

NOT SUCH A CAGEY START

Matt Richardson, TerraSource Global, USA, considers how a particular type of cage mill is becoming more popular for small product sizing operations.

It is no secret that coal and mineral producers and refiners continue to demand more precision and less waste in their material processing capabilities. As such, these companies are in an ongoing state of re-evaluating or even rethinking critical aspects of these capabilities, particularly in terms of how to increase the safety, performance and efficiency of the sizing equipment driving their operations.

As a result, forward-thinking sizing-equipment vendors need to continue to find innovative ways to bring value to customers, whether through new types of machines or strategic upgrades to existing technology. For example, even

though TerraSource Global offers a range of roll crushers and hammermills, the company is now finding that the capabilities of its Gundlach Cage-Paktor® cage mills are becoming a bigger part of material crushing conversations normally focused on other types of machines such as ball mills, rod mills, vertical shaft impactors, roll grinding mills and hammermills. Although typically used to size a wide variety of materials such as potash, lime, magnesite, bauxite and so on, these cage mills are becoming increasingly popular for coal operations requiring very small product sizing or better efficiencies in peripheral functions, such as crushing and mixing coal for coking, processing gob coal



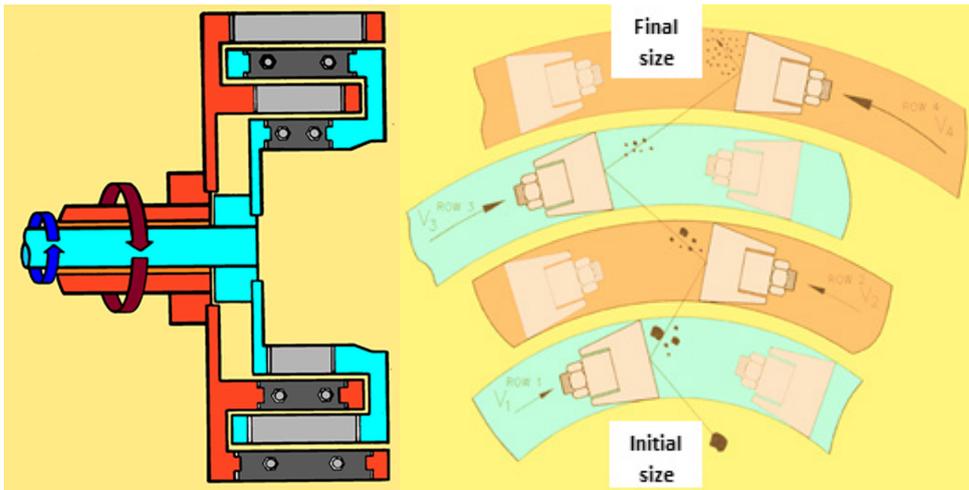


Figure 1. Rotation and striking action of Cage-Paktor cages.

and brown clay containing coals, and sizing limestone used to capture by-products in coal-powered power plants.

Positioning cage mills to bring value to customers in coal sector

The company knew that businesses operating in the coal space may not be familiar with Cage-Paktors and might be unaware of some potential benefits the machine could offer. Even if the technology is new in this space, TerraSource engineers decided to add in design modifications, broader configurations and new material compositions in order to ensure the machine's appropriateness for additional uses.

In large part, what TerraSource heard from customers is consistent with the feedback most vendors are going to receive from any company to whom they are pitching capital investment: enhanced performance, expanded usage capabilities, increased durability to extend mean time between failure (MTBF) and improved mean time to repair (MTTR) through better safety and ease of maintenance. Before examining how next generation of these cage mills deliver on these priorities for coal facilities and power plants, it is helpful to first examine the unique design of cage mills and some of the advantages they can offer over other types of crushing equipment.

Exploring the unique design of cage mills

In general, cage mills are screenless impact crushers that, rather than rolls or hammers, rely on rotating concentric steel cages. Feed enters the innermost cage, where it is initially struck by the first row of cage sleeves, which scatter the shattered material outward toward the next row which rotates in the opposite direction.

Further reduction occurs as the material moves outward through each successive row until the material exits the final row and is thrown against impact plates that line the crushing chamber. The sized material then

discharges through the open bottom of the mill.

This crushing process differs from typical solid rotor or hammer impactors, which use minimal large impacts with a combination of stationary and moving impact surfaces with much less material flow control. In a Cage-Paktor, the speed of the cage(s) is the primary factor for controlling output size, with the number of impact rows and the quantity of striking elements in each

row also influencing the sizing outcome in a secondary capacity. The company has found that limiting variables allows for the most accurate machine performance; as such, ideal product flow and machine capacity is maintained by ensuring that the quantity of striking elements in each row for a given Cage-Paktors are consistent.

These features allow the Cage-Paktor to easily achieve 40:1 reduction of feed material and easily vary from coarse down to fine output.

Multiple configurations of Cage-Paktor are available with 1 - 2 independently moving cages, usually with 3 - 6 rows. Even with the larger configurations, Cage-Paktors generally offer a smaller footprint than ordinary cage mills because the two motors used to drive the cages are positioned on the same side of the machine, away from the feed area, which also makes for easier access to the crushing chamber during maintenance.

Performance benefits offered by cage mills

Cage mills' unique design and capabilities are not appropriate for some types of applications and should obviously not be considered a wholesale alternative to other types of material crushing solutions, like hammermills. However, in certain instances, cage mills, especially the new Cage-Paktor, do offer considerable advantages over alternative crushing methods. These advantages include:

- n Less susceptibility to plugging, especially for wet material: Cage-Paktors have four different features to allow it to run material without plugging: A smooth stainless steel curved inlet feed chute, cage scrapers on the sides and periphery of the cages, an open bottom discharge and air canon blast ports on the housing. For particularly difficult material, the company can also add several other advanced features, including smooth stainless housing internals, different scraper designs and additional air cannons with specially designed discharge nozzles.

- n High yields, with minimal fines: of all impact type equipment on the market, the Cage Paktor provides the steepest product curve, typically with 95+% yield of product top size. For applications in which product is small (less than 0.5 in./12 mm), the Cage-Paktor's mix of high yield (material to desired size) and low fines offers a better performance ratio than other impact type equipment like hammermills and impactors. Cage-Paktors reduce size through pure impact without any attrition or grind action, with more controlled material flow than hammer type crushers. Cage-Paktors can also run at slower speeds than hammer type crushers, significantly reducing the amount of fines produced, which can be a critical consideration in situations where processing efficiency and/or adherence to certain environmental guidelines are emphasised. In addition, because this crusher does not have a screen, no attrition grinding exists, which is a common cause of fines. Noise and dusting are also considerably less than with other crushing methods.
- n Longer production of consistent product sizes: with Cage-Paktors, the product size stays relatively constant over the life of its striking plates, as opposed to other crushers like hammermills, which normally will only produce acceptable product if the hammer edges are relatively new. After a short period of running, and on a continuing basis, the hammermill must be adjusted (which is time consuming and requires costly maintenance) to maintain the required product size distribution.

Also, hammermills will normally only produce acceptable product if the hammer edges are relatively new. After a short period of running, and on a continuing basis, the hammermill must be adjusted (which is time consuming and causes downtime) to maintain the required product size distribution. In a Cage-Paktor, the product size stays relatively constant over the striking plates' lives.

Design advantage over traditional cage mills

Cage mills typically fall into two design types: flat face and round pin. Gundlach Cage-Paktors have always been known for flat face striking plate design. TerraSource engineers regularly perform comparative testing and analyses of flat face design against a round pin cage mill located onsite at the company's advanced testing facility in South Carolina, USA. Although the larger quantity of striking elements in the company's round pin design can offer maximum size reduction (1 - 3%) at max speed on the far operation end of the machine's capabilities, testing results continue to reinforce that the flat face design provides significantly more effective and efficient size reduction and fine minimisation than any alternative design for the majority of applications. Flat face design produces the steepest percentage of passing product curve by ensuring impact and reduction of material with the minimum required quantity and speed of striking

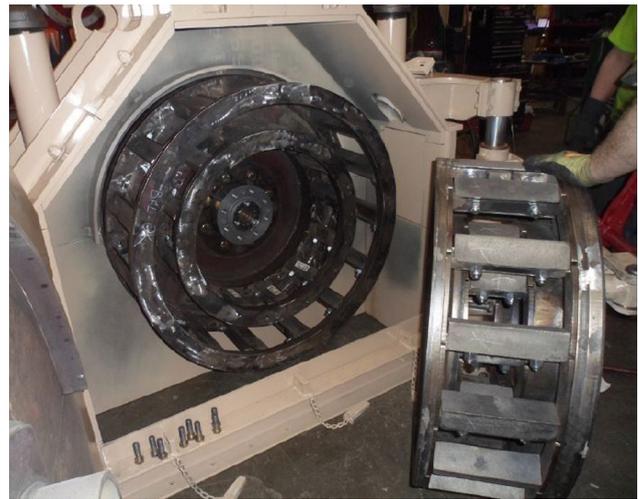


Figure 2. Cage-Paktor interior.

elements. The reduced quantity of striking elements enables a larger allowable feed size.

For customers venturing into new methods of producing product on the higher end of the mesh and micron range – a niche product band – the company is capable of providing flat face and round pin designs tailored to specific needs. In all other areas, however, the flat face still makes the most sense for the majority of customer uses.

Next generation extends MTBF and improves MTTR

Even with the overall advantages that cage mills can offer, the company wanted to ensure that companies considering the Cage-Paktor also gained the additional advantages of more durability (MTBF) and easier, faster and cheaper servicing (MTTR) when regular maintenance does need to occur. As such, not only does the next-generation Cage-Paktor provide more versatility by offering additional configurations to handle a broader array of material sizing requirements, this machine has a couple of other notable enhancements that broaden its appeal as a new option for more applications:

- n Elimination of weld-on liners and introduction of thicker, stronger, more wear resistant components: cages can now be maintained in segments rather than as a more labour-intensive whole. The whole cage, rather than just the liners, is made of wear resistant material, which makes the structural components much stronger than previous models and adds considerable durability and wear life.
- n Improved striking plate design: the new striking plate designs of the next-generation Cage-Paktor offer two distinct advantages: preventing plate ends from cracking or snapping off, and minimising wear on side rings and structural members of cage, with airflow better controlled through striking plate feature design enhancements. The Cage-Paktor is designed to run striking elements through a stream of rock, often very abrasive, 24/7 at approximately 100 mph. This

requires intricate and advanced designs to minimise wear and the associated downtime. The machine's new striking plate design adds baffling to the face and changes to the profile that redirects aerodynamic flow of fine abrasive particles away from critical structural components improving crushing efficiency and extending the life of the primary cage structure. The company's engineering team was also able to thicken rear sections of the striking plate to mitigate tramp-induced breakage, which greatly reduces the chance of needing to bring the machine down unscheduled for repair before fully consuming the life of the wear parts.

- n Backward compatible (adds more value and reduces capital outlay): for customers already using a Cage-Paktor, the updated array of cages and striking plates are seamlessly interchangeable with older models. These new segmented plug-n-play parts support faster lead times, enable quicker and easier maintenance, lower overall costs and promote safety.

Ongoing evolution

All told, the engineers continue to advance the Cage-Paktor to provide a solution for customers who are requiring smaller and smaller product sizing. In these instances, customers are looking for a machine other than traditional equipment like ball mills, vertical roller mills, or high pressure roller mills. The engineers are finding that the Cage-Paktor can effectively size some

material in the 150 - 1000 µm (20 - 100 mesh) range at a high enough efficiency (percentage passing), a capability that is very attractive, especially when coupled with the machine's minimal footprint, low install cost, and reduced long-term maintenance requirements.

Even if recirculation is required, more customers are looking hard at machines that can perform in this transition range between crushing and the comminution/grinding category that typically involves very large and costly equipment with limited capacity.

With a significantly smaller footprint, the Cage-Paktor can far exceed the capacity of traditional grinding and comminution type equipment, which requires passing all the material through small holes or gaps that make up a relatively small area.

When one considers the ability to handle wet and sticky material like gob coal or brown clay containing coals, the Cage-Paktor provides another level of benefit with its ability to provide a reliable small product at high percentage passing desired top size without grates that plug, clog, and often shut down operations.

A strong rainstorm can add enough moisture to incoming product to make some equipment non-operational or incapable of providing consistent product sizing. The cage mills can operate well with as much as 15% surface moisture, and various design features can be added like air cannons and housing modifications that allow even higher levels of operation regardless of moisture levels. ^{WC}