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# Repositioning clinker cooler air cannons for safer maintenance and longer equipment life

Consistent material flow is an essential part of the cement production process. Each step, from the introduction of raw materials to the loading of the final product for transport, has unique issues. A common problem occurs where clinker discharges from the kiln and falls into the clinker cooler. Chunky material tends to cling to the static cooler grates and/or cooler curbs, building upon itself and eventually creating a super-heated formation known as a 'snowman'.

Air cannons are commonly used to remedy this phenomenon, but if they experience clogging from backflow — or if they are set in an environment that is too hot to properly maintain them — accumulations inevitably form. Material buildup can lead to inefficient operation due to the restriction of air flow from the cooler to the kiln, damaging the kiln discharge seal and creating what's known as 'false air', which can cool the burning zone. These issues increase the cost of operation through higher fuel consumption. Worse yet, it can damage the kiln's nose casting, bull nose refractory or even completely choke off clinker flow from the cooler to the kiln, causing excessive unscheduled downtime for repair.

This issue troubles cement producers all over the world, but the operators at HeidelbergCement's Lehigh-Hanson Cement Plant, located in central Alabama, worked closely with Martin Engineering on an innovative air cannon configuration to resolve it. The design prevents material buildup and allows safe cannon maintenance at any time, resulting in longer equipment life, less unscheduled downtime and a lower cost of operation.


*In operation since 1905, the Lehigh-Hanson plant is the oldest continuously operating cement manufacturer in the state.*

"Our cannons were located close to cooler walls where the ambient conditions were very hot and dusty, making it difficult to keep the equipment functioning reliably," said Mike Schutt, Production Manager for Lehigh Hanson. "Our new air cannon arrangement has been a great success, and I have no doubt it could be effectively applied to many cement kiln operations around the world."

## Cooler concerns

Built in 1905, the Lehigh-Hanson facility is the oldest continuously operating cement plant in the state. Making Type I/II Portland cement, ASTM C595, and Type N & S masonry, the plant produces a total of 800,000 tonnes (882,000 tons) of product per year.

With a 24-hour production schedule, 160 tonnes (175 tons) per hour of raw material is passed through the kiln, reaching approximately 1,900°C (3,500°F). The viscous semi-molten clinker discharges into the cooler onto a sloped static grate and flows to a moving grate system that keeps the cooling material progressing toward the breaker and clinker storage.

Snowmen formed at the discharge point

*4.5 inch (11.5mm) pipes lead down to holes drilled into the concrete floor, then continue under the subfloor.*

when the river of semi-molten material came in contact with the static grate, causing the solid clinker to adhere to the surface and begin to build upon itself. Reaching up to 20 feet tall in as little as a single shift, the buildup could stretch back into the kiln and cause serious problems that result in excessive downtime and an increased cost of operation.

"Damage to the kiln seal raises our fuel costs, but if there's significant damage to the nose casting or cooler bull nose, we're forced to shut down the entire system and rebuild the refractory, which means days of lost production," Schutt explained. "It seemed practical at the time to place our air cannons next to the cooler hot wall where the kiln discharges, but the environment made it nearly impossible to do maintenance on them, which increased the chance of buildup. It was not a sustainable situation."

### When prevention creates more problems

To prevent such accumulation, plants commonly install air cannons. Connected to the plant's compressed air system, the cannons deliver a powerful shot of air across the vessel to prevent buildup and ensure the material flows through the cooler.

Lehigh-Hanson's first solution had five cannons with standard OEM piping leading directly to problem areas on what operators dubbed the 'hot wall', which was located right next to the hottest part of the cooler. The area had an average sustained temperature of 65°C (150°F) to 74°C (165°F), which made maintenance during operation impossible. Even during short downtime events for emergency repairs, high-heat personal protection suits were still required.

"The configuration of our blasters was pretty standard, but allowed too much backflow into the pipes and cannons," said Schutt. "It became burdensome to maintain."

Fine particulates from discharged clinker would migrate up the air cannon discharge pipe. Clinker dust would also settle within the cannon tank, diminishing the tank's capacity and decreasing the power and effectiveness of the shot.

According to Schutt, the company attempted to improve operation by testing another blaster configuration. Technicians removed the five-cannon/straight-pipe arrangement and replaced it with a massive single tank with five pipe outlets. This solution had several flaws, one being that the position of the floor-mounted tank underneath the discharge zone caused more maintenance issues and required more labour. This position also led to the plenum boxes being filled with dust and fines faster, reducing the equipment life. Moreover, the frequency and power of the configuration diminished quickly, forcing operators to monitor the cooler system closely through cameras.

*Valves face outward for convenient maintenance, requiring no tank removal to service them. Workers are able to access the tanks in a safe and comfortable area with ample room to work.*

"The system broke down so often, we finally just had to leave it and monitor the material buildup until the very last minute, then shut down the system for maintenance," Schutt said. "This allowed us to get the most production possible, but it caused at least a day of unscheduled downtime a few times per year."

Similar to the cleaning process in the preheater tower, personnel wearing hot suits would open the hatches to the cooler and knock down formations and adhered material using pressurized water. Due to the grueling nature of the work, the size of the job and the heat, the process took at least full shift to complete.

### Rethinking clinker cooler buildup

Lehigh-Hanson brought in Martin Engineering Product Specialist Mike Masterson to help find a solution. The expectations for the project required the system to:

- be 100% reliable and 100% accessible.
- eliminate material buildup within the cooler;
- withstand a 24/7 production schedule;
- reduce or eliminate backflow;
- be safely maintained with minimal exposure to heat;
- decrease the amount of unscheduled downtime; and
- reduce the amount of equipment failure.

The new air cannon configuration was introduced by Masterson in response to plant layout and conditions. "We worked closely with the contractor to finalize the design and implement the plan," said Masterson. "It's exciting to be part of a new solution."

Completed over a week by a team of four people during scheduled plant downtime, the design lifted the cannons away from the discharge area and up to a preexisting platform several meters away. Five cannons were connected to five U-shaped pipes that curved 90° from the cannon, ran vertically 10 feet (3m) down and through holes drilled into the concrete floor of the plant's cooler maintenance platform. They then curved 90° again and travelled horizontally for 20 feet (6m) under the platform to the kiln's discharge area, where they split toward different entry ports for maximum coverage. Special nozzles made out of refractory material — purchased by Lehigh operators from a refractory supplier — distributed the surge of air toward the areas of likely buildup.

Being set well away from the hot wall and the kiln's discharge zone allows the cannons to be serviced without workers wearing the special equipment needed for hot areas. The U-shaped pipe design directs the powerful shot of air and limits the amount of material backflow. Fugitive fines entering the pipe are obstructed by the curvature, the distance and the long vertical climb needed to reach the cannon.

### Innovative solutions require innovative equipment

The biggest challenge for the design was the distance the air had to travel before entering the chamber. The longer the distance, the more it would lose velocity and thus deplete the effectiveness of the shot once it reached the chamber. The solution to this problem was installing larger individual cannons using a positive firing solenoid valve.

"Previously, the cannons could be smaller because they were closer to the cooler," said Masterson. "But since the air

After five years of service, the cannons continue to operate at a high level of reliability.

has to travel further, we installed the powerful 150-litre Hurricane™ Air Cannons. They hold an enormous capacity and deliver enough pressure to carry the air all the way down the pipe system and still pack a serious punch at the end."

Connected to the existing compressed air system and weighing approximately 130 lbs (59kg) each, the Hurricanes supply more force output with less air consumption at half the size of other designs. Each unit fires a shot of air at up to 120PSI (8.27BAR) from a pressurized tank through the long pipes and spreads the airstream across the area of buildup.

Linked to the plant's logistical software in the central control room, the cannons are set on a ten-minute firing cycle with one discharging every other minute. To prevent unintentional firing due to drops in pressure, which can throw off the sequence and diminish the effectiveness of the system, the cannons are equipped with a positive-acting valve. To trigger discharge, the valve requires a positive signal from the solenoid in the form of an air pulse. Able to be located up to 200 feet away from the cannons, the solenoid panel also allows operators to fire manually if needed.

Though the valves at Lehigh-Hanson have not yet needed replacing, they require periodic maintenance and inspection. Previously, workers donned hot suits and protective gear to enter the area where the cannons resided, and they were required to remove the entire cannon from the manifold for valve service. Reported to have been one of the most unpleasant projects in the plant, at least two workers were needed to perform the maintenance and, due to the heat, they were only able to remain in the area for about five minutes at a time.

The Hurricane's valve faces outward, opposite the pipe end, and is serviced without removing the cannon tank. A single technician simply detaches the air and solenoid connections, removes the eight bolts from the valve assembly and slides it out for inspection and maintenance.

"The design reduces the amount of time and labour needed to maintain the equipment," said Masterson. "And by eliminating the need for heavy lifting, it improves safety."

### The standard moving forward

"After five years of constant operation, the results have been better than we ever expected," said Schutt. "Since installation, we have had a significant reduction in downtime due to snowman formation. Not having to get near the hot wall or put on special equipment has definitely made a difference in the morale of the maintenance and production staff."

By moving the cannons away from the hazardous area, the lack of heat exposure has reduced the impact on the equipment itself, increasing the life of the valves and the tank. Setting the tanks in an easily accessible and safe area means that workers can inspect the equipment more often and perform maintenance on a single cannon without downtime.

The cannons no longer experience buildup from backflow within the tank, allowing them to operate at full capacity. However, according to Schutt, there are some issues with abrasion on the air cannon pipes coming off the hot wall. The company has installed pipes with a different abrasion resistant alloy. So far the change has been a success.

"Overall, we are very satisfied with the design and the equipment," Schutt concluded. "I can see this configuration becoming a standard design across the cement industry."

Martin Engineering is a global innovator in the bulk material handling industry, developing new solutions to common problems and participating in industry organizations to improve safety and productivity. The company's series of *Foundations* books (available free in print and online) is an internationally-recognized resource for safety, maintenance and operations training — with an estimated 10,000 copies in circulation around the world — and employees take an active part in ASME, SME, VDI, CMA and CEMA. The firm also played a pivotal role in writing and producing the 7th edition of the CEMA reference book, *Belt Conveyors for Bulk Materials*. Martin Engineering products, sales, service and training are available from factory-owned business units in Australia, Brazil, China, France, Germany, India, Indonesia, Italy, Mexico, Peru, Russia, Spain, South Africa, Turkey and the UK.