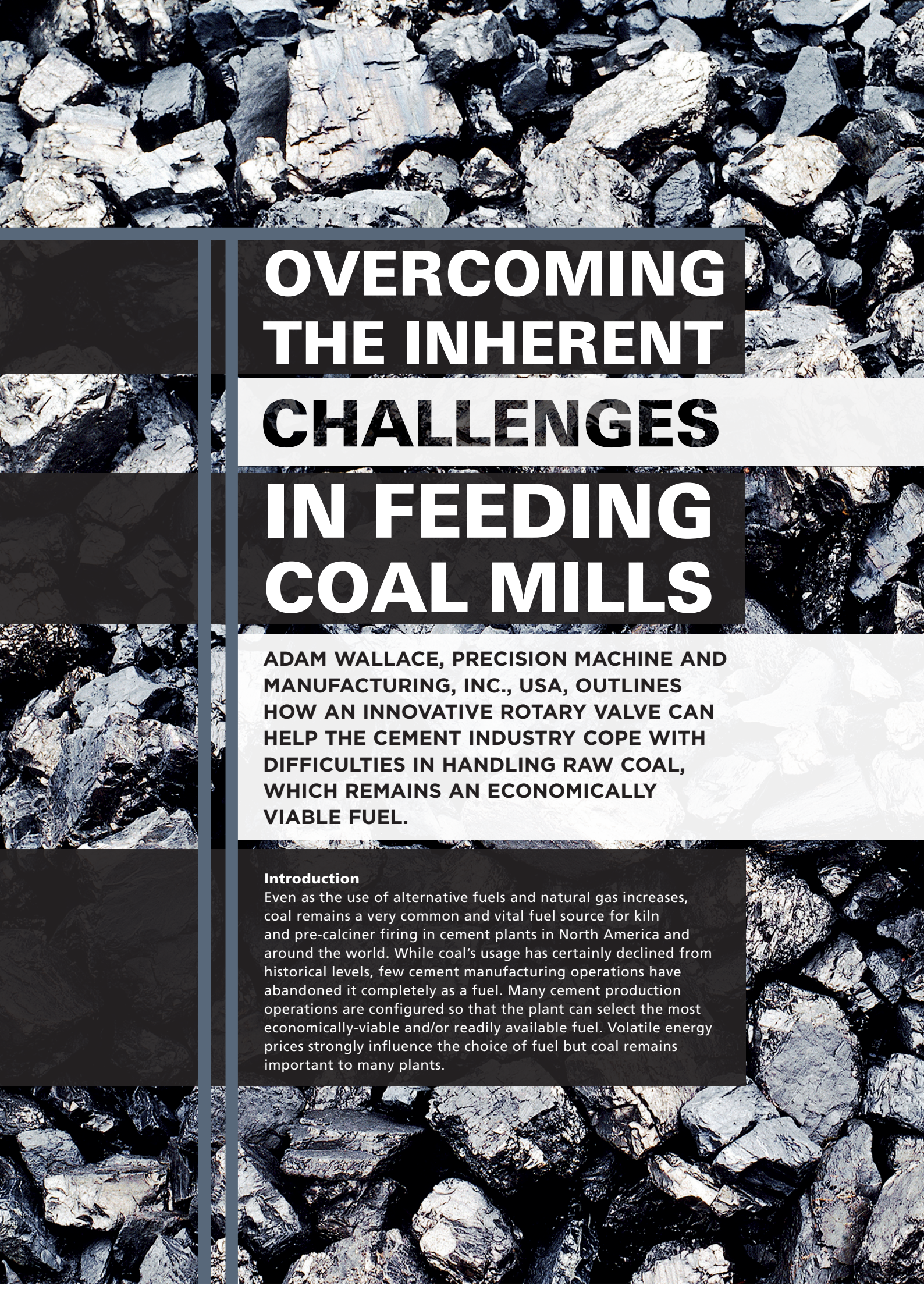


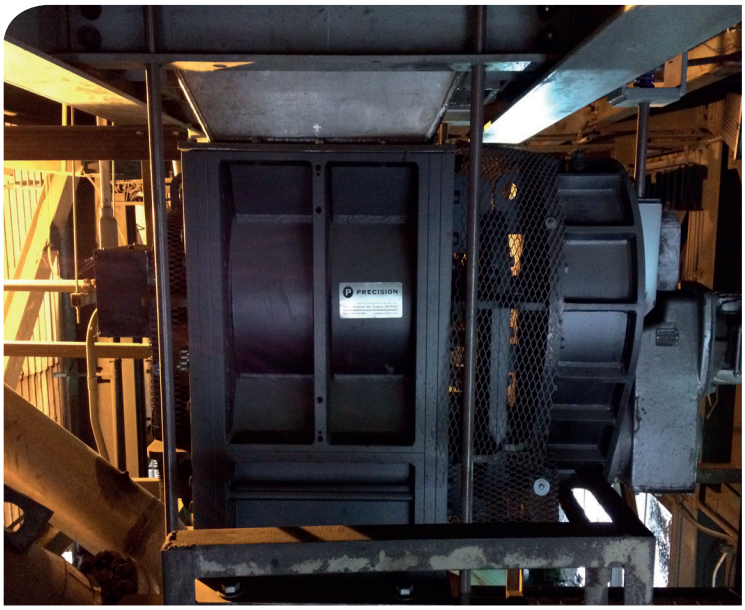
OVERCOMING THE INHERENT CHALLENGES IN FEEDING COAL MILLS

ADAM WALLACE, PRECISION MACHINE AND MANUFACTURING, INC., USA, OUTLINES HOW AN INNOVATIVE ROTARY VALVE CAN HELP THE CEMENT INDUSTRY COPE WITH DIFFICULTIES IN HANDLING RAW COAL, WHICH REMAINS AN ECONOMICALLY VIABLE FUEL.

Introduction

Even as the use of alternative fuels and natural gas increases, coal remains a very common and vital fuel source for kiln and pre-calciner firing in cement plants in North America and around the world. While coal's usage has certainly declined from historical levels, few cement manufacturing operations have abandoned it completely as a fuel. Many cement production operations are configured so that the plant can select the most economically-viable and/or readily available fuel. Volatile energy prices strongly influence the choice of fuel but coal remains important to many plants.

The PMDS shares a design philosophy with Precision's PMV rotary valves



Precision PMDS-18 Self-Cleaning Rotary Valve installed at Lehigh Northeast Cement in Glens Falls, NY.

Raw coal often presents a material handling challenge in these combustion systems. It can be very difficult to move wet, sticky coal in a controlled, predictable manner. Lignite coal, being relatively soft and with high inherent moisture content, is well known for sluggish feeding and plugging equipment. However, even higher ranks of coal can be difficult to work with if the transportation and storage arrangements at the plant are such that environmental moisture builds up on the coal surface.

A critical application in the utilisation of coal is the feeding of raw coal to a coal mill. Whether the mill is a ball mill, roller mill, or a vertical roller mill (VRM), the challenges are very similar. All coal mills operate best with a steady, consistent infeed of raw coal. In systems where the milled coal is sent directly to the kiln or pre-calciner, the need for accurate feeding of the mill is especially important.

For reasons of energy efficiency and environmental regulation compliance, a method for effectively feeding raw coal into coal mills has been highly desired by cement plants. Working in collaboration with two customers in the United States, Precision Machine and Manufacturing, Inc. has demonstrated the viability and high performance of its PMDS Self-Cleaning Rotary Valve for overcoming coal mill feeding challenges.

Direct-burn application

In early 2014 a team at the Lehigh Northeast Cement plant in Glens Falls, New York, led by Amr El-Hakim, a Process Engineer, was looking for a solution to improve the feeding of raw coal to the ball mill in their fuel system. The plant uses a pragmatic, flexible approach to choosing its primary fuel. In the winter, natural gas prices in the northeastern United States tend to increase as the demand for residential heating increases. At some times, the supply of natural gas is allocated and the plant may not be able to receive an adequate supply. Coal becomes an especially important fuel source at this time of the year. The team at Lehigh was quite familiar with the challenges of handling wet coal as open-top railcars and outdoor storage are a part of their coal system and they knew that a coal-feeder would have to address this.

However, an even more important goal was to establish an air lock to minimise the loss of heat in the ball mill. At the time, the ball mill was belt-fed with no airlock device at the inlet. Hot gas from the kiln flows into the ball mill to help dry the coal as it is milled. The lack of an airlock at the ball mill inlet led to two negative consequences. First, the introduction of cool, environmental air reduced the drying capacity in the mill that, in turn, limited the mill throughput. During periods of the year when coal was economically attractive, the plant would occasionally have to curtail its use in order to meet the energy requirement of the kiln. The second negative consequence, and perhaps even more

important for this NESHAP-compliant plant, was that incomplete drying of the coal could result in incomplete fuel combustion. Because the coal system at Glens Falls is a direct-burn system where the milled coal is sent directly from the ball mill to the kiln, disruptions in the moisture content in the coal could lead to incomplete combustion of the fuel and spikes in CO_2.

Knowing that fuel stability and kiln stability go hand-in-hand, the team was looking for a solution that could:

1. Deal with the material handling challenges posed by high-moisture coal.
2. Increase the drying capacity in the ball mill.
3. Maintain a consistent feed rate to the ball mill and to the kiln.

As the Lehigh team considered equipment alternatives, several criteria became clear. The new feeding device would have to be able to work with wet coal. A self-cleaning device would be very valuable. Otherwise, according to Plant Manager Neil Hodgson, "We'd have to have a guy standing there twenty-four-seven to clean out the feeder." And, finally, a US-based manufacturer who could provide service and support would be key as the new system came on-line.

El-Hakim was familiar with Precision and its PMDS Self-Cleaning Rotary Valve from an earlier assignment with another cement manufacturer. Working with the local Precision representative and the Precision sales engineers, a PMDS-18 was determined to be the proper size for the 12.5 tph feed rate. El-Hakim summarised the plant's thinking, "Based on our experience, we knew with wet coal there is always a problem with putting in a rotary feeder. So what really interested us about Precision's product was the self-cleaning design."

Precision PMDS-18 Double-Length Rotary Valve installed in the eastern US.

Precision PMDS-18 Double-Length Rotary Valve at the factory.

A self-cleaning rotary valve?

Precision designed the PMDS rotary valve approximately ten years ago in response to requests for a rotary valve that would be self-cleaning, provide maximum abrasion-resistance, and offer minimal blow-by or false air. The first applications were in handling lignite coal and in specialty chemicals.

The upper rotor is a six-pocket design with closed ends and special rounded bottoms in each pocket. The upper rotor carries the material, in this case raw coal, and is synchronised, through a set of timing gears, to the lower rotor. The lower rotor is a clean-out or sweeper rotor with two paddles that sweep through each of the pockets in the upper rotor every revolution in order to prevent material from building up in the pockets. The upper rotor operates in a counter-clockwise rotation and the lower rotor turns in clockwise direction at three

times the speed of the upper rotor. The clearance between the rounded pockets in the upper rotor and the paddles on the lower rotor varies with the size of the rotary valve but is generally 0.15 in. to 0.25 in. Depending on the temperature of the material moving through the PMDS rotary valve, the clearance between the upper rotor and the valve housing can be as small as 0.005 in. which minimises the introduction of false air in the case of Lehigh Cement or blowby in other installations where the PMDS is discharging into a pneumatic conveying line.

The PMDS shares a design philosophy with Precision's PMV rotary valves. In this modular concept, the valve body components are mated to one another with close-tolerance alignment pins and then bolted together. This allows for the replacement of individual component as they wear out rather than discarding the entire rotary valve. Also like the PMV, the Severe Duty PMDS is manufactured primarily of Tri-Braze Dura Plus steel, a 500-Brinnell material with exceptional through-hardness for long-lasting service.

New York installation

Raw coal at the Lehigh Glens Falls location is fairly typical of that for a US cement plant. Specifications include a bulk density of approximately 65 lb/ft^3, maximum material size of 3 in. with more than 50% of the particles less than 0.25 in., and a maximum moisture content of 11%.

The PMDS-18 has a capacity of 2.25 ft^3 per revolution (CFR) and for the installation at Lehigh was equipped with a Nord 5-HP drive package that produces an upper rotor speed of 15 rpm. Pocket fill was assumed at approximately 20%.

The rotary valve was installed in February 2015 and operated successfully until the plant switched over to natural gas for the summer. During the winter of 2015/2016, the plant is again operating on the coal system. Neil Hodgson, plant manager, commented, "We are pleased with the PMDS valve. It is meeting our expectations and we've not had any issues with it. It is delivering a more consistent feed to our ball mill and giving us the kiln stability that we were looking for when we burn coal."

Indirect application

At approximately the same time as the New York installation, a second, and larger, Precision PMDS rotary valve system was installed in a coal mill feeding application at a cement plant in the eastern United States. Unlike the situation at the Lehigh Glens Falls plant, in this second installation, the milled coal is sent to a silo system for storage prior to firing.

The coal mill is a vertical roller mill (VRM) and the plant had struggled for years to find a feeding device that could reliably maintain a consistent feed rate to the VRM. A number of rotary valves and other feeders had been tried but all suffered from coal build-up and plugging of the valves or the chutes into the valves. The plant was looking for a solution that would offer less downtime, increase mill efficiency, and reduce maintenance costs.

The PMDS valve at this plant was sized for 38 400 lbs/hour of raw coal of a maximum size of roughly 4 in. with a bulk density of 65 lbs/ft^3 and moisture content ranging from 5 to 14%. Due to the higher throughput, the PMDS chosen for this installation was a PMDS-18 'double-length' with a longer rotor and incorporated a doubled set of barrel sides to form the housing of the rotary valve.

The plant has operated the PMDS-18 Double-Length on a near-continuous basis since early 2015 with greatly improved feed efficiency and mill uptime.

Summary

Coal remains an economically viable fuel for the cement industry. Even under ideal conditions, and particularly under less-than-ideal conditions, the challenges inherent in handling sticky coal make mill feeding a problematic application. The difficulties in feeding coal reliably into ball mills, roller mills, and vertical roller mills must be overcome in order to optimise mill efficiency.

Precision has taken these conditions into consideration and have made significant advances in coal mill feeding. Because of the PMDS rotary valve's ability to self-clean and the close tolerances in the design, it has proven itself a reliable, valuable solution. Like Lehigh Cement, many cement producers are looking for equipment that can meet production, environmental, and cost objectives. As equipment alternatives are considered, each plant is likely to have unique goals or objectives in considering a retrofit solution. Precision's PMDS line of rotary valves can assist with effective feeding, minimised downtime, and long life. The company is committed to innovative solutions and to adapting equipment designs to help its customers solve their most difficult feeding and conveying challenges.