TAKING ADVANTAGE OF AI

Liran Akavia, Seebo, explains how AI can help cement manufacturers to reduce emissions, whilst maintaining or even improving their production process efficiency and key business KPIs.

Decarbonisation has gained increasing importance over the past decade, and continues to occupy the minds of cement manufacturing executives.

From improving energy efficiency to alternative fuels and clinker alternatives, cement manufacturers have a number of options at their disposal. Of course, many of these options are only as viable as local and national governments make them, but still, the race to net-zero is progressing at a global level.

However, there is a problem.

Cement manufacturers need to produce as much high-quality cement as possible, to meet demand and beat out the competition, or in fewer words – to be profitable. But if they use less energy, or switch to less ideal fuel or clinker alternatives, will they be forced to compromise key KPIs like clinker quality and kiln throughput?

This tension between profitability and environmental protection lies at the heart of the issue of decarbonisation. Cement manufacturers cannot be expected to cut emissions at the expense of their business. While this might rankle many die-hard environmentalists, it is simply a reality – for better or for worse.

But is there a way to do both? The answer is yes. Cement manufacturers can both reduce emissions, and still maintain or even improve their production process efficiency and key business KPIs.

At a recent panel discussion, a senior cement manufacturer discussed how some of their factories boast alternative fuel rates of 90% and still continue to push the limits in terms of process efficiency.

That might sound like a fairytale, but the 'secret' is actually quite straightforward. The production losses that harm cement manufacturers' bottom line – like unstable kiln throughput, clinker quality and energy inefficiency – usually stem from the same process inefficiencies that cause higher emissions levels as well.

So, if these process inefficiencies are eliminated, it is possible to reduce quality, throughput and energy losses, and bring down carbon emissions at the same time.

Consistent kiln stabilisation is key – but can it be done?

Stabilising the kiln at optimal levels is almost always the key. In fact, kiln instability is one of the greatest, if not the greatest challenge when it comes to reducing process-driven losses in areas like quality and throughput, and it is also a major cause of inefficient energy usage and high emissions.

High fuel and energy consumption, product quality and throughput issues, clinker quality issues, high maintenance costs, kiln feed variances and high NOx and CO_2 emissions are all problems usually related to instability or inefficiency at the kiln.

But kiln stabilisation and optimisation is a never-ending battle. There is no 'lightbulb moment', when the process expert suddenly realises what is going wrong, fixes the problem, and waltzes off into retirement.

Instead, the struggle begins anew each day, complicated by things like raw material variances and competing KPIs (like quality and throughput on the one hand, and energy costs and emissions on the other). In reality, it seems impossible to ever find the root cause of process inefficiencies.

The problem: Cement factories are reliant on human decision-making

The underlying issue is the complexity of the process itself. There are simply too many factors and variables for human beings to process. Even the most experienced and intelligent process expert cannot possibly analyse all the data, all the time, while keeping track of all the complex interrelationships between different data tags and points within the production line.

Process experts and production teams make dozens of critical, process-related decisions every day. These decisions can certainly be enhanced, informed and executed via analytics platforms, measuring tools, expert systems and so on. But ultimately, the decisions are made and carried out by human beings.

This is an inherent limitation, as every person approaches a problem with their own biases and preconceptions. It is natural that when approaching something as complex as a cement manufacturing production line, human beings cannot possibly consider all the options at all times. Engineers and experts have no choice but to conduct ad-hoc analyses based on their own past experience, knowledge and, in some cases, intuition.

Often, this works, but other times it does not, at least not continuously, as lines are constantly changing. So even a correct decision or analysis today might not be correct tomorrow – or even in a few hours' time!

Limitations of expert systems

Of course, in practice, cement manufacturing is not done entirely manually. In particular, expert systems have become an important automation tool for cement manufacturers around the world.

Although expert systems do provide great value, they have a number of significant limitations.

Dependence on human bias

Expert systems are programmed by process experts and engineers. They are a closed-loop system and will do exactly what they are instructed to do. But what if the calculation itself was incorrect? What if a particular factor further upstream or downstream should have influenced that calculation, but was not taken into account?

Siloed (asset-focused not process-focused)

Expert systems are meant to regulate a particular asset or point within the production line, and they can do that very well. However, they do not take into account the entirety of the production process itself.

The problem is that the optimal settings for a particular asset or point in the line may appear to fall into a certain range when considered by itself – but when considered together with other data tags, the situation might look quite different. For example, the 'ideal' speed of the kiln might change depending on the raw material variances that day.

Expert systems cannot adapt to changes

Expert systems use closed loop models, which do not update continuously. Process experts build the model once and it remains constant.

On the one hand, an expert system cannot react to all the dynamic changes on the line – whether further upstream, downstream or within that asset itself (say a change in temperature or moisture).

On the other hand, process experts cannot reprogramme the expert system each time those factors change. This is due to two factors: firstly, because programming the expert system is a lengthy, resource-heavy and expensive process, and secondly, because process experts are not always aware of a specific change on the line or its implications in the first place.

The solution: AI-driven decision-support tools

Artificial Intelligence can effectively free cement manufacturing processes from the limits of human capabilities, by conducting real-time, multivariate analysis of all the data, and providing clear recommendations and alerts on a user-friendly interface. Seebo uses

process based artificial intelligence for cement manufacturers.

This is not closed-loop automation; Seebo is a decision-support tool that is constantly providing cement manufacturers with the information they need to make the right decisions – whether directly on the line, or indirectly via expert systems.

Reducing emissions 12% while preventing quality, throughput and energy losses

To illustrate this approach, the following is an example of a cement manufacturer that was struggling with kiln amps inefficiencies. This was causing a variety of production losses, like kiln feed variances, lower throughput, energy inefficiencies and quality issues.

Intriguingly however, some 40% of the time, this manufacturer still achieved higher-than-average efficiency rates. Many of the cement production lines Seebo works with are clearly capable of achieving the desired efficiency range, which is why they actually are more efficient some of the time. They do not need to invest in new assets or equipment, or overhaul their process. The potential is already there – it is just being held back by unseen inefficiencies.

Revealing the hidden causes of process inefficiencies

Using automated root-cause analysis, process experts were able to identify the hidden causes of the manufacturer's production losses, and gain clear recommendations as to how to prevent those process inefficiencies.

Those recommendations were translated into real-time alerts, so the production teams knew as soon as inefficiencies were detected.

Firstly, Seebo unified all of the disparate data sources from the production line into a single schema, where it was enriched and cleansed. This included all relevant data related to the process, from raw material data, to process and quality data, to data on weather conditions and alternative fuels characteristics.

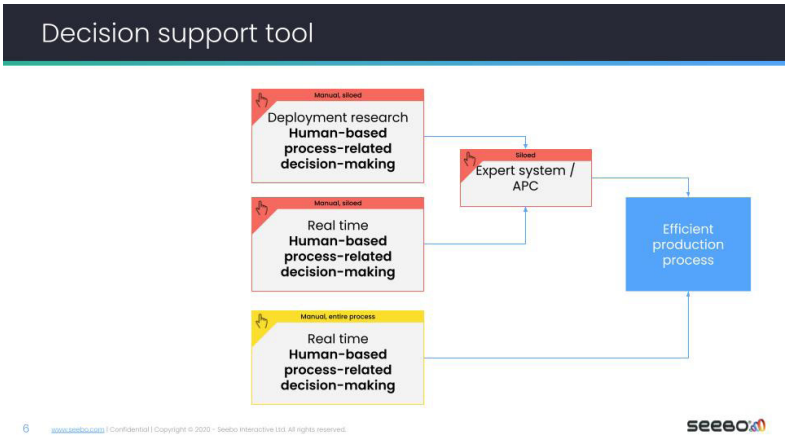
Next, the algorithms were taught to understand the entire production process, using Process-Based Artificial Intelligence™, which embeds the algorithms with the context of the unique plant topology, and expertise in the relevant cement manufacturing process. This enabled the algorithms to navigate through the unique complexities of each production process and truly understand the data in-context, providing a continuous, multivariate analysis that delivered clear information, eliminated data blindspots, and revealed important new insights into the production process that were previously hidden amongst the data.

These 'process-based' algorithms can now conduct automated root cause analysis, continuously analysing all the data tags, including the complex interrelationships between them.

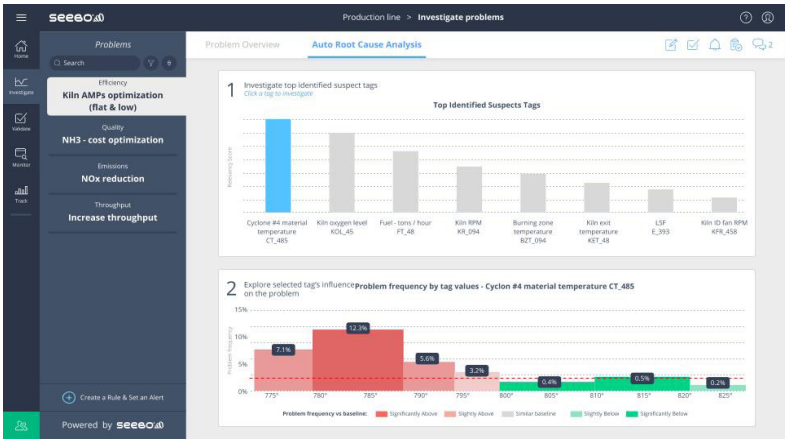
The team can now identify process inefficiencies that were previously invisible to the human eye.

For example, the team discovered that when the cyclone material temperature was above 800˚, and at the same time the kiln oxygen level was between 1.5% and 2%, the likelihood of a problem with the kiln amp increased significantly.

This is a hugely important insight that the process experts could never have figured out on their own, since both of those tags remained within their permitted ranges. It was only the



Every aspect of cement production ultimately relies on human decision-making.



Seebo automated root-cause analysis.

unique combination of those two specific ranges of tag values that was causing the losses.

Continuous process mastership with AI

Armed with this new understanding, Seebo created a set of Predictive Recommendations, which identify the optimal process settings.

For example, the team has now recommended optimal values for the cyclone material temperature and kiln oxygen level, to minimise instances of kiln amps inefficiencies as much as possible without negatively impacting other production parameters.

These recommendations are then turned into Proactive Alerts, which are delivered to the production team via a simple, intuitive screen as soon as the related process inefficiencies occur.

The alerts include a clear description of the root-causes (e.g. cyclone material temperature above 800° and kiln oxygen level between 1.5% and 2%), as well as a set of Standard Operating Procedures, so production teams can know exactly what to do to fix those issues before losses occur, and when to act.

Using these new insights, the manufacturing teams were able to significantly stabilise the kiln, resulting in an 11.9% reduction in emissions.

And of course this also translated into the company's business KPIs, for example they reduced energy costs by 5.6%, equivalent to €521 000. Clinker quality also increased by 4.2% and kiln feed capacity increased by 3.3%, resulting in €780 000 extra profit on a single line.

Conclusion

There should not be any contradiction between running a profitable, efficient cement production line, and reducing its carbon footprint.

High emissions and high production losses usually stem from the same process inefficiencies; remove or reduce those inefficiencies, and both areas will improve drastically.

Of course, this is no 'simple' task. It requires hard work, commitment, focus and one more crucial ingredient: AI. But those ingredients are all readily available, and cement manufacturers who take advantage of them in the right way are the future of the industry: Greener, more efficient and already moving ahead of the competition. ■

About the author

Liran Akavia is the COO and co-founder of Seebo. He is a serial entrepreneur and sales leader who specialises in the fields of AI and manufacturing – particularly in reducing waste and quality losses.

Before founding Seebo, Liran co-founded and led Playfect, which manufactured millions of gaming accessories that were sold across more than 35 countries, before being acquired in 2013. Liran has lived and worked in Israel, Australia, China, and France.