MILLING MENTOR

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The importance of feedrate control in size reduction

Size reduction, or *comminution,* plays an important role in many bulk solids processes in a wide range of industries. Depending on the industry served and the mechanisms used, size reduction may be called *crushing, grinding, milling, pulverizing,* or *slicing.* It may be used to reduce particle size or to increase surface area to boost chemical reaction rates, control power generation combustion rates, improve an active drug's bioavailability, change a food product's texture or "mouthfeel," increase a material's solubility, or improve a mineral extraction process's separation efficiency.

Approaches to size reduction vary according to industry practice, feedstock properties, and required product attributes. In mining, to make the desired minerals easier to extract, rock is often reduced to fine powder using a series of crushing machines that includes jaw or gyratory crushers, cone crushers, and ball and rod mills. In food processing, impact mills grind spices to powder, and high-speed precision cutters slice produce to usable sizes for consumption or for further processing, such as dehydration. In cement manufacturing, ball mills pulverize clinker. In power generation, coal is reduced in impact mills prior to combustion, and limestone is pulverized in roller mills before injection into the boiler to reduce sulfur compounds in the flue gas.

In all of these applications, efficiency, capacity, and reduction to the desired particle size distribution are of fundamental importance. In many cases, a company may consider a mill's feed system to be ancillary to the process and less important than the mill itself. However, ensuring reliable feed at a controlled rate influences the mill's production, operational costs, and, for some mill types, the discharge stream's size distribution.

Effective feedrate control also contributes to reduced energy use and maximizes equipment use. Size reduction as a unit operation is so widely used that it represents a considerable portion of the world's energy consumption. Studies estimate that between 1 and 10 percent of the world's total energy use goes toward size reduction in manufacturing.[1] A high proportion of the mining industry's energy consumption is for size reduction. One study of copper and gold mining in Australia concluded that between 21 and 52 percent of the total energy consumed in this industry goes toward size reduction,[2] and predictions are for this to increase in coming years as lower-grade ore deposits are mined, requiring mines to process larger ore volumes to extract the same amount of mineral.

While mining stands out because it handles large volumes of material and because the ore is sequentially crushed and ground from boulders to fine powder, energy consumption in size reduction applications is almost always a concern. Size reduction equipment often has a high capital cost, and it frequently requires substantial support equipment to operate, including surge bins, feeders, classifiers or screeners, conveyors, and more. Consequently, companies don't want to oversize equipment and

do want to operate a size reduction system close to its capacity. Because of its purchase, installation, and operating costs, a mill may define a manufacturing process's overall capacity, so it makes sense to operate it in a way that maximizes its capacity and the entire system's throughput.

Feedrate control can also influence a mill's effectiveness in achieving the required particle size distribution. Some size reduction equipment operates best when flood-fed. For example, a primary crusher handling ore — typically a jaw or gyratory crusher — may be fed directly from a truck dump or a belt or apron feeder that maintains a material level in the crusher's chamber. Undersized material falls through the crushing zone as the rock is reduced in size. For a system like this, feedrate control consists simply of maintaining a material level at the crusher's inlet so that the crusher can operate at its capacity.

Other types of size reduction equipment depend on an externally controlled feedrate to achieve the required particle size distribution, and the distribution can be affected by feedrate variations, particularly overfeeding. Hammermills, cage mills, and roll crushers are examples of mills that require external feedrate control. In these cases, the feed system must maintain the feedrate within a defined range so that the mill is neither over- nor underfed.

Size reduction equipment operates most efficiently, in terms of power consumption per ton, and effectively, from the standpoint of generating the desired particle size distribution, when the feedrate and the feedstock's size and composition are consistent. While starving a mill results in unused capacity, overfeeding can result in off-spec product, excessive power use, accelerated wear, and downtime resulting from plugging. Either over- or underfeeding a mill can generally be traced back to a poorly designed feed system in which the feedstock's properties weren't adequately considered.

A properly designed mill feed system can maximize the size reduction circuit's performance, not only by providing reliable material flow, but by delivering consistent feed to the mill, which allows it the opportunity to perform at its best. **PBE**

References

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