Case history

Conveying line elbows provide maintenance-free operation

A wastewater reclamation plant installs 17 specially designed elbows in its lime conveying systems to eliminate dust leaks and downtime caused by material abrasion.

The Upper Occoquan Sewage Authority (UOSA) operates an advanced water reclamation plant in Centreville, Va., that treats more than 30 million gallons of wastewater each day. One step in the reclamation process — transferring pebble lime from bulk trucks to storage silos — was proving to be a challenge for the plant.

The lime eroded through the pneumatic conveying system elbows too quickly, causing dust leaks, excessive downtime, and inefficient operation.

The plant operates two separate lime-storage buildings 24 hours a day, 7 days a week, 365 days a year and provides reclaimed water to more than

To reduce maintenance costs and worries, the company installed a new 90-degree elbow (shown in the highlighted area) in a conveying line to direct the pebble lime into a silo's top.

300,000 people in the surrounding counties. Each building has three large silos for storing pebble lime. This granular material, which contains some fines, is used to raise the water pH to levels where bacteria and phosphorous can be efficiently removed. Since the plant requires about 1 million pounds of pebble lime each month to effectively treat the wastewater, 25-ton-capacity pneumatic-discharge (PD) trucks deliver the lime to the plant up to 20 times a month.

After a truck arrives at the plant, it's directed to one of the storage buildings, where the driver positions the truck in the unloading area. The driver then connects the truck to the building's high-velocity pneumatic conveying system, which transfers the lime into a silo in about 1 hour. Each building's pneumatic conveying system has three 4-inch-diameter pneumatic conveying lines, each dedicated to one silo. Each conveying line has several 45- and 90-degree turns and connects a truck to a silo's top, which is about 4 stories above the ground.

Elbow failures cause problems

Since the plant began operation in 1978, the abrasive pebble lime would wear through each of the elbows about twice a year, causing the lime to blow out onto the ground and fugitive dust to escape into a building. "When an elbow failed and material leaked out, we had to shut down the conveying line and transfer the lime into another silo," says Bob Forgione, UOSA director of the operations and maintenance division. "Even though we stocked the elbows, it still took the maintenance crew about two hours to change one out."

The elbow failures forced the operators to spend extra time cleaning up the pebble lime accumulations from the ground and the fugitive dust from the buildings' interiors. The fugitive dust also invaded plant equipment electrical and mechanical components, requiring the equipment to be cleaned frequently, and it caused air quality issues, requiring operators to wear respiratory-protection equipment.

To solve the problems caused by failing elbows, the plant first tried installing pneumatic conveying lines and elbows constructed of more wear-resistant materials. "The original conveying lines were made of steel pipe with short-radius steel elbows, so we switched to ductile-iron lines with short-radius ductile-iron elbows," says Forgione. "When that didn't work, we tried ductile-iron lines with long-radius steel sweep elbows that

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The company had to remove this long-radius sweep elbow from the conveying line because the abrasive pebble lime wore a hole through its outer wall.

were about ten feet long and very heavy, but those elbows wore through quickly. We even researched wear-back elbows and various linings and contacted people in the lime industry, and still couldn't find a solution."

The long-radius elbows lasted a little more than 1 year before needing to be replaced. "However, replacing them wasn't easy, especially if we had to replace one at the top of a conveying line," says Forgione. "Because we don't have hoists in these locations, it was a pain for the mechanics to carry replacement sweep elbows up stairs or ladders to install them in hard-to-reach areas. We also considered this unsafe because the elbows were heavy and awkward to work with. We wanted to make it as safe as possible for the mechanics to replace an elbow, so we decided to look for a way to move away from the long-radius sweep elbows and toward something smaller and easier to handle."

Solution found nearby

In January 2003, Forgione was contacted by Joe Cathey, an area representative for HammerTek, an elbow supplier headquartered in Landisville, Pa. Cathey was familiar with the plant's conveying line problems and talked with Forgione about the supplier's Smart Elbows he had specified for a similar lime conveying system at a nearby water reclamation plant in Alexandria, Va. The elbows, Cathey told him, had been operating without failure for 5 years. Soon after, Forgione sent UOSA mechanical manager Larry Brown to tour the Alexandria plant and verify Cathey's claims about the elbows. Following the tour, he reported to Forgione that the Alexandria plant's elbows had indeed experienced no failures or leaks since their installation and that they would be easy to install in existing conveying lines.

A person from UOSA's mechanical section then called Cathey to order the elbows. Because of the abrasive material being handled, Cathey recommended elbows constructed of HammerLoy, a proprietary heat-treated iron product with a hardness rating of 500-550 Brinell, which is about three times harder than carbon steel.

As part of a two-phase project, Forgione planned to first replace the elbows in the conveying lines of the storage building that handled the most lime. In summer 2003, shortly after purchasing the first elbows, plant mechanics installed six flanged 90-degree elbows and three flanged 45-degree elbows in the first building's conveying lines. Less than a year later, plant mechanics completed the project's second phase by installing six flanged 90-degree elbows and two flanged 45-degree elbows in the second building's conveying lines.

The new elbow

A Smart Elbow consists of an inlet, a spherical-shaped vortice chamber, and an outlet and is available in many alloys with plain or flanged ends. The elbow can redirect material 45 or 90 degrees and is available in sizes to fit pipe diameters from 1.5 to 20 inches and tube diameters from 2 to 8 inches. The elbow can be installed in pressure or vacuum pneumatic conveying systems or slurry conveying systems and used for dilute- or dense-phase conveying applications. The elbow can be installed horizontally or vertically to redirect the material in any direction.

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When the elbow is installed on a horizontal conveying line to redirect material 90 degrees vertically, the inlet section is sloped slightly downward so that the vortice chamber's center is slightly below the center line of the incoming conveying line. As material and air enter the elbow, the shape and location of the vortice chamber forces a downward rotation. A slight kick-up area at the chamber's bottom forces the material back up to the chamber's top, creating a steadily rotating ball of suspended material that deflects incoming material to the outlet without contacting the elbow walls. This eliminates the material-on-elbow impact zone that occurs on a sweep elbow's outer radius, instead creating a material-on-material deflection zone near the chamber's entrance.

This flanged 90-degree elbow has functioned in the pebble-lime conveying line without problems for more than 5 years.

The material rotating in the vortice chamber eventually discharges back into the material stream and is replaced by new material and air entering the elbow. This ensures that when material flow to the system is stopped, an air-purge cycle will clear the chamber of material.

"In a standard sweep elbow, the solid material impacts the elbow's outer radius as it's conveyed through the elbow," says Dave Hunter, HammerTek's general manager. "As the material exits the sweep elbow, it stays to the outside and isn't evenly dispersed until much further down the line. With our elbow, the vortice chamber's material deflection zone disperses the material more evenly as it exits the elbow, returning the material to an equilibrium conveying profile much sooner than a conventional elbow."

Trouble-free pebble lime conveying

Since installing the elbows, the UOSA water reclamation plant hasn't experienced any type of elbow failure. "We haven't had any blowouts or leaks from the time we initially installed the elbows — that's five years for the first ones, and four years for the second ones," says Forgione. "The elbows have eliminated conveying line downtime, which has helped improve the plant's operational efficiency."

The elbows have also reduced the labor and maintenance costs associated with housekeeping and replacing and repairing elbows and other plant equipment. "The maintenance staff and operators are now able to spend their time working elsewhere in the plant performing other tasks," says Forgione. "And since we're lean on manpower, any labor or time savings is a real benefit."

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According to Forgione, improving staff safety and health was the main impetus for putting the elbows in the plant's conveying lines. "The operators no longer have to wear respiratory-protection equipment due to elbow leaks spewing fugitive dust into the air," he says. "We also no longer have lime pebbles or dust accumulating on the buildings' floors, so the operators don't have to worry about slipping or falling. Additionally, with the supplier's smaller wear-resistant elbows, the mechanics don't have to regularly climb up tall ladders with heavy and awkward long-radius sweep elbows."

"Once we found the elbows, the delivery and the installation were fast, and our experience with the supplier has been excellent," say Forgione. "To install the elbows, we simply extended the existing piping where we needed to and the elbows fit right into place; it was very easy to do." **PBE**

Note: To find other articles on this topic, look under "Pneumatic conveying" in *Powder and Bulk Engineering*'s Article Index at www.powderbulk.com or in the December 2007 issue.

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