

Toner tests mill, mix, and classify ingredients

Tests demonstrate equipment that can turn raw ingredients into finished toner.

Micron Powder Systems, Summit, N.J., manufactures and sells powder processing systems. To demonstrate more than 40 such systems, the company operates a 14,000-square-foot test center. Besides demonstrating individual pieces of equipment, the center helps develop systems to individual specifications.

Producer needs equipment tests for sensitive toner processing

Late last year, a US producer of toner used for photocopiers and other dry imaging equipment contacted the test center regarding equipment for a new production facility. The toner producer wanted the test center to perform size reduction, mixing, and classification tests for toner ingredients, including a resin (such as polystyrene, polyamide, or polyethylene), carbon

black (a pigment), silica (a flow agent), additives (for flowability or dispersibility), and a developer (for bicomponent toner). Although the toner producer manufactures both monocomponent and bicomponent toners, only bicomponent toner would be tested at this time.

The tests would be complicated by stringent toner processing requirements. To perform well as finished toner, the molecular structure of the toner's heat-sensitive resin can't be altered by processing. As the toner's ingredients are heated to their softening point, where they begin to melt, the heat can't exceed the resin's cross-linking point, or the resin's molecular make-up will change.

In addition, the finished toner's performance hinges on consistent particle shape and size distribution. Toner bonds to its



A conical screw mixer in the Micron Powder Systems test center combined toner ingredients without generating excessive heat.

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Because toner must have consistent particle shape and size distribution, the test center used laser particle-size analyzers to ensure the toner's particles fit into a relatively steep curve between 5 and 20 microns.

substrate (which is paper for photocopier toner) by means of electrostatic charge. The toner's particle shape and size distribution must conform to certain specifications so the toner particles will charge properly and bond correctly to the substrate. Particles may be spherical or irregular in shape and should be as close as possible to 10 microns in size. Minimizing the percentage of fines below 5 microns promotes a uniform, smooth surface without dark spots when the toner bonds to its substrate. (The toner producer's exact par-

ticulate shape and size requirements are proprietary.)

Center performs equipment tests

After conferring with the toner producer and receiving the toner ingredients, test center employees selected test equipment based on the producer's requirements. Test center employees had to reduce the toner's resin ingredient from $\frac{1}{8}$ -inch chunks to an average particle size of 30 to



A mechanical impact mill in the test center (mounted beneath a feeder) performed toner milling prior to final grinding and double classification.



Dust collectors mounted above the test center floor leave room for material and test equipment below.

40 microns. An air classifier mill reduced the heat-sensitive resin; the mill has an air-swept design that controls internal temperatures to between 40°C and 50°C by using a high volume of process air. An integral, forced-vortex (or turbine) air classifier prevented oversized particles.

After size reduction and subsequent tests, the toner ingredients were analyzed with laser particle-size analyzers, which were supplemented in the coarser range by air jet sieving.

The molecular structure of the heat-sensitive resin ingredient used in toner mustn't be altered by processing tests. The test center selected equipment that didn't generate excessive heat.

Test center employees then mixed the milled resin ingredient with carbon black and silica. The carbon black consisted of very fine, submicron particles agglomerated into clumps that required dispersal. The silica had a consistent particle size of about 1 micron. To thoroughly mix the ingredients, disperse the carbon black clumps, and minimize heat generation, the employees used a 1,500-liter-capacity conical screw mixer. The mixer's orbital arm rotates a mixing screw to promote fast, intensive mixing, allowing less time for the ingredients to heat up. Also, the unit's mixing screw is fully supported by the orbital arm, rather than by a support in the mixing vessel's bottom that could produce friction and heat.

After mixing, the toner producer took the mixture back to its in-house testing facility for proprietary processing and testing. The producer's facility kneaded the mixture in an extruder equipped with a heater to enhance kneading and a water-cooled jacket for temperature control. Kneading heated the mixture to an acceptable level above the softening point of the resin ingredient, causing a uniform, stable distribution of all the toner ingredients. From the extruder, the kneaded material fell onto a steel belt conveyor (water-cooled to about 10°C) and formed a brittle sheet. A roller prebreaker then broke the sheet into chips about the size and shape of nickel coins.

The chips were returned to Micron Powder Systems' test center for additional size reduction. To achieve the consistent particle shape and size distribution needed for good toner performance, several size reduction and classification tests were needed. First, a hammermill ground the chips to 1/8-inch maximum size. A mechanical impact mill then ground the material to a point where 90 percent of the particles were less than 75 microns in size and 50 percent were less than 35 microns. The test center's opposed jet mill ground the material to a point where 99 percent of the particles were less than 20 microns in size and 50 percent were less than 11 microns.

Test center employees then twice passed the material through a radial-vane, forced-vortex classifier to achieve a precise top-size limitation and minimum fines. The resulting material was the coarse fraction from the final classification, with a particle population of 6 to 10 percent less than 5 microns and 99 percent less than 20 microns — a relatively steep size-distribution curve between 5 and 20 microns.

Most of the fines fraction from final classification were collected by a cyclone; any fines escaping the cyclone were collected in a pulse-jet dust collector. (During production, the toner producer could recycle the collected fines during initial mixing.)

Next, a high-speed mixer combined the ground and classified material with additives to impart flowability or dispersibility. A sifter removed any stray agglomerates or foreign particles. Finally, a conical screw mixer mixed in the developer.

Tests result in finished toner, production information

Test center employees reported the test results to the toner producer in person and then in a formal, written report. The tests took 3 days and required as much as 500 kilograms of material for each test.

During the tests, capacities and power consumptions were measured to determine the proper scale of each piece of equipment in series with the others and to estimate operating costs.

Although only bicomponent toner was tested, all the equipment used can be fitted with wear protection for processing the abrasive magnetic ingredient — usually magnetite — in monocomponent toner.

Equipment tested for toner processing would also have to process toner with an abrasive, magnetic ingredient. The test center used equipment that could be fitted with wear protection for the abrasive toner.

Facts about Micron Powder Systems' test center

Micron Powder Systems' test center performs about 400 tests each year. The test center houses various processing systems that can perform size reduction, air classification, mixing, granulation, agglomeration, and product collection while controlling process temperature. The test center also handles powder characterization and analyzes particle size distribution. As with the toner producer's tests, the test center can perform tests involving several processes in series. Special systems are equipped for operation under inert gas, chilled air, and vacuum conditions.

Test results are presented initially in an informal review and finally in a formal report. Those interested in testing should consult with a test center applications engineer and prepare an Engineering Data Sheet and an OSHA Material Safety Data Sheet prior to scheduling an appointment.

PBE

Micron Powder Systems, Summit, NJ.

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Micron Powder Systems operates the most comprehensive Technical Center in North America devoted exclusively to powder processing technology. We conduct trials for customers on more than 40 different systems for size reduction, air classification, mixing, drying, and related unit operations.

If you are interested in scheduling a test, attending a seminar, or taking a tour, contact our marketing department today.



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