



TECHNICAL ARTICLE SERIES

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Deflection Elbows Prevent Blowouts, Preserve Purity of Ceramics at CoorsTek



HAMMERTEK CORPORATION

USA:
2400 Emrick Boulevard, Bethlehem, PA 18020-8006
1 800 505 9665 1 610 814 2273 Fax: 1 610 814 0600
sales@hammertek.com hammertek.com

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GOLDEN, CO — CoorsTek is a world leader in technical ceramics, materials that are highly resistant to mechanical, chemical, electrical, and thermal degradation. Applications span numerous industries including aerospace and defense, chemicals, electronics, energy, medical, and semiconductors.

In 2019, CoorsTek opened its Center for Advanced Materials (CCAM) in Golden, CO. It combines a research and development hub, an analytical laboratory, and a materials manufacturing facility. CCAM's mission is to accelerate production of commercial ceramics using the latest technologies.

Its manufacturing side is dedicated to handling alumina (aluminum oxide, Al_2O_3), which rates 9 on the Mohs hardness scale, just below diamond. "It's extremely abrasive," says Andrew Harm, CoorsTek process engineer, who led the commissioning of CCAM's eight pneumatic conveying systems. These dilute-phase lines were built to transport the alumina between operations, from railcar unloading to mixing, milling, spray drying, and storage. The conveying systems' elbows were unfortunately no match for the abrasive alumina.

"I don't think it was communicated clearly how abrasive our materials are," Harm says. "They very quickly started poking holes in the elbows." In some cases, the elbows failed after handling only 20,000 to 30,000 lb (9,100 to 13,600 kg) of alumina. "Our batch size is 100,000 lb (45,400 kg), so it was a substantial issue for us."

In addition to downtime, premature wear caused product contamination with as much as 150 ppm of magnetic iron emanating from pipeline and elbow wear. "We care about iron in our material, especially our materials that go to the semiconductor industry and for defense," Harm says. "The chemistry and purity are extremely important."

Preventing abrasive alumina from impacting the elbow wall

The ceramic linings of the original elbows had a Mohs hardness of just 5 to 6. As those wore through, Harm and his staff experimented with other types of elbows. The most effective proved to be Smart Elbow® deflection elbows from HammerTek Corp.

These specialty bends have a spherical vortex chamber protruding from the inlet leg. As material enters the bend, a portion of the flow is diverted automatically into the vortex chamber, where it forms a loosely packed mass that slowly rotates in the direction of flow. This gently deflects incoming particles around the bend. Because some material continuously filters out of the chamber as new material enters, the rotating ball of material is continuously replenished. In addition, the material exits evenly across the outflow of the elbow without skidding along the outside radius as occurs with sweep elbows.

Although the deflection elbows are more expensive initially than other styles Harm tried, such as blind-tees, they reduced costs and improved quality. "We get very little wear from the deflection elbows, so we're not wearing off that



CoorsTek installed Smart Elbow® deflection elbows after experiencing failures of ceramic-lined sweep elbows along its eight pneumatic lines conveying highly abrasive alumina.



The deflection elbows have reduced pressure drop and prevented contamination, blowouts, and unscheduled downtime.



CoorsTek has replaced most of its double-wall sweep elbows (foreground) with Smart Elbow® deflection elbows (rear).

metal into our product. That by itself is enough for us to justify the cost." Eliminating the blowouts, the mess, and unscheduled downtime was a bonus. "We can make the case from a purely manufacturing standpoint, too," Harm says.

Replacing sweep elbows proactively

CoorsTek initially installed the deflection elbows in phases after it commissioned each conveying system, and the original sweeps wore out. "We did that with a couple of systems, but by the time we started running the fifth or sixth system, we went whole hog," Harm says. "Waiting [for a blowout] was causing too much unplanned downtime. If you already have the part on hand and plan for it, changeout time is minimal, maybe half an hour."

Replacing difficult-to-access elbows, however, takes more time and planning. The most difficult were the elbows atop CCAM's 90 ft tall (27.4 m) outdoor silos. It took two days and required hiring a crane and building special scaffolding, but there was no alternative, Harm says. "We can't be blowing our material out to the open."

Those were the last of the 65 Smart Elbow bends that CoorsTek installed. Some of the bends are cast iron, but most are made from HammerTek's HammerLoy™, a more abrasion-resistant material.

Reducing pressure drop by one-half to one-third

In addition to preventing contamination and blowouts, the deflection elbows reduced pressure drop. "With the blind-tee elbows, we get 0.2 to 0.3 psi (1.38 to 2.1 kpa) pressure drop across the elbow itself. With the HammerTek elbows, we get about 0.1 psi (0.69 kpa) drop," Harms says. "That's a pretty significant difference. If we used four or five of those other elbows, it could mean a 20 percent pressure drop just across the elbows. It could drop the rate enough that we couldn't send material through."

Throughputs among the eight systems range from 4,000 to 20,000 lb (1,800 to 9,000 kg) per hour. Conveying line runs are 80 to 300 ft (24.4 to 91.4 m) and pipeline diameters are 4, 5, or 6 in. (100, 125, or 150 mm). At the discharge end, material velocities can exceed 100 mph (161 km/h).

The oldest of the HammerTek elbows, installed two years ago, continues to perform. In noncritical areas, CoorsTek still has some blind-tees and sweeps with double-wall construction. "If we can get away without replacing them, great," Harm says. "But the first time one of those fails, we'll go ahead and swap those out as well."

CoorsTek

+1 303-271-7100

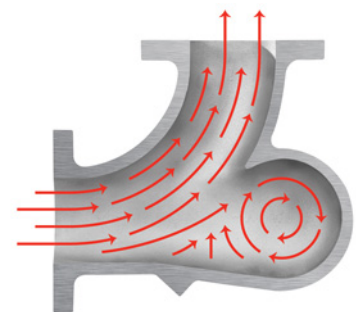
Golden, CO

info@coorstek.com

www.coorstek.com



CoorsTek's eight pneumatic conveying lines run between 80 and 300 ft (24 and 91m) in length and 4, 5, and 6 in. (100, 124, 150 mm) in diameter. They transport alumina from railcar unloading to mixing, milling, spray drying and storage.



A spherical vortex chamber protruding from the deflection elbow causes a loose ball of ceramic material to rotate in the same direction as the airstream that powers it, deflecting particles around the bend without impacting or wearing the elbow wall.