Case history

Material-feeding solution is crystal clear

A luxury lead crystal manufacturer installs several vibratory loss-in-weight mass flow hoppers in a new automated production line to help maintain the quality of its crystal products.

Steuben, a division of Corning, both of Corning, N.Y., manufactures fine lead crystal products. For the past 15 years, the various dry ingredients used to make the lead crystal were weighed, mixed, and batched offsite at a nearby Corning facility and then shipped to the Steuben facility for processing. However, because the production line's equipment was starting to age and the facility's space was needed for other projects, Corning decided to remove the production line from its facility and build a new automated production line in the Steuben facility. To ensure that the lead crystal production's high quality standards were maintained, Corning placed Steuben in charge of designing and building the new production line.

To preserve its quality control standards, the new Steuben production line would need several automated batch-feeding stations to consistently and accurately feed the dry ingredients to the process while avoiding contamination. Each batch-feeding station would have to be compact enough to fit in the facility's limited space and large enough to hold one weekend's worth of material to keep the production line operating through the weekend without having to fill the hoppers.

Searching for batch-feeding equipment

In October 2000, Steuben began planning and designing its new production line. Based on previous work with AccuRate, Whitewater, Wisc., a feeding and batching systems supplier and manufacturer, Corning's corporate engineering group recommended that Steuben contact the supplier for batch-feeding equipment. In February 2001, Steuben contacted the supplier, and, after evaluating Steuben's needs, the supplier recommended that each batch-feeding station consist of a bag dump station and a loss-in-weight mass-flow hopper with a vibratory feeder.

The bag dump stations are connected to the hopper's tops, allowing installation in areas with limited space.

Steuben sent samples of each dry ingredient used in the lead crystal production to the supplier's test lab for analysis. Based on each material's characteristics, the supplier established each material's hopper size, wall slope needed to create mass flow, and vibration frequency and duration needed to accurately feed the correct material amount to the process. The supplier then sent the analysis results to the company for approval.

The company decided to purchase the supplier's equipment. "We went with AccuRate's SolidsFlow product line because the analysis results and design recommendations showed us that the batch-feeding equipment successfully met all our requirements concerning quality control and production capacities," says Arlene McMahon, Steuben plant manufacturing engineer.

Batch-feeding equipment and installation

The supplier designed, manufactured, and delivered six manual bag dump stations and 10 vibratory loss-in-weight mass-flow hoppers, as well as one bulk bag discharger and one bench scale to hand-weigh small ingredient amounts. The supplier manufactured three different-sized hoppers for the facility: five 3-cubic-foot-capacity hoppers, three 6-cubic-foot-capacity hoppers, and two 10-cubic-foot-capacity hoppers. The hoppers create mass flow without tunneling, ratholing, or bridging and hold one weekend's worth of material. The supplier sprayed a type of polyethylene on the inside of each hopper to help prevent the material from abrading the hopper's sides and creating a contamination problem.

All five 3-cubic-foot hoppers and one of the 10-cubic-foot hoppers are connected to bag dump stations. Each bag dump station is connected to the hopper's top, which minimizes the vertical distance between the two components and allows the equipment to be installed in areas with height constraints. The materials fed into these hoppers arrive at the facility in 50-pound bags. To add a material, an operator lifts the bag dump station's lid and manually dumps the material into the hopper. A screen in each bag dump station prevents large lumps and debris from entering the hopper.

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An operator manually adds material to the bag dump station, maintaining the material level in the hopper.

One of the 6-cubic-foot hoppers is connected to an existing automatic drum dump station. The material fed into this hopper arrives at the facility in 600-pound drums. To add the material, an operator simply places the drum in the drum dump station, removes the drum's lid, and presses a button. This hopper, too, has a screen that prevents large lumps and debris from entering the hopper.

The other two 6-cubic-foot hoppers are connected to the bulk bag discharger via an existing pocket conveyor and diverter. The material fed into these hoppers arrives at the facility in 100-pound bags and 2,500-pound bulk bags. An operator manually feeds the 100-pound bags directly into the pocket conveyor, while a dedicated hoist places the 2,500-pound bulk bags in the discharger, which discharges the material to the pocket conveyor. The pocket conveyor carries the material to the diverter and, depending on the material, diverts it to the appropriate hopper.

The remaining 10-cubic-foot hopper receives cullet from an existing automatic cullet tilt table. Cullet is glass produced by the facility that isn't made into a product. The facility recycles the cullet and adds it back into the process where it's melted down with the other dry ingredients in a melting tank. Because the cullet is so abrasive, the company added a ¼-inch-thick abrasion-resistant liner after taking possession of the hopper to protect the hopper and guard against contamination.

The bench scale is located on a table near the end of a vibratory tray-type collecting conveyor that carries all of the dry ingredients to the melting tank. Operators use the scale to hand-weigh small material amounts for addition into the process. An operator places an empty container on the scale, tares the scale, fills the container with the appropriate material, weighs it, and then adds it to the process.

Five of the hoppers are suspended by load cells and the other five are mounted on load cells. To ensure accurate feeding, the load cells are mounted on isolation pads and their electronics are configured to dampen any external noise or vibration from a hopper's vibratory feeder or other equipment in the production line. The load cells register each hopper's weight and send the information to a PLC and central computer.

The entire production line is connected to the PLC and central computer. Because the hoppers are designed as loss-in-weight feeders, the PLC monitors and controls the material amount each hopper discharges. The PLC also tells an operator when a hopper is near empty so the operator can add more material. The supplier didn't install or program the PLC, but it did supply 10 digital indicators connected to the hoppers' load cells. An indicator located at each hopper provides an operator with the hopper's current weight.

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To facilitate material discharge, each hopper has an eccentric-style vibrating feeder with a variable-frequency drive attached at its bottom. The variable-frequency drive has a range from 0 to 60 hertz. The material feedrate depends on the feeder's vibration frequency; the higher the frequency, the faster the feedrate. The hoppers have no moving internal components because the steep hopper walls allow material to easily slide down them, and the large hopper opening prevents bridging while allowing gravity to draw material in a mass flow feed pattern. This feature prevents contamination resulting from metal-on-metal or material-on-metal contact that can often occur in hoppers that use moving parts, such as screw feeders and rotary feeders, to facilitate material discharge. The hoppers discharge the material through a short offset discharge tube onto the collecting conveyor. A magnet at the end of the collecting conveyor catches any metallic contaminants that may fall onto the conveyor before the dry ingredients are processed.

A vibratory feeder attached to the hopper's bottom induces material discharge.

The PLC is programmed to discharge the hoppers in sequential order and to operate the feeders using the bulk-trickle feed method. This means that the hoppers feed 90 percent of the material at a fast rate and the remaining 10 percent at a slow, constant rate, ensuring a consistent material shut-off and accurate material feeding. Because the hoppers and feeders are connected to the PLC, if the material amount a hopper feeds is outside the specified parameters, the PLC will stop the production line until an operator acknowledges that the overweighment or underweighment is acceptable. If an underweighment occurs, the operator can restart the production line and use the bench scale to hand-add the remaining material.

When a feeder is turned off, the material's natural angle of repose and the feeder's baffle system stop the material flow. The baffle system consists of a series of stationary slats positioned in the feed tray that help control the material flow. The feeders contain no mechanical devices, such as pinch valves or iris valves, to stop the material flow.

Level indicators in each hopper detect the material level and send a signal to the PLC, stopping the production line if the material drops below the appropriate level. "If a hopper becomes completely empty, we have to add the material slowly to fill the baffle section first, creating a plug so we can continue filling the hopper without having to worry about material flowing out," says McMahon. "This takes time, so we maintain a certain level of material in the hopper at all times."

Accurate feeding without contamination

Steuben hired a construction company to install the production line's equipment in its facility. After the feeding equipment was installed, the company's engineers only had to fine-tune each feeder's vibration frequency and duration to match the material that each feeds. By the end of September 2001, the production line was up and running.

"Since we installed the new equipment, we've run the production line twenty-four hours a day, seven days a week, and the equipment has performed very well," says McMahon. "The equipment has consistently given us the precise weighments that we need, and we haven't had any contamination, breakdown, or maintenance issues."

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According to McMahon, the production line is easy to monitor and recalibrate because everything can be done through the PLC and central computer. "We're also very pleased with the equipment's expandability and flexibility," says McMahon. "We can add two more hoppers to the production line in the future if we ever want to add another material or use two different manufacturers of the same material. And the equipment is very easy for our engineers to maintain."

The supplier provides maintenance services for all of its equipment, but the company didn't need it because its own engineers and maintenance staff are capable of recalibrating and maintaining the equipment. "We're scheduled to take down the production line during our upcoming plant shutdown to inspect and recalibrate the scales and feeders," says McMahon. "That will be the first time since we installed the equipment that we'll do that. And the only reason we're doing it is because we have the opportunity, not because we have an issue with any of the equipment." **PBE**

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