Pete Keena, Frank Romano, and Larry Farmer: *Air Products and Chemicals, Inc.*

Enhanced combustion of alternative fuels at Steetley Dolomite

Although alternative fuels can benefit cement and lime plants in many ways, they can also impact on production capacity and on process stability. After the use of waste solvents impacted production, the lime producers at Steetley Dolomite turned to Air Products for help in the use of oxygen-enhanced combustion, with successful results.

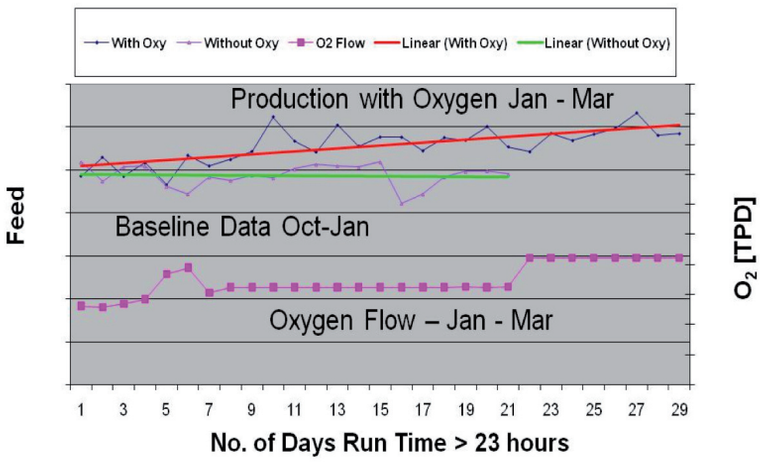
Steetley Dolomite is a leading producer of dolomitic products in the United Kingdom, with production facilities in Thrislington and Whitwell. In 2007, Steetley began using an alternative fuel consisting of waste solvents at both of its production facilities. The addition of this fuel created a challenge for its operators and resulted in reduced production and difficulties in maximising fuel substitution rates. Based on previous knowledge of Air Products' successful application of oxygen enrichment in the cement and lime industries, Steetley engaged Air Products' combustion specialists for assistance with its fuel issues. Specifically, Steetley was seeking a means to achieve higher production rates while maintaining product quality and maximising fuel substitution levels. Air Products worked closely with the engineers at Steetley's Thrislington facility and installed a proprietary oxygen injection system in 2008 that resulted in a 10% production increase. Steetley was so impressed with the improved performance of its kiln that it installed a similar system at Whitwell later in the year, thereby increasing its fuel substitution levels from an average of 25% to the maximum permitted level of 40% while gaining a slight production increase.

Alternative fuel challenges for lime producers

In an effort to lower operating costs, lime producers are now turning to a greater assortment of alternative fuels. While petcoke was the primary 'alternative fuel' to coal in the past, fuels available today consist of a wide range of materials that vary in chemical and physical composition. Depending on the nature of the fuel and its associated cost, the reduction in operating cost can be very attractive.

The cost benefit, however, is sometimes muted by the impact alternative fuels have on production and process stability. The heating values of alternative fuels vary greatly as alternative fuels can contain a substantial amount of moisture. Due to the wide range in properties, there is often a practical limit to substitution levels. In the kiln, maintaining sufficient and consistent temperature is paramount to the efficient production of lime at the desired bulk density. If stable temperatures cannot be maintained due to the lower heating value of an alternative fuel, production levels must be curtailed. As a result, overall fuel substitution and the economic benefits are limited. This was Steetley's experience at Thrislington and Whitwell once it began to fire with solvent-derived fuel (SDF).

Right: Steetley-Thrislington's production increased 10% with oxygen injection.



Left: Production trends with and without oxygen at Steetley-Thrislington.

Oxygen provides a solution

Steetley recognised a need to improve the combustion of its new fuel and investigated the use of additional oxygen. Air provides the oxygen necessary for combustion, but it is a rather dilute source. Air contains roughly four parts of nitrogen for each part of oxygen. The nitrogen contained in air absorbs heat produced from the combustion of fuels and does not contribute to the combustion process. All nitrogen contained in combustion air basically takes up space and must be pulled through the kiln, with all of the other gases, by the induced draft (ID) fan. By increasing the oxygen concentration of combustion air through the addition of relatively pure oxygen, flame temperature rises, heat transfer rates improve and overall combustion efficiency increases. Even a small increase in oxygen concentration can have a dramatic impact on kiln operations, especially when substituting difficult-to-burn fuels for coal.

Steetley-Thrislington

Steetley produces dolomitic lime in a preheater kiln at its Thrislington facility. In 2007, Steetley switched fuels in an effort to lower its operating costs. It replaced pulverised coal and petcoke with SDF and a lower calorific value coal. The SDF had a variable composition with heating values ranging between 20-24MJ/kg and water content up to 25%. While Steetley realised fuel cost savings, it experienced a production decrease of roughly 10% when maximising SDF substitution (40% of gross energy input) and maintaining bulk density values.

Air Products' combustion specialists designed a proprietary oxygen injection system that would enable Steetley to achieve higher production rates at 40% SDF substitution levels. Air Products worked closely with the engineers at Thrislington to install the oxygen supply and injection system without any interruption to the normal production schedule. Additionally, Air Products provided extensive safety and operation training prior to commissioning.

Baseline kiln data was collected prior to the commissioning of the oxygen injection system. Oxygen injection began in early January 2008 and injection rates were gradually increased over the course of the demonstration period. This period allowed operators sufficient time to adjust to the impact oxygen had on kiln performance and to achieve long periods of continuous operation for baseline comparison.

Over this period, all of the key objectives were attained as oxygen-enhanced combustion of fuel resulted in an average production increase of nearly 12% at the maximum permitted SDF substitution rate (40%). Additionally, a reduction in specific energy of 9% was also observed (Table 1).

Steetley-Whitwell

Following the success at Thrislington, Steetley decided to implement oxygen injection in one of two kilns at its Whitwell plant. The Whitwell kilns were fired on SDF and petcoke. Due to production and quality constraints, Steetley had routinely been able to achieve only a 25% SDF substitution rate. The objective at Whitwell was to maximise the use of SDF (40% substitution). In late July 2008, Air Products and Steetley commissioned oxygen injection and began to see immediate results. Within the first week of implementation, the SDF rate was increased by 14% while gaining an increase in production and a slight decrease in specific energy (Table 2).

With the experience Steetley personnel gained with oxygen injection at Thrislington, the demonstration progressed rapidly at Whitwell. By October 2008, Whitwell had achieved its objective of increasing SDF to the maximum permitted rate of 40%. Similar to Thrisling-

Table 1. Oxygen injection results at Thrislington.

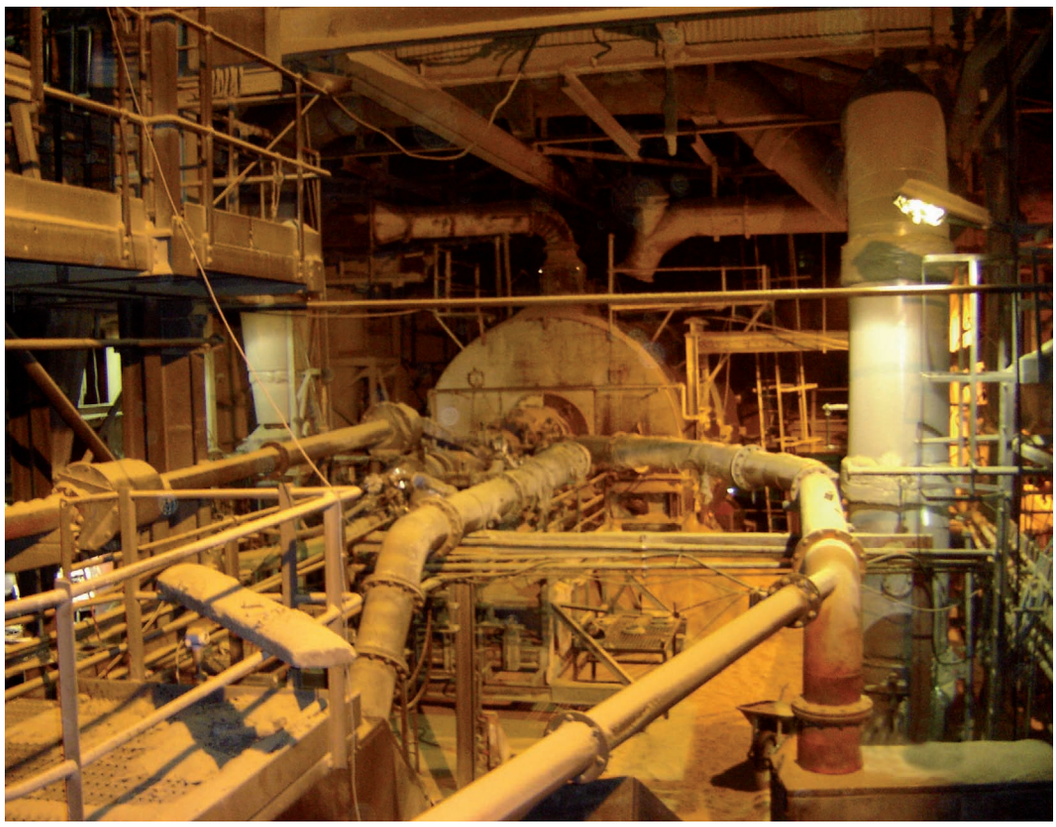
Variable	Baseline (Dec-Jan)	With Oxygen (Jan-Mar)	Change
Avg. Lime Production (TPD)	1000	1119	+11.9%
Max. Lime Production (TPD)	1060	1248	+17.8%
Avg. Specific Energy (Therms/Ton)	100	90.7	- 9.3%

(Note: All data is normalised and based on days of operation with a minimum of 23 hours up time.)

Table 2. Oxygen injection results at Whitwell.

Variable	Baseline (Dec-Jan)	With Oxygen (July)	Change
Avg. Lime Production (TPD)	1000	1063	+6.3%
SDF Rate (Therms/hr)	500	572	+14.3%
Avg. Specific Energy (Therms/Ton)	100	97	- 3.0%

(Note: All data is normalised and based on days of operation with a minimum of 23 hours up time.)



Above: Kiln at Thrislington .

ton, Steetley was also able to sustainably increase lime production on average by 10%.

The bottom line

The economics for oxygen-enhanced combustion of alternative fuels are driven by the cost differential between the primary and alternative fuels and the value of lost production or reduced quality. To be economical, overall fuel cost savings and enhanced production must offset the oxygen cost. At plants that are paid to burn alternative fuels or where the cost is near zero, the economics of oxygen-enhanced combustion are typically quite favourable. This is also the case when product demand is high and any shortfall in production has severe revenue and profitability impact. The capital cost to implement oxygen injection is relatively small in comparison to the benefit and simple payback of less than six months is often achieved. Even during periods of reduced demand, oxygen-enhanced combustion can be economically viable if plants are operating multiple kilns below 100% capacity. Incremental production gains achieved through oxygen injection could enable the complete shutdown of a kiln, resulting in significant energy and cost savings.

Steetley today

Oxygen-enhanced combustion continues to provide positive returns on both a financial and operational basis at each Steetley location. As a result, Steetley has continued its partnership with Air Products and has recently commissioned an oxygen injection system on the second kiln at Whitwell. Oxygen injection has become a standard practice at Steetley to maximise the benefits of alternative fuel substitution while meeting the needs of its customers.

Right: Steetley's Sam Bainbridge, Process Engineer, summarises the results: "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."

For More Information

To find out more about the benefits of oxygen injection technology, please contact us at a location near you.

Corporate Headquarters/North America
Air Products and Chemicals, Inc.
7201 Hamilton Boulevard
Allentown, PA 18195-1501
Tel 800-654-4567
Fax 800-272-4449
Email gigmrktg@airproducts.com

Asia
Air Products Asia, Inc.
2F, 21 Chung Shan N. Road, Sec. 2
Taipei 10419
Taiwan
Tel +886-2-2521 5891
Fax +886-2-2567 4704
Email huangr1@airproducts.com

Europe
Air Products Europe
Hersham Place Technology Park
Molesey Road
Walton-on-Thames
Surrey KT12 4RZ
England
Tel 0800 389 0202 (UK)
Tel +44 (0) 1270 614 314
Email apbulkuk@airproducts.com

Rest of World
Air Products and Chemicals, Inc.
7201 Hamilton Boulevard
Allentown, PA 18195-1501
Tel 800-654-4567
Fax 800-272-4449
Email sahad@airproducts.com

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