Case history

Air-classifying impact mill reduces processing costs

To reduce processing costs, a specialty chemicals company installs an air-classifying impact mill in one of its plants to consolidate production operations.

International Specialty Products (ISP), headquartered in Wayne, N.J., operates several national and international plants that produce various products for the pharmaceutical, chemical, healthcare, personal care, and coatings and polymer industries. The company's ISP Freetown Fine Chemicals plant, located in Assonet, Mass., was using a jet mill at another facility to size-reduce and classify two of its products because the plant's existing size reduction equipment couldn't handle the products' particle size requirements or necessary production capacities. Using the other facility added significantly to the products' overall production costs, so in 2002 the company started to look for a new system for the Freetown plant.

Making the products

The company's Freetown plant produces various products that are used by other companies to make a range of consumer products. One product, an additive for stabilizing and clarifying various beverages, arrives at the plant as a hygroscopic, free-flowing powder. The plant reduces it to a finer powder with a 10- to 15-micron particle size range. Another product, a thickener for various personal care and pharmaceutical products, arrives at the plant as a nonhygroscopic powder. The plant puts the powder through a post-treatment process that turns it into large granules that require size reduction to form two different thickener grades — one with a 50- to 75-micron particle size range and the other with a 5- to 20-micron particle size range.

"In the past, we used a standard mechanical hammermill to size-reduce a portion of the larger thickener grade," says Fran Minnock, manager of process engineering and development at the Freetown plant. "However, since the hammermill had a limited production capacity and size reduction capability, we had to ship a portion of the coarser thickener grade and all of the beverage additive to another facility for size reduction so we could maintain our production quotas. Also, because the hammermill couldn't reduce the thickener down to the particle size required for the finer thickener grade, we had to have the other facility produce all of

The air-classifying impact mill can reliably reduce dry friable powders with a Mohs hardness rating up to 3.5 down to a range of 5 to 100 microns.

that product for us. Over time, we realized how substantial the processing and material shipping and handling costs were to our bottom line, so we decided to look for a way to eliminate them."

Searching for a way to reduce processing costs

After gaining company approval, Minnock began searching for a system that would allow the plant to bring the size reduction operation in-house. "In the past, I've worked with both air-classifying impact mill and jet mill systems," says Minnock. "Jet mills are very expensive to install because they require a costly high-pressure, high-volume air source and other equipment. So I decided to focus on air-classifying impact mills, which cost considerably less to install and operate. I've previously worked with two air-classifying impact mill suppliers, and each one makes good equipment. But because I had more direct experience working with one of the suppliers, I decided to contact them."

In early 2003, Minnock contacted Sturtevant Inc., Hanover, Mass., a

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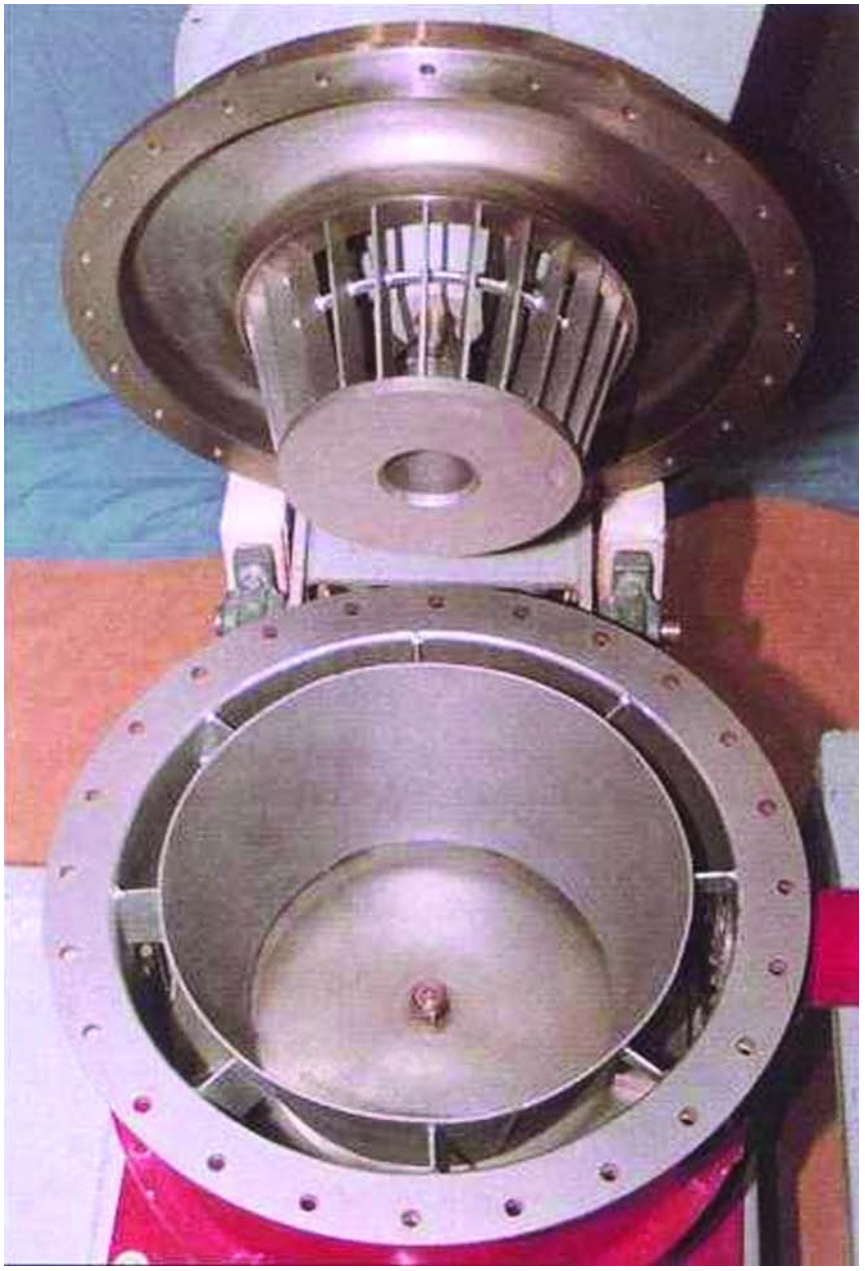

The mill's classifier section opens like a freezer lid, providing easy access for cleaning the classifier wheel and other internal components without having to completely disassemble the mill.

supplier of material process solutions, including size reduction and particle separation equipment and turnkey systems. Minnock talked with the supplier about the products' particle size and production rate requirements, and the supplier scheduled material tests. Minnock then sent several drums of each product to the supplier's test facility and, in spring 2003, traveled to the test facility to witness the tests.

After completing the tests, the supplier analyzed each sample with a laser particle size analyzer and provided Minnock with a report detailing the particle analysis results, the production rates, and the system's equipment specs and settings. Minnock also took the samples back with him so that the Freetown plant's lab could verify the results. Satisfied, Minnock requested a proposal for a turnkey size reduction system.

The turnkey system and air-classifying impact mill

ISP and Minnock reviewed the supplier's proposal and approved the plan. The supplier sent the turnkey system to the Freetown plant, and ISP's central engineering department installed it in early fall 2004. After installation, the supplier sent a technician to the plant for 1 day to oversee the system startup.

The turnkey size reduction system consists of a negative-pressure fan, a baghouse, an air-classifying impact mill, a feed hopper, two rotary airlock valves (one feed valve and one discharge valve), and various stainless steel piping and ductwork. The system includes equipment manufactured by the supplier as well as other equipment manufacturers.

When size-reducing a product, the plant first conveys it from a dryer into the system's feed hopper. The feed valve meters it from the feed hopper into the system, and the negative-pressure fan generates suction that pulls air and the product through the air-classifying impact mill and into the baghouse. The majority of the product's particles hit the baghouse filters and fall directly down into the baghouse hopper, while the air moves through the filters to the negative-pressure fan and exhausts outside the plant. Periodically, the baghouse reverse-air pulse cycle actuates to remove the particles that collect on the filters. After a large amount of product accumulates in the hopper, an operator activates the discharge valve and discharges it from the hopper into a drum.

The linchpin of the size reduction system is the supplier's model NSP-2 Powderizer stainless steel air-classifying impact mill, which reduces and classifies materials in one operation, producing a narrow particle size distribution. The mill can handle dry friable powders with a Mohs hardness rating up to 3.5, making it ideal for use in the chemical, pharmaceutical, food, and mineral industries. (The mill can be constructed with Tungsten and ceramic components to reduce wear when handling highly abrasive materials.) The mill can consistently and accurately reduce materials to between 5 and 100 microns. The largest initial particle size can be up to about ⅜ of an inch, and the final particles' fineness depends on the material's friability and required production rate.

The air-classifying impact mill is divided into three sections — the bottom air-inlet section, the middle impact zone, and the upper classifier section. The air-inlet section contains a large air inlet through which 80 percent of the air is pulled into the mill. This section also houses the impactor-wheel shaft-and-bearing assembly, which is connected to a variable-speed motor. The motor turns the shaft, which turns the impactor wheel located in the impact zone.

The impact zone has a smaller material feed inlet through which 20 percent of the air and all of the material are pulled into the mill. The impactor wheel consists of a round disc with impact blocks mounted on the outside circumference. The impactor wheel rotates within an impact liner ring, which is made of an abrasion-resistant material with a series of vertical grooves that help to further reduce the material. Material enters the impact zone just off center, and centripetal force throws the material out and into the blocks, which impact the material particles like hammers, smashing them apart. The impact liner ring can be flipped over so that it can be used twice, extending the liner ring's operating life and reducing replacement costs.

"The material feed inlet piping looks like an upside down T," says Steve Coulombe, Sturtevant sales engineer. "One pipe end connects to the mill, one pipe end faces up, and the other pipe end faces away from the mill and is open to the plant environment. An adjustable damper on the pipe end facing away from the mill controls the amount of air that goes into the mill through the feed inlet. A funnel is connected to the pipe end that faces up, and, to avoid material surges, we install a rotary airlock, screw feeder, or other material-metering device to consistently feed material into the funnel. Additionally, filters installed at each air inlet filter the outside air to eliminate contamination before it enters the mill."

The classifier section contains the classifier wheel, classifier-wheel shaft-and-bearing assembly, and an outlet through which all of the air and material are pulled to the baghouse. A variable-speed motor connected to the shaft-and-bearing assembly turns the shaft, which turns the classifier wheel. The classifier wheel resembles a rotating squirrel cage with blades and functions like a dynamic screen. The particles have to pass through the spaces between the classifier wheel's spinning blades to move from the impact zone to the outlet, so the faster the classifier wheel rotates, the smaller the particles must be to pass through, and vice versa. The particles that don't pass through the classifier wheel are circulated back into the impact zone for further size reduction. The mill doesn't generate a lot of heat during operation because it uses out-

side air to move material through it, making it ideal for use with temperature-sensitive materials.

The final particle size is determined by the system's various equipment settings, which can be controlled by a PLC or control panel or changed manually. For each product, the Freetown plant resets the system's equipment settings manually. "The system is easy to operate and the equipment settings are easy to change," says Minnock. "We always operate the impactor wheel at full speed. But depending on the product and required particle size, we reset the classifier-wheel speed, the negative-pressure-fan speed (which changes the airflow rate through the system), and the material feedrate coming into the mill. We established the equipment settings for each product during the material tests and verified them during startup to ensure that the system operates properly for each product."

The production rate for each product depends on the desired final particle size, because the finer the particle size, the more time it takes to reduce the particles. For the beverage additive, the size reduction system can produce about 600 lb/h at 10 to 15 microns. For the larger thickener grade, the system can produce more than 1,000 lb/h at 50 to 75 microns. And for the finer thickener grade, the system can produce about 600 lb/h at 10 microns.

The linchpin of the size reduction system is the air-classifying impact mill, which reduces and classifies materials in one operation, producing a narrow particle size distribution.

Because the company runs two different products through the size reduction system, the mill has to be easy to clean between production runs. "The mill's classifier section is mounted on hinges that allow an operator to open it like a freezer lid," says Coulombe. "This provides the operator access to the classifier wheel and other internal components without having to completely disassemble the mill. Also, all of the bearing lubrication is done externally, and the bearings are installed in cartridges that can be easily removed and replaced. Additionally, the mill doesn't have a screen that's constantly clogging and needing to be cleaned or replaced."

Since installing the size reduction system, the Freetown plant has reduced the products' overall production costs by eliminating all of the costs associated with shipping the products to and handling them at a different facility.

The size reduction system is completely enclosed, whereas the plant's previous hammermill wasn't. Minnock says, "The enclosure eliminates all potential outside contamination and has helped reduce cleanup time and costs because it prevents fugitive dust from escaping into the production area."

Additionally, because both products create potential dust-explosion hazards when reduced to small particle sizes, the supplier designed the size reduction system so that all of the equipment is grounded to prevent sparking. "We decided to install a completely grounded system because a closed-loop system that uses an inert gas was cost-prohibitive," says Minnock. "Also, the baghouse has an explosion-venting system; we use antistatic bags and baghouse filters; and we routinely perform continuity checks and other tests to ensure that the equipment is properly grounded."

Classifying the system a success

Since installing the size reduction system, the Freetown plant has reduced the products' overall production costs by eliminating all of the costs associated with shipping the products to and handling them at a different facility. "And for the particle size ranges that we need to achieve," says Minnock, "the supplier's air-classifying impact mill system is much more cost-effective than a jet mill system. The biggest selling points for us were the system's equipment and operating costs. And overall, the system uses less manpower than the previous hammermill did, so we also made the process less labor intensive." **PBE**

Note: To find other articles on this topic, look under "Size reduction" or "Screening and classifying" in *Powder and Bulk Engineering*'s Article Index at www.powderbulk.com or in the December 2005 issue.

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