Hammermills are fine-grinding machines that can handle a range of demanding applications. Like any size-reduction equipment, they use a lot of energy. This article explains what routine and long-term maintenance steps you can take to keep your hammermill performing at peak levels while operating at lower cost. The information concentrates on hammermills with a horizontal rotor shaft and swinging, rather than fixed, hammers, but most of the advice here can be applied to other hammermill types.

Hammermills are one of the toughest fine-grinding machines at work in today’s bulk solids plants. The mill handles a wide variety of friable and fibrous materials, including grains, oil seeds, wood scraps, paper and cardboard, chemical products, plastic and rubber products, limestone, and tobacco. Depending on the hammermill model and components you select, the unit can handle feed sizes up to several inches and, depending on the application, yield ground particles as small as 50 percent passing 50 US mesh (about 0.3 millimeter). The reduction ratio through a hammermill can typically range from 4:1 for a coarse process (such as reducing 10-millimeter feed particles to 2.5-millimeter particles) to 20:1 in a more extreme application (grinding 10-millimeter feed particles to a final size of 0.5 millimeter).

Properly maintaining your hammermill will help it yield on-size final product at the rate you need while operating at the lowest possible cost. Before we discuss maintenance steps, let’s review typical hammermill components and operation.

Some hammermill basics

The hammermill consists of a horizontal rotor assembly inside a housing, as shown in Figure 1. The rotor assembly includes a shaft mounted with two or more circular rotor plates, each fitted with four to eight hardened steel pins (or rods). Hammers — flat steel blades or bars with one or two holes — are installed on the pins in balanced sets; a pin passes through one hole of each hammer and then through the rotor plates to hold the hammer in place. The number of hammers and the hammer design — length, thickness, and style of hardfacing (abrasion-resistant material welded onto the hammer surfaces) — varies with the application.

A flow deflector (or flow director) is located inside the mill’s feed inlet, above the rotor assembly. A perforated metal screen, which can be teardrop-shaped or circular, fits around the rotor assembly, and a screen carriage assembly (or frame) typically holds the screen in place. A teardrop-shaped screen is usually split in two pieces, and a regrind chamber (or other small pocket-like device) is typically located at the bottom gap where the screen halves meet. A hammermill with a circular screen has breaker plates located above the screen or a breaker bar at the screen’s bottom. The area formed inside the teardrop-shaped or circular screen, including the hammers and the breaker plates or bar, is the grinding chamber. Wear liners cover the grinding chamber’s interior surfaces outside of the screen.

In operation, the rotor assembly rotates as feed flows into the inlet at the hammermill’s top. The flow deflector directs the feed in the hammers’ rotation direction and stops and redirects any material that’s circulating around the grinding chamber rather than contacting the hammers. The hammers reduce the feed in several ways; by impacting the feed when it’s airborne, by grinding it against the
screen, and — if the mill is so equipped — by grinding it against the breaker plates or bar. In a hammermill with a regrind chamber, the chamber interrupts the material flow through the grinding chamber and directs it back into the hammers’ path. The screen (whether teardrop-shaped or circular) retains oversize particles for further grinding.

Reducing maintenance costs with careful hammermill selection and operation

Keeping your hammermill maintenance costs low starts before the hammermill is installed at your plant. By carefully selecting the hammermill’s wear parts and determining the best way to operate the mill in your application, you can minimize required maintenance while ensuring that the mill provides top grinding performance. To speed and simplify maintenance, you also should select wear parts designed for easy replacement.

Selecting the screen area. The hammermill should have at least 14 square inches of screen area per horsepower for most applications. Too little screen area will make the mill inefficient and cause your material to heat up during grinding. When using a very fine screen (with holes less than 5/64 inch), you may need to use more screen area per horsepower because the screen has less open area.

Selecting the hammer pattern. The number of hammers in your mill is called the hammer pattern. For a large-diameter hammermill (with a diameter of 38 inches or more) that uses hammers over 10 inches long, the number of hammers you’ll need for a screen with large (at least 1/8-inch) holes is typically one hammer per every 2.5 to 3.5 horsepower. For a large-diameter hammermill with the same hammer size but smaller screen holes, you may need more hammers to prevent them from “rocking” back and forth on their pins and quickly wearing and enlarging the hammer holes. To produce a finer grind, you should also use more hammers. [Editor’s note: For more information on selecting hammers, see the “For further reading” section later in this article.]

Setting the tip-to-screen clearance. In most applications, the clearance between the hammer tip and screen has only minor influence on grinding performance. Generally, a larger tip-to-screen clearance provides the greatest grinding capacity and efficiency. For a fibrous or other tough-to-grind material, however, setting the hammer tip near the screen can achieve a finer grind, but this can also increase screen and hammer wear.

Setting the tip speed. To achieve a finer final size when using a screen with holes smaller than 1/8 inch, you should
use a high tip speed (greater than 18,000 fpm). This speed is more efficient in producing finer grinds and permits the hammer to do more of the grinding work, minimizing screen wear. Use a lower tip speed and a screen with larger holes to produce a coarser, more uniform grind.

**Maintenance steps**

Once the hammermill is installed and operating in your plant, it will require routine maintenance at regular intervals as well as some longer-term maintenance. You’ll need to perform regular hammermill inspections as part of your plant’s preventive maintenance program to spot worn parts or other problems and address them before grinding efficiency drops. Consult your hammermill manufacturer for detailed advice on inspection frequency, spare parts to keep on hand, and other maintenance issues.

**Routine maintenance.** Frequently inspecting your hammermill’s wear parts — screens, hammers, and pins — and replacing them when needed will ensure that the mill continues to produce the highest quality ground product at the lowest cost per ton. Worn parts lead to much higher production costs, including higher electrical costs as the hammermill runs longer to achieve the desired final product size. In fact, the energy cost to run a hammermill is typically five to ten times higher per ton of product than the cost of one set of the mill’s replacement parts.

Consider, for instance, a 100-horsepower hammermill that grinds corn. The cost of the mill’s replacement parts breaks down to $0.01 to $0.05 per ton of ground corn, and the mill’s energy cost per ton is $0.50 to $1.40. When the mill has a new screen, hammers, and pins, it yields 15 tph of ground product at a cost of $0.58 per ton (at $0.12 kWh). But when these parts are worn, the hammermill yields only 10 tph at a much higher cost: $0.90 per ton.

**Screen:** Inspect the hammermill screen daily for worn holes and other damage. When the screen is new, the hole edges are sharp and help direct most on-size particles through the hole, as shown in Figure 2a. But when the screen wears, the hole edges become rounded and deflect more on-size particles back into the grinding chamber, as shown in Figure 2b, rather than through the hole and out of the grinding chamber. This reduces the mill’s grinding capacity. Replace the screen whenever the wear causes the mill’s capacity to drop about 15 to 20 percent or product quality begins to deteriorate. Use a high-quality replacement screen with the same percentage of open area as the original screen and the same hole-staggering pattern. Some low-cost replacement screens have less open area (that is, more steel surface area between holes), which can reduce the hammermill’s grinding capacity by as much as 20 to 40 percent.

**Hammers and pins:** Inspect the hammers weekly for worn tips or hardfacing damage and hole wear. Replace the hammers whenever tip wear extends about 25 percent across the hammer width or hole wear has enlarged the hole more than 0.080 inch. More hammer wear not only reduces the hammermill’s grinding capacity and efficiency, but can severely unbalance the set of hammers on one rotor plate, causing serious mill vibration. Avoid replacing the hammers with low-cost hammers; such hammers often have inconsistent heat treatment and little or no hardfacing to protect the hammer’s working surfaces. This will cause them to wear unevenly, resulting in more mill vibration and lower grinding efficiency, and they’ll also require more frequent replacement, increasing your mill’s operating cost.

Inspect the hammer pins once a week for grooving. This wear pattern indicates that the hammer is damaging the pin at the point of contact. To prevent excessive wear that can lead to pin failure, it’s best to replace the pins whenever you change the hammers. If you must reuse a pin, rotate it end-to-end to ensure that the hammer is located in a new, less-worn spot along the pin.

Be aware that excessive hammer hole wear or severe pin grooving usually indicates that either the feed to the hammermill is inconsistent (that is, surging) and causing the hammers to rock on the pins, or you need a heavier hammer pattern (that is, more hammers). To eliminate the feed surges, repair or replace the feeder. A hammermill with a lower tip speed, such as a 38-inch-diameter mill with an 1,800-rpm motor, is more likely to need more hammers.

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**Figure 2**

**Effect of screen hole wear**

- a. Sharp hole edges direct on-size particles through hole, out of grinding chamber
- b. Rounded hole edges deflect some on-size particles back into grinding chamber
Hammers with better-quality hardfacing are also becoming more common, which helps the hammer tips last longer but exaggerates the problem of rocking on the pin when the hammer hole (which doesn’t have hardfacing) wears. In such a case, increasing the number of hammers per rotor plate may also help you prevent excessive hammer hole and pin wear. One caution: Consult your hammermill manufacturer before adding hammers to avoid any danger of overloading the rotor plates.

**Longer-term maintenance.** Other hammermill components besides the screen, hammers, and pins will require regular inspection and periodic replacement because they, too, are subject to wear, but they’re typically replaced at less frequent intervals. In general, these components should be made of wear-resistant materials and be heavy enough to provide a long service life. The components should also be reasonably simple to replace.

**Safety and interlock switches:** Check the hammermill’s safety and interlock switches once a month to ensure that they’re operating properly and protecting workers and equipment. Immediately repair or replace any malfunctioning switches.

**Rotor plate holes:** Once a month, inspect each rotor plate for wear that has enlarged the holes for the hammer pins. Replace the rotor plate if the holes are worn more than 0.080 inch. Also check the hammer pins at the point they contact the rotor plate, and replace the pins if they show grooving.

**Flow deflector:** The flow deflector at your hammermill’s feed inlet is subject to wear as it guides material into the moving hammers’ path. The material circulating in the grinding chamber constantly abrades the deflector’s back side, eventually causing enough wear to require the deflector’s replacement. Inspect the flow deflector for wear once a month. Depending on your material’s characteristics and the tons of material being ground per day, you may need to replace the flow deflector when the hammermill has been operating for 18 to 48 months. If you don’t replace the deflector in time, it can fail and fall into the hammers’ path, causing a catastrophic hammermill failure.

**Regrind chamber:** The regrind chamber, if your hammermill is so equipped, is also subject to constant abrasion by material and will eventually need replacement. Inspect the regrind chamber once a month. As with the flow deflector, you can expect to replace the regrind chamber after 18 to 48 months of operation, depending on your material and production rate, to prevent its failure.

**Breaker plates or bar:** If your hammermill has breaker plates or a breaker bar, these are also subject to constant abrasion and will need to be replaced at some point. Inspect the breaker plates or bar once a month, and be prepared to replace them after 10,000 to 20,000 operating hours, depending on their design and construction materials, your material’s characteristics, and your production rate.

**Screen carriage assembly or screen frame:** The screen carriage assembly or screen frame is also subject to material impact over the long term, causing it to wear and distort out of proper form, which can allow material to leak around the screen. This problem is especially troublesome for a hammermill used for fine-grinding material going into an extrusion process, such as for a pet food application, because a small number of oversize particles leaking past the screen can cause big problems for extrusion equipment. Inspect the screen carriage assembly or frame for wear once a month. Replace it if it’s worn or distorted to prevent leaks and restore your hammermill’s performance.

**Wear liners:** Every 6 months, inspect the hammermill’s wear liners. Replace them when wear exceeds more than 50 percent of the liner thickness, using new liners made from abrasion-resistant manganese steel (such as AR235 plate) rather than mild steel. The abrasion-resistant manganese steel *work-hardens* — that is, increases in hardness and wear-resistance — with use, outlasting mild steel by a factor of 2 in most applications.

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**The bearings supporting the rotor assembly’s shaft require regular maintenance to provide trouble-free operation over the long term.**

**Bearings:** The bearings supporting the rotor assembly’s shaft require regular maintenance to provide trouble-free operation over the long term. Good lubrication is key. Fortunately, a hammermill bearing doesn’t require frequent lubrication unless it has a leaking seal. On the other hand, if a bearing is overfilled with grease, its rolling elements are constantly turning through the grease, creating friction that causes excessive heating and can easily destroy the bearing. To avoid this problem, some plants remove the grease fittings that come with the hammermill bearings and lubricate the bearings themselves. In any case, you should remove the covers from your hammermill bearings every 6 to 12 months and carefully clean out the old grease. Repack the bearings from one-third to one-half full with new grease, and monitor the bearings closely for the first 8 to 12 hours of operation to ensure that they’re properly lubricated.

If the bearing has worn and requires replacement, make sure that you correctly position the new bearing on the rotor assembly’s shaft to prevent thrust loads (sideways loads, or loads parallel to the shaft) and adjust the bearing-
to-shaft clearance to the precise tolerance recommended by your hammermill manufacturer.

*Motor coupling:* Each time you start and stop the hammermill, the motor coupling connecting the motor to the rotor shaft is flexed and mechanically stressed. This stress, combined with the stress of the hostile environment typically surrounding the hammermill, will eventually cause the motor coupling’s elements, including the motor-mounting bolts, the coupling bolts, and bushing, to fatigue and fail. In fact, a badly fatigued coupling element or an out-of-alignment coupling is a common source of hammermill vibration. Every 6 months, inspect the motor coupling to verify that the coupling elements are sound and properly tightened, and then check that the coupling is properly aligned.

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**For further reading**

Find more information on hammermills in articles listed under “Size reduction” in *Powder and Bulk Engineering*’s article index in the December 2013 issue or the Article Index on *PBE*’s website, www.powderbulk.com.

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