Controlling classifier cut points brings more customers

An iron oxide producer installed an air classifier to gain finer particles — as well as its newest and largest customer.

by Craig Miller

Trouble-free, maintenance-free operation is a plant manager's dream — a dream that rarely comes true. "The biggest issue I've seen concerning new equipment for companies handling bulk materials like we do is maintenance. How long will the equipment hold up before you have to repair, replace, or rework what you have?" asks Darryl Mayton, director of operations at Prince Manufacturing Co., Quincy, Ill.

But when Prince installed an air classifier 6 years ago in order to meet the product demands of a large, potential customer, Mayton found that the new classifier's reliability exceeded his dreams.

Iron oxide producer Prince Manufacturing Co. installed an air classifier on its process line to bring in new business.

Established in 1858, Prince is one of the largest US producers of red and black iron oxides. The company also produces other minerals, including manganese dioxide and zinc oxide. In addition to the company's plant in Quincy, Prince has production facilities in Bowmanstown, Pa., Phoenix City, Ala., Marion, Iowa, and Breman, Ind.

Prince sells the oxides in bulk primarily to the pigmenting industry, but also to the brick and foundry industries. "We're a little bit more diverse than just grinding minerals," says Mayton. "We have another part of our company, Prince AgriProducts, that also does trace mineral premixes."

Raw minerals arrive at the plant via barge, railcar, or truck for eventual grinding to customer specifications. Each mineral moves through the plant on a variety of conveyors, elevators, and loaders. To remove the material's 2 to 5 percent initial moisture content, the mineral first goes through three drying circuits that use natural gas

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The MS-20 Micro-Sizer air classifier (here covered with red iron oxide dust) can handle up to 20 t/h of material, as well as produce cuts as fine as 100 percent less than 10 microns on most materials.

rotary dryers. Next the mineral goes to one of three roller mill circuits, where it's crushed to a variety of sizes before packaging in 50-pound bags or 2,000- or 3,000-pound bulk bags.

Sizing to spec

According to Mayton, the problem was that "we could only control what we got off the mill as far as top size." At the Quincy and Bowmanstown plants, Prince was unable to produce a sharp cut with clean top-size control while maintaining efficiency and the overall curve distribution. This resulted in poor product quality, material waste, and a higher production cost per ton for each product. The company needed a means of sizing a variety of materials with different product specifications.

"When you look at the particle size distribution throughout the mill's product," Mayton says, "you'll have certain fractions, say, one at less than 10 microns, one at less than 20 microns, and one at 45 microns — there's a very wide distribution of what comes off the mill."

When a customer in the coatings industry required a finer mean particle size, Prince knew it needed to find a solution to the sizing problem. "This customer, in particular, wanted a fine fraction with a two-micron mean — basically 100 percent of the product at less than 20 microns," says Mayton. In order to get the new business, Prince went in search of an air classifier.

Taking a test run

Prince considered air classifiers from various manufacturers, but finally concluded they were too complex or too slow, were unable to separate the necessary particle sizes, or had a combination of these disadvantages.

At the 1993 Powder & Bulk Solids Exhibition in Chicago the company met representatives from Progressive Industries, Sylacauga, Ala. Mayton and his team later visited Progressive's production-scale grinding and classifying testing facility. Here, two to three truckloads of material from the Quincy plant were milled and then separated by two air classifiers — one small and one large.

"They ran some of our red iron oxide for us and basically guaranteed that if we scaled up to the bigger unit the product would meet the criteria," says Mayton.

But Prince wasn't taking any chances. "We took that iron oxide product to a customer, who said that it looked good and that they'd be willing to buy it," he reports. "Then we installed Progressive's equipment with their guarantee that if it didn't work they'd take it out and pay us for our trouble."

Mayton doesn't expect trouble with the unit, however. "The equipment is very simple mechanically; not a whole lot can go wrong with it. We had been concerned that the other equipment we considered would have maintenance issues."

"The classifier's cut point can be precisely controlled by increasing or decreasing the rotary rejector's rotational speed."

He says that since 1994 "we went back to the testing facility several times. Over the course of the last five years, we've probably run a dozen or more test pilot runs with them." Prince personnel who have visited Progressive's testing facility include the director of new business development, the vice president, the general manager, and some laboratory staff.

After the testing, Prince selected the larger of the models that had been used in the tests — the MS-20 Micro-Sizer air classifier. This unit can handle up to 20 t/h of throughput, as well as produce cuts as fine as 100 percent less than 10 microns on most materials.

Prince had been looking for an air classifier that would produce 100 percent -20 microns in their fine fraction, which is their finished product. The air classifier also would have to process 4 t/h. Finally, Prince wanted a system that would give them superior sharpness of cut, which indicates what percentage of particles overlap between the fine and coarse fraction. With a sharp cut, for instance, a lower percentage of wrong-sized particles remain in each fraction.

Thirty-five percent of the material Prince feeds into the air classifier is at the 20-micron cut point. The air classifier is able to separate out 74 percent of the -20 micron particles from the feed material, producing a 100 percent -20-micron finished product.

The MS-20 air classifier was installed at the Quincy plant in 1994, and another was installed at the Bowmanstown plant in 1995. Mayton says of the installations, "They really went together very quickly. Again, the equipment is pretty simple. We have our own maintenance group that does installations for us, and basically we had the sections, drawings, and engineering done to put them together."

Progressive sent representatives to facilitate the installations and startups. They also showed Prince how to test the product, how to measure final particle size distribution, and how to run the air classifier to ensure that the final product meets specification.

Classifier in action

The MS-20 air classifier is a centrifugal air classifying system with a main classifying chamber that has a vertical-blade rotary rejector for separating coarse and fine particles. A fan blows air into an expansion chamber below the main chamber to suspend particles for classifying. A cyclone drawing fine particles from the main chamber also has an expansion chamber. Catch hoppers are located at the bottom of both the main chamber and the cyclone.

As ground red iron oxide from the roller mill feeds into the air classi-

fier's main chamber, it's accelerated by the mechanically driven rejector's rotor blades. The rotor allows high air and particle acceleration, resulting in high centrifugal spin. The spin creates a vortex that in turn allows particle separation at very fine cut points. Air from an external fan assists in particle dispersion and suspension.

The coarse particles move in an outward direction from the rotor. As they move to the outer edge of the vortex, their peripheral velocity decreases and gravity overcomes their centrifugal and drag forces. At this point the coarse particles drop out of the airstream into the expansion chamber and then flow into a catch hopper below the expansion chamber's discharge.

The fine particles, because of their lower mass, are affected more by the airstream's drag force, which is greater than the centrifugal force on the particles. So the fine particles are swept out of the main classifying chamber by the airstream, which suspends the particles. They then move up through the rotary rejector and out of the chamber.

After leaving the main chamber, fine particles travel through a duct to the cyclone where they drop into another expansion chamber and catch hopper. Meanwhile, the clean air flows upward into a return duct and back to the classifier's external fan. The closed classifier and cyclone system doesn't require a dust collector.

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Both the coarse and fine products leave their respective catch hoppers via rotary valve airlocks, at which point the material is ready for packaging.

The airflow introduced into the classifier by the external fan must be balanced with the solids loading to achieve the optimum air-to-solids ratio. These two process variables — airflow and solids loading — will be different for each material, depending on its specific gravity, particle shape, and particle surface area. Once these variables are determined, the classifier's cut point can be precisely controlled by increasing or decreasing the rotary rejector's rotational speed.

The air classifier features a patented Micro-Seal located above the rejector's rotor. The seal consists of a primary seal and a secondary safety seal between the rotor's positive-pressure and negative-pressure sides. In addition to ensuring accurate cut sharpness, the seal allows for lower particle velocities within the classifier, which results in less wear and less required horsepower per ton.

New products, new markets

Before 1994 Prince hadn't used an air classifier in its iron oxide process line. With the new air classifier's ability to make a sharp, precise cut at high feedrates and efficiencies, the company gained products that it couldn't produce previously.

"A percentage of the feed product going to the air classifier will be acceptable for the fine-sized criteria," says Mayton. Material that isn't fine enough is marketed as a dedusted product. "It has fewer fines in it, so it dusts less than our conventional product. We've been able to balance our production so that we don't really have to rework either product. We're generating enough fine product for that customer base, and at the same time, we have enough sales outlets for the dedusted product. We take both fractions of the product and are able to sell them."

The dedusted iron oxide was intended for the company's existing customers, who had requested coarser, less dusty product. Mayton notes, however, that the dedusted product has resulted in new customers as well.

By separating the fine and dedusted products, Mayton says, "The classifier has opened up additional markets to us." He says that the new customer who started buying from Prince only after the air classifier's installation has become Prince's largest in terms of sales volume over the last 6 years.

In May 1999 Prince installed another smaller Progressive air classifier, the MS-10 Micro-Sizer, to perform toll processing for customers on a range of materials.

Of the Quincy plant's three process lines, only the red iron oxide line currently features an MS-20 air classifier. Mayton says that there are plans, however, to add the units to the black iron oxide process lines as well.

The company also has ordered an RMC-50 Micro-Sizer air classifier that will be installed at Bowmanstown. The unit is an airswept mill retrofit that will allow the company to make finer products at increased production rates with their mill.

No downtime

Mayton says he is extremely satisfied with the MS-20 air classifier's ability to handle the red iron oxide — a highly abrasive material. "I can truly say that in five years with the Progressive equipment, we have not experienced one minute of downtime. We have not changed one set of blades — the internal part of the classifier that makes the cut — after running thousands of tons of product." He estimates the Quincy plant's throughput at about 10,000 to 20,000 t/y.

Mayton adds, "The biggest question for me on the operation side is What's the equipment going to cost me to run, long-term? Once we've bought it and installed it, what will be the cost of maintaining it? And that's another item that brings us back to the Progressive equipment time and time again. There's really no cost to maintaining it."

In fact, if he had the project to do again, Mayton says he would have installed more air classifiers faster. "When we installed the first one, it was a very big step for Prince. The fact that it went in successfully and operated well — and we were able to meet our customers' demands and actually grow our customer base — all added up to a very successful situation. We probably shouldn't have been as nervous and tentative about it at the beginning. Given what we know now, we probably would have put the second one in earlier, as well as the third one, the fourth, fifth, and so on.

"Progressive will look at the curves, run the samples, and help us with whatever we need to do," he continues. "So their cooperation with us has been tremendous. That's what has really made the relationship — their commitment to a good piece of equipment and their dedication to serving us as a customer." **PBE**

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