
feeding

ACCURATELY AND SAFELY DISPENSING
PHARMACEUTICAL AND HIGH-VALUE POWDERS
WITH AN AUTOMATED LOSS-IN-WEIGHT FEEDER

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This article explains how an automated loss-in-weight feeder can accurately and safely dispense pharmaceutical and other high-value powders in continuous feeding and batching applications, eliminating the dangers and inefficiencies of conventional manual loading.

Difficult-to-handle, toxic, and/or highly reactive powder ingredients are regularly used in chemical and pharmaceutical processes, yet dispensing them into blenders, granulators, extruders, reactors, or other process vessels presents major challenges: The powders must be dispensed accurately to meet process or batch set-points, and they must be fully contained during the process to protect workers.

A good way to overcome the challenges of dispensing these tough-to-handle powders is to select an automated loss-in-weight (LIW) feeder with high-accuracy load cells, advanced controls, and a contained, easy-to-clean feeding device. By working with the supplier to choose a

feeder that has these components and is suited to your powder's characteristics, your total batch size, the process's upstream and downstream equipment, and your application's other unique requirements, you can ensure that the feeder meets your accuracy and safety goals.

Some LIW feeder basics

A LIW feeder, as shown in Figure 1, typically consists of a hopper with a feeding device (such as a single- or twin-screw feeder or vibratory feeder), a weight-sensing device with high-speed load cells, and a controller. The feeder can be suspended from a weight-sensing frame mounted with three load cells (Figure 1) or can rest on a platform scale with one load cell. For continuous feeding applications, the operator programs the controller to dispense powder at a pre-determined continuous feed rate (set-point), and for a batching application, the operator programs it to dispense a predetermined batch weight within the desired batching time.

In operation, the feeding device discharges powder from the hopper at a speed determined by the controller. The weight-sensing device continuously reports the powder weight in the hopper to the controller. In a continuous feeding application, the controller determines the actual rate of weight loss and compares it to the feed rate set-point; in a batching application, it determines the measured (or absolute) weight loss and compares it to the batch weight set-point. The controller then increases or decreases the feeding device's speed to increase or decrease the powder weight change in the hopper, matching the feed rate or batch weight to the set-point.

The controller regulates the feeding device's speed to compensate for non-uniform material flow characteristics and bulk density variations, providing high feeding or batching accuracy. The LIW feeder is most accurate when it uses high-resolution, high-speed load cells that are immune to vibration and temperature fluctuations. [Editor's note: For information on how a LIW feeder can be better suited to a batching application than a gain-in-weight (GIW) feeding system, see the sidebar "Comparing LIW batching with GIW batching."]

Selecting a LIW feeder to handle a toxic or reactive powder

Let's consider two examples showing how LIW feeders can be selected for dispensing a toxic or highly reactive powder.

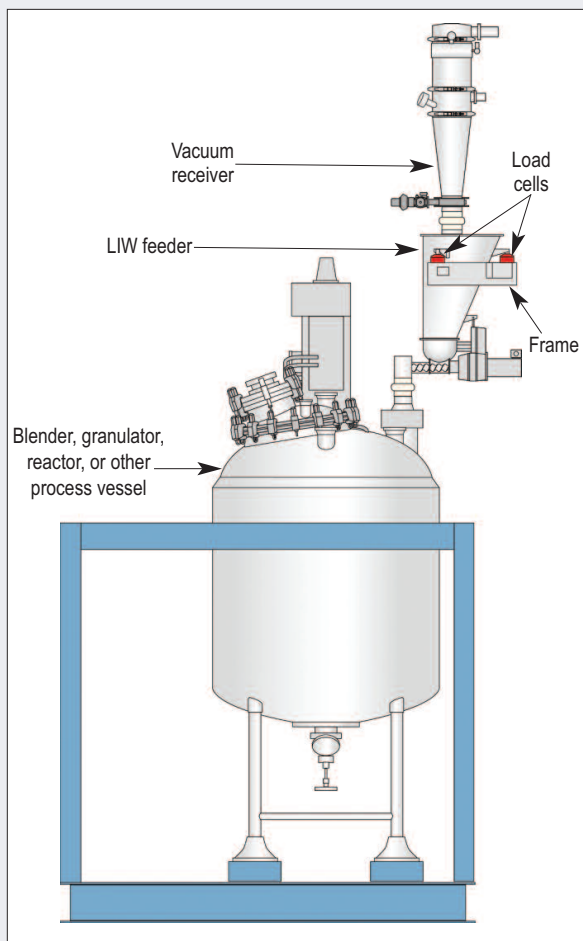
Single LIW feeder dispensing powder from vacuum conveying system. This batching application requires one LIW feeder, as shown in Figure 2a. A large quantity of a highly reactive powder in a supply vessel on one floor is transferred by a vacuum conveying system to the LIW feeder on the floor above. The powder is completely contained as it discharges from the conveying system's vacuum receiver into the feeder's hopper.

FIGURE 1
LIW feeder

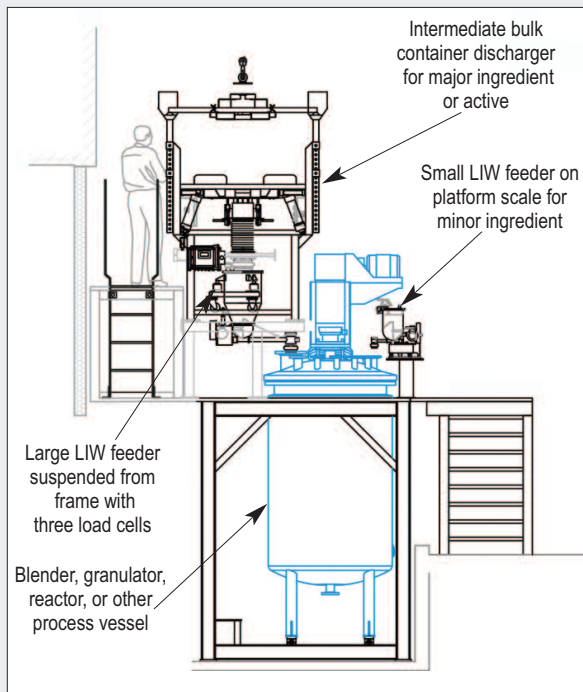


FIGURE 2

LIW feeders in two batching applications



a. Single LIW feeder dispensing powder from a vacuum conveying system



b. Two LIW feeders dispensing two powders into one vessel

Comparing LIW batching with GIW batching

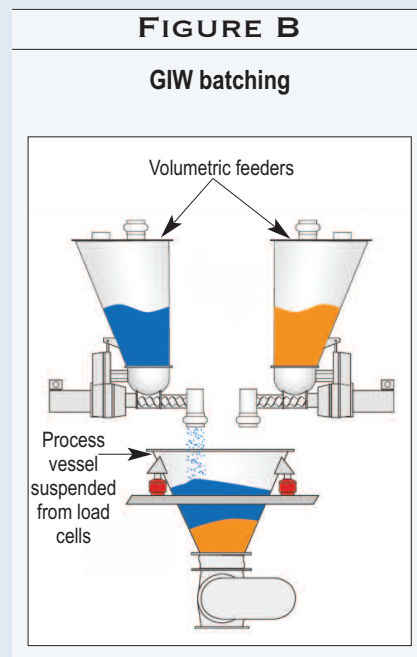
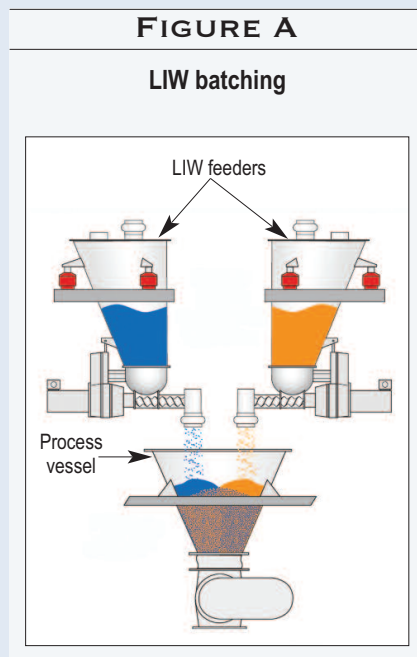
Both LIW feeders and GIW feeding systems can be used in batching applications, but they work in fundamentally different ways. These differences typically make the LIW feeder better suited for dispensing powder actives or other ingredients with high accuracy requirements.

The LIW feeder is suspended from or rests on high-speed load cells and dispenses powder into a granulator, blender, or other process vessel at a rate based on sensing the feeder's loss in weight. The LIW feeder's weight-sensing device provides high-speed, high-resolution weight-loss measurements of the powder in the feeder hopper. An example of an LIW batching application with two LIW feeders simultaneously dispensing ingredients into a process vessel is shown in Figure A.

The GIW feeding system includes one or more volumetric feeders above a process vessel that's suspended from high-capacity load cells or rests on a high-capacity floor scale. Each volumetric feeder sequentially dispenses powder at a rate based on sensing the gain in weight of the entire vessel and its contents. In the GIW batching application shown in Figure B, two volumetric feeders sequentially dispense ingredients into the process vessel.

Which feeder type is best for your batching application depends on several factors, including the total batch size, the number of ingredients in the batch, your desired batching time, each ingredient's flow characteristics, and your application's accuracy requirements. When the batch ingredient is an active pharmaceutical ingredient, feeding accuracy can be a critical factor in determining whether the LIW or GIW batching method is best.

Here's why: With a GIW feeding system, a volumetric feeder dispenses



powders into a vessel mounted on load cells, which must detect the weight of that powder addition as well as the full weight of the vessel and the powder it already contains (called the full scale capacity). Because most high-capacity load cells and floor scales don't have enough speed or resolution to detect the weight of a small amount of powder relative to the much larger overall weight of the vessel and its contents, a GIW system's expected batching accuracy is typically ± 0.5 percent of the full scale capacity. However, the LIW feeder can achieve batching accuracies of ± 0.1 percent of the batch set-point. This is because the LIW feeder's operation depends on sensing only the weight of the ingredient being fed rather than the much larger weight of the vessel and all of its contents, and the LIW feeder's high-speed load cells provide very high resolution (typically one part in four million).

The LIW feeder can also speed your batching operation. When a

GIW system handles an application with multiple ingredients, multiple volumetric feeders (one per ingredient) must dispense ingredients one at a time into the vessel, because the vessel is weighed for each ingredient. In contrast, multiple LIW feeders can all dispense their ingredients at the same time into the vessel, because each ingredient is weighed as it's dispensed. This significantly cuts the total batching time.

Be aware, however, that using LIW feeders for all the powders in a multi-ingredient batch can be expensive. A cost-saving alternative is to select a batching system that includes both GIW and LIW equipment. The GIW system can handle the lower-cost ingredients that have lower accuracy requirements. The LIW feeders can dispense the more costly ingredients, such as actives, that have higher accuracy requirements or can dispense ingredients required in a large quantity, thus cutting the total batching time.

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The feeder is located above a blender, granulator, reactor, or other process vessel and is suspended from a frame with three load cells to handle the large batch size. The load cells are connected to the feeder's controller. The controller is programmed to control the feeder to meter the powder at a high-speed (or bulk) flow rate into the vessel below it until the controller determines that the dispensed powder is within 90 percent of the powder's batch set-point. Then the controller automatically slows the feeder to a trickle (or dribble) rate to ensure that the feeder accurately delivers the desired batch weight.

Two LIW feeders dispensing two powders into one vessel. In this batching application, two LIW feeders—one large and one small—each dispense a powder into a process vessel, as shown in Figure 2b. In this process, the final dosage form includes a large quantity of active, which is supplied in intermediate bulk containers. The large LIW feeder is suspended from a frame with three load cells and located below a discharger, which provides fully contained discharge through an airtight connection into the feeder's hopper.

The small LIW feeder receives a minor ingredient supplied in small bags; because this feeder handles less weight than the large LIW feeder, it rests on a platform scale with one load cell. Each small bag of powder is manually emptied into the small LIW feeder's hopper.

Both feeders are connected to a controller that automatically controls the feeder speed at fast and trickle feed rates to accurately meet both ingredients' batch set-points. The LIW feeders allow simultaneous batching of both ingredients, reducing the overall batch cycle time. The feeders are also mounted on casters that roll on tracks, allowing the feeders to be rolled in and out of place as needed for cleaning.

More about the LIW feeder's weighing system

To provide the feeding control and performance required for accurate batching, the LIW feeder's controller must receive accurate high-speed measurements of powder weight changes from the load cells. This weighing system (that is, the load cells and controller) must also filter out measurement errors caused by plant vibrations, non-uniform powder flow, or bulk density variations and remain stable despite changes in the temperature of the ambient air or powder. The higher the resolution of the load cell weight measurements and the faster the measurements are taken, the better the information going to the controller and the better its control and vibration-filtering algorithms will work.

LIW feeders typically use analog strain gauge or digital load cells based on advanced weighing technologies. Work with your LIW feeder supplier to choose load cells that provide the speed, resolution, vibration-filtering capability, and stability your application requires. [Editor's

note: For detailed information on load cells for LIW feeding and batching applications, contact the author.]

LIW feeder options

Your LIW feeder's components can be fabricated of various materials to suit your pharmaceutical or high-value powder. The components can also be designed to safely contain your powder while simplifying inspection, cleaning, and changeovers. Which components are best suited to your LIW feeder will depend on your powder's characteristics.

For example, equipping the feeding device's outlet with a split butterfly valve (which combines active and passive components to provide maximum containment) will ensure that your powder is completely contained when the feeder is moved away from the process vessel after batching is completed.

You can also select a feeder (and the hopper or receiver that discharges powder to it) with a retractable wash- or clean-in-place (WIP or CIP)

spray system that eliminates many labor-intensive steps, thus ensuring fast changeovers and minimizing contamination between runs while protecting workers. The spray system also can pre-wet the feeder's interior before it's opened, thus wetting the dust and preventing it from becoming an airborne hazard to workers. Even a feeder equipped with a WIP/CIP system will still need to be disassembled for inspection from time to time, so look for feeding devices that give you quick, easy access.

Consult your LIW feeder supplier for advice on selecting the components that suit your powder's characteristics and containment requirements, as well as your expected inspection, cleaning, and changeover frequencies.

Maximizing your LIW feeder investment

Using a LIW feeder to accurately weigh and deliver pharmaceutical and other high-value powders to a process without manual intervention can provide several advantages. These include achieving better product quality, reducing manufacturing costs, and obtaining maximum yields. The feeder supplier can help you not only design the feeder to accurately and safely handle your tough powder, but help you combine the feeder and upstream and downstream equipment into a system that reduces your operating costs while maximizing your process efficiency and product quality. T&C

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LIW feeders are a must for continuous manufacturing. In batch operations, they can feed two or more ingredients, reducing cycle times.