• Selecting an automated batching system
• PBE Midwest Powder Show™ product preview

WEIGHING AND BATCHING
Automated batching can overcome the inaccuracy, limited output, and other problems associated with manual batching operations. This article discusses factors — previously published in PBE — to consider when selecting an automated batching system.

Manual batching is a time-consuming operation in which an operator adds premeasured ingredients or individually weighs ingredients before adding them to a blender or other process vessel. The operation can slow an entire process, generate considerable dust, and result in lost product through spillage and incompletely emptied bags.

The biggest problem with manual batching, however, is that it can be an inaccurate and inconsistent method of weighing batch ingredients, which can affect product quality and consistency.

Consider, for example, the potential for human error in this typical manual batching operation. To add 500 pounds of an ingredient to a mix, an operator dumps 10 “50-pound” bags of material into a blender. Bags, however, may not contain exactly 50 pounds. Or, the operator may not completely empty each bag. These inaccuracies compound as all 10 bags are dumped. If the operator counts the bags as a way of measuring ingredients, one mistakenly uncounted bag can lead to a major error in ingredient proportions. In contrast, an automated batching system controls the weighing and addition of each ingredient into the blender, eliminating the possibility for human error.

For many plants, whether large or small, switching to an automated batching system (also called a weigh batching system) is a cost-effective way to solve these problems. While an automated system usually requires a more significant capital investment than a manual system, automation can quickly pay for itself by improving ingredient measurement accuracy and, in turn, product consistency. Automated systems also can increase production rates, minimize dust and product loss, and reduce raw ingredient costs by allowing you to purchase materials in larger containers or bulk volumes.

There are some basic things to consider when choosing an automated batching system. To make the best decision for your plant, consider these factors:

**How automated batching systems work**

Two types of automated batching systems are available: gain-in-weight and loss-in-weight. While these systems share many characteristics, they operate in fundamentally different ways.

**Gain-in-weight system.** A gain-in-weight system, as shown in Figure 1, measures the amount of weight gained by a central batch vessel as each ingredient is added. The system typically includes a source for each ingredient such as a hopper or bulk bag, a mechanical or pneumatic conveyor for each ingredient, the batch vessel (called a weigh hopper) mounted on or suspended from load cells and located over a process vessel (such as a blender), and a controller.

An operator pushes a manual start button — or a plant PLC sends a signal — to start the batching process. The controller then starts the mechanical conveyor (or the rotary airlock valve at the pneumatic conveyor's inlet) for the first ingredient to load it into the weigh hopper at the maximum feedrate. The load cells transmit weight-gain data to the controller. The controller steps down the feedrate to dribble before the ingredient reaches the target weight to achieve greater accuracy. The controller stops the mechanical conveyor or rotary airlock valve at a preset amount before the target weight is reached to compensate for material in flight — that is, discharged from the conveyor or valve but not yet loaded into the weigh hopper. The process is repeated for each ingredient in the batch. When all the ingredients have been added to the weigh hopper, the
controller automatically discharges the batch from the hopper into the process vessel.

**Loss-in-weight system.** A loss-in-weight system, as shown in Figure 2, measures the amount of weight lost at the ingredient source as each ingredient is conveyed to a central batch vessel. The system includes a source for each ingredient, often a bulk bag unloader or preloaded hopper, that’s mounted on load cells; a mechanical or pneumatic conveyor for each ingredient; the batch vessel, such as a hopper, blender, or other process vessel; and a controller.

An operator pushes a manual start button — or a plant PLC sends a signal — to start the batching process. The controller then starts the mechanical conveyor (or the rotary airlock valve at the pneumatic conveyor’s inlet) at each ingredient source to load the ingredient into the batch vessel at the maximum feedrate. As each conveyor discharges an ingredient, the source’s load cells transmit weight-loss data to the controller. When the weight loss from a source approaches the target weight for that ingredient, the controller steps down the feedrate to dribble for greater accuracy. This system can be configured to allow all ingredients in the batch to be weighed and transported simultaneously to the batch vessel.

**Suitable applications**

Each type of automated batching system is suited to different applications. A gain-in-weight system is generally more suitable for weighing a relatively large number of smaller-volume ingredients transported by relatively short mechanical or pneumatic conveyors from the ingredient source to the batch vessel. Reasons for that include:

- The entire system requires only one set of load cells.
- A gain-in-weight system can generally achieve higher system accuracy because the load cells used by the system's relatively light central batch vessel can weigh smaller amounts of ingredients than the load cells in a typical loss-in-weight system, which must support the weight of each ingredient and the equipment containing it.

A loss-in-weight system is typically better-suited to weighing a smaller number of larger-volume ingredients from nearby or distant sources. Reasons for that include:

- Mounting the bulk bag unloader or supply vessel for each ingredient on its own set of load cells increases the system’s cost.
- The heavy-duty load cells capable of supporting large volumes of material and equipment at the ingredient

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**Figure 1**

Typical automated gain-in-weight batching systems

- **a. With mechanical conveyors**

  - Flexible screw conveyors
  - Weigh hopper
  - Bag dump station

- **b. With pneumatic conveyors**

  - Filter receiver and weigh hopper
  - Bag dump station
  - Pneumatic conveying lines
sources cannot weigh small amounts of ingredients in a batch with high accuracy.

- Loss-in-weight systems weigh the amount of ingredient lost from the source; the system doesn't have to account for in-flight material, eliminating this potential source of batching inaccuracy.

Other factors

Which automated batching system is best for your application also depends on a combination of additional factors, including:

- **Raw ingredient receiving and storage.** If your ingredients are delivered in railcars or bulk truck trailers and stored in silos, a gain-in-weight system is more appropriate because mounting the silos on load cells for a loss-in-weight system would be impractical.

- **Batching rate.** If you require the shortest possible batching cycles, a loss-in-weight system can fill your requirement because the system's load cells are located at the ingredient sources, allowing the system to weigh all ingredients in the batch simultaneously compared to a gain-in-weight system where only the batch vessel is on load cells so ingredients must be weighed sequentially.

- **Space limitations.** If headroom in your batching area is limited, you may not be able to fit a gain-in-weight hopper and conveyors above your process vessel. Options for overcoming headroom limitations include using low-profile feeding equipment or mounting the process vessel directly on load cells, eliminating the need for a separate weigh hopper.

- **In-flight material.** If you select a gain-in-weight system, the controller should be programmed to compensate for the in-flight material to avoid inaccurate batching.

The gain-in-weight system's conveyor configuration has a significant effect on the amount of in-flight material. In a system with mechanical conveyors that discharge ingredients by gravity directly into a weigh hopper, the vertical distance between the conveyor discharges and the hopper will determine the amount of in-flight material and, accordingly, the weighing accuracy you can achieve. For example, if a conveyor discharge is positioned immediately above the weigh hopper, in-flight material will be minimal, allowing the controller to compensate with the greatest accuracy by stopping the conveyor an appropriate amount of time before the target batch weight is gained.

In contrast, a gain-in-weight system with relatively long pneumatic conveyors between the ingredient sources and the weigh hopper, has a significant

Figure 2

Typical automated loss-in-weight batching systems

a. With mechanical conveyors

b. With pneumatic conveyors

Flexible screw conveyors
Batch vessel
Bulk bag unloaders
Filter receiver over batch vessel
Pneumatic conveying lines
amount of in-flight material. When the controller stops the rotary airlock valve at a conveyer’s inlet, the conveyer will be full of material that’s already en route to the weigh hopper. In this case, a better choice may be to use a loss-in-weight system, which eliminates the in-flight material variable because the rotary airlock valve feeding the pneumatic conveyer stops as soon as the ingredient source has lost the preset target weight of that ingredient. All the material in the conveyer is transported to the batch vessel.

- **Load cell protection.** A potential downside to a loss-in-weight system is that the load cells weighing the system’s ingredient sources are often at floor level, where they can be hit by pallet jacks, forklifts, and other mobile equipment, causing damage or requiring recalibration. Installing steel bumpers can help protect load cells. Choosing a gain-in-weight system also can help as its load cells are typically mounted on a weigh hopper suspended above the floor.

- **Checkweighing.** A gain-in-weight system with a weigh hopper to accumulate ingredients above the process vessel offers the option of checkweighing the batch before discharging it into the process vessel. This allows the operator to adjust a batch that exceeds allowable weight tolerances before it’s discharged at the downstream process. Conversely, checkweighing isn’t possible with a gain-in-weight system in which the process vessel itself is mounted on load cells or with a loss-in-weight system that discharges each ingredient directly into the batch vessel, precluding the possibility of correcting a batch weighing error.

**Testing**

Thorough testing is the best way to determine which equipment configuration best meets your automated batching requirements. Factors such as material delivery method, infeed rate, surge vessel capacity, weighing equipment location in relation to mixers, hopper and chute design based on the material’s physical properties, and proper upstream and downstream equipment sequencing are critical.

A supplier’s test facility should contain a diverse selection of production-scale — not just lab-scale — equipment allowing you to test the batching system with components in your process and your own material. This will ensure that recommendations are based on the most efficient solution for your application.

Considering all these tips should help you effectively integrate an automated weigh batching system into
your process and reap the benefits associated with such an investment.

For further reading
Find more information on this topic in articles listed under “Weighing and batching” in Powder and Bulk Engineering’s article index in the December 2016 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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