Test center | Analyzing and classifying bulk solid particles in a lab

Test center classifies and analyzes particles to determine size and shape for separating purposes.

Analyzing a powder's particles to determine their characteristics is a key step in creating an efficient processing system. Knowing your material's particle size, size distribution, and shape helps in accurately determining the correct classifying equipment for an application. Elcan Industries, a toll processing and screening solutions company, offers full-scale testing and processing services at its recently commissioned test center in Tuckahoe, NY.

The test center provides particle size analysis and lab-scale material testing for companies. With many different pieces of particle size analysis and classification equipment, the test center allows customers to develop new products and characterize powders. This powder modification and improvement is especially beneficial for small-scale companies as the processes can be done using only a small amount of powder. Along with particle analysis, the company also helps customers determine what type of classifying equipment will work best for their process. With years of experience in these fields, the company helps clients develop the advanced materials that are in today's leading technologies.

Determining particle shape

When the company's test center received a titanium powder sample to be used for 3D printing, the first step in the process was, and always is, to look at the material under a microscope. Looking at particles under magnification tells more about the material than just particle size. Particle magnification shows the individual particles' shape. Knowing whether the particles being dealt with are spherical, angular, or flake-shaped is the first step in determining not only what system to measure the particles with but also what system to use to efficiently separate the powders. On examining the titanium sample under the microscope, lab technicians determined the particles to be sphere-shaped.

The entire particle evaluation process takes only a matter of minutes. From there, the company will recommend equipment to run the trial, and this trial can take anywhere from a few hours to a few days depending on the amount of powder needing to be ran. All customers are welcome to come to the facility to witness the testing firsthand.

"Most of our customers come to us looking for a sieving solution for their powdered material," says Russ Grotto, director of operations for Elcan Industries. "We enable people to enhance their powders without having to purchase the equipment themselves."

Determining particle size

Once particle shape was established, particle size analysis needed to be done on the titanium sample. The equipment to use for this analysis depends on the particles' general size. For instance, if we can tell that the powder is comprised of mostly fines, then a laser diffraction unit will be more suitable for determining the specific particle size. However, if the sample is mostly oversize particles, then either a RoTap sieve or a jet sieve should be used. Although, if the sample contains a wide range of particle sizes, from fines to oversize particles, then a laser diffraction unit should

The company's lab has various particle analysis technology to determine a powder's particle shape and size.

be paired with a RoTap or jet sieve to determine particle size. Because the titanium sample was made up spherical-shaped fine particles, we used the laser diffraction unit to determine the exact particle size.

Sieve analysis allows customers to see particle sizes within certain sieve-size channels and can be used to get an overall idea of the powder at various sizes down to 44 microns.

While a laser diffraction unit is typically regarded as the most efficient process to determine particle size for fine particles like our titanium powder, it's not a perfect system. A laser diffraction unit analyzes the particle sizes that make up a powder by measuring the angle of light broken up by the particles as they pass through a laser beam. The company uses this unit type to determine the feed's particle size distribution. This system works for many different powders and can give accurate readings of powders below 1 micron. However, the laser system often struggles with reading the percentage of oversize particles that make up a material due to the way the system measures particles. If the sample particles have been determined to be misshapen, flake-shaped, or angular, more likely than not, the laser system will show a higher percentage of oversize particles that make up the material range. The reason is that particles pass through the laser lengthwise, which causes a 20-micron by 100-micron particle to be read as 100 microns. Typically, the company recommends that customers use the laser system, but for customers with angular or flake-shaped particles, the system should be run in conjunction with another piece of testing equipment — such as a RoTap sieve or a jet sieve — in order to verify the results.

The titanium sample was put through the laser diffraction unit, and based on the angle of light broken up by the spherical particles as they passed through the laser beam, it was determined that the particle sizes in the sample ranged from 15 microns to 45 microns.

Another option for measuring particle size is to use a RoTap sieve system to run sieve analysis on the material based on a projected output of particle sizes determined by the powder's original supplier or lab. Running powders through a sieve for testing is a tried and true process that companies have been using for decades. This system uses a uniform rotary motion and tapping on a sieve stack's top to determine what percentage of powder falls within a specific mesh or micron size range. This is calculated by the amount of material retained on each test sieve after running the machine.

This method allows companies to accurately measure the true percentage of oversize particles that make up a material and emulates what the powder will do inside of a screener. Sieve analysis allows customers to see particle sizes within certain sieve-size channels and can be used to get an overall idea of the powder at various sizes down to 44 microns. Sieve analysis has its limitations though and oftentimes struggles below 44 microns. The lack of energy inside of the sieve analysis system may make passing fine particles through the sieve mesh difficult, which would lead to an inaccurate representation of fines in a material. Using a sieve to measure a material's oversize particles and a laser system to measure the fines will give customers a full spectrum of what the material's actual particle size is.

"No one machine works for every powder," says Grotto. "Each powder is different and requires close examination, which might lead us to using a combination of particle size determination techniques."

"What I've learned from years of using these various methods to determine particle size is that no one machine works for every powder," says Grotto. "Each powder is different and requires close examination, which might lead us to using a combination of particle size determination techniques."

Jet sieve analysis is another method used to help determine particle size. The jet sieve uses an airflow push-pull method. The system has an air knife right below the test sieve that rotates and blows air to keep the mesh holes open (this is the method's push portion). Then, there's a vacuum that provides overall suction below the screen that pulls the smaller-sized particles through the test screen mesh (this is the method's pull portion). The jet sieve is extremely useful for determining a powder's fines percentage and oversize percentage. The jet sieve is limited to using only one sieve at a time but can provide very accurate results due to the lack of *blinding* that occurs with this system. Blinding is when a sieve's mesh hole aperture gets clogged by material due to the material being sticky, staticky, or close in size to the mesh hole aperture. When determining fines percentage at a certain sieve size, simply put 100 grams into the jet sieve at the desired size and run the system. The amount of material that's removed during the process will indicate the fines percentage. To measure oversize percentage, the material amount left on the screens' top will indicate how much oversize is in the material as well.

While the titanium sample could've been put through the RoTap sieve system, the system would've only been able to verify the 45-micron-sized particles. The particles below 45 microns were too fine to be detected by the system. A jet sieve analysis wasn't suggested to determine the titanium particles' size because the powder is explosive and there would've been too much movement in the jet sieve.

Separating the particles

Once the particle size analysis was completed for titanium, the next step was choosing the right classifying equipment for the material being used. For spherical, fine particles, a high-energy screener would likely be chosen because the fine particles will require the intense energy to separate. However, for angular and flake-shaped oversize particles, a tumbler sieve would be a better choice because the particles are easier to separate and don't need that much energy imparted on them. The company's new laboratory houses a few different pieces of lab-sized particle classifying technologies that allow companies to develop new products while only using a small quantity of test powder.

One such piece of equipment is the elbow-jet air classifier, which performs simultaneous, multiple classifications of fine, dry powders. The classifier contains no rotating parts unlike a classifying wheel. Instead, the equipment is built in such a way to use the Coandă effect, which uses physics and airflow mechanics, to separate the particles. The Coandă effect is the tendency of a fluid jet stream to attach and maintain attachment to a convex surface when the two are placed near each other. The elimination of the classifying wheel makes the air classifier ideal for abrasive and high-purity powders in the electronics, biomedical, and aerospace industries. The equip-

A laser diffraction unit is used to assess a powder's particle size.

The high-energy sieving system separates powder using a strong vertical vibration.

ment is also capable of making up to three fractions at one time.

The laboratory also houses a 400-millimeter lab-sized high-energy sieving system. As the name suggests, this system is comprised of high-energy-style screening equipment that can make efficient, dry-particle separations down to sizes as fine as 10 microns and wet separations down to 5 microns.

"The high accelerational energy of the high-energy sieving system is the key to separating fine particles in any powder," says Grotto. "The high energy is imperative."

The high amount of energy being directed onto the screening surface prevents blinding from occurring and provides efficient particle separation. This system works well in the specialty chemicals, batteries, and additive manufacturing industries due to these industries' use of potent materials in small amounts and the system's highly accurate sieving ability.

Because of the fines that make up the titanium sample, the high-energy sieving system was the best choice for separating the titanium's particles. Running the titanium through this system resulted in the titanium being classified into multiple groups of different-sized titanium particles all falling within the 15- to 45-micron range. Separating particles in the titanium sample into groups according to size was necessary for the powder's use in 3D printing. In order for the powder to be properly layered within the 3D printer, the final powder product needed to be of the same particle size.

"The high-energy sieving system's technology allows companies to achieve particle size distributions that may not be achievable on a conventional sieve or air classifier," Grotto says. "The advanced technology eliminates fines and standard deviations that are commonly associated with this equipment, and customers experience higher yields across the board as well."

Some materials separate better with a finesse approach, which mirrors a hand-sifting motion, and for those materials, the 3-dimensional gyratory motion of a Minox tumbler screener can be used. The company's 600-millimeter screener uses the 3D gyratory motion as well as screen-cleaning devices such as air knives, brushes, ultrasonic, and bouncing balls to eliminate blinding and achieve good efficiency. The system works best with powders that are perfectly spherical (like alumina), angular (like silicon carbide), or flake-shaped (like natural graphite) and helps guide particles through the screen mesh while using a variety of methods to prevent the sieve mesh from blinding.

The high-energy sieving system and the Minox tumbler screener give customers the opportunity to test on the systems with smaller powder quantities. After the initial test success, larger quantities can be run on production screeners that have the exact same screen conditions as the lab units. **PBE**

For further reading

Find more information on this topic in articles listed under "Screening and classifying" and "Particle/powder analysis" in the article archive on *PBE*'s website, www.powderbulk.com.

Elcan Industries
Tuckahoe, NY
800-283-5226
www.elcanindustries.com