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SAFE SOLUTIONS TO STICKY SITUATIONS

Manually clearing buildup in preheater systems exposes workers to multiple risks. So, why are people asked to do it when there are safer, more efficient and more cost-effective solutions that support the flow process? Brad Pronschinske, Martin Engineering, investigates.

One of the most critical aspects of successful cement production is the consistent flow of materials. Yet accumulations in ducts, chutes, cyclones and vessels often chokes the movement of materials, causing bottlenecks that create expensive impediments to plant performance, process efficiency, productivity and profitability. Buildup needs to be manually cleared with alarming regularity – unless, of course, the right technology is employed to keep things flowing smoothly.

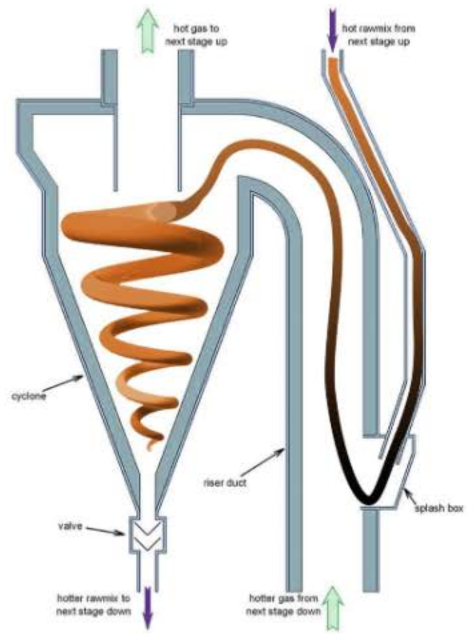
Go with the flow

Preheater towers, in some form, have been in operation since the 1920s, and today's cement plant designs can include as many as

six stages in towers reaching up to 12 storeys (120 ft/35 m) tall. Preheaters operate on a tried-and-tested principle: the mix flows down a chute into a splash box, where it is lifted by the hot airflow of the riser duct into the top of a cyclonic collector. From there, the material passes through a valve to the next preheater stage, repeating this process until the material reaches the kiln feed inlet.

Effective as this process is, one of the biggest contributors to material buildup is the high heat and material velocity. As material gets hotter, it gets stickier, clinging to the sides of the flow chutes and splash box, as well as in the riser duct and elsewhere.

With the increased use of a range of waste-derived fuels, plus alternative raw materials such as shale replacements, in many cement plants around the world there is evidence of increasing hard buildup causing reduced and unstable flow. Large accumulations can even completely block the outlet of a cyclone. If left unchecked, clogs can form quickly, stopping the material flow, leading to unscheduled downtime and lost production.



The material flows through this process several times within seconds, leading to the kiln.

Air cannons are employed in a number of applications in cement production to resolve material flow issues.

Lancing the boil

To make matters worse, poor material flow also takes its toll on maintenance teams, not only diverting them from core activities but also presenting serious health and safety risks.

That is because the traditional way of dislodging buildup is to implement regular cleaning schedules, assigning workers with water lances extended through access holes. A worker ascends the tower and dons a thick full-body suit of high-heat personal protective equipment (PPE).

Lancing the material with high-pressure water clears the blockage and restores proper flow. Despite the risks, this procedure is typically done while the preheater is still in operation, causing a tremendous amount of heat and some molten material to blow back. The exposure to heat, manual handling, awkward and confined spaces and even the PPE itself makes preheater cleaning one of the most unpleasant jobs in a cement plant.

Clearance is a blast

The biggest single improvement when it comes to safety and efficiency in preheater performance is the use of air cannons. Also known as air blasters, air cannons have a long history of resolving material flow issues associated with all bulk handling.

Air cannons are employed in a number of applications in cement production, from unclogging chutes and hoppers to moving super-heated material through the cooling process. In the preheater, air cannons dislodge buildup from the walls of riser ducts, feed pipes and other locations to prevent clogging and promote the free flow of materials down into the kiln. Recent innovations in the engineering, installation, assembly and design of air cannons have been particularly effective in maintaining safe, efficient flow in preheater towers.

Air cannons can

Air cannons function by releasing a powerful shot of pressurised air from a tank through a pipe assembly to a specialised nozzle, removing any buildup of material from surfaces and directing it back into the process stream.

The basic components of the air cannon include an air reservoir, fast-acting valve with a trigger mechanism and a nozzle to distribute the air in the desired pattern that most effectively clears the accumulation.

Often installed in a carefully calculated series and precisely sequenced for maximum effect, the network can be timed to best suit individual process conditions or material characteristics.

A series of air cannons can be programmed to deliver precisely-timed operation for maximum benefit.

New cannon designs are more compact and have significantly increased power, efficiency and safety.

The air blasts help break down material accumulations and clear blocked pathways, allowing solids and/or gases to resume normal flow. In order to customise the air cannon installation to the service environment, specific air blast characteristics can be achieved by manipulating the operating pressure, tank volume, valve design and nozzle shape.

Over the years, technology has developed to the point where both installation and maintenance can be performed safely without a shutdown or exposure to intense heat.

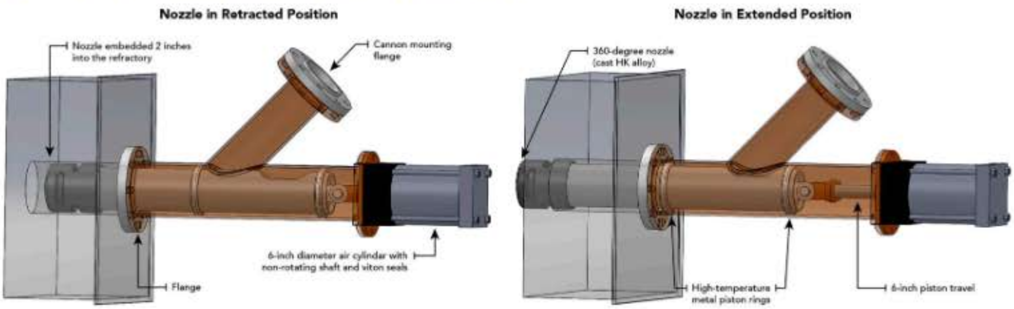
The use of air cannons is a direct route to separating people from harsh operational environments in the heart of a cement plant.

Low pressure, high performance

Today's low-pressure air cannons deliver a powerful surge through a specially designed high-heat nozzle positioned to clear a specified area inside the flow zone.

Until recently, cannons relied on air tanks weighing hundreds of pounds, with inward-facing valves firing straight across the vessel. To perform maintenance on the valve, the whole tank required removal, involving significant labour and time, and posing potential safety issues due to the weight of the units. Older models also featured negative firing valves that had the potential to misfire due to drops in pressure, throwing off the firing sequence and further burdening the compressed air system.

In the past, nozzles were commonly welded to the vessel wall, protruding through the refractory. The abrasive high-heat environment wears them down quickly, with replacement needed in as little as 3 – 6 months. For proper maintenance in this situation a complete cool-down is required, along with both confined space entry and working at height for the removal and replacement.



Retractable nozzles are only exposed to the material stream for the split second it takes to deliver the shot.

Not only does this increase human exposure to hazards, but removing the nozzles can contribute to fractures in the refractory. Further, first generation pipe nozzle designs can allow material to build up inside the pipe, potentially reducing the cannon's effectiveness and contributing to the need for replacement.

Air cannon innovations

Air cannons have been around for more than 50 years, but the last decade in particular has seen a revolution of sorts in air cannon technology. Engineers have gone back to the drawing board and completely reinvented the equipment, from the moment compressed air enters the tank to its contact with material. This makes modern air cannons more efficient, cost-effective and, most importantly, safer to install and service.

The outward facing valve allows safe servicing by one worker, without a shutdown.

Core drilling during production by a trained technician.

Today, engineering advancements are producing air cannons that are more compact and lighter, with greater efficiency and power. Suppliers are innovating the way they are built, fitted, maintained and powered in order to maximise production and reduce both downtime and the overall cost of operation, while significantly contributing to improved safety.

Smart nozzles and safer servicing

One of the most effective innovations has been the Y-shaped assembly that allows the nozzle to be safely maintained or replaced from outside, without removing the tank or disrupting the refractory. The system allows specially-trained technicians to mount the units on furnaces, preheaters, clinker coolers and in other high-temperature locations without interrupting production. It significantly reduces downtime associated with traditional approaches to service and replacement, which require that high-heat processes be halted.

The nozzle itself is the component that takes the stored energy in the form of compressed air and directs it to do work, so it has the biggest effect on the performance of any air cannon. The new series of retractable air cannon nozzles has been developed specifically for high-temperature applications, extending into the material stream only during the firing cycle to protect the nozzles from extreme temperatures and abrasion.

These 'smart' nozzles allow the cannon and nozzle to be installed independently, so the nozzle can be accessed for inspection or service during production, without stopping the process or removing the cannon. The new design solves two common industry problems – effectively dislodging accumulations in hard-to-reach areas without shutdown, manual labour or safety risk, while extending nozzle life. Further, the units can be serviced from outside the vessel without disturbing the refractory, reducing potential damage while minimising service time and risk of injury.

Many designers proactively include the mountings for air cannons in new designs, allowing for future retrofits to be conducted without vessel entry or extended downtime. New technology has even been developed for installing air cannons in high-temperature applications without a processing shutdown. This allows specially-trained technicians to safely mount the units on furnaces, preheaters, clinker coolers and in other high-temperature locations while production continues uninterrupted.

Hassle-free valve maintenance

At the heart of the air cannon system is the valve assembly, which requires regular inspection and occasional service/replacement. To facilitate maintenance without a process shutdown, air reservoirs with volumes typically ranging from 35 l up to 150 l are now fitted with outward-facing valves that can be removed without dismounting the tank. This provides easy access by a single worker from outside the vessel and eliminates manual handling issues.

Today's fast-acting valves can release the tank volume in a fraction of a second, creating a high-magnitude force at the exit nozzle that is installed through the wall of the vessel or duct. The new designs feature a hybrid valve concept that provides more force, uses less air and simplifies maintenance in challenging applications with limited budgets.

Another innovation that has also made air cannons safer is the development of positive-firing valves. These valves respond to an air pressure surge delivered by a solenoid, which can be mounted at an accessible location away from the air cannon. Unlike negative pressure-firing designs, a cannon equipped with this type of valve will not discharge accidentally in response to a drop in pressure, so an air supply failure or broken line cannot trigger it suddenly. The high-speed valve design is mounted on a smaller air reservoir, delivering higher discharge forces than less efficient valves on larger tanks. The new generation of valves produces about twice the blast force output of previous designs, saving energy by using about half the compressed air volume.

Installation whilst operating

In the past, when material accumulation problems became a recurring issue, processors would have to either limp along until the next scheduled shutdown or endure expensive downtime to install a better air cannon network. That could cost hundreds of thousands of dollars per day in lost production.

Accordingly, the ability to avoid shutdowns and yet safely service these systems has been a fundamental priority in new equipment designs, and many designers now proactively include the mountings so that a future retrofit can be done without hot work permits or extended downtime.

Martin Engineering invented the concept of low-pressure blasting using networked compressed air, and has commercialised a patented new technology for installing air cannons without a process shutdown. The system allows specially-trained technicians to mount the units on furnaces, preheaters, clinker coolers and in other high-temperature locations while production continues uninterrupted.

Specialised core drill bits are engineered to create the exact diameter hole at the precise angle needed. Once a core is safely installed in the vessel wall, an isolation gate is inserted to protect from heat and blowback. Trained technicians then attach the Y-pipe assembly with no process disruption. The technology significantly reduces expensive downtime associated with traditional installation methods, which require that high-heat processes be halted to allow core drilling and mounting of the cannons.

Controlling the flow

Material flow through the preheater tower takes only seconds, but a clog can cause hours or days of downtime that cannot be made up, resulting in significant losses. While older air cannon installations can help to reduce buildup and blockages, they inadvertently create new problems – they were not designed with safe maintenance or installation in mind, putting workers at potential risk in a daunting set of gruelling clean-up tasks.

With advancements in air cannon technology over recent years, cement plant operators are now able to implement a long-term production strategy that maintains the flow of materials, reduces downtime, increases efficiency and, crucially, improves worker safety. ■

About the author

Bradley Pronschinske, Global Air Cannon Product Manager for Martin Engineering is responsible for the development and management of the company's air cannon products and vibration systems used to improve bulk material handling in applications around the world. He joined Martin Engineering in 1998 as a Product Specialist–Air Cannons and became Global Product Manager – Air Cannons in 2005 and continues in that role today. Brad holds many US and International patents on air cannon models with additional patents on nozzles for air cannon systems. He has a BS in Electronics Engineering from Hamilton Technical College in Davenport, Iowa.

Note

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