

Evaluating Pellet Quality

Feed quality is often defined by physical characteristics. Pelleted feed quality is often based on the amount of fines present. In the case of feed-pellet quality, relating the physical characteristics and amount of fines involves determining pellet durability. Pellet durability represents the ability to handle pellets without experiencing unacceptable breakage or generating a significant amount of fines.

Benefits derived from manufacturing feed in pellet form include decreased segregation of ingredients and improved physical handling properties, including increased bulk density, reduced dustiness, and less bridging in bulk feed bins. Research demonstrates that feeding pellets improves average daily gain (ADG)

and feed to gain (F:G) ratio in swine (Stark, 2012a), and poultry (Stark, 2012b).

Directly related to pellet quality, the amount of fines in the feeder affects animal performance. McKinney and Teeter (2004) demonstrated poorer feed conversion in poultry as fines in the feed pan increased from 0 to 100 percent. Nemecek et al. (2012) observed finishing pigs fed screened pellets (no fines) had the best feed conversion, pigs fed meal had the poorest conversion, and pigs fed a mixture of 50 percent fines and 50 percent pellets were intermediate. Swine and poultry research studies indicate establishing a specification for the maximum percent of fines at the feeder is important for growth performance and feed conversion.

A method for evaluating pellet durability was first developed in 1962 (Pfoest et al., 1962) and standardized in 1969 (Young et al., 1969; ASAE Standard S269.1). The standard was most recently revised in 2012, and the technique is defined by the American Society of Agricultural and Biological Engineers as ASAE Standard S269.5 (2012).

ASAE Standard S269.5 – Pellet Durability Test

The standard states the durability of pellets and crumbles shall be determined by the following procedure:

Equipment

Durability of pellets and crumbles should be determined by tumbling the test sample

Table 1. Sieve Sizes

Diameter of Pellets or Crumbles		Required Screen Size		
mm	in.	size*	mm	in.
crumbles	crumbles	No. 12	1.7	0.066
2.4	0.094 (3/32) ^a	No. 10	2.0	0.079
3.2	0.125 (1/8)	No. 7	2.8	0.111
3.6	0.141 (9/64)	No. 6	3.4	0.132
4.0	0.156 (5/32)	No. 6	3.4	0.132
4.8	0.188 (3/16)	No. 5	4.0	0.157
5.2	0.203 (13/64)	No. 4	4.8	0.187
6.4	0.250 (1/4)	No. 3.5	5.7	0.223
7.9	0.313 (5/16)	0.265	6.7	0.265
9.5	0.375 (3/8)	5/16	7.9	0.313
12.7	0.500 (1/2)	7/16	11.1	0.438
15.9	0.625 (5/8)	0.530	13.5	0.530
19.0	0.750 (3/4)	5/8	15.9	0.625
22.2	0.875 (7/8)	3/4	19.0	0.750
25.4	1.00 (1)	7/8	22.2	0.875

*American Society for Testing and Materials Standard E11-87, Specification for Wire-Cloth Sieves for Testing Purposes • ^aPellet Diameter

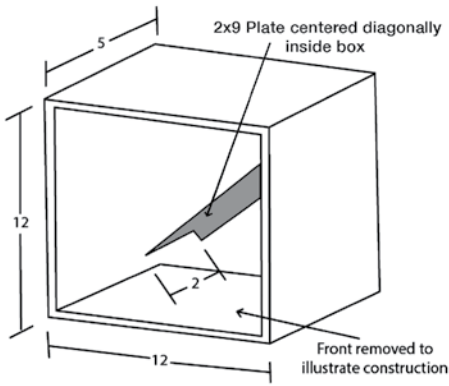


Figure 1. Tumbling Can



Figure 2. Seedburow PDI Tester

for 10 minutes at 50 rpm in a dust-tight enclosure. The construction of this device is illustrated in Figure 1. The device is rotated around an axis that is perpendicular to and centered in the 12-inch sides. A 2-inch by 9-inch plate is affixed symmetrically along one of its 9-inch sides to a diagonal of one 12-inch by 12-inch side of the can. A door may be placed on any side and should be dustproof. Projections, such as rivets and screws, should be kept to a minimum and well rounded.

Screens

Fines shall be determined by screening a sample on a wire sieve having openings just smaller than the nominal pellet diameter. Table 1 shows the recommended sieve sizes for crumbles and pellets of various diameters.

Test Procedure

A sample of pellets or crumbles to be tested should be sieved on the appropriate sieve to remove all fines (Figure 3).

If pellets of 0.5 inch diameter or larger are being tested, select pellets that are between 1.25 inches and 1.5 inches long. Place a 500 gram sample of sieved pellets or crumbles in the tumbling can device. After tumbling for 10 minutes, the sample will be removed, sieved, and the percent of whole pellets or crumbles calculated. Pellet and crumbles durability is defined as:

$$\text{Durability} = \frac{\text{Weight of pellets or crumbles after tumbling (___ g)}}{\text{Weight of pellets or crumbles before tumbling (500g)}} \times 100$$

This value is known as the pellet durability index (PDI) and is typically reported as a percentage (e.g. 95 percent PDI).

Normally, the pellets should be tested immediately after cooling. When the temperature of the pellets is within ± 10 degrees Fahrenheit of ambient, they are considered cool. If the pellets are tested at a later time, the time, in hours after cooling, will be indicated as a subscript of the durability. For example, if they tested at 95 percent after a 4-hour delay from the time of cooling, the results will be expressed as (95)₄.

Pacheco and Stark (2009) reported that changing the weight of whole pellets at the beginning of the test significantly changed the PDI results. The results of starting with 300, 400, 500, and 600 grams

of whole pellets were 87, 88, 89, and 90 percent, respectively. These results demonstrate the importance of using a consistent starting weight to conduct a repeatable analysis. The results were even more dramatic when the test was modified to include two 3/4-inch hex nuts (47, 60, 70, and 76 percent, respectively).

Modified Pellet Durability Test

The standard method is often modified by adding items to the tumbling chamber to create a more abrasive test, which may better represent a company's manufacturing and delivery processes. Modification of S269.5 can be done with hex nuts or ball bearings, which are added to simulate downstream bulk handling. The test should be modified to model in-facility bulk handling that occurs after the pellet mill as well as feed delivery. Ideally, the model should be based on the percentage of fines typically found in the feeder on the farm. Each feed mill should determine the number and size of hex nuts or ball bearings based on the pellet handling equipment in the feed mill and the type and condition of the delivery equipment.

Holmen Durability Tests

The Holmen durability method uses air to create abrasion of the pellets, rather than the tumbling action that occurs in the metal box of the PDI tester. The NHP 100 tester (Figure 4) requires the operator to screen

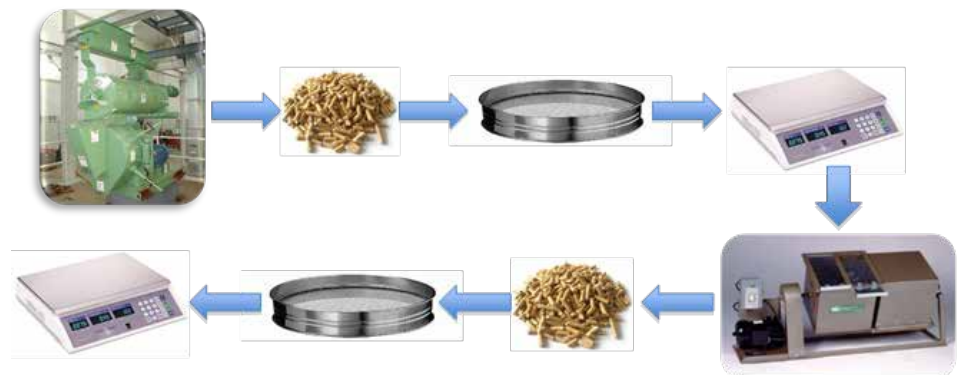


Figure 3. Pellet Durability Procedure – Pacheco and Stark, 2009



Figure 4. Holmen NHP 100

and remove the fines to obtain 100 grams of whole pellets. The pellets are added to the testing chamber and agitated by forced air for 30, 60, 90, or 120 seconds. After testing, the sample is removed, weighed, and the percentage of whole pellets or crumbles is calculated. While the design allows for fines to exit the agitation chamber during testing, the sample also can be sieved with the appropriate screen as designated in Table 1. The NHP 200 tester (Figure 5) automatically sieves the sample, determines the weight of the



Figure 5. Holmen NHP 200

sample, performs the test, and calculates the percentage durability. The NHP 300 tester (Figure 6) is a fully automated in-line tester that obtains the sample directly after the pellet mill and determines pellet durability. The NHP 300 collects, cools, and sieves the sample, performs the test, calculates the durability, and exports the data to a computer.

Summary

Pellet durability tests indicate the effectiveness of the pelleting process



Figure 6. Holmen NHP 300

and the quality of the product delivered to the customer. Each feed mill should develop a testing model that estimates the percentage of fines at the feed mill, in the bag or delivery truck, and in the feeder on the farm. A well-designed pellet durability model provides continuous feedback on the effects that formulation and processing variables have on pellet quality. Most importantly, the pellet durability results should be used as a tool to improve the quality of the feed delivered to the customer.

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