



Oxygen-enhanced combustion for optimised kiln performance tell me more

Burning alternative fuels in rotary kilns can cut costs, but often at the expense of reduced throughput and controllability. Dolomitic lime producer Steetley Dolomite is using Air Products' proprietary oxygen injection technology to boost production and improve flame characteristics without harming product quality.



Steetley Dolomite opted for a liquid “solvent-derived fuel” (SDF). This is available in ample quantities, and has the advantage of producing less sulphur dioxide and particulates than high-quality pulverised coal and petroleum coke.

The decision to use alternative fuels – typically industrial waste, tyres or biomass – is a big one for any rotary kiln operator. On one hand, alternative fuels can cut operating costs significantly. On the other, their low heating value and variable composition may at best reduce throughput, and at worst can cause quality problems.

When UK manufacturer Steetley Dolomite started burning a combination of waste solvents and low calorific value coal in its three rotary kilns, product quality did not suffer, but throughput fell.

Having won approval to use alternative fuels for up to 40 percent of the kilns’ energy input, the company opted for a liquid “solvent-derived fuel” (SDF). This is available in ample quantities and has the advantage of producing less sulphur dioxide and particulates than Steetley Dolomite’s standard fuels: high-quality pulverised coal and petroleum coke.

SDF does have its drawbacks, however, including a water content that can reach up to 25 percent. The resulting large volumes of steam can be troublesome, because the capacity of the kiln is largely limited by the size of the exhaust gas fan.

SDF also has a relatively low heating value (20-24 MJ/t) and a variable composition. Both these factors tend to cause poor flame control within the burning zone. "Achieving the high mixing velocities needed for good combustion of SDF was challenging," says Sam Bainbridge, process engineer at Steetley Dolomite's Thrislington site.

The combination of high water content, low heating value and poor flame control meant that to maintain product quality, throughput often had to fall. At Thrislington, for instance, burning SDF required production to be cut by around 10 percent compared to firing with high-quality coal alone.

The answer for Steetley Dolomite is Air Products' proprietary oxygen injection technology. Rather than attempting to enrich the entire volume of combustion air, the Air Products system uses the minimum quantity of oxygen needed to ensure effective combustion of the SDF.

"Air Products' experience, gained from working with the cement industry, coupled with the in depth knowledge we have of oxygen enhanced combustion applications, enables us to provide the best solutions to the market. Our ability to efficiently burn increased quantities of alternative fuels is becoming more and more important to our customers and the work completed at Steetley Dolomite, in the UK, demonstrates how this can be achieved."

Petr Tlamicha

Primary Metals, Minerals manager, Europe

Oxygen benefits

Early in 2007 Steetley Dolomite was looking for ways to bring throughput at Thrislington back up to what it had been before the plant started to burn SDF.

In April 2007 Air Products started work to design an oxygen injection system specifically for the Thrislington kiln. The key point was to ensure that oxygen would deliver the desired process benefits without harming product quality or damaging the kiln.

Oxygen from the Air Products system makes up rather less than the stoichiometric requirement for the SDF portion of the fuel, so the bulk of the oxygen used in combustion comes from the air supplied to the coal burner. In fact, the Air Products system increases the average oxygen concentration in the combustion zone by only 0.6 percentage points, but this is enough to have a big influence on performance.

The expected benefits were a shorter, hotter and more controllable flame with lower exhaust gas volumes – thanks to the reduction of nitrogen from the combustion air – that would allow throughput to increase without overloading the exhaust fan.

With these predictions in mind, Steetley Dolomite gave Air Products the go-ahead to install an oxygen injection system at Thrislington. The design provides a high degree of safety, with close control of oxygen pressure and flowrate, and interlocks to ensure that oxygen can only be injected when process variables including fuel firing rates, fan speeds and kiln rotation speed are within normal limits.



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Proof in production

“During commissioning, we found that we had to adjust the shape of the coal flame, but thanks to the oxygen that was not a problem,” says Sam Bainbridge. “Previously, burning SDF made control difficult. With oxygen the control is better, and there are visual and audible cues which tell us when the flame is properly adjusted.”

“The system at Thrislington has worked well and Air Products has been very supportive,” Sam Bainbridge continues. “We have been able to increase production by around 10 percent, taking us back to the performance we had before we started to use alternative fuels – but with the extra cost savings, of course. The kiln is now more stable, and quicker to recover from operational disturbances.”



Steeley Dolomite was so impressed with the oxygen system at Thrislington that it added an identical system to one of the two kilns at Whitwell. These are similar to the Thrislington kiln, except that their main conventional fuel is petroleum coke and they are not fitted with preheaters. They also produce hard-burned dolomite rather than the dolomitic lime produced at Thrislington.

Oxygen injection at Whitwell has allowed Steeley Dolomite to increase the gross energy input provided by SDF from 25% to 40% and still achieve a small increase in throughput.

The UK Segment Manager involved in the original Thrislington project said: "Our oxygen injection technology should support alternative liquid fuel substitution of 35-45 GJ per tonne of oxygen, though this will vary between fuels and would be different for solids. For out-and-out fuel economy, where the customer is not looking to raise production or use a higher proportion of alternative fuels, we could provide a specific fuel saving of around 5%."

Steeley Dolomite managing director, John Carlill, is certainly impressed. "We believe Air Products is leading the way in oxygen enrichment technology through their knowledge, expertise and professional approach," he says. "From installing the equipment, operating the plant, training and providing continued support, Air Products has exceeded all expectations, and continues to impress."

Steetley Dolomite - a leader in dolomitic lime



Steetley Dolomite is a leading producer of dolomitic products, mostly for the steel industry. Starting from dolomite (a carbonate mineral containing magnesium and calcium: $\text{CaMg}(\text{CO}_3)_2$), the company produces dolomitic lime ($\text{CaO} + \text{MgO}$) that is used as a flux in steel production, and hard-burned dolomite for refractory linings in furnaces and ladles.

The Steetley group has been associated with dolomite since the 1880s. Today Steetley Dolomite operates at two quarry sites in the UK: Whitwell, near Worksop in Nottinghamshire, and Thrislington, near Ferryhill in County Durham.

Dolomitic lime is produced by the dry calcining of crushed dolomite in a rotary kiln. The single kiln at Thrislington, which dates from the late 1950s, is around 3.5m in diameter and 70m long. From a feedstock of around 1,500 t/d of dolomite in the size range 20–70 mm, the kiln produces 600–700 t/d of dolomitic lime.

Air Products - a deeper understanding

Air Products has annual revenues of over \$10 billion, operations in more than 40 countries, and 21,000 employees around the globe. The company believes that the best way to do business is to build a deep understanding of customers' needs so that we can use that knowledge to meet and exceed their expectations. Founded in 1940, the company serves industrial, energy, technology, and healthcare markets worldwide with a unique portfolio of atmospheric gases, process and specialty gases, performance materials, and equipment and services. Air Products is recognized for its innovative culture, operational excellence, and commitment to safety and the environment.

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