Hammermill design tip for feed materials:

Producing a finer grind with a large-rotor, high-speed hammermill

A large-rotor hammermill has a higher hammer-tip speed, which increases hammer-to-particle impacts and improves grinding efficiency.

Changing a hammermill's screen hole size isn't the only way to control the ground material's particle size. Hammer-tip speed, which increases with a larger diameter rotor, also affects particle size. Read the information here, adapted with permission from an article in the September 1994 issue of *Feed Management,* to learn how higher hammer-tip speed in a large-rotor hammermill affects grinding speed, efficiency, and particle size for feed materials. The information relates primarily to reducing pelleted or extruded feed materials to a 75- to 600-micron mean particle diameter; other applications would require testing by the hammermill manufacturer.

You probably rate your hammermill's performance on its capacity to grind a certain amount of material in a given time. But this practice ignores the ground material's particle size, which is important to the material's handling characteristics and performance.

A common misconception is that changing your hammermill's screen hole size is the only way to control particle size. Hammer-tip speed is also important. In fact, if all other factors are the same, a hammermill with a higher tip speed produces a finer grind than one with a lower tip speed. Before considering how hammer-tip speed affects particle size, let's look at what happens inside the hammermill.

How a hammermill works

In hammermill operation, feed material flows through the material inlet and is guided into the hammers' rotation direction. The hammers reduce material by impact and attrition. The hammers impact the material while it's airborne, accelerating the material against the screen's inner surface and against the breaker bar. The particles that are too large to immediately discharge through the screen form a fluidized bed against the screen, where they're ground against the screen and against each other by attrition. Particles small enough to pass through the screen flow downward and exit the material outlet. The hammers continue to grind larger particles against the screen and the breaker bar until they're small enough to pass through the screen and exit the material outlet. Particles that otherwise might be trapped in the rapid circular airflow between the rotor assembly and screen are drawn through the screen by an air system.

Grinding efficiency

Impact is the more efficient of the two grinding forces. Thus, increasing the hammer-tip speed, which increases the amount of impact between hammers and particles, improves hammermill grinding efficiency. When two units run at the same motor speed, the unit with the larger rotor diameter has a faster hammer-tip speed. For instance, when a conventional hammermill with a 44-inch-diameter rotor (measured from hammer tip to hammer tip) rotates at 1,800 rpm, the hammer-tip speed is 20,724 fpm. When a hammermill with a 54-inch-diameter rotor[1] rotates at the same motor speed, it has a 25,434-fpm tip speed.

The large-rotor hammermill's construction permits it to operate safely at rotation speeds of more than 25,000 fpm. The hammermill's rotor shaft and plates are made from high-strength steel alloys that withstand large forces, and the rotor assembly is balanced to prevent excessive vibration. More hammers — typically 20 to 30 percent more — are mounted on the rotor than in a conventional hammermill. The large-rotor hammermill's bearing mounts, base, and frame are strengthened to support the unit and maintain its alignment.

The large-rotor, high-speed hammermill produces a finer grind and is more efficient to operate than a conventional hammermill equipped with the same size screen holes. But its greatest advantage is its grinding efficiency: It can produce the same mean particle diameter as a hammermill with a slower hammer-tip speed while using a larger screen hole size. In fact, if all other factors affecting the two mills' efficiency are equal, each unit's efficiency is directly proportional to its screen hole size. And if the two mills have the same size screen holes, the large-rotor, high-speed unit produces a finer grind.

Testing for speed, efficiency, and particle size

Efficiency tests[2] were conducted on hammermills with 44- and 54-inch-diameter rotors at a feed mill. The hammermills reduced postmix ground feed (coarsely preground feed ingredients that are mixed before finer grinding). Both mills were operated at 1,800 rpm, so the 54-inch unit had a higher hammer-tip speed.

Samples of the ground feed were collected from each hammermill for particle size analysis. The 44-inch mill had a screen with 6/64-inch (2.4-mm) holes and ground the particles to a mean diameter of 378 microns. The 54-inch unit had a screen with 8/64-inch (3.2-mm) holes and yielded particles with a 373-micron mean diameter. Thus, the mean particle size results were similar even though the 54-inch hammermill's screen had 33 percent larger holes.

Because the larger hammermill can finely grind particles using larger screen holes, the unit can be operated with a lower horsepower motor, which reduces its operating cost. Consider this example: A 44-inch hammermill grinds 50 t/h of corn through a screen with 1/8-inch holes and requires a 350-horsepower motor that uses 263 kilowatts of electricity. A 54-inch hammermill grinds the same amount of corn through a screen with larger (10/64-inch) holes. This unit requires a 300-horsepower motor that uses 225 kilowatts of electricity. Thus, reducing the motor size by 50 horsepower lowers electricity consumption by 38 kilowatts. These numbers translate into significant long-term cost savings. If the feed mill operated the large-rotor unit for 5,000 hours and electricity cost $0.06/kWh, the cost savings would be about $11,400 per year over using the hammermill with the smaller rotor.

Maintenance costs

The large-rotor, high-speed hammermill also has lower maintenance costs because the unit's hammers impact particles at a greater tip speed with less attrition. Less attrition reduces abrasion on hammers and screens, extending their service life.

Longer hammer life. Despite the greater number of hammers in the high-speed hammermill, the hammers yield more tons of ground material per hammer because they last about 33 percent longer than the conventional unit's hammers.

Longer screen life. In the high-speed hammermill, the screen does less work because most of the grinding occurs at the impact point between the particles and the hammers. The result is a longer screen life, which reduces costs. **PBE**

References

1. Champion model HM54-48 hammermill available from Roskamp/Champion, Waterloo, Iowa.

2. Test conducted by Roskamp/Champion, Waterloo, Iowa.

–Scott Anderson,
assistant sales manager
Roskamp/Champion, Waterloo, Iowa
319/232-8444