Cement manufacturing remains an energy intensive and emissions-heavy process, with the industry as a whole responsible for up to 9% of global carbon dioxide emissions.

Sustainability, specifically reducing energy usage and greenhouse gas emissions, is therefore a key driver for cement producers as they strive to decarbonise plant operations and adhere to the goals of the 2015 Paris Agreement, while at the same time optimising processes and profitability.

Using carbon capture utilisation and storage, fuel switching and thermal efficiency, and reducing the ratio of clinker to cement will help the industry achieve its goal of zero emissions by around 2040, or even sooner. Operators must also be cognisant that sustainability is a priority for the next generation of talent, and that genuine environmental innovation is needed in order to address the skills gap.

The digital revolution has a key role to play in this transition. Like all process industries, the cement sector cannot afford to lose the early adopter advantage when it comes to digital technologies and big data. Innovations like artificial intelligence (AI) and industrial analytics offer unprecedented visibility across the entire value chain, boosting throughput, availability and end product quality.

Digital advanced process control (APC), for example, can help manufacturers reduce the electrical energy and manufacturing costs associated with grinding circuits. APC solutions control, stabilise and optimise processes such as coal, raw material and finished cement grinding, helping plants lower energy consumption and hit sustainability targets, while maintaining output standards.
**AI and advanced process control**

A holistic approach to digital strategy is important. This involves transforming the process so that discrete or siloed functions are instead connected using internet of things (IoT) technologies, and then are automated. It is then possible to optimise these autonomous operations and for management functions to take place largely without human intervention within a secure environment.

The key to successful digitalisation is, of course, data, collected from connected equipment and processes or using soft sensor models.

Plant operators can use APC and advanced analytics models deduced from first principles or process data to predict or estimate process performance, even without reliable measurement data – for example, when real-world measurement would be too expensive – or to increase the frequency of data input and provide back-up for unreliable measurements. Analytics models include graphical (first principles), linear regression, non-linear regression, principal component analysis, artificial neural networks, and support vector machines. Here, advanced analytics really comes into its own, allowing users to test various models and select the one with either the best fit or performance statistic.

**How AI informs the Blaine process**

The Blaine process measures the specific surface area or the fineness of the cement, which is then given a Blaine number based on its quality. This number is important because process adjustments are made based on it, and infrequent sampling may impact both production and product quality.

At present, in the majority of cases, the Blaine process takes place in a laboratory at a frequency of every one to two hours. However, this manual approach has significant limitations in that, despite being used for process control, it does not provide real time insight into the measurement process.

Applying AI in the form of predictive quality analytics makes it possible to accurately forecast cement quality in real time at any point in the process, allowing plant operators to improve quality, stabilise industrial operations, and reduce variability, as well as avoid additional OPEX to hit quality targets.

**The application of soft sensors**

Soft sensors have established themselves as a viable alternative to traditional methods of acquiring data on critical process variables, process monitoring, and other tasks related to process control.

In the context of the Blaine process, soft sensors have evolved to the point where they now employ data-driven machine learning algorithms to predict...
Blaine at specific production intervals using an array of relevant parameters including fresh feed, separator speed, grinding pressure, and mill DP. This can be accomplished by following these steps:

- Collect historical data from control system for model training (production parameters and lab data).
- Data cleansing (for e.g. removal of data during mill stoppages etc.).
- Create a fully-automatic regression training model selecting best fit from the library of models.
- Deploy the model and test the model accuracy using the real time online data.
- Automatic data pull and retraining of the model if the accuracy is not met.
- Predicted Blaine output is used for further control.

The resulting prediction model transforms the cement quality process Blaine from an output process parameter to an input parameter, thus increasing the benefits from adaptive remodelling and tuning.

For example, Blaine is unable to provide continuous real time measurements and is liable to provide infrequent sampling. Adopting this new soft sensor methodology enables plant operators to make more informed decisions based on relevant data in order to improve the efficiency of the process.

The evolution of advanced analytics means that machine learning models are now more accessible and user-friendly. This, combined with proven domain knowledge, allows users to leverage the true power of machine learning (ML) algorithms to perform a multitude of tasks, from data cleansing and anomaly removal, to analysing the correlation of parameters and efficient interpretation of results.

Partnering with a trusted technology provider such as ABB, which has a track record of domain knowledge and know-how around electrification and process control, is key to the successful application of leading-edge innovations such as soft sensors, advanced analytics and ML. Having served the cement industry for more than a century, ABB’s extensive portfolio of analytical and process modelling tools are designed to improve operational performance and energy efficiency.

**Industrial analytics and AI suite**

At present, less than 20% of the data taken by distributed control systems (DCS) from operational technology (OT) devices, networks and silos is used by companies, and only a fraction of that is analysed to improve business.

With the emergence of new digital technologies, ML models can provide productivity improvements in addition to APC solutions, helping industrial plants to monitor and optimise their systems and related assets based on how they react to triggers such as age or operating condition.

The ABB Ability™ Genix platform harnesses the power of digitalisation to improve operational excellence, process performance, asset integrity and performance, sustainability and energy efficiency.

Sitting in-between the DCS and upper-level business functions, ABB Ability Genix helps cement industry clients to unlock value from OT, IT and engineering data by contextualising and integrating information from multiple systems spanning units, plants and even the entire enterprise ecosystem. The solution then applies AI and analytics to provide actionable insights that add business value.

ABB Ability Genix’s 40+ preconfigured asset models can be customised, or have custom templates added, with rule-based models based on pre-decided thresholds. Alternatively, AI/ML models are trained with relevant datasets to provide prescriptive analytics. ABB Ability Genix then presents data on a variety of key parameters – emissions monitoring, system anomalies and asset alarms, for example – in customisable dashboards that are intuitive, highly visual and user-friendly.

When talking about digital solutions, it is the additional ‘horsepower’ provided by advanced...
data analytics and artificial intelligence (AI) that is the real gamechanger.

Cement plants may not be ready to transition to the cloud, but still want to take advantage of the additional computing ‘horsepower’ provided by data analytics and AI. ABB recognises this fact, and takes a phased approach based upon each individual client embarking on its personal digital journey.

Securing the connection between the cloud, control systems and smart devices, the solution allows the edge to ingest data. ABB can apply an asset management solution to condition monitoring at the edge, as well as advanced analytics, for instance. When the client is ready to transition to the cloud, Genix simply makes the data available for cloud applications.

**Optimising operations in India**

ABB was approached by one of Asia’s largest manufacturers of grey cement, ready mix concrete and white cement. The customer has 19 integrated plants, one clinkerisation plant, 25 grinding units and seven bulk terminals. With operations spanning five countries – Bahrain, Bangladesh, India, Sri Lanka and the United Arab Emirates – the client needed to optimise production and operating efficiency.

Working together with ABB domain experts, the company used maintenance-oriented algorithms that alerted the client to the potential failure of a particular part or electronic device, allowing it to perform predictive rather than reactive maintenance. This, combined with a range of other digital solutions, including ABB Ability Expert Optimizer and ABB Ability Collaborative Operations, meant the customer was able to:

- Increase quality by up to 15%.
- Reduce operating costs by 3 – 5%.
- Achieve ROI in eight months.
- Increase life cycle of assets.

As assets such as conveyor belts are added to the operation, thickness and wear-rate monitoring, temperature monitoring and slip monitoring applications can also be included in the asset model.

In this way, manufacturers can fully utilise the power of digitalisation to reduce energy usage and emissions, paving the way for the smart, sustainable and profitable cement plants of the future.

**About the authors**

Max Tschurtschenthaler joined ABB as a commissioning engineer in 1998. He has worked various cement and mining industries roles at ABB since 2004, including Project Manager for Large Projects and Sales and Regional Manager for South East Asia and Australia. Max has led the Global Cement Industry Segment for ABB’s Process Industries since 2019. He holds a BSc in Electrical Engineering and Digital Signal Processing from the Eastern Switzerland University of Applied Sciences.

Sanjit Shewale joined ABB in 2020 as the Head of Digital for Process Industries. He has more than 20 years of experience in the advanced industrial software space across many different verticals, including discrete. Most recently, he was with Honeywell’s Connected Plant & Advanced Solutions and Danaher’s Product Identification business. Sanjit holds a Chemical Engineering degree from McMaster University and a Management Sciences degree from University of Waterloo. At ABB his focus is on digital strategy and sustainability. He writes about ways to accelerate the shift to carbon-free and energy-efficient operation, autonomous systems, remote management, asset performance and more.