Pellet crumbles: Reducing granule size while minimizing fines

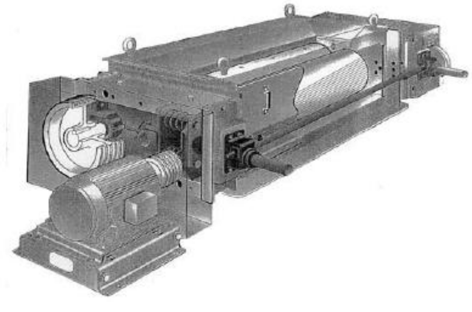
BY MR. RON TURNER

REVIEWED AND EDITED BY CHARLES STARK, ADAM FAHRENHOLZ, AND CASSANDRA JONES

The typical pellet crumbler is configured with either one or two pairs of rolls. **Figure 21-1** shows a pellet crumbler of the single-stand version with one pair of rolls. Double-stand versions with two pairs of rolls are available to give twice the capacity of the single-stand. One roll is driven by an electric motor and V-belt drive on one end. This roll then drives the other roll through another V-belt drive mounted on the opposite end. This secondary drive includes a different size sheave to provide the speed differential between the two rolls, and a serpentine belt so that the second roll rotates in the opposite direction.

One roll rotates faster than the other, and the speed depends on the size or diameter of the rolls used as to maintain an ideal peripheral speed of the rolls to give maximum performance at the nip point. The adjustable roll is usually spring-loaded in order to allow large objects to pass through the nip point without causing any damage to the rolls.

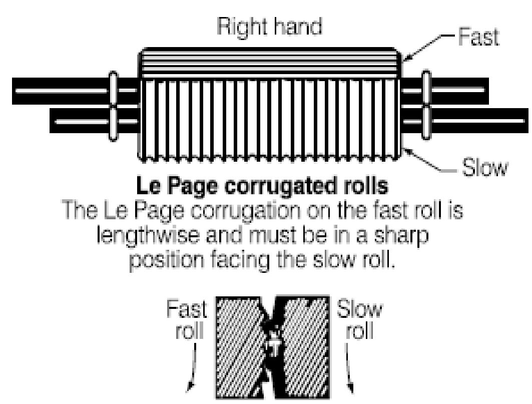
Figure 21-1. Modern pellet crumbler (single-stand model).



Early Design

Some early-model crumblers had one roll cut circumferentially and one roll cut longitudinally, which allowed some crushing of the pellets, resulting in more fines being produced. This configuration is shown in **Figure 21-2**.

Figure 21-2. Early-model crumbler with cross-cut rolls.



Early-model crumblers had handwheels, which are used to adjust each end of the adjusting roll individually. This often allows for some roll misalignment and an uneven gap between the rolls, which results in an uneven-sized finished product being produced. The new model crumblers have a shaft connecting both ends of each adjusting roll so that both ends of the roll are being adjusted at the same time, in order to keep the rolls parallel and the roll gap even along the full length of the rolls.

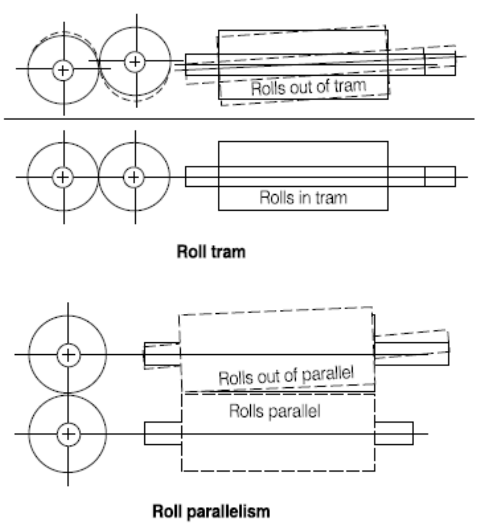
Current Design

The more recent model crumblers have both rolls cut longitudinally in what is known as a "sharp-to-sharp" configuration. This sharp-to-sharp arrangement pulls the pellets into the nip point more efficiently, thus producing a better quality crumble with less fines at a higher capacity, and making this design more efficient than the old design. This efficiency is due to the fast and the slow roll being cut identically with the same helical angle so that where they meet at the nip point, the angle is opposite to one another and the teeth are coming together at different speeds. This results in the pellet being cut rather than crushed, which is similar in some respect to a scissors action.

The rolls should be no more than 0.012 cm out of parallel with one another in order to maintain maximum performance. This new design crumbler can be set up to be adjusted either manually or with an air motor. The air motor arrangement also allows for the roll gap to be adjusted automatically with a control unit from a remote location. This allows the machine to be able to produce a fine, medium or coarse crumble from the same machine without having to reset the roll gap manually every time.

For maximum performance, crumbler rolls should be kept in tram and parallel to one another at all times, as shown in **Figure 21-3**.

Figure 21-3. Roll tram and roll parallelism.

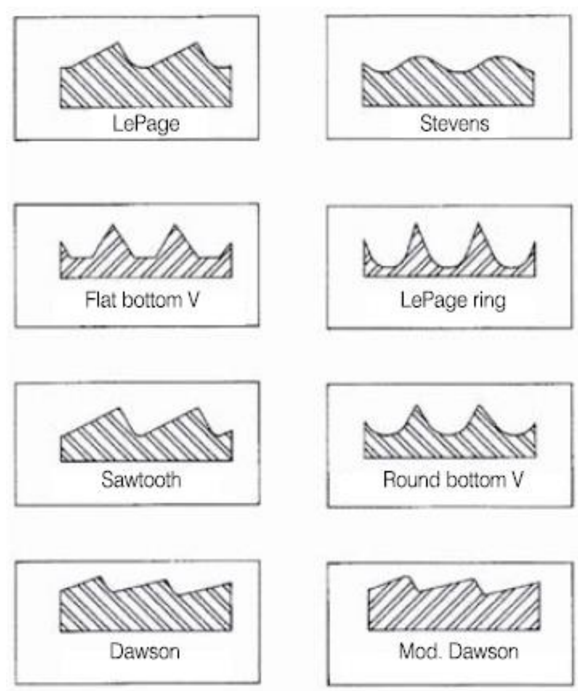


Roll Parameters

Roll diameters vary depending on the production capacity requirements, with the smallest being 15.24 cm and the largest being a 40.64 cm diameter. The more common sizes used today are 20.32 cm and 30.54 cm diameter. Rolls also vary in length depending on the production capacity requirements, and can range from 60.96 cm long to 182.88 cm long.

Crumbler rolls can be cut with different corrugations depending on the size of the crumble rolls and the application. Roll corrugation profiles also vary as shown in **Figure 21-4**, with the "LePage" cut being used on the smaller and older designs, and the "round-bottom V" being used on the larger new designs.

Figure 21-4. Roll corrugation profiles.



The number of cuts per centimeter can vary depending on the application and the results expected. The older, smaller model crumblers usually have a LePage cut with 25 cuts per centimeter, with the fast roll cut longitudinally and the slow roll cut circumferentially, as shown in **Figure 21-2**. The newer, larger model crumblers are cut with 15 cuts per centimeter on the fast roll and 20 cuts per centimeter on the slow roll. Both rolls are cut with the same helix angle longitudinally—sharp-to-sharp—with both cuts being the round-bottom V configuration.

This configuration has usually resulted in being the most efficient in providing the best results for both production capacity and overall crumble quality for such applications as poultry and pig starter feeds. Smaller cuts of 30 to the centimeter and 36 to the centimeter are also available, and are typically used for crumbling shrimp feeds for feeding shrimp larvae. The corrugation size is usually matched to the size of the pellet to be crumbled.

Crumbler Operation

There is some opinion within the feed industry that if you are going to end up crumbling pellets, then there is no point in making a good quality pellet to start with. In my opinion, this is not true. In order to produce good quality crumbles, it is necessary to start off with good quality pellets. Good pellet quality produces the best field results and conversion ratios, and the same applies to crumbles.

Some feed manufacturers prefer to make small diameter pellets for pig starter feeds in order to reduce the amount of fines. They do this instead of making crumbles. Producing smaller pellets entails changing the die on the pellet mill and also results in a drastic reduction in production capacity. It is much more efficient to use a large-hole die with a larger percentage of open area and a higher production capacity and make crumbles, than to use a small-hole die and produce only pellets. This can be seen in **Figure 21-5**, which shows the comparison of the small-hole and large-hole dies.

The crumbler achieves particle reduction by passing material, or pellets, between counter-rotating corrugated rolls as shown in **Figure 21-6**. The degree of reduction depends on the material, the roll speed differential, the type of corrugation, the roll gap setting and the volume of material fed to the rolls. For correct operation, it is important that the pelleted material flows evenly into the nip point of the crumbler in a steady stream, as shown in **Figure 21-6**, and there should be no material build-up on top of the rolls ahead of the nip point (**Figure 21-6**).

Figure 21-5. Small-hole versus large-hole dies.

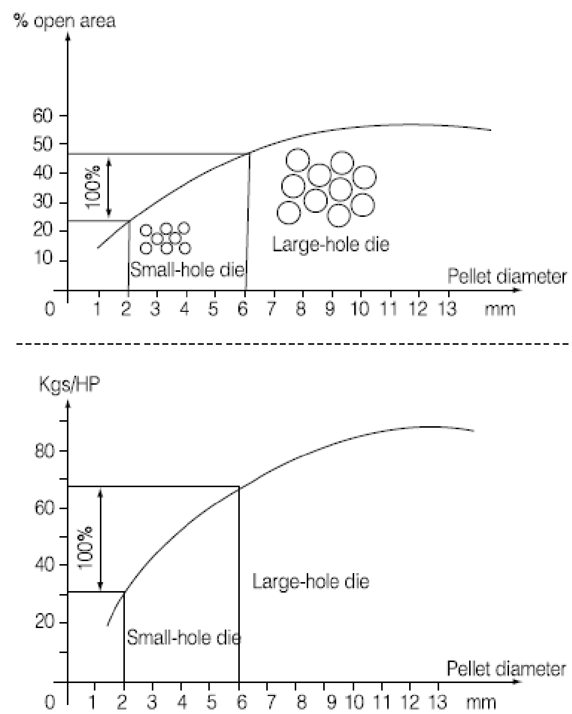
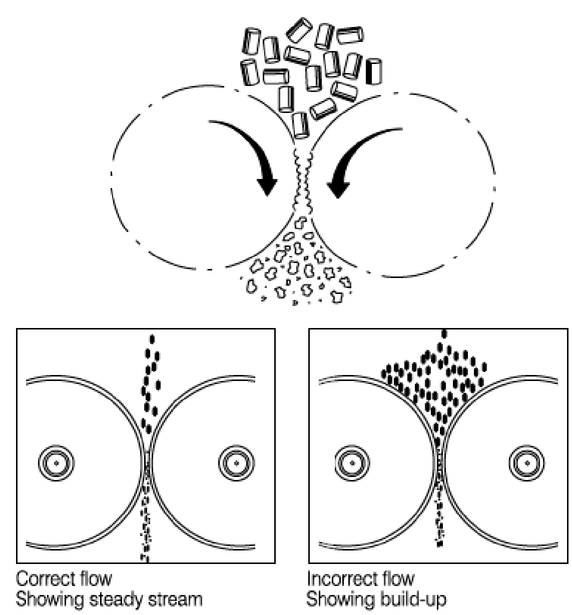


Figure 21-6. Counter-rotating corrugated rolls. Correct flow showing steady stream on the bottom right and incorrect flow showing build-up in the bottom left.



Roll-feeding devices are available for use with crumblers in order to ensure a smooth and steady flow of material into the nip point of the rolls, such as a roll-type feeder or an adjustable surge panel—both of which are installed at the crumbler inlet. These devices eliminate surges caused by such things as pellet coolers and elevators.

If surges and build-up occur due to uneven feeding of the crumbler, the rolls will be temporarily forced apart by compression of the springs on the adjustable roll, resulting in an inconsistent product ranging from fine crumbles to whole pellets. This is not acceptable. On double-stand crumblers with two pairs of rolls, a distributor is installed in the crumbler inlet to ensure that both pairs of rolls are fed evenly.

New model crumblers are fitted with an air-actuated bypass, consisting of an air motor mounted at one end of the adjustable roll, which is connected to the other end of the roll with a jackshaft (see **Figure 21-7**). The air motor operates the adjustable roll by remote control, with the rolls in their closed position for crumbles, and in their open position for bypassing the pellets, as can be seen in **Figure 21-8**.

Figure 21-7. Single-stand crumbler. Manual roll adjustment with air-actuated bypass.

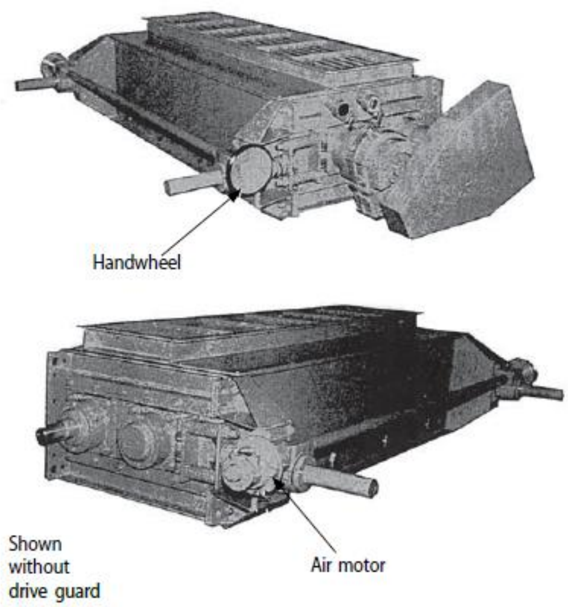
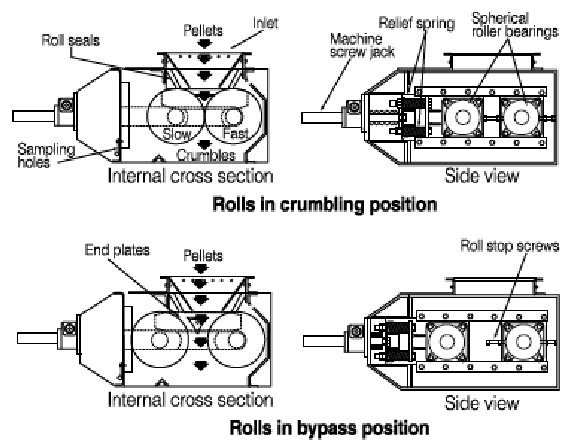


Figure 21-8 also shows the relief springs, which compress to allow large objects to pass through the nip point to avoid damaging the rolls; the sampling holes for taking crumble samples; and the roll-stop screws for setting and maintaining the correct roll clearance. The correct roll clearance should be set at 0.79 mm to 1.59 mm more than the actual pellet diameter being crumbled, and the minimum gap should never be less than 0.76 mm. A feeler gauge should be used at each end of the nip point of the rolls in order to set the roll clearance correctly and to make sure they are parallel to one another. An alternative method is to use a feeler gauge underneath the roll-stop screws to establish the correct setting.

Figure 21-8. Rolls in crumbling and bypass position.



Manual roll-adjust

With the manual roll-adjust system (see **Figure 21-7**), the user adjusts the rolls manually at the crumbler. The manual adjust crumbler is more suitable for long production runs that require few adjustments, or when the operator is located near the equipment. The manual adjust system uses jack screws mounted on the crumbler to slide the movable roll in the bearing rails. The jack screws are joined with a coupling shaft.

A handwheel, with a position analog indicator mounted to the jack screw, drives one jack screw. The handwheel allows rapid roll travel in both directions. When closing the rolls, adjustable roll-stop collars prevent the rolls from touching. Stop bolts control the maximum roll opening.

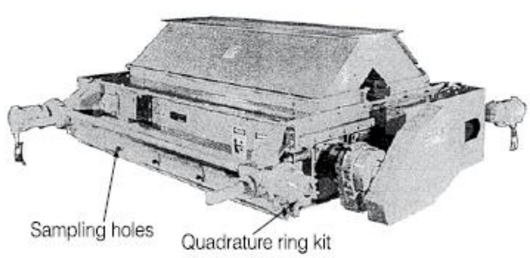
Full-feature roll-adjust

The full-feature roll-adjustment system provides a digital readout of the roll gap. A quadrature ring kit, mounted on the end of one jack screw, keeps track of the motion of the coupling shaft and converts this into gap distance. The digital readout displays the gap distance to an accuracy of +/-0.025 mm. An air motor, mounted on the jack screw, adjusts the roll gap. A selector switch or push buttons operate a solenoid valve that directs the air to open or close the rolls.

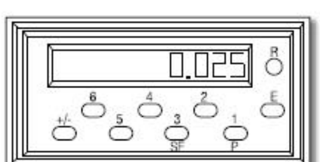
The full-feature roll-adjustment option has two built-in systems to prevent damage to the rolls. Correctly adjusted roll-stop nuts provide positive protection against roll-to-roll contact or the rolls opening too far. A programmed stop in the digital readout unit also limits the roll travel.

The full-feature roll-adjust system provides unlimited gap adjustment to enable the crumbler to produce different size crumbles on demand, from a remote location. **Figure 21-9** shows a double-stand crumbler fitted with the full-feature roll-adjustment and the LED digital readout.

Figure 21-9. Double-stand crumbler with full-feature roll-adjustment.



Double stand crumbler with full feature roll adjustment



LED digital readout

Samples of crumbles can be obtained by inserting a sample scoop through the sample doors provided at the front of the crumbler, as shown in **Figure 21-9**. Samples should be taken at each end and the middle of the roll length to determine the performance of the crumbler. The rolls should be adjusted as necessary in order to obtain the desired results.

Mr. Ron Turner is a feed pelleting consultant.

This content was edited and reviewed by Dr. Charles Stark, Jim and Carol Brown Associate Professor of Feed Technology at Kansas State University, Dr. Adam Fahrenholz, Assistant Professor of Feed Milling at North Carolina State University, and Dr. Cassandra Jones, Assistant Professor of Feed Technology at Kansas State University.