

MILLING MENTOR



Fluidized-bed jet milling: It's not just for size reduction anymore

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The fluidized-bed jet mill has long been known as an excellent machine for reducing a wide range of friable or crystalline materials down to micron-sized powders (called *micronizing*), grinding partly brittle but low-melt materials without damaging them, and grinding abrasive materials without the danger of cross-contamination from metal abraded from the mill's housing. But the mill has more uses, as well. In this column, we'll briefly describe the fluidized-bed jet mill and the variety of applications it can handle.

There are many jet mill types, and all of them operate by using air (or other gas) jets to force particles to collide against each other at high speeds and break into smaller micron- and even submicron-sized pieces. In some jet mill types, the particles impact the grinding chamber walls as well as each other. The particles in the fluidized-bed jet mill don't contact the walls; therefore, they produce finished products with high purity and little to no contamination. The fluidized-bed jet mill, in which the grinding action takes place in a fluidized bed in the mill, is the most versatile.¹

The fluidized-bed jet mill has a lower grinding area called the *grinding chamber* and an upper classification area called the *classifier wheel*. Several gas nozzles are arranged around the grinding chamber's periphery and aimed toward the chamber's center. Pressurized gas is

forced through nozzles, forming high-velocity gas jets. Material enters the chamber by gravity and is entrained by the high-velocity gas, which produces a fluidized bed. The gas jets rapidly accelerate the particles and force them toward the bed center. Along the way, they impact each other and break into pieces. The gas expands, carrying the particles upward to the classifier wheel, which spins at a predetermined speed to produce the desired *cut point*, or particle size, and throws out the coarse particles, sending them back down to the fluidized bed. Fine particles entrained in the gas exit the classifier wheel, and the particles and gas are separated in a cyclone or dust collector.

The fluidized-bed jet mill is known for its ability to grind very abrasive materials down to precise micron sizes with little possibility of cross-contamination because the mill's grinding action is particle-on-particle. The mill has no hammers, grinding discs, or grinding media that can wear away. In addition, the particle grinding occurs almost entirely in the



A chemical engineer and mill operator examine a material after micronizing in a fluidized-bed jet mill.

fluidized bed's center, while the bed's outer portions act as a wear barrier, eliminating the danger of housing fragments wearing away and contaminating the material.

The fluidized-bed jet mill can also blend powders while grinding, coat particles with liquid, or dry a moist material by using jets of superheated steam rather than gas. Because the mill tightly controls all process conditions, it provides very stable and repeatable results within tight grinding specifications for particle shape, density, surface area, aspect ratio, particle diameter, and color.

In any jet mill type, the grinding temperature is the same as the gas temperature. This has long been seen as a major benefit because the mill is typically run with cool gas, which prevents damage to heat-sensitive materials. However, the fluidized-bed jet mill can be run not only with cool gas (down to 68°F [20°C] or so), but with hot gas (up to 390°F [200°C] or so) or superheated steam (around 750°F [400°C]). This temperature versatility allows the mill to successfully reduce many materials without changing their characteristics. Although other jet mills have been known to run on steam, the fluidized bed jet mill lends itself particularly well to this application.

Interestingly, the mill's temperature versatility also allows the user to

purposely change the material's characteristics by selecting a particular gas temperature. In this case, the chosen gas temperature causes a reaction during grinding that modifies the material's chemistry or surface morphology. This allows the mill to be used as a reactor, grinding and modifying a material in a single processing step.

If needed, the user can add another material or a liquid during grinding to cause or enhance the reaction. The mill's ability to precisely control process parameters also helps the user achieve the desired chemical reaction.

Many materials, including minerals, pigments, food, polymers, and a wide variety of organic and inorganic chemicals, are candidates for reaction processing in the fluidized-bed jet mill. Though this advance is still in its early days, some bulk solids processors are already successfully using the mill this way. With the fluidized-bed jet mill's versatility, tight process control, and other pluses, we expect users to develop many more practical uses for this mill in the future. **PBE**

Reference

1. For more information about jet mills, see articles listed under "Size reduction" in *Powder and Bulk Engineering's* Article Archive on *PBE's* website, www.powderbulk.com. Registered users can download any article in the archive free.



A lab-sized fluidized-bed jet mill (bottom) is used for testing material grindability and throughput rates.

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