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APPLICATION REPORT FEEDING POLYMER INGREDIENTS

Loss-in-weight feeders produce only gains

A company installs several load-cell-based loss-in-weight feeders to automate its ingredient feeding process and eliminate problems caused by manually handling and feeding the ingredients.

PolyOne Corp., headquartered in Avon Lake, Ohio, is a worldwide polymer services company that produces and supplies polymers, elastomers, colorants, and additives for various products. The company's plastic compounds and colors group operates a facility in Vonore, TN., that produces color concentrates used by other industries to color plastic products. The company recently upgraded the Vonore plant's processing lines and automated the ingredient-feeding process to eliminate problems caused by operators having to manually handle and feed the various ingredients.

Making a color concentrate

In the past, to make the various color concentrates at the Vonore plant, the company operated several processing lines that each used a batch mixer and a continuous single-screw extruder. Many of the ingredients arrived at the plant in bags, which the company stored on the plant's ground level. To prepare a batch for one mixer, an operator had to manually open the bags and preweigh and premix the ingredients in small containers, using a scale on the ground level. For most ingredients, the operator forklifted the containers up onto a mezzanine built around the mixers and manually dumped the contents into a dedicated hopper above the mixer's inlet. The other ingredients were conveyed into the hopper.

The operator discharged the hopper's contents into the mixer, which mixed and melted the ingredients. The molten material discharged from the mixer to the extruder and was extruded as strands. The strands were cooled and cut before being packaged and shipped to customers. The company operates the plant's processing lines 24 hours a day, 7 days a week.

The feeder's controller monitors the hopper's load cells to ensure a continuous and accurate feedrate to the twin-screw extruder.

Solving an ingredient feeding problem

The company experienced several problems manually handling the ingredients: It was difficult to maintain the finished product's consistency because manually weighing the ingredients was not 100 percent accurate. This sometimes led to an ingredient's weighment being outside the acceptable accuracy range. Also, manually opening and emptying ingredient bags, dumping the ingredients into the small containers and hoppers created fugitive dust that decreased the plant's cleanliness. Manually handling the bags and small containers created ergonomic issues for the operators. Additionally, the company experienced inefficient production rates because the dry ingredients in the hopper couldn't be

discharged to the mixer until the mixer had completely discharged the molten material to the extruder.

To maintain its market competitiveness, the company decided to redesign and upgrade the Vonore plant's processing lines by eliminating the batch mixers and single-screw extruders and installing several continuous twin-screw extruders, which mix, melt, and extrude the ingredients in one continuous process. As part of the plant upgrade, the company also decided to fully automate the ingredient-feeding process to eliminate the problems caused by manually handling the ingredients.

The feeder is connected to a graphical interface and recipe management system that allows an operator to set the feeder parameters and monitor its operation from one central location.

During its search for automated feeding equipment, the company contacted several feeder suppliers and traveled to three suppliers' test labs for material tests. "We gave each supplier our toughest-flowing materials for use in feeder tests that focused on a feeder's feeding accuracy over time," said a plant engineer at the Vonore plant. "To help us nail down the accuracy of each feeder, the tests were computerized, and all of the test data was collected so we could do statistical process control testing and charting."

Of the three suppliers, two manufactured feeders that were able to feed the material at the accuracies the company required. Because of this, the plant engineer said, "We decided to evaluate the feeders on other issues, such as the feeder's overall design and how the operators and maintenance crew would interface with them. We also looked at the components of each feeder and how well they would function over time in our manufacturing environment."

After further evaluation of the two competing feeders, the company decided to purchase 14 MechaTron® continuous loss-in-weight (LIW) single-screw feeders with DISOCONT® (LIW) controllers and a group manager graphical interface and recipe management system from Schenck Process, Whitewater, Wis. The supplier manufactures volumetric and gravimetric feeding systems, multiple-ingredient batching systems, weighfeeders, flow meters, bulk bag discharging systems, and vibratory feeders.

Installing the LIW feeders

The MechaTron® feeder is constructed of Type 304 stainless steel and has a Coni-Flex flexible vinyl hopper with an external paddle agitator that continuously massages the hopper's outer wall to promote material flow. The feeder can gravimetrically feed material between 0.117 and 330 ft^3/h and is available with feed screws in eight different diameters and a range of flight arrangements to suit customers' applications. Feed screw lengths can be customized to meet specific installation requirements. The feeder is suspended from a set of load cells, which are connected to the feeder's controller. The controller is prewired and integrated into the feeder's frame.

During operation, an operator enters a feedrate setpoint into the controller and starts the feeder. As the material discharges from the feeder, the controller monitors the load cells and accurately keeps track of the weight-loss rate from the feeder. The controller compares the actual weight-loss rate to the feedrate setpoint and automatically adjusts the screw speed.

To ensure that there is a sufficient amount of material in the hopper when the feeder is operating, the operator enters a low and high refill setpoint into the controller. When the material weight reaches the low setpoint, the controller signals the material-delivery system to discharge material into the feeder. When the material weight reaches the high setpoint, the controller shuts down the material-delivery system. (The company's new material-delivery system consists of one surge hopper mounted above each feeder; the surge hoppers are fed ingredients pneumatically or directly from bulk bags.)

When the feeder goes into refill mode, the controller uses a dynamic refill compensation algorithm that automatically adjusts the screw speed to compensate for material changes that can occur during refills. For example, if during the

refill the material aerates in the feeder and its density decreases, the algorithm detects this change and the controller automatically increases the screw speed to feed more material. If the material in the feeder compresses during the refill, the controller decreases the screw speed to feed less material. This algorithm maintains an accurate feedrate at all times.

The feeder can be completely disassembled in place between product runs and its internal components accessed from the non-process side. This allows the operator to simply and quickly change the feed screw or hopper, clean the feeder, or perform any required maintenance. The feed screw motor is mounted on a pivot and easily swings up and out of the way, allowing access to the internal components. Releasing a 360-degree band clamp allows the operator to easily remove the hopper. Additionally, process connections between the feeder inlet and the material-delivery system or between the feeder discharge and the extruder remain in place when an operator disassembles the feeder.

The supplier connected the feeders in the Vonore plant to the group manager, which allows the company to set the feedrate and hopper setpoints, manage recipes, and monitor process trending from one central location. At this time, the control station isn't programmed to print reports about the feeders' operation. "However, we're working with the supplier to connect the feeders to the central computer interface we use for our systems," said the plant manager of the Vonore plant. "The feeders have networking capabilities, and we're in the process of developing them."

Experiencing the gains

Since upgrading the processing lines and automating the ingredient-feeding process with the feeders, the company has eliminated all of the problems caused by manually handling and feeding ingredients. "Because the operators no longer manually handle the ingredients, we've improved the product consistency and plant cleanliness and eliminated the ergonomic issues," said the plant engineer. "We've also increased our production efficiencies, because the feeders continuously feed ingredients to the twin-screw extruders — there's no batching involved anymore."

And even though the feeders are all the same model, "We can use the same feeder to discharge different ingredients at different rates by inserting a feed screw with a different diameter and flight arrangement."

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7901 NW 107th Terrace
Kansas City, MO 64153
816-891-9300
americas@schenckprocess.com
www.schenckprocess.com/us