A loss-in-weight feeder can provide accurate and consistent metering for a range of bulk solids materials. This article describes the three feeder components that most influence a loss-in-weight feeder’s performance in continuous and batching applications and explains how to optimize those components for your material.

The loss-in-weight screw feeder is commonly used in both continuous and batch bulk solids applications because of the feeder’s ability to accurately control material flow over a wide feedrate range. Screw feeders are available from many different suppliers in screw diameters as small as 1/2 inch up to about 8 inches and with varying pitches (distance between screw flights) to meet most common application requirements.

A typical loss-in-weight screw feeder, as shown in Figure 1, consists of an extension hopper, which holds the material to be fed, mounted above a screw trough. The screw trough directs material into the flights (or blades) of a horizontal rotating screw (not shown) that feeds the material through a feed tube and discharges it into a mixer or other downstream process vessel. The screw trough typically includes an agitation mechanism to encourage material flow and “condition” the material so it uniformly fills the cavities between the screw flights. The screw and agitation mechanism are driven by one or more variable-speed motors linked to the feeder’s controller. The feeder is mounted on load cells that are also linked to the feeder controller.

In operation, material flows by gravity (with the assistance of the agitation mechanism) from the extension hopper into the screw trough and fills the cavities between the screw flights. As the screw rotates, the material is driven through the feed tube and discharged to the downstream process. The load cells monitor the feeder’s overall weight, including the feeder and material, allowing the controller to continuously track how much material the feeder is discharging per unit time and adjust the screw speed to maintain the desired feedrate.

Reliable performance of a loss-in-weight screw feeder is primarily determined by the screw trough, the agitation mechanism, and the screw. To ensure that you select the best feeder for your continuous or batching application, you should optimize these components to handle your material’s flow characteristics. The best way to ensure that your loss-in-weight feeder will reliably perform for your application is to have a supplier test several alternatives using a sample of your material. A feeder supplier will generally have a test lab where you can witness the tests first-hand before purchasing a feeder.

Screw trough

The screw trough forms the critical transition between the extension hopper and the screw. This converging geometry can cause material flow problems if the screw trough isn’t carefully selected for the material and application. Most bulk solid materials won’t flow reliably through such a converging transition because of interparticle friction and a tendency for particles to interlock, which can restrict or stop material flow (called bridging). Every bulk solid material has a minimum cross-sectional dimension across which a bridge can form, and the converging screw trough often reaches this bridging dimension as the trough narrows near the bottom.
The screw trough’s shape will greatly affect how well material will flow and fill the screw. As shown in Figure 2a, a wedge-shaped trough exposes a larger section of the screw to the trough compared to a conical or spherical trough. This encourages downward material flow and helps to ensure that the screw flights fill completely before the material moves into the feed tube. The relatively small exposed screw section of a conical or spherical trough, as shown in Figure 2b, can starve the screw of material and result in intermittent material discharge from the feed tube.

**Figure 1**

Typical loss-in-weight screw feeders

- a. External paddle agitation

**Figure 2**

Screw-trough designs

- a. Wedge-shaped screw trough
- b. Conical screw trough

**Agitation mechanism**

Regardless of the screw trough shape, many loss-in-weight feeders still require an agitation mechanism to ensure adequate material flow and prevent bridge formation. A loss-in-weight feeder’s main purpose is to accurately feed the material at the desired setpoint. The weight feedback control requires that each screw flight is filled with the same weight of material. A properly
designed agitation mechanism both maintains flow and conditions the material to a consistent bulk density, providing repeatable weight filling of each screw flight.

A loss-in-weight feeder typically uses one of two common agitation mechanisms: external paddle agitation or internal stirring agitation.

**External paddle agitation.** A screw feeder with external paddle agitation (Figure 1a), requires that the screw trough is constructed of a flexible material, typically polyurethane, in a wedge shape. Oscillating metal paddles are positioned outside the two sloped sides of the trough. During operation, the paddles oscillate, alternately pressing and releasing the trough walls. This bathing action breaks up any bridges that are starting to form and keeps the material flowing down into the screw.

An advantage of a flexible-walled, external-paddle screw trough design is that the flexing trough walls create interparticle motion throughout the trough, with no dead spaces. An internal agitator leaves two dead zones in the top corners of the trough where the agitator’s rotational motion can’t reach. A screw trough with internal agitation is designed to reduce the volume of these dead zones, so an internally agitated screw trough typically has a smaller inlet dimension and over-all volume than a flexible-walled, external-paddle screw trough.

Since the feeder’s extension hopper is mounted directly above the screw trough, the bottom dimension of the hopper is typically the same as the screw trough inlet. As a rule of thumb, a loss-in-weight feeder extension hopper is commonly sized to hold 4 minutes of storage at the material’s maximum feed rate and minimum bulk density. An extension hopper with a large bottom dimension mounted to an externally agitated screw trough can often achieve this volume with vertical side walls (Figure 1a), whereas an extension hopper with a smaller bottom dimension mounted to an internally agitated screw trough may need to be wider at the top to hold the same amount of material (Figure 1b). A vertical-walled extension hopper can save floor space and ensure that no additional agitation is needed in the extension hopper since the material isn’t converging.

**Internal stirring agitation.** With internal stirring agitation (Figure 1b), the screw trough is constructed of metal, typically stainless steel, and the trough bottom is curved in a constant radius to accommodate a rotating agitator mounted above the screw. The agitator has flat blades that move through the material with an upward motion on one side of the trough and a downward motion on the other side. This blade movement conditions the material and prevents bridging in the screw trough.

Generally, a screw feeder with a flexible-walled screw trough and external-paddle agitation is a better choice for a loss-in-weight feeder, but some applications require an internal stirring agitator. Cohesive materials, for example, can form a solid mass when exposed to compression. Some materials are so sensitive to compression that gravitational force can cause the material to solidify in a storage hopper. Such materials are difficult — and sometimes impossible — to feed reliably without internal stirring agitation. If your material is cohesive, you should conduct tests with a supplier that offers several feeder types to ensure that the one you select will successfully maintain flow during operation.

High-temperature materials may also be unsuitable for external-paddle agitation. For example, polyurethane becomes too soft for a trough material at ingredient temperatures above 50ºC (122ºF), so a feeder handling material above that temperature will require a metal screw trough.

**Screw**

While the agitation mechanism ensures that the screw flights fill uniformly, the screw does the actual feeding. You should select your feeder’s screw design to achieve your application’s maximum and minimum required feedrates. The screw diameter and pitch are sized to achieve the feed rate at an optimal screw rotational speed. A screw speed that’s too slow can cause “pulsing flow,” in which slow-feeding material falls from the feed tube in intervals rather than in a smooth, consistent stream. Such pulsation may cause an undesirable variation in the final product. A screw speed that’s too high may cause incomplete filling of the screw.

The three screw types commonly used in loss-in-weight screw feeders are spiral, blade, and twin concave, as shown in Figure 3. Each screw type has advantages and disadvantages, and the best type for your feeder depends on your material.

**Spiral screw.** The spiral screw (Figure 3a) is the most common screw type. The screw consists of an open spiral with no center shaft, which allows material to freely flow into the screw flights. The shaftless design has a small surface area, which helps to reduce shear and material adherence to the screw but can also allow easily aerated materials to flood past the screw flights.

**Blade screw.** A blade screw (Figure 3b) offers more resistance to aerated materials than a spiral screw, but the screw’s increased surface area can cause sticky materials to adhere to the screw surface. This reduces the volumetric space between the screw flights available for feeding material. A blade screw is often more suitable than a spiral screw for heavy powders with bulk densities greater than 80 lb/ft³ because of the blade screw’s increased structural strength.

**Twin concave screws.** Twin concave screws (Figure 3c) are two co-rotating (rotating in the same direction) screws with intermeshed flights in a single feed tube. Twin concave screws are self-cleaning because the intermeshed flights
allow the screws to wipe adhered material from each other. This self-cleaning action makes twin concave screws a good choice for poorly flowing, adhesive powders. Twin concave screws are structurally solid, but the screw flights have a low conveying volume compared to spiral or blade screws and generate more shear, particularly in the feed tube. To reduce the negative effects of this higher shear, a feeder with twin concave screws typically has a short feed tube.

Twin concave screws are ideally suited to materials with feedrates below 5 ft³/h. The cross-section of the two screws is wider than that of an equivalent capacity single-screw, which reduces material bridging. Also, the screw speed can be higher for twin concave screws than for a single screw with the same feedrate because of the twin screws’ larger inlet area and lower screw-flight volume. This higher screw speed can reduce the negative effects of pulsation.

**For further reading**

Find more information on this topic in articles listed under “Feeders” and “Weighing and batching” in *Powder and Bulk Engineering*’s comprehensive article index in the December 2015 issue or the Article Archive on PBE’s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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**Figure 3**

**Common screw designs**

a. Spiral screw

b. Blade screw

c. Twin concave screws