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COVER STORY:
Brad Pronschinske, global air cannon product manager at Martin Engineering, explains how air cannons can safely and effectively clear blockages from silos and hoppers.

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Breaking the cycle of silo buildup and clogging

Brad Pronschinske, global air cannon product manager at Martin Engineering, explains how air cannons can safely and effectively clear blockages from silos and hoppers.

MOST HOPPERS AND SILOS WERE designed for the needs and environment at the time they are constructed. However, production demands and shifts in climate are changing the dynamic.

Modest changes in moisture content can cause adhesion to silo walls. Low temperatures and changes in atmospheric pressure – especially if the silo is stagnant for long periods – can contribute to flow changes.

In the past, when material accumulation problems became a recurring issue, operators would usually limp along until the next scheduled shutdown. That could cost a business hundreds of thousands of dollars per day in lost production. Once coarse material adheres, the buildup is generally fast and dense, eventually resulting in downtime to remove. Seeking ways to address it quickly without the proper tools or training can also be the moment when workplace safety degrades.

Air cannons are engineered to safely clear and prevent clogging, promote material flow and avoid costly downtime. To know if the technology will work best for a specific application, the first step is understanding how, where, when and why clogs happen in any given silo. The second step is removing any worker involvement in clearing the clog, aside from pushing a button to activate the cannon if it is not automated or controlled by logistical software.

Silo clogging and safety

Regardless of the cause, the types of clogs in a hopper can pose unique challenges for discharge, as well as very serious safety issues. There are several unsafe practices around silos that too often result in serious worker injuries or fatalities, mainly sudden discharge of adhered material and entrapment.

Poking or lancing from beneath the clog at the spout can result in a sudden surge of falling material, burying, or crushing the workers below and seriously damaging the receiving belt. Beating the vessel walls with mallets or other objects to loosen adhered material is common. Operators who engage in this method find this worsens the situation over time as the divots and ripples left from hammer strikes provide places for additional material accumulations to start.

If a worker enters the vessel and stands on the volatile bridge, a sudden

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

New designs no longer require tank removal for valve replacement saving time and manpower.

discharge could pull the worker into the cavity. Sometimes material buildup on the sides of the vessel reaches higher than the worker and falls from above, causing serious injury or burial.

Material churn

Silos are designed to hold a certain volume of a particular material, so awareness of the maximum load is important. Repeatedly filling and emptying them makes load requirements especially important in those cases, since capacity is reached repeatedly under many conditions. When working with bulk solids, environments with high moisture and freezing regularly experience clogging. Wide variations in the size and shape of the material can also affect the flow characteristics, leading to buildup and clogs.

Arches form when material consistency changes during loading or the top material contains more moisture. It can also just be caused by gravity. This is very dangerous since material discharge has a long fall distance. The flat top surface can give workers a false sense of stable ground, so vessel entry is ill-advised. Air cannons placed at the upper point of where material begins to adhere keeps the cargo flowing toward the discharge spout.

Plugs are generally caused by compacted moist material or the contents that have been left for long periods. Strategically placed air cannons can help loosen material to get it flowing. Sometimes the contents have hardened to such a degree that a silo cleaning service is needed, which utilises the support of the air cannon system to resolve the issue faster, lowering the cost of the service.

Buildups can be caused by several factors: weather, silo design, the way the silo is loaded, a horizontal grain of the metal on the side of the silo, the silica content of the material, etc. Buildups can be economically mitigated using strategically placed air cannons at common collection points to keep material flowing toward the discharge spout.

Ratholes often form over time and reduced the capacity of the silo. Since the material is flowing, they are often ignored by operators, but can severely impact on production. The significant weight put on the thin walls of the silo and structural supports can pose a serious safety issue.

Air cannons

Low-pressure air cannon technology has progressed exponentially over the 50 years since its conception. They use a plant's compressed air system to deliver a powerful discharge to dislodge material buildup. Mounted on a pipe assembly, the basic components include an air reservoir, a fast-acting valve with a trigger mechanism and a nozzle to distribute the air in the desired pattern to clear the accumulation most effectively.

Strategically positioned on the silo, when compressed air (or some other inert gas) in the tank is suddenly released by the valve, it is directed through an engineered nozzle toward the specific or general location depending on the design of the nozzle. The air blasts help break down material accumulations and clear blocked pathways, allowing solids and/or gases to resume normal flow.

Often installed in a series and precisely sequenced for maximum effect, the network can be timed to best suit individual process conditions or material characteristics. Specific air blast characteristics can be achieved by manipulating the operating pressure, tank volume, valve design and nozzle shape.

Valve replacement

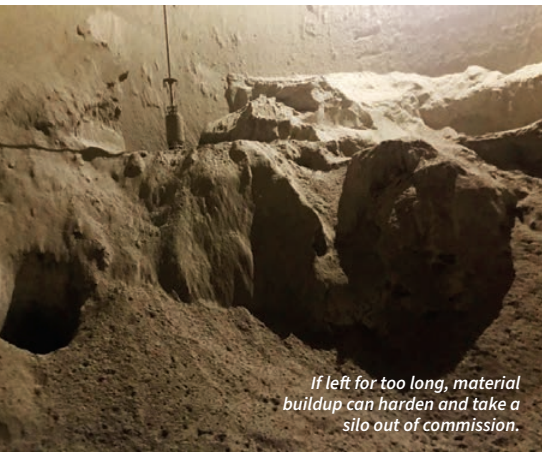
The valve in an air cannon is considered a wear part, but it is common practice to refurbish them rather than replace them with new ones. Since clearances and fits are critical to proper operation, valves should be rebuilt and repaired by the manufacturer, or specifically trained plant maintenance personnel.

Martin Engineering has created a program to supply factory-rebuilt air cannon. Customers can receive a standard pallet-sized container with six refurbished valves, so there's no need for users to rebuild worn-out components. The changeout can be accomplished in just ten minutes, at less than half the cost of new valves. Used valves are shipped back to the company, where the units are rebuilt to as-new condition by factory-trained technicians. Customers save time and money, with no need to stock repair parts or provide the training/labour to rebuild.

Case study

Toledo Power Plant in Cebu, Philippines (a subsidiary of Global Business Power Corporation) was experiencing clogging issues in its coal hopper. The material was wet and slightly sticky, which made it adhere to the walls of the hopper and accumulate creating blockages and unscheduled downtime. Temporary shutdowns affected production as employees manually knock down the material from the walls of the hopper with mallets.

Along with lowering production, clogs removed labour from other tasks, created a potentially unsafe work environment, and raised the cost of operation.



If left for too long, material buildup can harden and take a silo out of commission.

After installation, the cascading sequence of the cannons is apparent, aiding the direction of the material flow.

After evaluating the problem, Martin Engineering recommended the installation of 18 Martin Air Cannons. Fed by the compressed air system and discharged either on a schedule or manually from a convenient central location, air cannons provide effective performance by supplying a powerful discharge of air that dislodges material buildups and enhances the flow of bulk solids.

Mounted on the slope of the hopper with nozzles pointing in the direction of the material flow where accumulation and blockages were most prominent, the cannons both dislodged accumulation and promoted consistent throughput. The low maintenance requirements and high-velocity discharge make the Martin Air Cannons suitable for use on high temperature applications and humid conditions, as well as helping move the most challenging materials.

The air cannons eliminated the blockages and successfully prevented the accumulation that impacted efficiency and required process interruptions for manual cleanout. With the Martin Air Cannon installed at the slope of the hopper, the material now flows freely through the hopper to the screw feeder. Martin installed a total of 18 air cannons at the plant.

Silo flow

Air cannons are not new, but the technology has progressed to the point that the footprint on the compressed air system of a plant is considerably lower. Efficient silo flow is essential to plant production, so justifying the expense of installation and operation are easy once calculated against the cost of downtime and the importance of workplace safety. B