Test center

Company's test lab experience is classified A-OK

An equipment manufacturer's test lab and toll processing center help a company choose classification and size reduction equipment for its additive production.

Prater-Sterling, Bolingbrook, Ill., manufacturers industrial processing equipment, including fine grinders, air classifiers, hammermills, mixers, airlocks, and systems and controls for use in various industries. The supplier also operates a 10,500-square-foot test lab and toll processing center. The test lab enables bulk solids handling and processing companies to perform particle analysis and equipment tests on their materials under actual operating conditions. Recently, a company that produces pulp and paper products used the lab to test equipment for classifying and size-reducing a mineral additive used in paper products.

Processing the mineral exposes equipment problems

The pulp and paper company had been using a classification and size reduction system that required two preclassification stages, one final classification stage, and one size reduction stage to make the mineral additive. The company first fed the original feed material into a classifier that removed particles of silica, metal, and other contaminants with different bulk densities than the mineral. The resulting material was transferred to a second classifier that removed particles larger than 100 microns. The material that discharged from this classifier was transferred to a third classifier where particles smaller than 16 microns were removed from the feedstream and collected for use in the paper products. Particles larger than 16 microns were routed to a size reduction mill. After the appropriate residence time, the size-reduced material discharged from the mill and rejoined the feedstream entering the third classifier for final classification or rerouting back to the mill.

After about 12 months of production, the company found that it was spending more time fixing and maintaining the system than using it. The original equipment manufacturer tried to the solve the problems, but was unsuccessful. So, as downtime and maintenance costs continued to add up with no end in sight, the company decided

In another area of the test lab, the supplier conducts equipment tests for another customer using a classifying mill (front right), a cyclone separator (back right), and a dust collector (left).

to cut its losses, return the equipment to the manufacturer, and look for a different system.

Looking for a new equipment supplier

The company went to a manufacturers' rep it had worked with in the past and directed the rep to conduct a search for a new equipment supplier. In spring 2006, the rep contacted Prater-Sterling and talked to a sales engineer about the company's application. The sales engineer was confident that Prater-Sterling's equipment could handle the application, so he had the company send several 1-pound samples of both the original feed material and finished product to the test lab for material characteristic and particle size analyses.

After analyzing the samples, the test lab engineer concluded that the contaminants and mineral particles larger than 100 microns could be removed from the feed material in one step, rather than the previously required two steps. The test lab engineer then designed a two-stage classification and grinding system to process the material, and the sales engineer proposed the concept to the company.

With some initial skepticism, the company sent a 5,000-pound bulk bag of feed material to the supplier so that the test lab could test and prove the recommended system. On testing day a few weeks later, the company sent an engineering team to witness the tests.

Visiting the test lab for equipment tests

The test lab engineer set up the classification and size reduction system as if it were in the company's facility, using scalable lab-size equipment to demonstrate the system under continuous operating conditions. The test lab engineer also incorporated several sampling ports at critical points throughout the system so that samples could be taken during operation and tested with a laser particle analyzer.

During the tests, the feed material discharged from the bulk bag via a rotary airlock into a vacuum transfer line that moved it to the supplier's MAC-0 forced-vortex air classifier, which removed the contaminants and particles larger than 100 microns from the feedstream. Particles smaller than 100 microns discharged from the classifier and were pulled to a dust

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During the time the full-scale production equipment was being manufactured, the supplier's toll processing center processed more than 2.4 million pounds of on-spec product for the pulp and paper company.

collector, where they accumulated in the collector's bottom hopper. The material discharged from the dust collector's hopper via a rotary airlock into another transfer line that moved it to the supplier's MAC-1 forced-vortex air classifier. Particles smaller than 16 microns discharged from the classifier to a second dust collector, and this on-spec material then discharged from the dust collector via a rotary airlock into a bulk bag.

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Particles larger than 16 microns were separated from the feedstream and routed to the supplier's M51 fine grinder impact mill, which uses high-speed rotor-on-particle and particle-on-particle impacts to reduce material. (The pulp and paper company's friable mineral has a Mohs hardness of 2.5 and can be size-reduced by impaction.) After passing through the mill, the particles rejoined the feedstream entering the MAC-1 air classifier, where they either discharged to the dust collector as on-spec material or were routed back to the fine grinder for more size reduction.

Throughout the testing, test lab engineers retrieved material samples from the various sampling ports to ensure that the system was processing the material properly. At day's end, the pulp and paper company's engineering team was pleased to find that the particle analysis tests proved the supplier's equipment capable of properly classifying and size-reducing the mineral to meet its requirements. After reviewing the equipment test data, the test lab engineers scaled up the results and provided the engineering team with a cost estimate for a system with full-scale production equipment.

Toll processing the material

Several weeks later, after reviewing the test data, the company called the supplier and ordered a full-scale classification and size-reduction system for its facility. The company also ordered batch weigh hoppers, bucket elevators, and other equipment to handle the material before and after the classification and size-reduction system. The supplier needed time to manufacture the equipment and install and start up the system, but the company needed the system for immediate production, so the supplier proposed processing the material in its toll processing center in the interim, using a pilot-scale production system.

The company agreed, and the supplier began processing the material for the company in late spring 2006, using the same equipment that it had used for the tests.

For 8 months the supplier processed the material, producing more than 2.4 million pounds of on-spec product. "The feed material arrived in bulk bags, and we used the same process that we used for the tests," says Pat Campbell, technical services manager of the supplier's test lab. "To ensure the final product's quality, we'd take more than six samples a day and analyze each sample's particle size range. I'd then issue a certificate of analysis for each outgoing shipment."

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The full-scale classification and size reduction system

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A central control panel in the test lab monitors and controls the equipment operation during testing and toll processing.

full-scale production system, and it's been operating since. The system includes a MAC-4 forced-vortex air classifier, a MAC-5 forced-vortex air classifier, and a M101 fine grinder impact mill. The system setup is similar to that used for the tests: The feed material moves from the MAC-4 classifier to the MAC-5 classifier and is then either collected in the dust collector as on-spec product or is routed to the fine grinder for milling.

The MAC-4 classifier uses a maximum of 10,000 cfm of air and can handle 4 tons of material per hour. The MAC-5 classifier uses a maximum of 15,000 cfm of air and, for this application, handles about 10 percent less material than 4 t/h because the material is contaminant-free. Each classifier separates particles from a feedstream using the opposing principles of centrifugal and aerodynamic drag force. As the particles enter the classifier through its primary air inlet, the conveying air subjects them to aerodynamic drag forces, which vary depending on the size and density of each particle. As a particle spirals toward the classifier's rotating rotor, either the drag force exceeds the centrifugal force created by the rotor and the particle passes through the classifier as an on-spec particle, or the centrifugal force overcomes the drag force, causing the particle to accelerate away from the rotor and fall by gravity into a cyclonic chamber where

it's collected and discharged with the other oversize particles. The classifier's cut point, which occurs when both forces are equal and onsize particles have a 50 percent chance of passing as fines, is variable and can be controlled by adjusting the rotor speed.

The 250-horsepower fine grinder uses a maximum of 6,000 cfm of air and can reduce dry, free-flowing material as fine as 75 microns down to just a few microns with a tight particle size distribution. Material is metered into the center of the mill's grinding chamber where the particles are impacted by the mill's moving rotor and thrown outward, impacting other particles. After the initial impact, the particles are projected across a stationary sizing screen and sheared between the rotor's blades and the screen. This action continues until the particles are properly sized and can pass through the screen and discharge through the mill's bottom. For the company's application, the mill's screens have fairly large holes to prevent blinding, so one trip through the mill doesn't necessarily reduce all of the particles to the right size range.

The company is happy with the equipment, says Campbell: "I've talked with them a couple of times since we started up the system and they haven't had any problems." **PBE**

Note: To find other articles on this topic, look under "Size reduction" and "Screening and classifying" in *Powder and Bulk Engineering*'s Article Index at www.powderbulk.com or in the December 2006 issue.

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