quality information into one decision support tool.

## **Optimize<sup>IT</sup> Expert Optimizer as plant management decision support tool**

Optimize<sup>IT</sup> Expert Optimizer is ideally suited to provide these functionalities:

- Immediate detection and corrective action taken for process disturbances.
- Consistent overall economic process optimization of the plant as a whole i.e. process set-points and coordination thereof, energy management, production planning, energy supply contract optimization etc.
- Environmental sustainability issues are given appropriate weight in the enterprise operations as it now becomes possible to track and enforce company environmental goals

### **Application example**

The grinding plant operation can be coordinated with the clinker production process, and this with the availability and properties of material, market conditions and the contracts with the energy suppliers. Real time true optimization is the result.

**Optimize<sup>IT</sup> Expert Optimizer helps management enforce comprehensive, plant-wide economic process optimization measures**

BENEFITS	SPECIFICATIONS
Benefits	<ul style="list-style-type: none"> <li>• Precise material balancing</li> <li>• Throughput as dictated by the market</li> <li>• Lower energy consumption</li> <li>• Better and more stable quality</li> <li>• Lower maintenance costs</li> </ul>

# Advanced Process Control



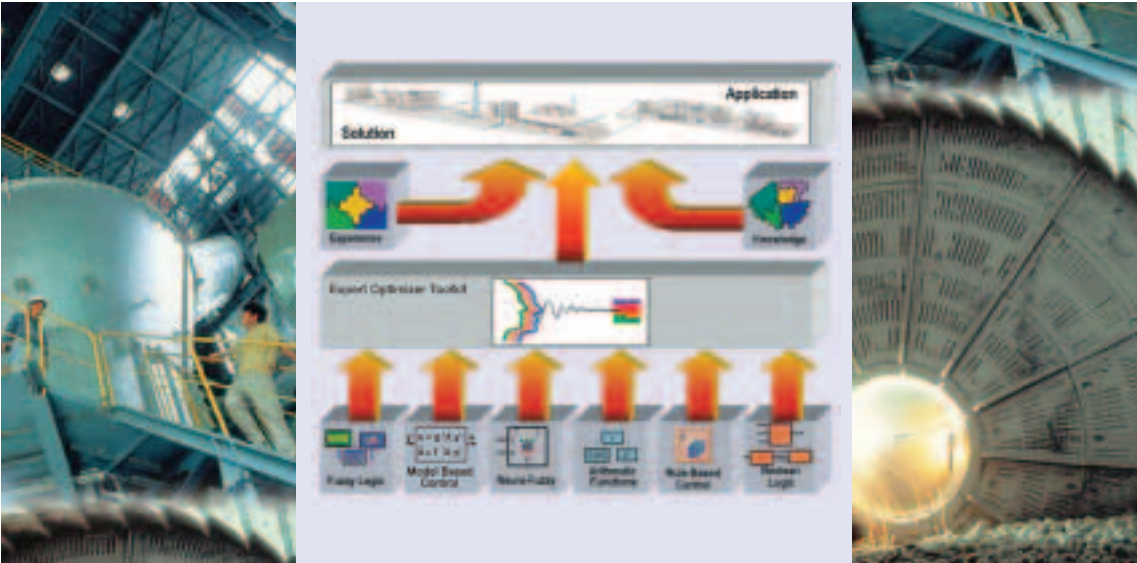
**Complex real-world problems require intelligent systems that form partnerships with different artificial intelligence methods – fuzzy logic, neurocomputing and model based control.**

The challenges of cement operations require intelligent systems that possess human-like expertise within a specific domain, adapt themselves and learn to improve in changing environments, thus making decisions and taking action.

In the Optimize<sup>IT</sup> Expert Optimizer Toolkit a number of proven control techniques for the development of the application are offered. In a control strategy, use is made of all of these control techniques to develop a robust control and optimization solution.

- The fuzzy logic inference system incorporates human knowledge to make and implement effective decisions during the process.
- Neuro-Fuzzy networks are used to learn relationships between key process variables and adapt themselves to cope with changing process conditions. The ability of Neuro-Fuzzy objects to learn relationships is an extremely useful method for predicting important process variables. This technique is extremely useful when it is not possible to continuously measure a process variable that is important to the control and optimization of the process. In cement kiln control, an obvious example is predicting the clinker free lime.
- Model based control allows incorporating predictive elements into the strategy by exploiting concrete knowledge about the process chemistry and thermo dynamics. Expert Optimizer graphical tools allow the construction of process models and application of techniques like model predictive control (MPC) with models in the mixed logical dynamical (MLD) systems framework. This allows exploitation of process knowledge to the maximum, increasing performance and reducing long term maintenance costs.
- The integration of all these complementary control techniques, coupled with ABB's extensive process experience and expertise, allows the engineering of powerful robust solutions. Well engineered solutions provide constant financial benefits to the cement factory for extended periods of time.

# Basic Software and Toolkit



## Control strategy

**The control strategy is broken up into various solution components.**

The Optimize<sup>IT</sup> Expert Optimizer Toolkit is used to build and display the control strategy required to achieve the process, chemical, metallurgical and business objectives. Typically the process engineer will break up the strategy into various solution components. These components are linked together to form a control strategy. Such solutions may be hierarchically arranged into logical workspaces.

The Toolkit provides a comprehensive variety of advanced control techniques for appropriate strategy development in the workspace.

These include:

- Mathematical functions
- Ruleblocks
- Fuzzy logic
- Boolean logic
- Model based control (MPC + MLD)
- Neuro-Fuzzy

Importantly, the control strategy is structured into Interrupt Actions, Stabilization and Optimization Actions. This, coupled to the graphical engineering environment, ensures fast development and implementation with long term maintenance of a system.

## Process optimization

It achieves this through technologies that enable the knowledge of the best expert to be applied accurately, tirelessly and consistently at all times. The forecasts of quantifiable potential benefits are often exceeded as a result of the additional process expertise from ABB application engineers and of the interaction between these engineers and the client's specialists. These benefits include:

- Increased production
- More consistent product quality
- Reduced operating costs
- Reduced key variable standard deviation
- Operational consistency

The purpose of the server is to run the expert system software, to communicate with the plant control system and to run the Oracle database. The Personal Assistant (client) provides an interface for the operator to information relevant to the optimization.

**The objective of Optimize<sup>IT</sup> Expert Optimizer is to achieve continuous process optimization, improving a cement plant's overall performance by combining the powerful control techniques available in the Toolkit.**

## **Optimize<sup>IT</sup> Expert Optimizer is a proven product from ABB**

- More than 170 kilns benefit from this technology and ABB experience.
- Installations on all continents.
- Now installed at over 90 mills.
- Globally, over 50 kilns burning waste fuels benefit from Expert Optimizer.
- Over 2 million hours of run time in closed-loop control every year.

**Controlling more than 260 processes worldwide, Expert Optimizer systems save our customers more than \$100 million per year.**



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