



O The Power of xygen

Introduction

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.

The decision to use alternative fuels – typically industrial waste, tyres or biomass – is a big one for any rotary kiln operator. On the 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 can at worst cause quality problems.

Pete Keena, Major Account Segment Manager, Air Products, and Sam Bainbridge, Process Engineer, Steetley Dolomite, Thrislington, UK, describe a case where oxygen enhanced combustion has optimized kiln performance.



Figure 1. Steetley Dolomite's Thrislington dolomitic lime plant faced challenges in burning SDF prior to oxygen injection.



Figure 2. Air Products engineers designed the oxygen system as an easy retrofit.

Case study

When UK lime 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% 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 sulfur dioxide and particulates than Steetley Dolomite's standard fuels: high quality pulverised coal and petcoke.

SDF does have its drawbacks, however, including a water content that can reach up to 25%. 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/kg) 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.

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% compared to firing with high-quality coal alone.

The answer for Steetley Dolomite was 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.

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 (Figure 1). 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%, 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 (Figures 2 and 3). The design provides a high degree of safety, with close control of oxygen pressure and flow rate, 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.

Proof in production

During commissioning, Steetley Dolomite found that they had to adjust the shape of the coal flame, but thanks to the oxygen this was not a problem. Previously, burning SDF made control difficult. With oxygen the control is better, and there are visual and audible cues that show when the flame is properly adjusted.

Air Products' system at Thrislington has worked well.

The production has been increased by around 10%, taking the company back to the performance they had before using alternative fuels, but with the extra cost savings, of course. The kiln is now more stable and quicker to recover from operational disturbances (Figure 4).

Steetley 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 petcoke 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 Steetley Dolomite to increase the gross energy input provided by SDF from 25% up to their maximum permit level of 40% and still achieve a small increase in throughput.

Air Products' oxygen injection technology supports alternative liquid fuel substitution of 35 - 45 GJ per t 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, the technology could provide a specific fuel saving of around 5%.

John Carlill, Managing Director at Steetley Dolomite, has stated that Air Products has exceeded all expectations and continues to impress.



Figure 3. Oxygen is delivered and stored as a liquid and then vaporised before injection into Steetley Dolomite's kiln.

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 approximately 3.5 m dia. x 70 m long. From a feedstock of around 1500 tpd of dolomite in the size range 20 – 70 mm, the kiln produces 600 – 700 tpd of dolomitic lime. 

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Figure 4. Steetley Dolomite's production increased about 10% with oxygen injection, restoring the performance they had before using alternative fuel.



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315-09-006-GLB-Feb10 (30957)
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