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APRIL 2023

global cement MAGAZINE

Features

Technical

Concrete

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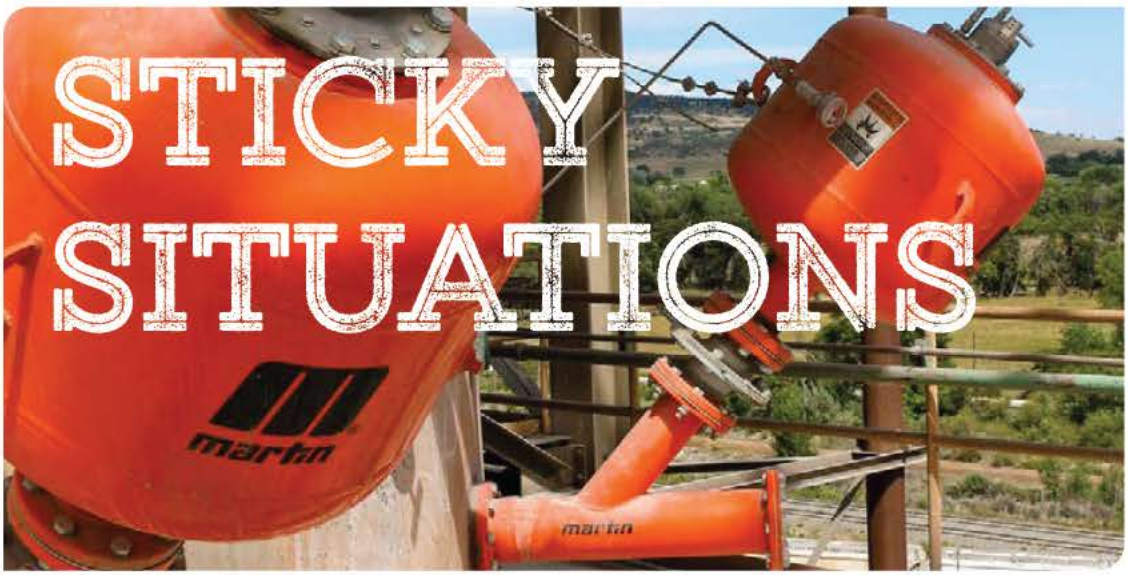
STICKY SITUATIONS



Above - Figure 1: New air cannon designs are more compact and have dramatically increased power, efficiency and safety. ©Martin Engineering 2023.

Manually clearing build-ups in vessels and preheater systems is one of the most unpleasant tasks at a cement plant. It also exposes workers to multiple risks. So why do we ask people to do it when there are safer, more efficient and more cost-effective solutions to support the process?

Successful cement production depends on the constant flow of materials. Accumulations in ducts, chutes and vessels can choke the movement of materials and cause bottlenecks that create expensive impediments to plant performance, process efficiency, productivity and profitability. Build-ups may need to be manually cleared with alarming regularity unless 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. Today's designs can have as many as six stages in towers up to 35m tall. As effective as they are, the high temperature and and material velocity within preheaters makes them prone to material build-up. Hotter material is stickier, clinging to the sides of the flow chutes and splash box, the riser duct and elsewhere. The use of alternative fuels and raw materials can even make the situation worse. Large accumulations can even completely block the outlet of a cyclone. If left unchecked, clogs can form quickly and stop the material flow completely, leading to unscheduled downtime and lost production.

A bad day at the office

Poor material flow takes its toll on maintenance teams too, not only diverting them from core activities but also presenting serious health and safety risks. That's because the traditional way of dislodging build-ups is to implement regular cleaning schedules, assigning workers with water lances extended through access holes. A worker ascends the tower, dons a thick full-body suit of high-heat personal protective equipment (PPE) and lances the material with high-pressure water to clear the blockage. Despite the risks, this is typically done while the preheater is still in operation, causing tremendous heat and even 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.

Improving flow and safety

The biggest single improvement to safety and efficiency in preheater performance is the use of air cannons. These have a long history of resolving material flow issues associated with all bulk handling. In cement production they are used to unclog

chutes and hoppers to move super-heated material through the cooling process. In the preheater, air cannons dislodge build-up from the walls of riser ducts, feed pipes and elsewhere to prevent clogging.

How air cannons work

Air cannons release powerful shots of pressurised air from a tank through a pipe assembly to a specialised nozzle. This removes any build-up of material from surfaces and directs it back into the process. The basic components of any air cannon include an air reservoir, fast-acting valve with a trigger mechanism and a nozzle to distribute air in the 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. 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 separates 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, they relied on air tanks weighing hundreds of kilos, with inward-facing valves firing straight across the vessel. Valve maintenance required the whole tank to be removed, 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. Here, the hot and abrasive environment wears them down quickly, with replacement needed in as little as 3-6 months. Proper maintenance in this situation requires a complete cool-down, as well as both confined space entry and working at height. Not only does this increase human exposure to hazards, but removal can fracture refractories. Further, first generation pipe nozzle designs can even lead to material build-up *inside* the pipe.

Air cannon innovations

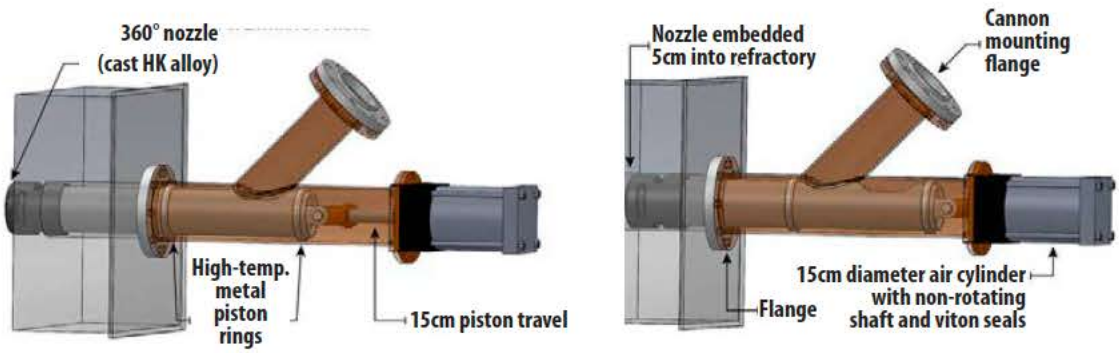
The past decade has seen a revolution in air cannon technology. Engineers have gone back to the drawing board, from the moment compressed air enters the tank to its contact with material. This makes modern air cannons more efficient, cost-effective and, most importantly, safer to install and service.

Air cannons are now more compact and lighter, with greater efficiency and power. Suppliers are innovating the way they're 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 patented 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 technicians to mount the units on furnaces, preheaters, clinker coolers and in other high-temperature locations while production continues. It dramatically reduces downtime associated with traditional approaches to service and replacement.

Below - Figure 3: Retractable nozzles are only exposed to the material stream for the split second it takes to deliver the shot. ©Martin Engineering 2023.



Above - Figure 3: Drilling for a new air cannon on an operating preheater by a trained specialist. ©Martin Engineering 2023.

The new series of retractable air cannon nozzles has been developed specifically for high-temperature applications, extending into the material stream only during firing to protect the nozzles from extreme temperatures and abrasion. These 'smart' nozzles allow the cannon and nozzle to be installed independently. The nozzle can be accessed for inspection or service during production, without stopping the process or removing the cannon. This solves two common 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.

Many designers proactively include the mountings for air cannons in new designs, so that future retrofits can be done without entering vessels or extended downtime. New technology has even been developed to install air cannons in high-temperature applications without a shutdown. This means that units can be safely mounted on preheaters, clinker coolers and in other high-temperature locations while production continues.

Hassle-free valve maintenance

At the heart of the air cannon system is the valve assembly, which requires regular inspection and occasional service or replacement. To enable maintenance without a shutdown, air reservoirs with volumes typically ranging from 35L up to 150L 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.

Modern fast-acting valves can release the entire tank in a fraction of a second, creating a high-magnitude force at the exit nozzle through the wall of the vessel or duct. 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 is the development of positive-firing valves that respond to an air pressure surge delivered by a solenoid. This can be mounted accessibly 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 suddenly trigger it. 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 without a shutdown

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. This could cost hundreds of thousands of dollars per day in lost production.

The ability to avoid shutdowns and yet safely service these systems has been a fundamental priority in new designs. Retrofits can be carried out without hot work permits or extended downtime.

Martin Engineering was the inventor of low-pressure blasting using networked compressed air, and has commercialised a patented new technology to install air cannons without shutdowns. This allows technicians to mount the units on preheaters, clinker coolers and in other high-temperature locations while production continues.

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. Technicians then attach the Y-pipe assembly with no process disruption. The technology dramatically 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 can't be recovered. While older air cannon installations can help to reduce build-ups and blockages, they inadvertently create new problems, as they were not designed with safe installation or maintenance in mind, putting workers at risk in a daunting set of 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.