Medium-fineness size reduction: An equipment glossary

This article describes equipment commonly used for reducing dry bulk materials to medium fineness — that is, between 100 mesh (149 microns) and 1 inch.

Today, size reduction equipment for grinding dry bulk materials is available in a variety of types, with widely different components, operating principles, and feed and final particle size ranges. This equipment variety answers the needs of processors who must reduce materials to coarse, medium, or fine particle sizes. Coarse particles are typically between 1 and 60 inches; medium particles are between 100 mesh (149 microns) and 1 inch;[1] and fine particles are smaller than 100 mesh.

Following are descriptions of common equipment for medium-fineness size reduction. The information includes standard equipment components, general operation, applications, and typical feed and final particle sizes. Be aware that these details may vary among models in the same equipment line and among equipment from different suppliers. Find more information about the equipment in articles listed in the later section "For further reading," and find size reduction equipment and suppliers listed in *PBE*'s *2008 Reference & Buyer's Resource Issue* and at *PBE*'s Web site (www.powderbulk.com). [***Editor's note:*** Look for glossaries covering coarse and fine grinding equipment in future issues.]

Cage mill. Impact mill that handles friable materials such as aggregates, coal, and ores. Mill typically has a vertically oriented housing with a rotor assembly (consisting of a rotating shaft and wheel-shaped cage equipped with several bars), breaker plates lining the housing walls, a large swing door with a center inlet, and often a vibrating screen below the bottom outlet. Feed material flows through the inlet toward the cage's center, and centrifugal force propels the particles into the cage bars. The bars, breaker plates, and other moving particles impact the particles until they are reduced, hit the housing wall, and drop out the bottom outlet. On-size particles pass through the vibrating screen below the outlet while oversize are recirculated back to the mill for further reduction. Mill typically handles feed materials with a top particle size up to several inches and reduces them to a top size as small as 1½ inches. Variation for lighter-duty applications, called a *multirow cage mill,* has multiple cages and two rotating shafts mounted on opposite sides of the housing that spin the cages in opposite directions. See *Universal mill.*

Conical screen mill. Compression milling machine for soft materials with a Mohs hardness up to 3.5, commonly used for foods and pharmaceuticals. Mill has a cone-shaped sizing screen inside a conical housing; a rotor fitted with blades that match the screen's slope is mounted at the screen's center. Material chunks are fed into the mill's top, and as the rotor spins, the blades compress the chunks against the screen and fracture them. On-size particles pass through the screen, and oversize are retained for further reduction. Mill typically handles feed materials with an average particle size from 2 to 3 inches and reduces them to an average size of about 0.5 to 3.0 millimeters.

Hammermill. Impact mill with a horizontal rotor assembly consisting of hammer blades mounted on a rotor that rotates at high or low speed inside a cylindrical sizing screen (or grid). Feed material is loaded through the

Hammermill

Courtesy of Schutte-Buffalo Hammermill, Buffalo, N.Y.

mill's top or side as the rotor assembly spins, and the swinging hammers reduce the material by impact and attrition. On-size particles pass through holes in the screen and exit the hammermill's bottom outlet, while oversize are retained and impacted again by the hammers until they're small enough to pass though the screen. Particles fine enough to be trapped in the circular airflow between the rotor assembly and screen are drawn through the screen by an air system. High-speed unit typically handles foods, fine minerals, chemicals, and pharmaceuticals with a Mohs hardness up to 3 and a maximum feed size of about ⅛ to ½ inch and reduces them to a top size less than 75 to 250 microns. Low-speed unit typically handles foods, wood waste, cardboard, and similar materials with a Mohs hardness up to 3 and a maximum feed size of 3 to 4 inches and reduces them to a top size of 1.5 to 2 millimeters.

Pin mill. Impact mill for materials with a Mohs hardness up to 3, such as plastics, chemicals, pharmaceuticals, spices, and minerals. Mill typically has a vertically oriented housing with two discs, each equipped with several rows of pins. One disc is mounted on a large swing door and is stationary, and the other is mounted on a rotor, while a ring of stationary pins can be located around the discs' periphery. Feed material enters the rotating disc's center, where centrifugal force causes the particles to accelerate outward and pass through the rotating disc's pins, then hit the stationary disc's pins, then impact the rotating disc's pins again. On-size particles pass through the pins and discharge at the disc edges to drop through the mill's bottom outlet, while oversize remain in the mill until they're small enough to pass through the pins and exit at the disc edges; for further grinding, the particles can impact the outer ring of stationary pins. Mill typically handles feed materials with a top particle size up to 7 to 10 millimeters and reduces them to a top size of less than 500 microns. In other pin mill versions, both discs rotate, either in the same or opposite directions, allowing the particles to be ground to smaller sizes. See *Universal mill.*

Roll crusher. Machine that applies compression to reduce materials with a Mohs hardness up to 7, such as rocks and ores, chemicals, pharmaceuticals, foods, and waste materials. Crusher consists of one roll or two parallel rolls, each mounted with integral teeth, blades, or other projections and powered by a drive, inside a rectangular housing equipped with one (or more) breaker plate. Material chunks fall into the crushing chamber formed by the roll(s) and breaker plate(s) and are crushed either by the roll teeth against the breaker plate or between the two counter-rotating rolls. On-size particles pass through a sizing screen (or grid) above the crusher outlet; oversize particles remain in the crushing chamber until they're reduced to the desired size. Unit typically handles feed materials with an average particle size up to 3 inches and reduces them to an average size between 1 and 100 millimeters. Also called a *crushing mill, rotary crusher,* or *crusher.*

Roller mill. Machine for reducing friable or fragile and breakable materials (any material that breaks rather than flattens under pressure). Mill has from one to four pairs of horizontal rolls with a smooth or corrugated surface; one roll in each pair is fixed and the other can be moved closer to or farther from the fixed roll to adjust the space between the rolls (the *roll gap*) to achieve the desired size reduction. Material is fed at a constant rate into the roll gap between the top roll pair and is crushed at the nip point between the rolls. In a machine with multiple roll pairs, the reduced particles will drop to the next roll pair for further reduction, and so on, until the particles reach the desired size and discharge from the bottom roll pair. Mill typically reduces feed materials with an average particle size up to about ¾ inch to an average size usually between 100 and 2,000 microns.

Rotary knife cutter. Machine that applies shear to reduce soft materials with a Mohs hardness less than 3, such as corn husks, plastic film, and tires. Unit has a horizontal housing enclosing a set of stationary knife blades, a rotor mounted with another set of knife blades, and, typically, a sizing screen at the outlet below the rotor. Feed material is loaded into the unit's top as the rotor spins inside the housing, and the stationary and rotating blades intermesh, cutting the material into pieces. On-size particles pass through the screen while oversize are retained until they're cut to the desired size. Cutter typically handles feed materials with a particle size up to several inches and reduces them to pieces as small as 1 to 6 millimeters.

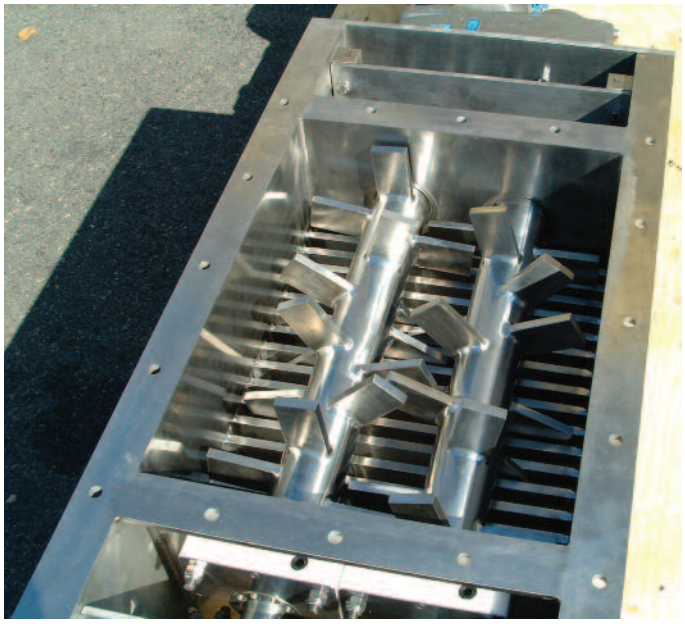
Common rotary knife cutter variations include the blow-through cutter, granulator, pelletizer, and guillotine cutter. The *blow-through cutter* operates similarly to the rotary knife cutter but has two or three rotating knives, one bed knife, and no screen. Unit is installed near a pneumatic conveying system's material pickup point and chops film trim or paper into shorter pieces so they can be conveyed to a collector for further reduction, disposal, or recycling.

The *granulator* operates similarly but has an open hopper, rotating knives, one bed knife, and a perforated screen. Unit is installed near a plastics extruder or molding press. Scrap loaded into the open hopper flows into the unit's cutting chamber where it's chopped by the knives. On-size particles exit the unit for mixing with virgin raw materials for reprocessing in the extruder or molding press, and oversize are retained on the screen for further reduction.

The *pelletizer* operates similarly but has two or three rotating knives, one bed knife, and two variable-speed feed rolls. Feed strands (such as plastic from an extruder) enter the unit's top and are pushed between the feed rolls; as the feed exits the nip point between the rolls, the knives cut the feed into pellets.

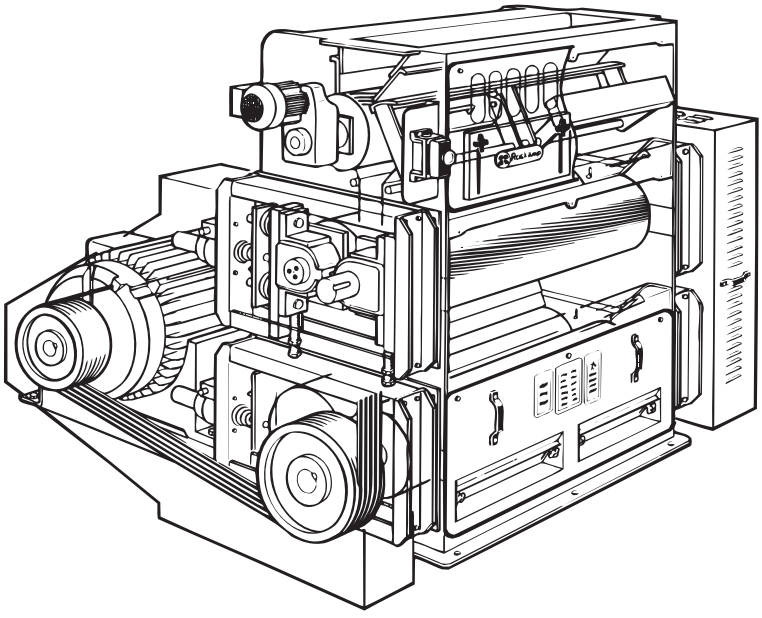
The *guillotine cutter* has a hydraulically powered shear-cut blade instead of rotary knives. Unit cuts large blocks of plastic or rubber into thin slices that are fed to a rotary knife cutter for further reduction.

Roll crusher



Courtesy of Atlantic Coast Crushers, Kenilworth, N.J.

Roller mill

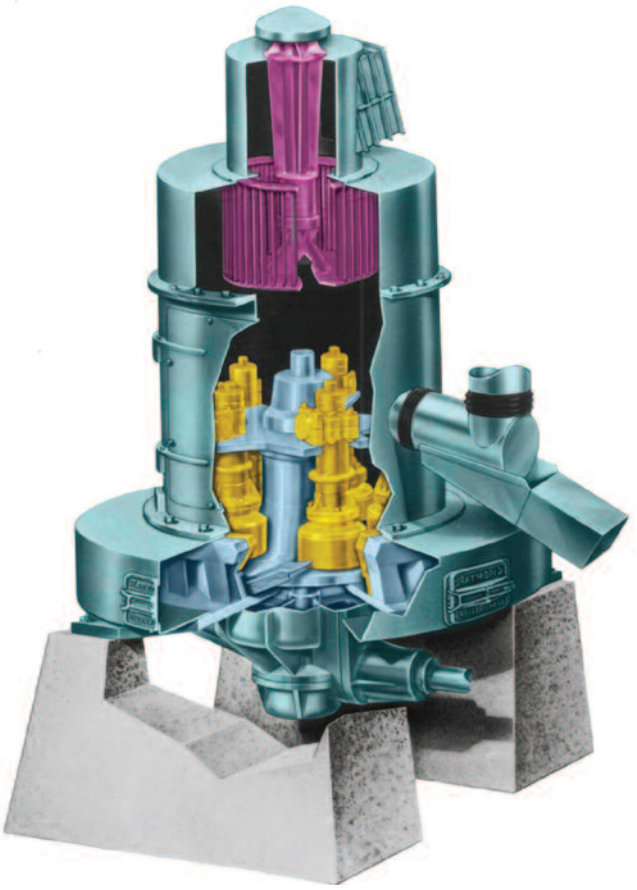


Courtesy of CPM/Roskamp Champion, Waterloo, Iowa.

Rotor-and-screen mill. Compression milling machine for soft materials with a Mohs hardness up to 3.5, commonly used for foods and pharmaceuticals. Mill has a cylindrical screen inside a cylindrical housing; a rotor fitted with bars is mounted at the screen's center. Material chunks are fed into the mill's top and, as the rotor spins, the bars compress the chunks against the screen and fracture them. On-size particles pass through the screen, while oversize are retained for further reduction. Mill typically handles feed materials with an average particle size from 2 to 3 inches and reduces them to an average size from about 0.5 to 3.0 millimeters.

Universal mill. Impact mill that uses interchangeable grinding tools to handle materials in a range of hardnesses. Unit has a vertically oriented housing with a large swing door and a grinding tool mounted on a rotating shaft inside the housing. The grinding tool can be a rotating disc (called a *rotor disc*) fitted with pins or teeth at the periphery, or a rotating wheel-type rotor fitted with blades or bars. Feed material flows into the inlet in the door's center, and the grinding tool's high-speed rotation creates centrifugal force that accelerates the particles outward and hurls them against the tool's pins, blades, or other elements at the tool's periphery, fracturing and

Vertical roller mill



Courtesy of Alstom Power, Air Preheater Co., Warrenville, Ill.

reducing them. On-size particles exit through the mill's bottom outlet after passing through the disc periphery or through the wheel-type rotor's blades or bars, and, depending on the grinding tool, a sizing screen or similar device; oversize are retained for further reduction.

Vertical roller mill. Machine for grinding and classifying nonmetallic minerals with a Mohs hardness up to 5, such as gypsum, limestone, clay, coal, and talc. Typical mill has a vertical cylindrical housing with a center rotating shaft; an assembly, consisting of a set of freely pivoting, rotating rolls mounted inside a stationary or rotating grinding ring, is mounted on the center shaft. Feed material enters at one side and falls to the mill's bottom as the center shaft rotates. The shaft's rotation causes each roller to pivot freely and contact the grinding ring. Plows at the mill's base scoop up material and force it between the grinding ring and rolls, where the material is ground. Air enters at the mill's bottom and sweeps the ground material toward an air classifier at the mill's top, which discharges on-size particles and returns oversize to the mill for further reduction. Mill typically handles feed materials with an average particle size from ½ to 1½ inches and reduces them to an average size between 10 and 325 mesh. Also called a *ring-roll mill;* variation is a *bowl mill.* **PBE**

Reference

1. 100 mesh = 149 microns or 0.149 millimeters or 0.005 inch.

For further reading

Find more information on medium-fineness and other size reduction equipment in articles listed under "Size reduction" in *Powder and Bulk Engineering*'s comprehensive article index (in the December 2008 issue and at *PBE*'s Web site, www.powderbulk.com) and in books available on the Web site at the *PBE* Bookstore. You can also purchase copies of past *PBE* articles at www.powderbulk.com.