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Abstract

Quality feed can be manufactured on farm using hammer or roller mills for particle size reduction and volumetric or weighing devices for proportioning ingredients. An understanding of each of the seven steps involved will enhance the ability to manufacture a quality feed for maximum feed efficiency at a feasible price.; Swine Day, Manhattan, KS, November 15, 1990

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FEED MILLS FOR ON-FARM FEED MANUFACTURING

J. P. Murphy and J. P. Harner[1]

Summary

Quality feed can be manufactured on farm using hammer or roller mills for particle size reduction and volumetric or weighing devices for proportioning ingredients. An understanding of each of the seven steps involved will enhance the ability to manufacture a quality feed for maximum feed efficiency at a feasible price.

(Key Words: Process, Swine, Diets.)

Introduction

Quality swine feed can be manufactured on the farm with many different types of equipment, as long as the feed mill operator understands the limitations of his feed processing equipment. Seven steps are necessary to manufacture feed: acquire ingredients, store and retrieve ingredients, reduce of particle size, proportion ration, mix ration, store ration, and deliver ration.

Hammer Mills

Reducing particle size normally involves two types of mills, hammer mills and roller mills. Hammer mills have the following characteristics relative to roller mills:

1) easier maintenance
2) higher horsepower
3) process wider variety of materials
4) greater range of particle size
5) nosier
6) more dust
7) greater capacity per size

Hammer mills are advantageous because they will handle any combination of grains and have a low maintenance cost. These mills will grind all kinds of feed including hay and are used when it is desirable to mix hay and grain for a ration. Particle size reduction occurs in three ways: 1) explosion from impact of the hammers; 2) cutting by the edge of the hammers; and 3) attrition or rubbing action. The rubbing action is important with small cereal grains and the impact is important with corn and heavy, brittle materials.

[1]Extension Agricultural Engineers.

Capacity of a hammer mill will vary depending on condition of the feed being processed and the fineness of the grind. An average range for a hammer mill is from 600 to 1,200 lb of feed per horsepower hour.

Hammer mills consist of fixed or swinging hammers mounted on a hub/rotor assembly (normally dynamic and static balanced), which is on a rotating shaft. Hammers rotate at speeds from 1,800 to 4,000 RPM, depending on the overall diameter at the tips of the hammers; tip speed varies from 5,000 to 20,000 ft/min.

The screen (usually perforated metal) is mounted below, above, and/or around the hammers through which the reduced product must pass. The product being ground remains in the grinder until it is small enough to pass through the holes in the screen. The hammers do not touch the screens, but as a general rule, if the hammers are farther away from the screen, it will be beneficial for chopping hay or fodder, will use less horsepower, and will create less fine material (powder, flour, dust, etc.). If a fine product is desired, the hammers should be very close to the screen, which will increase horsepower requirements. Most hammermills have 10 to 12 sq in. of screen area per input horsepower. A 10 to 15°F rise in feed temperature through the mill is acceptable, but greater than 15°F indicates inefficiency (worn hammers or screens). Efficient hammer mill operation is depended on the distance from the end of the hammer to the screen surface. Replacement of hammers is necessary when the hammer length shortens from its original length (Figure 1). It is very important to use magnets to remove metal and protect hammer mills. In some cases, parallel bar scalpers are necessary to remove non-magnetic objects such as rocks. The hammers also very greatly in size and shape and can be reversed to give four wearing surfaces; removable tips and various wearing materials are also offered.

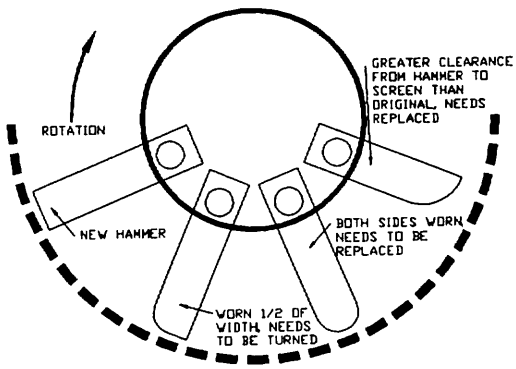

Figure 1. Maintenance of hammers on hammermills.

Roller Mills

Roller mills have the following characteristics:

1) maintenance requires regrooving of rollers
2) low horsepower

3) used for small grains only
4) narrow range of particle sizes produced
5) quiet
6) little dust produced when milling

Roller mills offer the advantages of low power requirement per ton of feed, very little flouring and dusting, and simple compact equipment. Roller mills are limited to non-fibrous product (i.e. cannot be used for hay or fodder). An average capacity for a roller mill is 900 to 1,800 lb per horsepower hour, depending on the size and type of roll. For rolling high-moisture grain, the mill must be carefully selected to prevent problems with grain sticking to the rollers.

Roller mills are sized according to the diameter and length of the rolls. A 10 x 42 mill has a 10 in. diameter roll that is 42 in. long. The most popular sizes for grinding are 9, 10, and 12 in. diameter rollers with a length of 6 to 52 in. Foreign objects such as nails and bolts will damage roller mills and should be removed with magnets. The mills cannot be started with product on or in the rolls. It must be up to speed prior to starting the feeding of the rolls. The setting of the rolls is different for each product desired. A sample should be run prior to starting a production run. Too close a setting causes fines (or flouring) and increases or wastes power. On the other hand, too wide a setting does not grind the product enough.

Roller mills can be furnished with rolls having 5 to 18 corrugations/in. As a rule, the fewer the corrugations per inch, the higher the capacity for a given mill and the less frequent regrooving will be necessary. However, more corrugations/in are required for smaller-sized kernels to prevent uncracked grain from passing through the rolls. Although there is some variation in recommendation among manufacturers, the general range used for feed grains are: 5 or fewer corrugations/in for corn; 7 to 8 corrugations/in for corn, wheat, milo, oats, or barley; 10 or more corrugations/in for milo, oats, barley, or wheat (limited capacity on corn).

There are approximately 50 different types of corrugations for roller mills. Most mills will use a saw tooth or a Dawson configuration. In order to get the recommended particle size of 800 microns, it is necessary to use rollers that have 10 to 12 grooves/in. Most manufacturers will also use a differential drive (one roller will turn slower than the other) of 10-25%. Roll speed ranges from 350 to 600 RPM depending on surface speed. This relative low speed causes less wear and less dust. The rollers are normally turned so that the sharp edge of each roll meets the grain (called sharp-to-sharp action). Roller mills can process grain with half the energy of a hammer mill and give equal particle size. The efficiency of a roller mill can be affected greatly by the roll corrugations, roll spacing, and the efficiency of the roller drives. Swine producers who wish to obtain a particle size analysis of their feed can send a 150 gram (3 cups) sample along with $10.00 to Dr. Jim Nelssen, 243 Weber Hall, Kansas State University, Manhattan, Kansas 66506.

Proportioning Ingredients

Equipment to measure out each part of the ration with the required accuracy must be selected and worked into the overall flow plan. All ingredients must be combined in the proper proportions to produce the intended ration. Two methods are used to proportion the ration, volume and weight. Nutritionists normally formulate rations by weight. Proportioning

devices meter by volume. If the bulk density (test weight), flow characteristic, or moisture content of an ingredient changes, the volume proportioning device must be recalibrated. Some PTO driven grinder mixes use viewing windows for volume measurement. More accuracy is obtained by using a weight measurement that normally involves electronic scales. Portable grinder-mixers and portable mixers with built-in electronic scales are available. The scales are sufficiently accurate for weighing grain and soybean meal; however, they are not adequate for small quantities, such as minerals and premixes. For adding small amounts of ingredients such as minerals, vitamins, and salt, these materials should be premixed by weight in correct proportion with the protein supplement. Some of the low capacity grinder mixers have accurate meters for special minerals and medication as part of the unit.

Commercial equipment to proportion ingredients volumetrically is available that uses either augers or belts. Using different augers to proportion ingredients prior to a roller mill is an example of volumetric proportioning. Electric mills with volumetric ingredient measurement usually have four or more augers, all of which must be calibrated. Proportioning is accomplished by using intermittently timed or variable speed augers. The auger speeds must be set with respect to one another. Because swine rations are predominantly grain, the auger supplying the grain should be set first. The remaining augers are then set to deliver a flow rate in the proper proportion to the flow rate of grain.

The belt-type blender has an adjustable spout for each ingredient mounted over the belt. The height of each spout is adjusted to give the correct ratio of the ingredients. This equipment provides a satisfactory method of measuring rations when several free flowing ingredients are used. The equipment does not work well on material such as bran.

A number of continuous weighing devices are available for attachment to augers for volumetric or weight determination of auger output. Most of these devices have a two-chamber design that flip/flops or a trip weight that measures small unit quantities continuously. These devices are sufficiently accurate for grain and soybean meal, but not for minor ingredients. The best measuring method is to use scales to weigh out the ingredients for a "batch". Scales can be incorporated into a system in three ways: 1) a hopper bottom bin, large enough for a batch of feed, is mounted on scales, each ingredient is added individually until the required weight for each is reached, and the feed flows into a grinder and then into a mixer or directly to a mixer; 2) the mixer is mounted on scales, and each ingredient is added in turn to formulate a batch ; 3) large platform scales are used to accommodate a wagon, truck, or portable mixer; feed is added to the wagon, truck, or mixer while it is on the scales. The last method works well for large feeding operations.

Mixing

Portable or stationary mixing equipment is available commercially. A batch mixer to prepare separate batches of feed is a practical system. On-farm feed systems normally use three types of mixers: vertical, horizontal, or rotating drum. Vertical mixers take up the least floor space and have the greatest height requirement. Mixing times on vertical mixers normally run 10 to 15 min. Horizontal and rotating drum mixers can mix in 5 to 10 min. Either type will do a satisfactory mixing job for farm use.

The vertical mixer is composed of an upright tank, usually round, with a vertical auger in the center to mix the feed. Smaller, less costly mixers are usually of the vertical type. Typical vertical mixers are available in models ranging in size from a 1/2-ton model requiring a 3-horsepower motor up to a 4-ton model requiring a 25-horsepower motor. The vertical distance required for installation can be a limiting factor in the use of vertical mixers on the farm. A typical 3-ton vertical mixer requires an overhead height of about 20 ft for installation.

Larger mixers are usually of the horizontal type with a horizontal shaft in the center carrying paddles or ribbons for the mixing. Power requirements range from 3 to 5 horsepower for a 1/2-ton mixer up to 20 to 30 horsepower for a 3-ton model.

Mobile mixers, usually of the vertical type, either with or without a grinder attached, are now available at about the same price (for the mixer) as stationary units. The wheels and frame are added costs, but the units are more versatile than stationary equipment, and the equipment also doubles as a conveyor for delivering feed to self-feeders. Attachments are available for most mixers to add and mix oils, fats, molasses, and other liquids to the ration. Vegetable oils (corn, soybean, sunflower, etc.) are normally added to the mixer through the use of a positive displacement, rotary gear pump. The oil is discharged into the mixer with a nozzle to disperse the oil.

CAUTION: In selecting mixers (and other handling equipment) for rations involving hormones, antibiotics, and other medications, be sure that the equipment will mix the ingredients as required by Federal regulations and that equipment will clean out properly so as not to contaminate other feeds. Sequencing of different feed types can aid in reducing contamination problems. When regulated products (antibiotics, hormones, and medications) with withdrawal times are mixed in the mill, the next succeeding feed mixed in the mill should be rations going to pigs that are farthest from market (Figure 2).

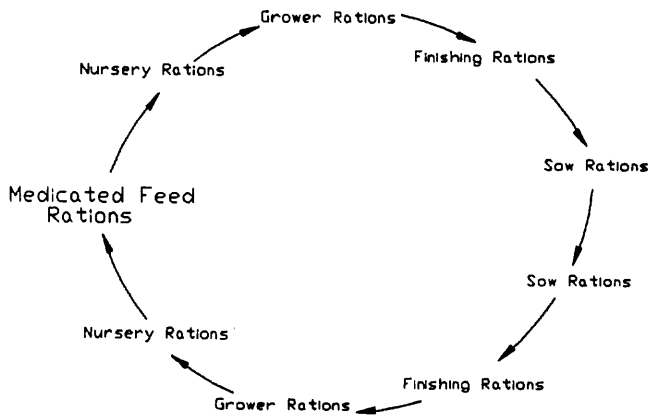

Figure 2. Sequencing of medicated rations.