

# Controlling upstream and downstream influences on loss-in-weight feeders

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Loss-in-weight (LIW) feeder performance is affected by a number of influences, both internal and external to the feeder and feeder process. Understanding the significance of these influences is critical for achieving optimal performance. This article will describe some strategies to help ensure accurate weighing with your LIW feeder.

A loss-in-weight (LIW) feeder is a gravimetric device that directly measures a material's weight to achieve and maintain a predetermined feedrate that's measured in units of weight per time (such as pounds or kilograms per hour). The LIW feeder, similar to that shown in Figure 1, consists of a hopper, a refill device, a weight sensing device (either a digital or analog load cell), a feeder (typically a volumetric screw feeder powered by a variable-speed motor), and a controller.

Before use, an operator programs the controller to discharge material at a predetermined feedrate (or setpoint). It's important to note that the weight sensing device can either include the mounting of a feeder on a weight scale, as shown in Figure 2, or suspension of the feeder on load cells, as shown in Figure 3. If the measurement taken by the load cells is inaccurate or influenced by outside forces, the resulting mass flow from the feeder may be at risk. This inaccuracy can not only include deviations of the amount of material sent to the process below, it can also include increases in material costs due to the deviation from mass-flow setpoint.

LIW feeders are used in both batch dispensing and continuous feeding applications in the chemical, pharmaceutical, food, and plastics industries. As manufacturers look to automate their processes with LIW feeding, they are also looking to optimize overall

Figure 1

## A loss-in-weight feeder

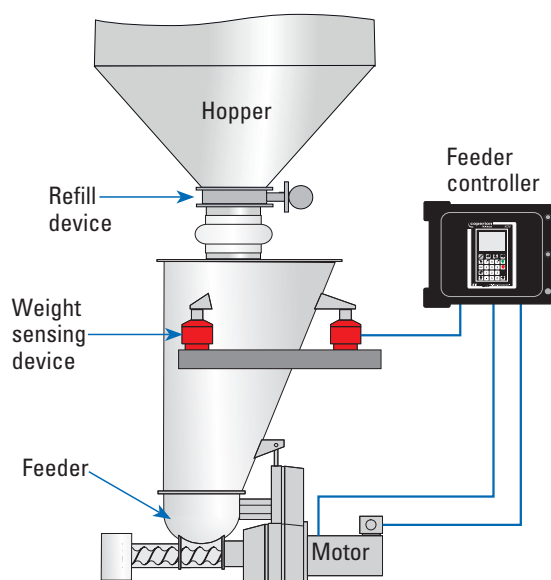


Figure 2

## A feeder mounted to a weight sensing device



Figure 3

Feeder mounted to a frame and suspended on load cells



ingredient costs. Slight changes in the mass-flow accuracy of a feeder or multiple feeders can make a significant difference in both product quality and in raw ingredient costs. A LIW feeder can be especially sensitive to ambient influences because it must precisely and continually measure very small differences in the weight of a relatively massive load — the feeding system itself.

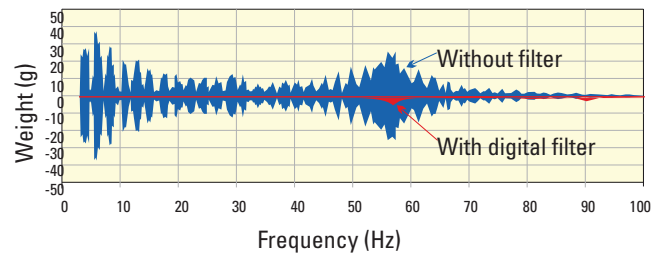
In this article, the term “ambient” is used to refer to environmental factors and also to potential concerns resulting from improper installation and maintenance. These influences, crucial to the weighing operation, include vibration that’s transmitted to the weighing system from nearby machinery, insufficiently flexible inlet/outlet connections, random physical shocks (such as bumping the feeder while in operation) and other mechanical disturbances, and pressure variations within the system and at the process connections. Even air drafts and currents in the processing zone, if excessive, could affect weighing performance. We’ll focus on three of the main influences in this article.

### Counteracting vibration problems

Vibration from other pieces of machinery can cause incorrect readings by the load cell. To help compensate for any potential vibrations, modern load cells and control algorithms are able to discriminate between the load to be measured and the transient forces imposed by vibration. In order to distinguish between these two

Figure 4

Weight sensor output with and without filtering



forces, a sophisticated digital filtering algorithm can be applied to the process data identify and extract frequency components characteristic of in-plant vibration, as shown in Figure 4. Even with such filtering algorithms, it’s essential to further ensure that the feeder has a stable mounting by using the recommended shock mounts and platform acceleration measurements as recommended by your feeder supplier. In addition, when dealing with very low feedrate applications, it’s also important to eliminate strong air currents near the feeder, as the currents can move across the scale and influence the weight readings.

### Connecting the feeder to your system

Since the LIW feeder’s operation depends upon accurate weight measurements of the material in the hopper, it’s imperative that the feeder and weight sensing devices are completely isolated from the upstream and downstream processes of the feeder so as not to influence the overall weight signal. In the case of a continuous process, the upstream process may include a pneumatic receiver or a large hopper/IBC — both with a modulating valve. If this receiver or hopper is directly coupled to the feeder, the scale interprets the overall weight as much higher. Therefore, it’s essential that the feeder be isolated with flexible connections to both upstream and downstream equipment with adequate space for maintenance.

One of the most common connection types is the *flexible bellows*. These bellows are typically constructed of a flexible elastomer, such as silicone. If these connections are in place and too tight, too many tensile forces are put on the feeder below. This can cause the feeder controller to give an incorrect weight signal. Conversely, if the bellows are being sucked inward due to influences of pressure, these forces will also cause the controller to react. Figures 5a, 5b, and 5c illustrate bellows designs that are both either too loose, too tight, or improperly aligned.

It’s essential that the process connection isolates the feeder from any noise or force that may impact the feeder and scale performance. Often these issues may result after shutdown or maintenance has occurred, and

the flexible connections have been improperly installed. If your feeder is experiencing performance issues after a maintenance program, the first place to troubleshoot is by examining the system's flexible connections.

### Monitoring pressure and vacuum shifts

If a LIW feeder discharges material to a non-ambient-pressure environment, such as a pressurized or vacuum conveying line, a pressure pulse (air leaking from the downstream system through the feeder's discharge tube to the weight sensing device) can cause a feedrate error. A pressure pulse affects the hoppers instantaneous weight measurement by exerting a vertical force on the weight sensing device opposite to the hopper's downward force. In effect, this force slightly lifts the load so the controller reads a lower hopper weight than it should.

A feeder's refill cycle increases air pressure in the hopper due to the sudden inflow of material. Any positive air pressure acts equally towards all sides and so also pushes up on the hopper lid and the refill valve. Because the force in the inlet area isn't applied to the hopper lid but to the refill valve above, pressure forces inside the hopper aren't balanced. Due to the inlet opening, forces acting upon the lid are lower than those acting oppositely on the floor of the hopper. These higher forces result in an increase in the weight signal. The LIW controller would interpret the increased weight signal to mean that mass flow is slowing and react by erroneously increasing the feeder output creating a mass-flow error.

Hopper pressure issues can also be caused by a clogged vent filter, a dust collection system connected to the hopper vent, or a nitrogen blanket applied to the hopper. Sometimes the dust collection systems or nitrogen blankets are connected across many feeders and when any of the feeders refill, the others see pressure disturbances. One of the most common sources of pressure fluctuations in LIW feeders is the presence of a clogged or blocked dust collection vent filter.

A pressure fluctuation at the feeder discharge also distorts the feeder's weight signal if the outlet is sealed with a cap. Pressure increases in the discharge tube push up on the cap, which, if it's connected to the feeder, pushes up on the feeder and reduces the measured weight. To mitigate pressure fluctuations on the outlet, the cap may be isolated from the feeder by a flexible bellows rigidly mounted to an outside structure, such as a supporting frame.

In addition, discharge pressure problems may be caused by extruder back pressure or vacuum, which are caused by changes in the downstream process. This could be back pressure in a mixer or extruder, or vacuum influences by a micronization or milling system, for example.

Traditionally, these troublesome pressure fluctuations have been compensated for by mechanical means, such as piping from the outlet back of the feeder, as shown in Figure 6. However, factors such as mechanical tolerances, the alignment and age of the flexible bellows, and more can impact the mechanical pressure compensation and prevent the pressure from fully compensating for the forces generated by changing pressures, often making this costly solution deficient.

Figure 5

### Potential flexible bellows issues

a. Poor venting causing the bellows to balloon



b. Bellows being sucked inward

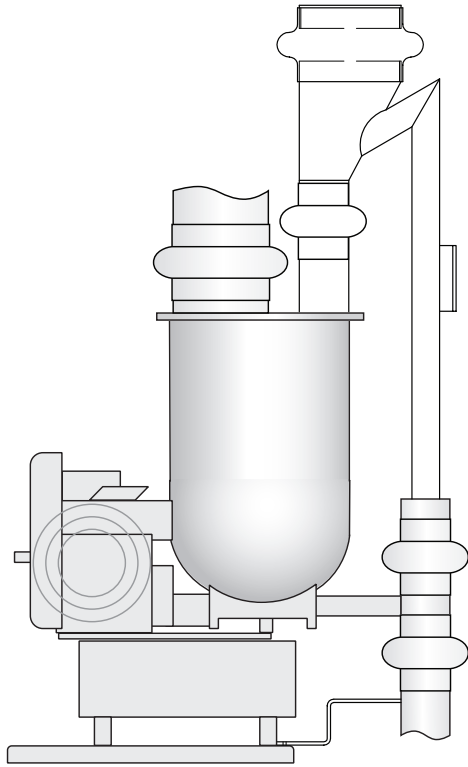


c. The results of improper material being used for bellows



**Figure 6**

**Feeder with traditional mechanical pressure compensation on both hopper and discharge**



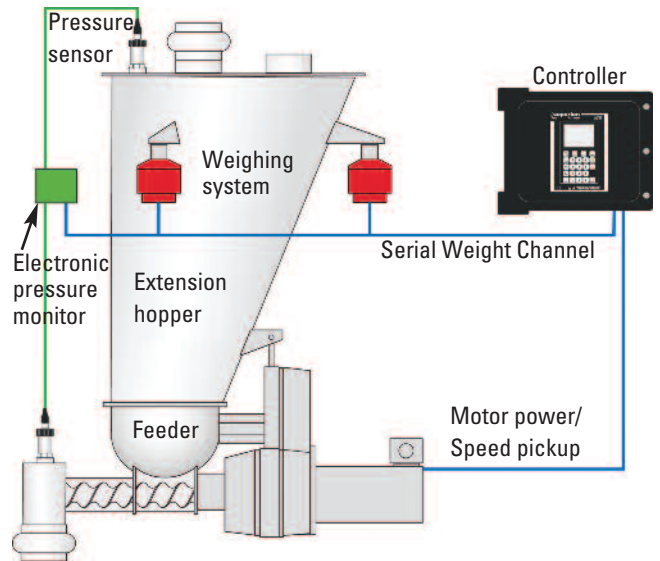
Alternatively, instrumentation and control algorithms to electronically monitor and compensate for this pressure influence can be supplied. An example of a LIW feeder with this type of pressure compensation is shown in Figure 7. The system uses simple pressure transmitters to send signals back to the controller, which compensates for the pressure influences. PBE

### For further reading

Find more information on this topic in articles listed under “Weighing and batching” in *Powder and Bulk Engineering’s* comprehensive article index in the December 2017 issue or the Article Archive on *PBE’s* website, [www.powderbulk.com](http://www.powderbulk.com). (All articles listed in the archive are available for free download to registered users.)

**Figure 7**

**Electronic pressure compensation principle applied in gravimetric feeding system**



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