HOSOKAWA MICRON POWDER SYSTEMS

High Performance & Low Cost Size Reduction with the Mikro Pulverizer® Hammer Mill

By Rob Voorhees, President of Hosokawa Micron International Inc. – March 29, 2016

The Mikro Pulverizer® Hammer & Screen Mill combines a high speed mechanical impact mill with an outlet screen to control particle size. These hammer and screen mills are used in the production environment to provide continuous size reduction at high capacities for a variety of materials. This type of mill is used widely for the size reduction of powders in the Food, Chemical and Cosmetics Industries.

Size Reduction equipment for processing dry bulk materials is available in a variety of designs and sizes. This article is about the Mikro Pulverizer® Hammer & Screen Mill high speed hammer mill which can produce fine particles, with a nominal top size of 50 - 75 microns.

A hammer and screen mill provides impact grinding and top size control in one step. Material is metered into the mill through a volumetric screw feeder which is designed as an integral part of the machine. Material is impacted by a series of hammers that rotate at high speed. A screen at the outlet of the mill controls the residence time of the material in the mill to reach the desired final particle size. Processed material is gravity discharged from the mill and then can be air conveyed away to a product receiver for continuous material collection and system operation. The hammer mill can be equipped with wear resistant hammers, however there are few wear protection options for the screen and liners, which makes the processing of materials with a Mohs hardness of more than three (3) not practical from a component wear life and parts cost viewpoint.

These hammer mills can be provided in a variety of sizes with 1 horsepower and up to 350 horsepower. Typically food grade pulverizer are constructed in stainless steel; chemical grade are constructed in cast iron and steel.

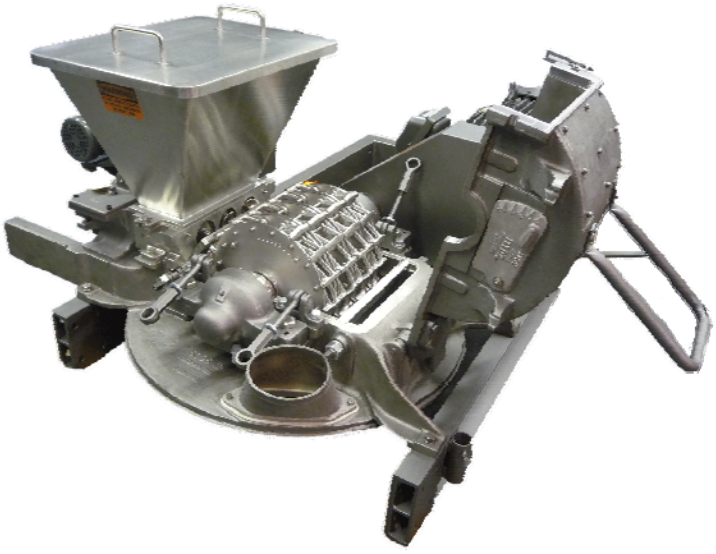
Application:

The Mikro Pulverizer® Hammer & Screen Mill can be used for pre-grinding, de-agglomeration and medium to fine size reduction applications depending upon the design and operating parameters of the mill and system. Pulverizers will typically produce products having a particle top size of 75 microns or finer. A wide range of particle size distributions with defined top sizes can be produced. Rotor speed, screen configuration and the type of grinding elements provide for flexibility in producing many different finished products.

As an example, the combination of higher rotor speeds, smaller screen openings and impact grinding elements with maximum surface area will generate the finest finished products. The combination of lower rotor speeds, larger screen openings and impact grinding elements with minimal surface areas will produce the coarsest products.

Basic Components

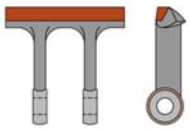
The mill components consist of a main body, mill cover, rotor assembly, feed mechanism and drive. This hammer mill design consists of rotor assembly with hammers that rotate inside a cylindrical housing. The top of the housing contains a multiple deflector liner (impact surface). Particles are accelerated into the liner by the impact force of the hammer. The impact breaks the particles into smaller pieces; the liner slows the peripheral velocity of the particles and deflects them back into the hammer path for further size reduction.



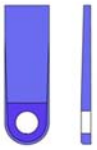
The lower half of the housing contains a screen. The screen is used to control the size of particles that exit the mill. Various screen types and perforation sizes are used to change the final product particle size.

The rotor of the mill acts like a fan and will generate some airflow, but it is relatively small compared to the volume of

material the mill can process, so heat generation will occur during the milling process and must be considered when designing a system around this type of mill. Air can also be conditioned to provide the appropriate operating temperature for the material being processed.

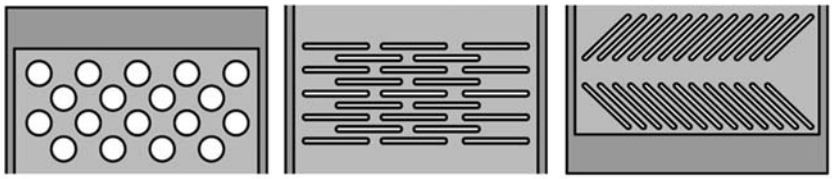


Most pulverizers are provided with a feed screw mechanism, designed to meter material into the mill, uniformly across the full face of the impact hammers. Uniform feeding and an even distribution of material is important to maximize horsepower utilization and capacity. Uniform feeding will also minimize the potential for overheating of the material and will reduce the potential for screen blinding.



There are basically three hammer types; the stirrup of LFS hammer, the swing bar hammer and the rigid bar hammer. The stirrup hammer has the most surface area and is used at high speeds to produce the finest particle sizes. The swing bar hammer is used on materials that do not respond well to impact. Fibrous materials that need to be cut or shredded work well with these types of hammers. The rigid bar hammer is used for coarse or granular size reduction and for producing narrower particle size distributions when a minimal amount of fines generation is desired. Hammer use stellite or tungsten carbide tipping to prolong the life of the hammer.

There are three basic variations of perforations used on the outlet screens to control particle size. They are round perforations, herringbone slots and cross slots. In addition, the size of the perforations and slots can be provided in many dimensions. Of these a screen with a round hole is structurally the strongest and will provide the finest particle size. In general slotted screens will produce slightly coarser products, but with larger open areas the problems of screen plugging or blinding are greatly reduced. Regardless of the screen type, all screens have dust seals at either end which seal the screen to the body and cover, prohibiting oversize particles bypassing the screen and affecting the final particle size distribution.



Operation – Controlling Particle Size

There are five basic parameters that affect overall particle size distribution. Process parameters include feeder speed and rotor speed. The major impact on particle size will be from the speed of the rotor. Maximum rotor speed will produce the maximum fineness. The other variables are the types of components installed in the mill, namely the hammer type, screen type and liner type. By making changes in these components and process variables we can affect not only the particle size, but the particle size distribution. As an example let's say we want a tighter particle size distribution. We would use the screen type to control the PSD top size and we would reduce the rotor speed to reduce the amount of fines generated thereby making a tighter/narrower particle size distribution.

Products

The list of materials and particle sizes demonstrate the flexibility and range of the machines processing capabilities.

- Sugar 150 µm
- Corn Starch 75 µm
- Oat Fiber 150 µm
- Melamine 250 µm
- Oxide 45 µm
- Gypsum 70 µm
- Stearic Acid 150 µm
- Soda Ash 80 µm

Variations and Options

A number of variations of the standard mill are available. Options are available for different feed arrangements, different grinding elements, different liners, different screens and different drives. There are many feeding options, but the most common is a volumetric screw feeder. The size of the feeder and number of screws varies with the size of the machine. The SCB feed hopper was designed to be used for air conveying light density material directly into the mill on a continuous basis. This feeding device and be used on all but the laboratory size mills and can be used whenever light density or sticky materials are required to be fed to the Mikro Pulverizer® Hammer & Screen Mill.

The “W” feed cover is used when larger feed materials need to be introduced to the mill. This feed option works well for large feed sizes of 1-2” inches or more. It is intended to be used with softer feed materials that are brittle and easy to fracture.

All Mikro Pulverizer® Hammer & Screen Mills that are designed for continuous operation are supplied with a discharge hopper attached to the outlet of the mill body. The air conveying discharge hopper is used when it is desired to convey material away from the mill on a continuous basis. The conical discharge hopper is used when it is desired to gravity discharge from the mill directly into a bin or storage hopper or when it is desired to discharge material into a pneumatic conveying system. In both cases the bottom of the hopper is provided with a rotary valve to provide a positive seal at the discharge of the mill system.

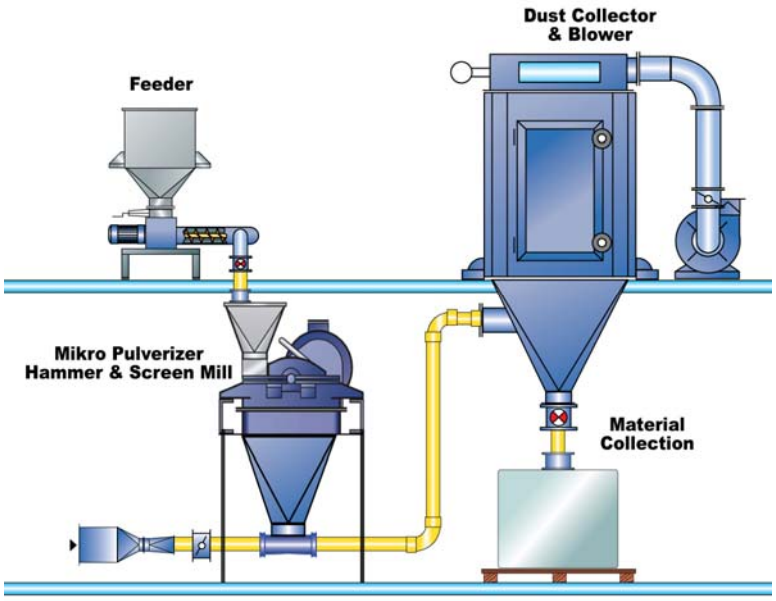
An air inlet manifold can be attached to the mill housing cover so that both cover inlets can be isolated when cooled or conditioned air needs to be introduced to the mill system.

Other options include shaft seals which provide a positive seal between the rotating shaft and the mill cover and body. The O-ring provides the seal to the mill cover and body. A cover seal can also be provided and it consists of a groove machined into the mill cover that accepts and O-ring that provides a positive seal between the mill cover and body. This option is used when the application requires that no air enter the mill or when the mill is operated with a positive pressure and it is desired to eliminate any material from escaping the mill.

The Mikro Pulverizer® Hammer & Screen Mill can be provided in a non-sparking design, where we use materials such as monel for the hammers and brass for the liner and screen, so that if contact inside the mill takes place, no sparks are generated. The vented rotor is used for better air distribution within the mill for cooling and uniform air intake. Uniform airflow through the mill helps to prevent buildup within the rotor. Recirculating oil lubrication system are provided for severe duty applications when mills are required to run at elevated temperatures or high loading over extended periods of time. Mikro Pulverizer® Hammer & Screen Mills are often used in cryogenic grinding applications as it is quite easy to inject nitrogen into the mill through a modified cover design and SCB feed inlet can easily accept a cryogenic feed tunnel.

Pulverizer Systems

The Mikro Pulverizer® Hammer & Screen Mill can be set up in several different system configurations. The smaller mills are designed for independent operation, each of these small machines is provided with its own integrated feed, air relief and product collection system. The larger mills are designed to be part of an integrated system designed for continuous operation. These systems have independent feeding and product collection systems. Since a hammer mill will generate airflow, the air generated during operation will have to be vented from the machine.



In basic Mikro Pulverizer® Hammer & Screen Mill Systems the mill and product receiver are mounted on a common hopper. Material processed by the mill and displaced air, flow to the product receiver. Particles entrained in the airstream are collected on the surface of the receiver filters and are discharged back to the hopper below. If required a fan can be used to pull a negative draft through the system. Negative pressure systems reduce or eliminate dusting to the atmosphere and result in a cleaner operation.

For continuous operation of the Mikro Pulverizer® Hammer & Screen Mill, material can be air conveyed away from the mill and collected in a downstream product collector. The valve you see located in the ductwork at the inlet of the conveying duct under the mill is used to regulate the amount of air pulled through the mill during operation.

When additional product sizing is desired the system can be designed to incorporate an inline air classifier or screening deck for more versatility. A high efficiency cyclone is effectively used to collect milled material greater than 20 microns. The discharge of the cyclone is gravity fed to a screening device that permits secondary classification of the milled product into two fractions.

Summary

To select the correct Mikro Pulverizer® Hammer & Screen Mill for your application you will have to provide some basic information about your application and material. This information will include your feed materials particle size and other characteristics (such as particle bulk density, cohesiveness, hardness, moisture content and melting point) and your final product's required particle size distribution. Testing of your material on a pilot scale system is recommended, as the results will help determine which mill size and configuration will be best suited for your application.