WEIGHING AND BATCHING: WEIGHING THE OPTIONS

This article first describes how weighing and batching systems operate and then provides information on feed consistency, scale variables, and controls sophistication to help optimize your system’s performance.

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Accuracy requirements play a large role when designing a weighing and batching system. Regardless of whether you’re dealing with 30 silos and a 0.01 percent accuracy or a single weigh hopper and ±5 percent accuracy, the system’s consistency, speed, and automation should always be top-of-mind.

Define deliverables and material characteristics

When talking about weighing and batching, an efficient system has two key identifiers, timing (throughput) and accuracy (quality). By defining your system’s deliverables first, you can reverse-engineer the process to get a system that fits your needs.

Before concentrating on the system, however, you need to understand the characteristics of the materials you’re handling. Having consistent material temperature, moisture content, and particle size is desirable. When uncontrolled, these variables and other seasonal conditions can result in material flow fluctuations and reduced accuracy. Proper feeder design (into or out of the scale) will greatly alleviate this problem.

Scales: Loss-in-weight vs. gain-in-weight, continuous vs. batch

When talking about batch processes, you can either have a loss-in-weight (LIW) or a gain-in-weight (GIW) process.

LIW batching has a scale for each ingredient. This scale usually contains more material than is required for an individual batch and also includes a volumetric measuring feature at its discharge. When an ingredient is called for, the feeder turns on and the scale measures the loss in weight of material from the entire assembly. The load cells are sized for the gross weight capacity of the feeder, hopper, and material. With LIW batching systems, multiple ingredients can be discharged simultaneously.

With GIW batching, ingredients are dispensed one at a time into a weigh hopper or container that sits on a single scale. System processing is controlled by the receiving container’s weight gain. The scale usually controls the feeders that are set to fast speed, slow speed, and jog with auto pre-act adjustment.

How you decide your ideal process is a question of the volume rate, batch speed, and accuracy that best suits your process parameters. It’s not uncommon for a total process to include both LIW and GIW systems. It’s also common to have scales for major, minor, and micro-ingredients. These classifications are based on material amounts in the mix.

Feeders: Volumetric vs. gravimetric

The above description mostly addresses batching scenarios; however, many processes require continuous material feeding or metering. Continuous material feeding by weight is referred to as gravimetric metering.

There are a multitude of feeder types for scaling applications, including screw, rotary, and vibratory feeders. Or a simple orifice valve can be used. The type of...
feeder used for any given application is based on material characteristics, accuracy required, and feedrate.

Proper feeder selection is critical for a successful weighing and batching system. Metering systems are also referred to as being either volumetric or gravimetric. Simply stated, volumetric feeding doesn’t involve any sort of scale. The feeder speed is adjusted to increase or decrease the volumetric feedrate. Gravimetric feeders are controlled via weight change.

Generally, gravimetric feeding systems measure how fast the weight is lost from a feeding device. A continuous gravimetric feeding system operates like your car’s cruise control. If you set it to 75 miles per hour, the automation algorithm adjusts the throttle up and down to maintain the preset speed regardless of the road conditions or number of passengers.

The LIW batch system’s instrumentation algorithm operates the feeder in the same way so the preset weight (or rate) goal is achieved regardless of outside factors. A continuous volumetric feeding system loses a preset volume out of the feeder and into the process. There is no scale involved. Batch GIW systems include a common weigh hopper, which can be fed from multiple volumetric feeders, though these feeders must come on one at a time. The controller regulates the feeding and is set to fast speed, slow speed, and jog with auto pre-act adjustment.

There are benefits and tradeoffs to using LIW and GIW systems. GIW systems typically require fewer parts because multiple ingredients are collected and weighed on a single scale. Yet, because you can only measure one material at a time, the batching process will take longer.

LIW systems require a dedicated scale for each ingredient — the benefit being that multiple ingredients can be weighed simultaneously. If you need to achieve a certain processing rate goal — for instance, so many pounds per hour — you can feed all materials at the same time. Another advantage of LIW is that by requiring a separate scale system for each material, your accuracy can be increased.

When considering a system, other influencing factors that need to be considered include available headroom, equipment size, scale emptying time, and other existing material-specific factors.

Efficient design considerations
Repeatability is the key to a successful weighing and batching system installation. For a system that meets your processing needs, consider:

- **Feed consistency.** Good systems have a feed mechanism that has a predictable feedrate. Feed consistency is important so that the control system can effectively stop the system at the targeted weight. For instance, if you use a rotary valve as your feeding device and the valve pockets don’t contain consistent material amounts, your overall scale weight won’t be accurate, which can affect other measurements. This will drastically affect the ability of the control system to stop on target.
  - **Free fall.** System controls typically have a self-teaching mechanism that operates based on the set pre-act. This is the stopping point set by the operator based on the predicted amount of material still in the system after feeder cutoff (often referred to as “free fall”). Once that cutoff point is reached, material goes into free fall and the dust settles. If you don’t wait for all the dust to settle, it can sometimes settle on the scale and affect outcomes. An automated, self-teaching function can help avoid that problem.
  - **Scale variables.** Besides feeder consistency, factors that can affect scale accuracy include material type, feeding rate, live vs. dead load, equipment vibration, and air currents. It’s imperative that scales “float.” In other words, all connections attached to the scale must be flexible so as not to affect scale performance.
  - **Weigh hopper venting.** Weigh hopper venting is another factor that can affect scale accuracy. Venting to an air source that’s pulling a negative pressure (such as a central dust collection system) onto the scale can affect accuracy. Self-contained venting on a weigh hopper must maintain a consistent pressure differential across the filter elements. Automatic reverse pulse-jet cleaning of the filter is preferable.
  - **Load cell sizing.** For better accuracy, you want to keep a scale’s gross weight capacity as low as you effectively can. The scale has to be able to weigh the dead weight plus the material. The use of aluminum or a much thinner gauge steel can reduce the weight of a weigh hopper, thus reducing the size of the load cells.
  - **Control sophistication.** Controls and specifications such as hardware and communication architecture, instrumentation compatibility, and environmental ratings need to be considered for an effective weighing and batching system. A solid controls platform incorporates proven algorithms to maximize system mechanics.

Controls for your weighing and batching system are very important to its operation as they monitor production quality. The control system can automatically accept production based on measurable variables or halt and sound an alarm, warning operators about an out-of-spec batch. Finally, the automation system can capture and report the processed batch data for decision-making in terms of inventory, production planning, and quality tracking.
In summary
Due to the number of impactful variables, an efficient weighing and batching system can be difficult to design without an experienced partner by your side. Between rate, accuracy, and repeatability, there are many goals a company wants to achieve but, as we’ve learned, there are multiple process options. By reverse-engineering a system, you can identify your problem areas and design an efficient system customized for you.  

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 2018 issue or the Article Archive in PBE’s website www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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