Optimizing Coal Blends for Cost, Quality, and Composition

Tata Steel's new coal-blending strategy is projected to save them millions in costs.

Tata Steel is one of the world's most geographically diversified steel producers, with operations in 26 countries and commercial offices in more than 35 countries. Through serving many demanding markets worldwide, including construction and infrastructure, automotive, packaging and engineering, Tata Steel understands that customer needs are different in each market.

Industry: Metals and Mining
Location: Europe
Use Cases: Production, Resource
Website: tatasteeleurope.com

Results

- Discovered a new coal-blending strategy
- Projected to save them millions of pounds in the long term

As one of Europe's leading steel producers, Tata Steel UK supplies high-quality steel products to the world's most demanding markets, including construction, automotive, packaging and engineering.

A part of Tata Steel's process involves the blending of different types of coal, a complex task that can be extremely time consuming. On top of that, it's virtually impossible for a human to evaluate all possible combinations of coal and select the optimal blend.

That's why Tata Steel decided to use mathematical optimisation to create and run their own Coal Blending Optimisation Model (CBOM). With the help of Gurobi, this model is projected to save the company millions of pounds in the long term.

What Tata Steel Needed

Different coals have a range of chemical and physical properties, which impact the final output Tata Steel produces at Morfa Coke Ovens in Port Talbot Works.

Historically, coals were blended by an expert who had detailed knowledge of the process, material properties, quality specifications, prices and availability of the material.

However, each material is available in a range of quantities and prices that are subject to the volatility of the market, and each has defined properties that affect the final product's quality.

Because of these variables, it takes a significant amount of time to evaluate blend possibilities while also aiming for the lowest possible cost. To evaluate all possible combinations of blend materials and also select the global optimum without violating constraints would be virtually impossible for a human alone.

But mathematical optimisation can do what humans can't: evaluate all possible options and consistently identify the best solution within seconds, allowing Tata Steel to blend cheaper input materials without sacrificing quality, so they can improve their cash position and lower the costs per slab produced.

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Dr. Paul Dickinson
Works Technical Manager Cokemaking, Tata Steel

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> *Works Technical Manager*
> *Cokemaking, Tata Steel*

Optimising Coal Blends with Gurobi

Knowing that mathematical optimisation was the solution, Tata Steel just needed to find an optimisation engine that could meet their needs.

“After researching the alternatives, we opted to use the world-leading Gurobi engine and built the application in Visual Studio with C# WinForms,” explained Dr Christopher Melvin, Process Specialist.

They developed a model that, using the Gurobi Compute Server, allows Tata Steel to optimise the coking coal blend value-in-use while maintaining coke quality and satisfying customer constraints.

The model allows users to specify multiple constraints, including:

- The total number of materials that can be used in each blend
- The desired percentage and weight of specific coals in each blend
- The relevant quality, product, material availability and conditions of use

“We went from building optimisation models in Excel to using the Gurobi C# .NET API, and though the learning curve was steep, Gurobi provided excellent support,” said James Watson, Optimisation Specialist. “The published application is now an intuitive, slick and focused blending tool with best-in-class solver performance able to perform all our required tasks and offer further areas to explore how we can add value.”

The tool also includes a set of modules for conducting sensitivity analysis to objectively find, quantify and rank potential sources of added value.

Additionally, the CBOM can identify alternative blends that could provide significant value compared to the “as standard” blends. Constraints can be adjusted to identify opportunities in stocks or costs, which allows Tata Steel to challenge business norms to find better solutions.

Designing a More Efficient Steel Production Process

When Tata Steel began testing their model with Gurobi, they found it provided blends of coal that they had never utilised before, leading them to a very different strategy. Tests found that these new blends were indeed superior to those that were being used at the time.

Overall, identifying high-value blends has allowed Tata Steel to reduce the number of coals used in their steel production. This supports their goal of minimising stocks and keeping cash in the business.

Gurobi has helped decrease the CBOM’s time-to-run scenarios from days to hours, increased Tata Steel’s range of approved coals, and allowed them to try new materials that could save them millions of pounds in the long term.

“The tools we have developed with Gurobi are now part of our business-as-usual operations and will be for the foreseeable future,” says Dr. Paul Dickinson, Works Technical Manager Cokemaking. “This optimisation model, the technology, and the lessons learned while developing it have acted as a template for other models, providing further benefits and more opportunities to find and deliver value.”

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