This article describes feeder performance tests and the type of information feeder manufacturers need to know to perform those tests.

Feeder performance tests can give you a true picture of how a feeder will handle your material.

Most feeder manufacturers maintain test facilities to prove their feeders’ performance. Feeder accuracy testing is fairly simple. The test procedures may vary slightly between manufacturers, but the basic tests are performed as follows:

**Standard test.** In the standard feeder performance test, the feeder is filled with your material, turned on, and allowed to run continuously. A container is placed under the material discharge point for a specified time interval — usually 1 or 2 minutes. At the end of this time interval, a new container is placed under the material discharge point. This continues until 30 or more material samples have been taken. In most tests, the containers are placed by hand and the time intervals, called sample times, are measured with a stopwatch. The resulting material samples are then weighed on a check scale; these sample weights are the data used to calculate the feeder’s accuracy. This test is usually performed at the feeder’s minimum and maximum feedrates and at one feedrate in between.

**Short-sample-time test.** This test is the same in concept as the standard test and provides the same type of results. The major difference lies in the short sample times — 1 to 2 seconds or less — and the sampling methods. The most common methods for obtaining short sample times — using a static weighed container or multiple moving containers — have their advantages and disadvantages. Both methods allow the feeder’s accuracy to be tested quickly and completely.

The static-weighed-container method involves filling a container on a scale, which is connected to a computer that takes weight readings at selected time intervals. This method has a number of advantages:

- Weight readings can be taken over short time intervals and grouped to form longer time intervals, producing accuracy comparisons for different sample times.
- Container placement error is virtually nonexistent and timing error is low.
- Sampling is less messy compared to moving containers by hand.
- Results are provided instantly. If problems exist, another test can be run immediately.

There are some shortfalls to this system, however. First, a very accurate check scale is required. The capacity of the check scale must be at least as large as the total of the sample weights. The check scale should also have an accuracy of 0.025 percent of the smallest sample weight (this means a sensitivity of 1/4,000) so that inaccuracy won’t affect the test results. If you take 30 samples, the check scale must have a sensitivity of 1/120,000. In real terms, this means a 120-kilogram scale capable of accurately sensing a weight change of 1 gram is required.

Second, the scale’s readings aren’t static; they’re dynamic. This is because the momentum of the falling material affects the weight reading. The force on the scale is a combination of material weight and impact force. Generally, the impact force is constant throughout the test. As a result, its effect is overshadowed by the accuracy of the static weighed container method.

The multiple-moving-containers method uses 100 or more overlapping containers moving on a conveyor past the feeder discharge at a constant speed. The containers are then removed from the conveyor and individually weighed. The sample time is varied by changing the speed of the conveyor. This method also has several advantages:

- The scale capacity only has to be as large as one container and sample. As a result, each sample can be weighed accurately with low scale error.
- The check scale is only subjected to a static weight, with no impact effect.
Feeders and flow characteristics

Not all feeders are suited to handling all materials, so a good place to begin when searching for the best feeder is to identify your material’s properties. Manufacturers conducting performance tests will also be interested in the material flow properties.

Here are some common material categories and the recommended feeder for that material type.

Adhesive. An adhesive material sticks to everything, making it one of the most challenging materials to feed; a good example is color pigments, which are notorious for adhering to all types of surfaces. Screw feeders, except for those that are internally agitated, are well-suited to handling adhesive materials because of the feeder’s positive material extraction. An internally agitated screw feeder isn’t recommended for adhesive materials because the particles can quickly build up on the feeder’s agitator.

Aeratable. An aeratable (or floodable) material, such as glass microspheres, flour, or phenolic resin, typically has a low angle of repose and behaves like a fluid when aerated. This can cause it to flood in an uncontrolled flow from an equipment discharge. A screw feeder, particularly an externally agitated model, is a sound choice for preventing this type of material from flooding out of the feed screw during feeding. Selecting a feed screw with a center rod rather than a standard open-flight design also can prevent this problem. To avoid aerating the material during refill, refill the feed hopper frequently with a small amount of material rather than less often with a large amount.

Cohesive. A cohesive material typically has a high angle of repose and tends to pack or clump like a snowball rather than flow easily. Examples include very fine powders and powders containing fat — for instance, a cake mix — or moisture. Feeding this material typically requires the positive extraction provided by a screw feeder, but the feeder must also be equipped with some type of flow aid to break up material clumps. Good choices include externally agitated and internally agitated screw feeders and other screw feeders that have hoppers equipped with air sweeps or air pads.

Fibrous. A fibrous material, such as wood flour or biomass fibers, contains long particles that tend to interlock and form masses that slow or stop flow. An internally agitated screw feeder is well-suited to handling a fibrous material because the agitating action inside the feeder hopper pushes the material into the screw flights.

Free-flowing. A free-flowing material, like plastic pellets, flows easily by gravity without help from flow aids or specially designed equipment. This type of material doesn’t require the positive extraction provided by a screw feeder, making the energy-efficient vibratory feeder a good choice.

Friable. A friable material, such as wax beads, pasta products, or flake adhesives, has particles that are easily broken, so it requires gentle handling to avoid reducing the particle size, changing the particle shape, or causing the material to flow at an inconsistent rate. The gentle handling provided by vibratory and weighbelt feeders makes either ideal for feeding this type of material.

Hygroscopic. A hygroscopic material, such as sugar, salt, or cellulose fibers, readily wicks up moisture that can cause it to clump. Leaving this material in equipment overnight can cause it to harden into a rock-hard lump by morning. Which feeder is best for a hygroscopic material depends on how hygroscopic it is and how well the application environment is controlled. A variety of feeders can handle a less hygroscopic material, such as phenolic resin, in a humidity-controlled environment. However, without a controlled environment, even mildly hygroscopic materials can wick up enough moisture to prevent them from feeding. In an enclosed feeder, a hygroscopic material can be blanketed with clean, dry air or nitrogen to keep moisture out and promote uniform flow.

Melttable at low temperatures. A material with a low melting temperature tends to break down, melt, or caramelize when subjected to excess friction or energy. This type of material can be fed by any screw feeder, but one with a large-diameter feed screw rotating at a low speed is better suited than one with a small-diameter screw running at high speed. However, the larger the feed screw and the slower the screw speed, the lower the feedrate accuracy.

Pressure sensitivity. A pressure-sensitive material, such as wax beads, is prone to packing, especially under a large head load. A variety of feeders would be suited to handling this type of material as long as they don’t have a large-volume hopper extension, which can cause the material to pack.

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However, this method also has disadvantages. First, each sample container must be weighed by hand before and after filling — a very time-consuming process. Second, the conveyor system is large and cumbersome. As a result, this type of sampling apparatus is uncommon. Third, the sample time is fixed for any one run. The sample time can only be increased by adding samples together.

**Special performance tests**

In addition to the basic feeder performance tests, you may want the feeder manufacturer to perform special tests to predict the response time of the feeder or controller, or with loss-in-weight feeders, to determine accuracy during volumetric operation. Some of these tests require special recording equipment. Not every feeder manufacturer is equipped to perform all the tests.

**Feeder-response-time test.** When the feeder’s controller sends a signal to the feeder and instructs it to change the feedrate, there may be a lag between the time the signal is sent and the time the feeder responds. The feeder’s response time is tested by changing the setpoint (the feedrate the feeder is trying to achieve) while the feeder is operating and recording the setpoint signal and the feeder speed on a two-pen chart recorder.

The feeder manufacturer analyzes the resulting chart to determine the time lag between the setpoint change and the feeder’s response. With a good feeder, the time lag should be less than 2 seconds.

While feeder manufacturers seldom perform this test, the feeder’s response time is an important consideration for processes where the feedrate changes, either during production or during a gradual startup or shutdown.

**Controller-response-time test.** The feedrate information provided by the feeder’s controller is slightly behind the actual feedrate. To determine the time lag, the feeder is filled, turned on, and the setpoint is changed during the test. Using a multiple-pen recorder, the controller data is plotted against the setpoint, the check-scale output (assuming the static-weighed-container method is used), and the controller output to the feed mechanism. By analyzing the resulting strip chart, the feeder manufacturer can determine the response time of the feeder’s controller.

In statistical process control situations, data from the feeder controller must be synchronized with data on the finished product. In these cases, the controller’s response time is critical.

**Volumetric-feeding accuracy tests.** Nongravimetric feed time can have an extensive effect on overall feeder accuracy. Loss-in-weight feeders switch to a volumetric mode while their weigh hoppers are being refilled to prevent the filling process from affecting flowrate. The test for volumetric accuracy is the same as the standard feeder performance test, except that the feeder is run at a constant feed rate. The resulting accuracy figures are then applied to the time the feeder spends in the volumetric mode during weigh hopper refill. This time is equal to the hopper refill time (generally 10 seconds or less) plus the material stabilization time (0 to 10 seconds depending on the amount of entrained air) plus the scale stabilization time (generally 2 seconds or less).

**Provide adequate information to the testing facility**

The purpose of the feeder test is to provide you with the information you need to choose the correct feeder and install the feeder successfully in your plant. To get accurate results, you should provide the feeder manufacturer with information about your ingredient(s) and your application.

**Ingredients.** Be sure to provide the name, bulk density, and current feeding methods of the materials to be tested. Also provide an SDS for each ingredient and list any special handling procedures that are necessary to protect your plant and employees from toxic materials or fire and explosion hazards. Also provide disposal (or return) instructions for the feeder manufacturer to follow after the test.

**Application.** For batch feeding, provide minimum and maximum batch weight, minimum time between batches, maximum quantity of batches per hour, feeder refill method (hand, hopper above feeder, mechanical conveyor, etc.), and the expected batch accuracy (percentage of batch weight). For continuous feeding, provide the maximum and minimum feedrates, the preferred control type (loss-in-weight or other), the preferred feeder type (single screw, twin screw, vibratory, belt, etc.), the feeder refill method (hopper above feeder, mechanical conveyor), and expected feedrate accuracy (plus/minus percentage of feedrate).

**Results**

Ask beforehand how the data will be presented so you know what to expect. When comparing test results from different suppliers, keep in mind that the tests should be identical for the comparison to be valid. By thoroughly understanding the performance testing procedure, results, and analysis, you’ll be able to choose a feeder that suits your accuracy needs.