A cage mill can meet demanding size-reduction specs for an enormous range of materials, including limestone, aggregate, clay, shale, fertilizer, distillers’ grains, detergent, corn, salt, coal, and more. This article describes how a multirow cage mill works and discusses performance factors that can help achieve your desired particle size reduction.

Components and operation

Cage mills are available in various configurations, including single-row and multirow models. This article focuses on the multirow cage mill, which is more versatile and more frequently used than the single-row cage mill.

Multirow cage mill components. A typical multirow cage mill consists of a fabricated steel housing that encloses two, four, or six wheel-shaped cages. Each cage includes a steel plate fitted with equally spaced pins (bars) arranged in a row around the cage perimeter. Pins can be configured in a close, medium, or wide spacing arrangement. The pins’ opposite ends are attached to a one-piece steel ring (or band) for rigidity. The cage assembly consists of one, two, or three outer cages and one, two, or three corresponding inner cages that are fitted between the outer cages, forming concentric rows of pins. Figure 1a shows the two outer cages of a four-row cage mill, and Figure 1b shows the two inner cages.

The inner cage centers are mounted on a horizontal shaft supported by bearings and driven by a motor. The outer cages are mounted similarly on a second shaft, supported by bearings and driven by a motor. The motors rotate the
shafts in opposite directions. The cage mill housing is fitted with liners to handle various operating conditions and prevent abrasion. An intake hopper is located at the housing side and is linked to a chute that ends at the cage center. The cage mill doesn’t use screens or grates to achieve desired product gradations, so material is discharged out of the open housing bottom.

How it works. In operation, feed flows through the cage mill’s intake hopper and chute, into the innermost cage’s center. As adjacent cages rotate in opposite directions, centrifugal force propels the particles from the innermost to the outermost cages. The farther away the particles travel from the mill center, the higher their impact velocity as they repeatedly hit each successive cage’s pins, other particles, and the housing liners, and finally drop through the bottom outlet. Figure 2 shows a cutaway view of a cage mill in action.

The cage mill speed can range from as slow as 5,000 fpm up to as high as 12,000 fpm, depending on the cage mill size, the cage configuration diameter, and the mill design and construction. This relationship is simple: the higher the cages’ speed, the more energy is transferred to the material for size reduction, thus yielding a finer product gradation.

Generally, larger cage mills have lower operational cost per ton of output.

Mill size and capacity
Standard cage size diameters range from as small as 18 inches to as large as 6 feet. In general, the larger the cage mill, the larger the feed size it will accept and the greater its production capacity. Capacity also depends on the cage

Figure 1

Cages for four-row mill
a. Outer cages

b. Inner cages

Figure 2

Four-row cage mill in operation
mill’s speed, the feed’s bulk density, and the desired product size. Generally, larger cage mills have lower operational cost per ton of output.

**Applications**
Multirow cage mills can handle heavy-duty applications involving hard, highly abrasive materials, as well as lighter-duty applications for reducing both abrasive and nonabrasive materials. The mill also handles wet, sticky materials, such as clay and shale.

Multirow cage mills can handle heavy-duty applications involving hard, highly abrasive materials, as well as lighter-duty applications for reducing both abrasive and nonabrasive materials. The higher the number of pin rows, the more size-reducing impacts that occur, so more rows equal more pulverizing. The two-row mill is commonly used for reducing fertilizer, for crushing wet, sticky shale and clay in brick-making, and for making manufactured sand for construction. The four-row unit is commonly used for pregrinding agricultural limestone and for pregrinding coal in superfine grinding operations for transfer and gasification processes. The six-row unit, while less commonly used, is still popular for grinding corn, malt, and rye for the distilling industry.

Carefully selecting and operating your cage mill will help it efficiently meet your size-reduction specs. The cage mill supplier should test the cage mill’s performance with your feed material and use the results to make process adjustments to achieve the desired output.

**For further reading**
Find more information on crushers in articles listed under “Size reduction” in *Powder and Bulk Engineering*’s article index in the December 2014 issue or the Article Archive on *PBE*’s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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