

Particle reduction technology

BY GREG ALLES

This chapter will deal with particle size reduction. It will not be exhaustive in nature, but we will cover the basic principles to consider when choosing and installing size reduction systems. We will concentrate on size reduction utilizing hammermills for the manufacturing of petfood. There are many types of designs and technologies utilized in particle size reduction; however, hammermills are generally accepted as the most efficient type of grinder for the manufacturing of petfood and aquatic diets and feeds.

The use of air-swept pulverizers is common in aquaculture feeds when the target particle size is in the range of 150 microns and smaller (see Table 3-1). In the use of air-swept pulverizers, hammermills are utilized in the initial size reduction.

We will try to concentrate our discussion regarding hammermills around the particle reduction of petfood. The basic guidelines will generally apply to other products, but the specifics may not be exactly the same. Petfood and aquatic feeds have some specific guidelines that may not be generally true for other products. The main premise of discussion will be towards energy and cost efficiency. Efficiency will be defined regarding long-term data and not the initial cost of installing a system. All too often, size reduction systems are designed and installed with inadequate funding being the primary decision maker.

Guidelines

Hammermill size reduction is relatively simple on the surface. There are some basic rules or guidelines to follow to ensure a successful system. We will cover most of the basic guidelines. However, size reduction systems can become very complicated and almost impossible to troubleshoot when some or many of these rules are not followed.

In my experience, a large number of size reduction systems that are currently operating are in violation of the majority of these guidelines. Most of these installations were installed fol-

Table 3-1. Hammermill screen size comparison.

Tyler	US	Opening in microns	Opening in inches	Opening in millimeters
3.5	3.5	5,664	.223	5.664
4	4	4,749	.187	4.749
5	5	3,987	.157	3.987
6	6	3,360	.132	3.360
7	7	2,819	.111	2.819
8	8	2,380	.0937	2.380
9	10	2,000	.0787	2.000
10	12	1,680	.0661	1.680
12	14	1,410	.0555	1.410
14	16	1,191	.0469	1.191
16	18	1,000	.0394	1.000
20	20	841	.0331	0.841
24	25	706	.0278	0.706
28	30	594	.0234	0.594
32	35	501	.0197	0.501
35	40	420	.0165	0.420
42	45	353	.0139	0.353
48	50	297	.0117	0.297
60	60	250	.0098	0.250
65	70	212	.0083	0.212
80	80	178	.0070	0.178
100	100	150	.0059	0.150
115	120	125	.0049	0.125
150	140	103	.0041	0.103
170	170	88	.0035	0.088
200	200	73	.0029	0.073
250	230	64	.0025	0.064
270	270	53	.0021	0.053
325	325	42	.0017	0.042
400	400	37	.0015	0.037

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lowing these guidelines but over time have been altered for one reason or another, and no longer retain their ultimate efficiency potential. Another reason is that the guidelines have been refined in recent years and a lot of systems were installed under fewer and less stringent guidelines.

All size reduction systems should be reviewed on some type of periodic basis. Most particle size reduction experts or manufacturers are more than willing to offer and perform evaluations and make recommendations on existing size reduction systems. There is an old saying that "a man cannot learn if he thinks that he already knows." Most learning takes place through the careful evaluation of all the available information and then applying that which has the most merit for the current situation.

There are very few absolutes in size reduction. There are many ways to accomplish the same thing. When somebody says that there is only one way to accomplish certain size reduction goals, it is usually ego and ignorance talking. The correct system to install is the one that will accomplish your particle size reduction needs. General guidelines are just that, "general" and "guidelines."

The general variables (the author concedes that there could be more variables that are not listed) affecting grinding or size reduction efficiency are:

- Type of ingredients to be reduced in size;
- The soundness of the hammermill design;
- The method of sizing a hammermill for a particular application;
- The peripheral tip speed of the hammermill rotor;
- The hammer arrangement, or pattern of the hammers in the grinding chamber;
- The design of the air system used for assisting the grinding process;
- The type and design of the product feeding or introduction into the hammermill;
- Tramp metal protection;
- The installation of the hammermill system;
- The process flow or design of the manufacturing process; and
- The preventive maintenance schedule and program.

Ingredients

It is very important to remember that ingredient quality varies. Whether your ingredients include grains, protein meals or other by-products, there is always a certain amount of variation in these ingredients on a regular basis. Weather can affect growing conditions of grains and therefore the physical characteristics of the grains. These physical changes can affect the ability of these grains to be reduced in size at efficient rates and the uniformity of the particle size reduction. In most cases, the variation is slight, but in certain cases it can cause size reduction systems to fall below their needed capacity range to maintain manufacturing goals.

Protein meals and by-products can be affected by supplier

processes and variations in the type of equipment used in the processes. The moisture content and fat percentages of an ingredient can also affect the grinding efficiency of the hammermill. A higher than normal moisture content will not necessarily adversely affect grinding capacity, but it will affect particle size. Generally speaking, a smaller, perforated screen will be needed with ingredients of higher moisture (15% to 17%) content to achieve the same particle size as grinding ingredients with lower moisture levels.

The smaller screen will reduce grinding capacity. Also, higher fat contents will reduce capacities. Fat contents of 12-14% in the mixed formula to be ground through the hammermill will tend to seal closed the perforated openings in the hammermill screen. Hammers will need to be placed closer to the screen in order to keep the screen holes open. Capacity and hammer clearance will be discussed later in this chapter.

GMO considerations

Genetics is a big topic of discussion these days. The new genetically-modified (GM) varieties of grains are causing much discussion as well as processing problems. It is difficult to say which GM varieties are causing the processing problems. Grain identity is not preserved unless grains are grown and segregated for storage. This makes it difficult for most people to trace the origins of the ingredients.

We are aware of many grinding problems developing in grains that were not existent four or so years ago. The grain kernels tend to powder with certain GM varieties, which is great if you want to grind to a fine particle size, but can reduce capacity by as much as 50% in the grinding of the grains alone. It can also produce problems in other areas of the process.

This topic is getting a lot of attention by size reduction manufacturers and processors. However, complete data and information are still in the developmental stage. It is something to be aware of and check if there are new capacity problems with your process that seem to appear overnight.

Hammermill design

There are several different types of hammermill designs that are being used out in the industry. We will concern ourselves in this chapter with the two prevalent designs being sold currently in the market. The first is the full-circle or teardrop design (see Figure 3-1) and the second is the impacting or grinding plate design (see Figure 3-2). The impacting plate design will usually achieve a smaller or finer particle size reduction and utilize more horsepower. The teardrop design will achieve more capacity with less horsepower, but will not achieve the same particle size or fineness.

The teardrop design has a full-circle or teardrop designed grinding chamber. This allows the hammermill to operate both clockwise and counterclockwise (bi-directional). The perforated screen will be the outer surface for almost the entire grind-

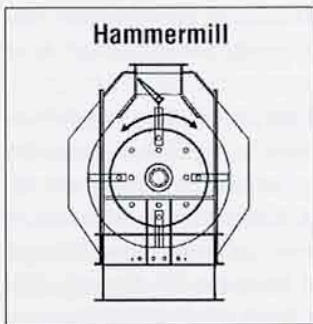


Figure 3-1. Full-circle or teardrop design hammermill.

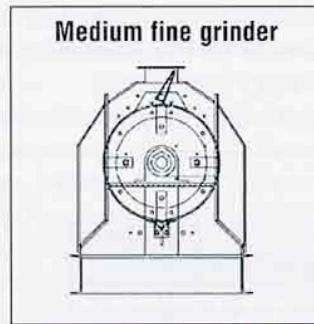


Figure 3-2. Impacting or grinding plate design hammermill.

ing chamber. Most have a top center feed inlet. There is a small impacting plate area to both sides of the feed inlet. The balance of the entire grinding chamber is made up of perforated screen held by some type of locking carriage. Good designs have internal flow interrupters to keep the product and air flow under control.

The impacting plate design has a full-circle or abbreviated full-circle designed grinding chamber. Some have an offset top feed inlet and others have a top center feed inlet. The offset inlet does not allow for bi-directional operation. The top center inlets allow bi-directional operation. The impacting plate design has about one-half to two-thirds of the perforated screen area as the teardrop design. The other half of the screen area is replaced with impacting or cutting plates. The idea is to impact the product multiple times against the plates before allowing the product to escape through the perforated screen openings.

The best of both designs has replaceable internal wear plates. The rotor is supported by bearings that are located outside of each side of the grinding chamber (no over-hung rotor). The screen carriage is a one-piece, heavy-duty design that is capable of allowing a positive screen seal to prevent product leakage from the grinding chamber. The screen carriage design allows for quick and easy screen change. The mill housings, doors and bearing bases are made from thick-plate steel.

The main shaft is large enough in diameter to allow a minimum of flex in the shaft during operation. The rotor is not welded. The main mill housing has greater longevity and smoother operation if it is constructed in one piece. These are the major individual features of a good design.

Hammermill sizing

There are two types of hammermill designs that we have discussed. However, we will discuss only one sizing method, which applies to the teardrop or full-circle design. This design requires careful attention to the ratio of screen area to horsepower. Actually, we will look more specifically at the ratio of open screen area to horsepower.

Different screen sizes are manufactured with different amounts of open screen area. For example, a standard 4/64-in. (1.588-mm) perforated screen has 30% open screen area (see

Figure 3-3). Screen sizes utilized in petfood and aquatic grinding systems can differ greatly in the amount of open area (see Figure 3-4). Sometimes the same screen size can vary in open area, depending upon the supplier (see Figure 3-5). Look at the 3/64-in. (1.191-mm) screen in Figure 3-5. A 3/64-in. screen can be purchased with 23% and 27% open area. Screens should always be purchased with the largest amount of open screen area.

For example, one person can walk through a door very easily. If two people try to walk through that same door, it can be done, but the space is tighter. Now think of three or four people through the same door and then ten or eleven. All the people cannot fit through the door at the same time. If all of them try at the same time, confusion results and some will be knocked backward and will need to try again to exit the door. Now, double the size of the door, and we will have more room to let the same number of people exit. More people will be able to exit easily before confusion sets in and people start to get knocked back and will need to try a second or third time in order to exit the door. The same scenario is true in a hammermill grinding chamber.

If you have 1,000 square inches of screen area and a 100-horsepower motor, then you will have a ratio of 10 square inches of screen area per horsepower. If you are grinding your product through a 4/64 (1.588-mm) perforated screen, you will have three square inches of open screen area per horsepower. A 4/64 (1.588-mm) perforated screen will commonly have only 30%

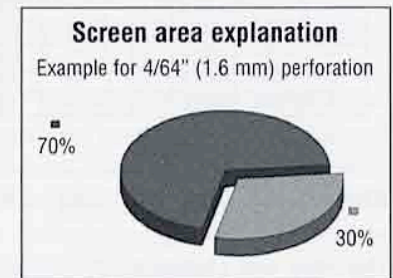


Figure 3-3. Screen area explanation. Example for 4/64-in. perforation.

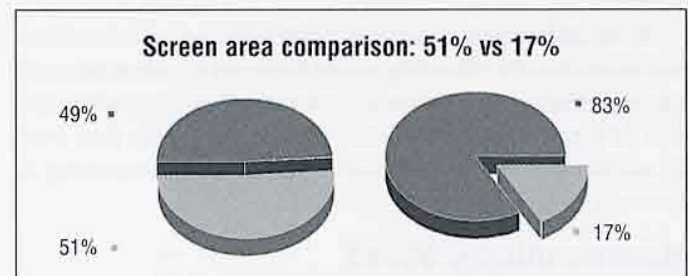


Figure 3-4. Screen area comparison: 51% vs. 17%.

open area. This means that only 30% of the 1,000 square inches of screen area is open and will allow product to flow out of the grinding chamber. This scenario will have 300 square inches of open screen area for the 100 horsepower motor.

Let's say that the above application needs to grind 12,000 pounds per hour of a petfood mix. Twenty pounds of the petfood mix will need to go through the three square inches of open screen area every minute. Three square inches is approx-

imately equal to a one and three quarters of an inch square (4.5-cm) opening.

Now, let's double the screen area. We will increase the screen area from 1,000 square inches to 2,000 square inches.

Screen area						
Hole diameter				% Open		
No.	in	in	mm	GA	H	C
1	1/64	0.020	0.5	26	23	23
1.5		0.027	0.7	24	15	N/A
2	1/32	0.033	0.8	22	18	22
2.5		0.040	1.0	24	24	N/A
3	3/64	0.045	1.1	20	23	27
3.5		0.050	1.3	18	N/A	25
3.5		0.055	1.4	20	N/A	31
3.5		0.060	1.5	18	33	N/A
4	1/16	0.063	1.6	16	30	30
5	5/64	0.079	2.0	14	36	36
6	6/64	0.095	2.4	14	40	32

Hole diameter						
No.	in	in	mm	GA	H	C
7	7/64	0.109	2.8	14	42	36
8	1/8	0.125	3.2	11	40	40
9	9/64	0.140	3.6	14	51	N/A
10	5/32	0.156	4.0	10	36	36
11	11/64	0.172	4.4	10	43	N/A
12	3/16	0.188	4.8	10	41	53
12	3/16	0.188	4.8	3/16	41	41
14	7/32	0.219	5.6	10	45	36
14	7/32	0.219	5.6	3/16	45	N/A
16	1/4	0.250	6.4	10	40	40
16	1/4	0.250	6.4	3/16	40	40
16	1/4	0.250	6.4	1/4	40	N/A

Figure 3-5. Open screen area comparison.

The ratio will change to 20 square inches of screen area per horsepower. The same 4/64 (1.588-mm) screen with 30% open area will give us six square inches of open screen area per horsepower. We have doubled the amount of open space that the product can utilize to escape the grinding chamber. We now have an area that is twice the size. We now have 600 square inches of open screen area for our 100 horsepower motor. This will allow more products to leave the grinding chamber at the same time.

The rule of thumb for petfood and aqua feeds is to size your hammermill initially with 24 square inches of screen area per horsepower. The minimum is 20 square inches per horsepower. This will allow a range of 6.0 to 7.2 square inches of open screen area per horsepower, utilizing a 4/64 (1.588-mm) screen.

Sizing the screen area smaller will generate additional heat and/or reduce the efficiency of the hammermill. Heat is one of the biggest enemies to an efficient hammermill grinding system. If your hammermill system is generating more than a 10° F temperature increase above ambient, then something is wrong with your system.

Hammermill tip speed

The peripheral speed of the hammer tips will have an effect on the particle size. Simply, the faster the peripheral speed of the hammers, the smaller the particles produced by the impact of the hammers. Generally speaking, the larger the diameter of the hammermill from tip to tip with the hammers extended, the faster the peripheral speed of the hammermill. This is always true as long as the same operating speed is being applied to the main shaft when comparing tip speeds of different diameters. However, increasing tip speed does not always result in increased efficiency when finer or smaller particles are the

desired result. That is why product testing is always a very prudent method in determining the proper tip speed, as well as in sizing a hammermill.

Through the years, I have heard people mention that they do not want a high-speed hammermill. The statement reflects the belief that a slower hammermill is more efficient than a high-speed hammermill. Usually, this is referring to a 3,600-RPM (revolutions per minute) hammermill as a high-speed mill and a 1,800-RPM mill as a slow-speed mill. This is true in reference to the main shaft speed but not about tip speed. A 22-inch diameter mill direct-coupled to a 3,600-RPM motor will have the same tip speed as a 44-inch diameter mill direct-coupled to a 1,800-RPM motor (see Table 3-2). Both mills will have a tip speed of 20,735 feet per minute (FPM) at a true 3,600 and 1,800 RPM, respectively.

Table 3-2. Hammermill tip speeds. Note: 1,500 RPM and 3,000 RPM for 50-cycle, all other RPMs for 60-cycle.

Diameter size	3,000 RPM	3,600 RPM
19-in. diameter	14,923 FPM	17,907 FPM
22-in. diameter	17,279 FPM	20,735 FPM
24-in. diameter	18,850 FPM	22,620 FPM
26-in. diameter	20,420 FPM	24,504 FPM
	1,500 RPM	1,800 RPM
38-in. diameter	14,923 FPM	17,907 FPM
44-in. diameter	17,279 FPM	20,735 FPM
48-in. diameter	18,850 FPM	22,620 FPM
52-in. diameter	20,420 FPM	24,504 FPM

In general, petfood and aquatic feeds require the smallest particle size that they can achieve. The faster peripheral speed will achieve a smaller particle size. Therefore, larger diameter mills should be the choice for this application. However, through years of observation and many applications, the choice is not so easy. Many people choose a diameter in the middle range; however, there are other considerations besides particle size to consider. Among the considerations are energy consumption of the equipment, as well as the digestibility and palatability of the finished product.

Hammer patterns

The term hammer pattern refers to how the hammers are arranged in the grinding chamber. It is generally considered very important for the immediate trailing hammer to not "track" with the hammer preceding it. Tracking can be defined

as a following hammer that travels over the same space or holes in the grinding chamber. Tracking hammers will travel over exactly the same screen openings.

Hammer patterns are staggered for the maximum impacting efficiency (see Figure 3-6). Staggered patterns provide better representation over the screen area, which will result in cleaner screen openings. Clean or open screen openings are critical in petfood grinding applications. Blocked or plugged screen openings cause a reduction in capacity and generate additional heat (see Figure 3-7). Blocked or plugged screen openings will effectively reduce your screen area and open screen area per horsepower. Blocked screen openings will increase motor amperage load and wear to the parts in the grinding chamber.

Most hammermill rotors are drilled with two sets of hammer rod or pinholes in the rotor plates. One set of holes allows an approximate 3/16-in. hammer-to-screen clearance, while the second set of hammer rod holes allow for an approximate 0.5-in. hammer-to-screen clearance. The four holes that allow a 3/16-in. setting are known as the four-row outside, or fine setting, and the four holes that allow the 0.5-in. setting are known as the four-row inside, or coarse setting.

There is a hammer pattern that is used very often in petfood applications that utilizes both settings. It is referred to as an eight-row hammer setting. It disperses the amount of hammers that were on the four-row patterns and spreads them over eight rows. This pattern usually achieves a tighter particle size range. The most efficient hammer pattern needs to be carefully considered for each individual location, application and formulation.

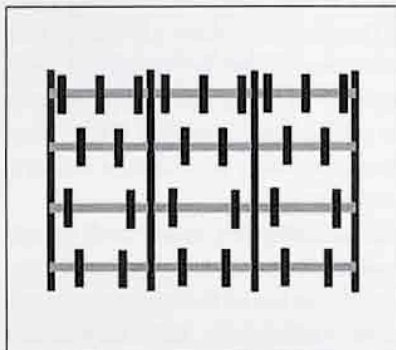


Figure 3-6. Hammer pattern example.

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The general rule for the amount of hammers for a given

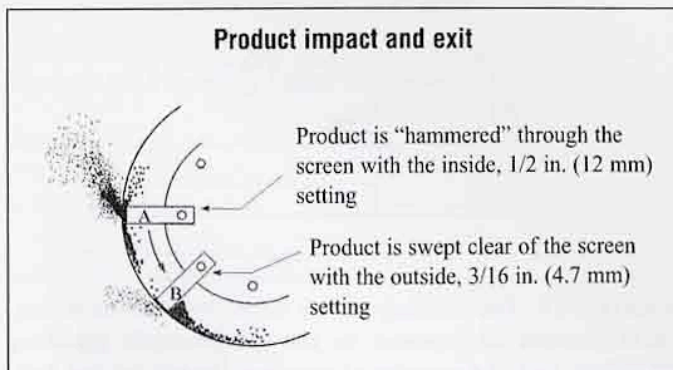


Figure 3-7. Blocked or plugged screen openings cause a reduction in capacity and generate additional heat.

hammermill horsepower is one horsepower per hammer for 3,600-RPM mills and two horsepower per hammer for 1,800-RPM mills. This ratio will be used plus or minus, dependent upon the particular hammermill and the application goal.

Air-assist systems

There are two primary air-assist system designs that we will discuss. The first is a hammermill with a bottom outlet discharging into a plenum chamber with a bin-vent filter installation (see Figure 3-8). The second is a hammermill with an air pan discharge for pneumatic product conveying to a filter receiver (see Figure 3-9).

The bin-vent filter design is my personal favorite. This design allows the ground product and the fine particulate collected by the bin-vent bag filter to be discharged into one common conveyor. The integrity of the batch is retained. This system eliminates the need for another conveying or collection system discharge that requires the product to be reintroduced with the original ground material. In other words, if the system had a remote filter collection (see Figure 3-10), the collected material would need to be conveyed or spouted to be reintroduced with the ground material or discarded.

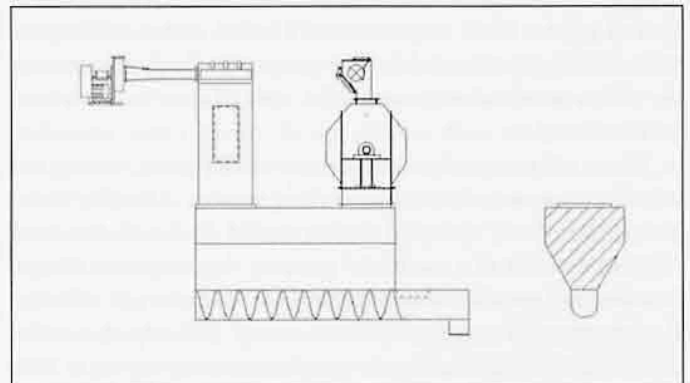


Figure 3-8. Air relief system with bin vent.

The plenum is the bin-vent filter hopper as well as the hammermill discharge hopper. This simplifies the system to one discharge conveyor and one airlock. The only air piping is from the

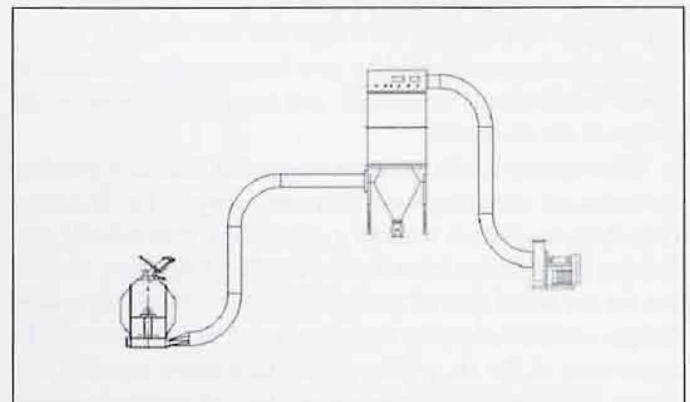


Figure 3-9. Negative air system.

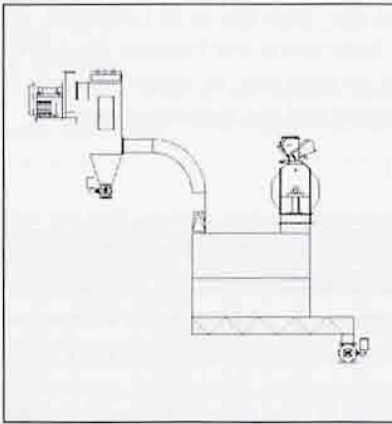


Figure 3-10. Air relief with remote filter collection.

bin-vent bag filter to the fan. Additional conveyors, spouting and air piping are eliminated. The ground product can then be conveyed pneumatically more efficiently by a pneumatic blower package from the discharge of the airlock located at the outlet of the plenum discharge conveyor or mechanically conveyed.

The second system retains the integrity of the batch also. This design allows the hammermill to be located on or near floor level. All mechanical conveyors are eliminated. The air-assist system that helps the grinding process and the air conveying system is one and the same. This system requires heavier air conveying pipe and replaceable flat-back elbows. Additionally, the air system design usually requires more cubic feet per minute (CFM) of air and greater static requirements. The fan motor will require more horsepower than a bin-vent air system; however, because the mill is installed on ground level, a lot of structural steel can be eliminated.

There are many important aspects to designing, sizing and installing a successful hammermilling system. After the initial sizing procedure, air-assist design would likely be the most important aspect of a successful system. The air system design, function and installation need to be done accurately in order for the hammermill grinding system to work properly. A poorly-designed or installed air system can cost a company up to 50% of the production design capacity.

In other words, the air system is not the area to cut corners. A well-designed and installed air system can cost 30-40% more money, but will pay huge dividends in increased capacity over the life of the system. On the other hand, an air system that is designed poorly will not only hinder production, but will cause unexpected downtime for troubleshooting and maintenance. It pays to pay more and to do it right the first time. Air system requirements recommended by your hammermill manufacturer should be discussed extensively and highly considered in the design of the air system.

When I receive calls from customers that their new grinding system is not achieving the anticipated capacity, the first thing I ask them to check is their air system and if it is actually performing to the design criteria. In over 90% of the cases, the reason for the initial lack of performance is due to the air system design, installation or the functionality of the air system. The importance of the air system cannot be stressed enough. It is vitally important that the air system be designed and operate properly. There are no exceptions.

There are “rules of thumb” regarding the amount of air required for a hammermill grinding system. The rules vary from one CFM of air volume per square inch of hammermill screen area, to three CFM per square inch of hammermill screen area. “Rules of thumb” will get you into trouble if they are used in a general sense. Different designs will have their own requirements; however, the one thing that can be assumed is that you will need an air system and it will need to work effectively. Otherwise, there will be production problems; excessive parts replacement and dust problems; explosion hazards; excessive heat; and possible product damage.

Feeders

There are many types and designs of feeding devices on the market today. There are also many of these that will adequately work in a hammermill application. However, there are two critical criteria for a proper feeding device. They are that the feeding device provides a uniform curtain of product to the hammermill grinding chamber and that the curtain of product be fed full-width or near full-width across the hammermill grinding chamber (see Figure 3-11). Any deviation from these two criteria will hurt the performance of the hammermilling system.

There are three main types of feeders provided with hammermill grinding systems. They are the rotary cup feeder (see Figure 3-12), vibratory feeder (see Figure 3-13) and the traditional screw feeder (see Figure 3-14). The rotary cup feeder is the most widely used in the petfood industry. This feeder, supplied with round bottom cups, provides a consistent uniform curtain of product to the hammermill.

The rotary feeder should be choke-fed, which will ensure the full-width or near full-width feed to the hammermill. The rotary feeder is mounted directly on top of the hammermill and is very compact in its design. Additionally, the rotary feeder can be manufactured in combination with magnetic protection and still maintain a compact height.

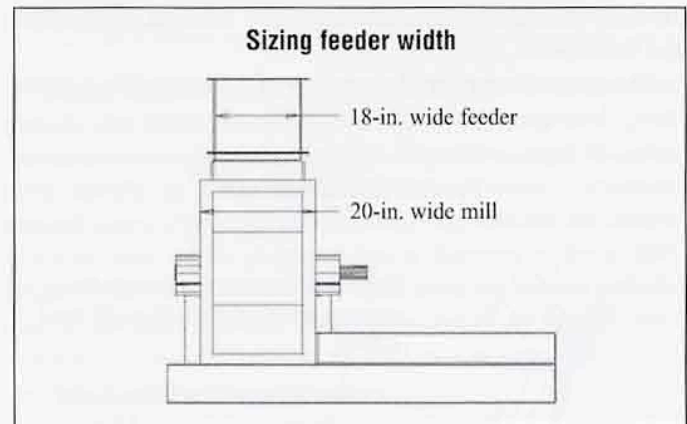


Figure 3-11. The feeding device needs to provide a uniform curtain of product to the hammermill grinding chamber and the curtain of product should be fed full-width or near full-width across the hammermill grinding chamber.

Regardless of the type of feeder, it should be installed with a variable-speed drive. The variable-speed drive should be able to read the amperage of the main drive motor and adjust the feeder speed to ensure that the feeder does not provide more product than the main drive motor can tolerate. You do not want your main drive motor to overload and shut down or burn up.

Magnetic protection

All hammermills should be installed with magnetic protection from tramp metal. The magnet protection should be easy to clean. The magnet's ability to provide protection will be directly related to how often the magnet is cleaned.

The best place to install magnetic protection for a hammermill is directly above or before the product enters the hammermill. As mentioned above, the rotary feeder can be manufactured in a compact design that includes magnetic protection.

Hammermill installation checklist

The first step in installation of a hammermill is to closely follow the manufacturer recommendation. If you desire the

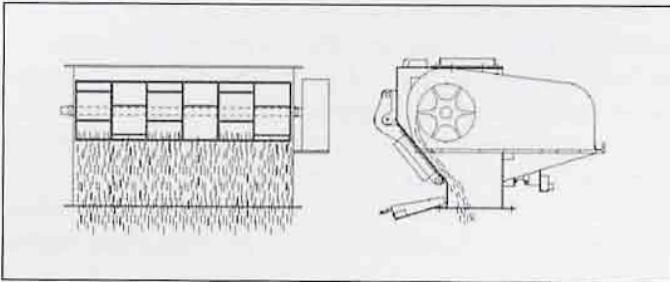


Figure 3-12. Rotary cup feeder example.

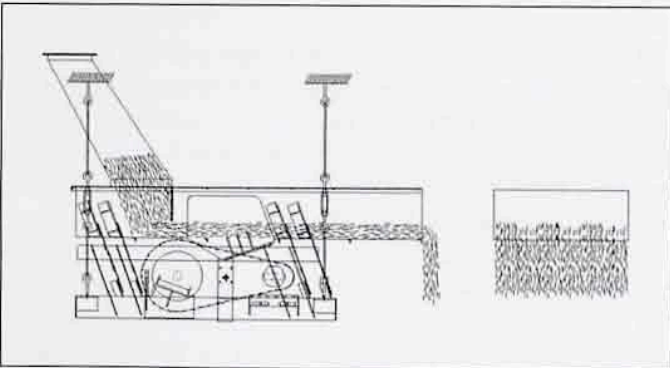


Figure 3-13. Vibratory feeder example.

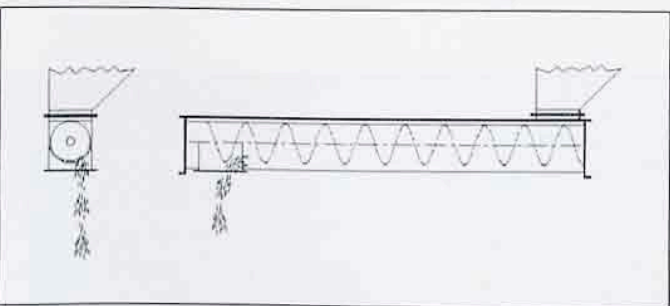


Figure 3-14. Traditional screw feeder example.

manufacturer to back-up their equipment and provide good service, then the least that can be done is to follow their recommendation on the installation. They have more experience with their equipment and users should respect their knowledge and experience regarding their equipment. However, on another note, the manufacturer and customer should work closely, because the customer is an expert on their business and the manufacturer is an expert on their equipment. The best installations are the ones where the customer and manufacturer work together to provide an installation that will be the best for both.

1. The first aspect of a hammermill installation is to place rubber mounting pads at the corners of the hammermill base (see Figure 3-15). Elaborate isolation mounting springs can be used but are not necessary. A shock absorbent soft rubber or 1-in. thick pad of neoprene works well. Do not tighten the hold-down bolts too much. This will remove the vibration and noise absorption that the pads can provide.

2. A hammermill should be installed with a reversing starter. This will allow the rotation of the hammermill rotor to be changed from clockwise to counterclockwise on a regular interval for better hammer and screen wear. The money saved on parts usage will pay for the reversing starter quickly.

3. The equipment before and after the hammermill should be interlocked in the motor control center. For example, if the hammermill discharge conveyor shuts off, then the hammermill feeder motor should shut off automatically. Every piece of equipment down stream in the process flow should be interlocked with every piece of equipment up stream. Otherwise, a lot of equipment damage and lost production time can occur. At the time of start-up all interlocking should be checked to be sure that everything is properly wired.

4. The hammermill should be installed with a load-minder control system. This system allows for the speed of the feeder to be adjusted automatically by the amperage reading of the main drive motor of the hammermill. The control allows for the set-point amperage to be chosen by the operator. This allows the hammermill to be operated at the maximum amperage loading without overloading the capability of the main drive motor. This control system should allow for the hammermill to achieve the maximum capacity on a consistent basis.

5. A temperature monitoring system for the main shaft ham-

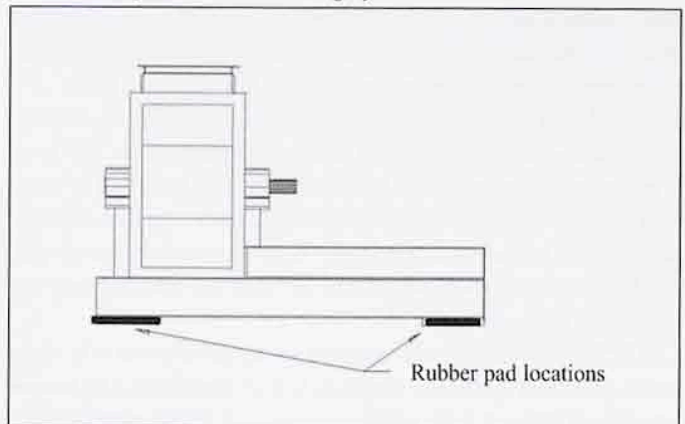


Figure 3-15. Rubber pad mounting locations.

mermill and motor bearings is recommended. This system is not absolutely necessary, but it helps with the maintenance and unexpected downtime for your hammermilling system. Another nice touch is a temperature sensor for the hammermill grinding chamber. This will alert you to the fact that the grinding chamber is operating under unsafe high temperatures.

6. The product feeding area needs to be designed to allow air to enter the hammermill with the product. The general rule is to have an opening equal to 3.5 inches by the width of the hammermill grinding chamber. The absence of this opening will short-circuit your entire grinding system. The premium that you just spent on a nice air system is being wasted. However, this is one of the easiest things to fix after the fact.

7. The feeder of the hammermill will need to be choke-fed. If the feeder is not choke-fed, then the possibility of an uneven feed across the width of the grinding chamber is high. If the grinding chamber is not evenly fed, then capacity will be a problem. Also, the internal parts of the hammermill will wear quickly in the areas receiving the product. The best way to check for proper feeding is to check the wear in the grinding chamber after the first week of operation.

8. The discharge parameters of the hammermill will also need to be considered. This is not an issue with the air-pan discharge installation. However, with the plenum-chamber installation, the height between the hammermill discharge and the discharge take-away conveyor will need to be a certain distance. This distance will need to be between 18-36 inches, dependent upon the hammermill size. If the hammermill discharge is too close to the discharge conveyor, then the hammermill will not be able to achieve its maximum capacity. It creates a reverse pressure and hinders the grinding process.

9. The size of the plenum chamber is also important. Most people make the plenum chamber too small. You cannot make a plenum chamber too large. The bin-vent filter mounted directly on the plenum chamber almost makes it impossible to make it too small. The filter is such a size that it forces the plenum chamber to be a certain width and length. This is another reason why I like the bin-vent bag filter mounted directly on the plenum chamber, because the plenum chamber needs to be a certain size in order for the bin-vent filter to be mounted on the chamber. The cross-sectional area of the plenum needs to be a large enough area to allow the product to settle out of the air stream. The smaller the cross-sectional area translates into more pressure and maintenance for the bin-vent bag filter.

10. The air system's air-piping diameter needs to be checked and double-checked for proper size before purchasing. Nothing is more aggravating than to have a beautifully-installed system, only to find out that it is not working, and it's all because the air piping is too small or too large. This is critical on the air-pan discharge systems. A little time at the start can save a whole lot of trouble and cost at the end.

11. The last thing I will mention about installation is to store and house the equipment properly before installing. Do not let equipment arrive to the jobsite and sit out in the elements for

days and months. This can cause huge problems at start-up and later. You may void manufacturers warranties and create problems that you will be forced to live with for the entire life of the equipment. Always store the equipment upon arrival in a covered, dry environment.

Process flow

There are many process flow arrangements being utilized in the petfood and aquatic industries. Among them are post-grind, post-mix grind, hybrid-batch grind, post-mix regrind, post-grind screen and many variations of each method. Some of these names or terms are actually the same process—just a different way of saying the same thing. However, there are differences, and these differences can affect the particle size and capacity of the hammermilling system. That is why it is very important to communicate with your supplier and offer them clear direction on the process flow that you will utilize. Your supplier will use different sizing criteria dependent upon the process flow of the system.

Preventive maintenance

Preventive maintenance is very important for a successful grinding system. You may have the best process flow and install the best equipment in the world, but it will not be any better than the preventive maintenance program that you follow. What good is the best equipment in the world if it is broken down and not operating because of poor maintenance?

Again, my recommendation is to communicate and follow the manufacturer's instructions. Things that may appear similar may in fact be different. So do not make assumptions that could cost you lost production and quality. Manufacturers are always happy to work with customers on details of proper preventive maintenance.

Hammermilling systems appear to only relate to horsepower on the surface. The fact is, that horsepower is only part of the equation. In order to produce the maximum amount of product to the highest quality standard, there are several other variables that need to be considered. We have only touched the surface regarding the main considerations.

Do not let anyone talk you into installing an inefficient grinding system. A poor system will cost you money every day that it operates, while a well-designed, sized and installed system will pay you dividends for its entire operating life. It will add to your bottom line. It's just good business to do it right. The time dedicated to designing, sizing and installing the "best" hammermill grinding system is time well spent.

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