Application Example

Automated Batch Dispensing of Reactive Powders into Reactors and Tanks via LIW Feeders

Background

Metered dispensing of reactive powders into reactors and large tanks has been a challenge faced by many chemical and pharmaceutical process engineers. The requirement to dispense difficult to handle ingredients in a contained and accurate method is an application which can be fulfilled and completely automated using specifically designed loss-in-weight (LIW) feeders. The combination of highly advanced weighing technology, and a contained and sanitary feeder design provides for an ideal automated method of powder delivery, without the danger and inefficiencies of traditional manual loading techniques.

Application

As shown in figures 1 and 2, LIW feeders can be easily designed for dispensing of powders into a reactor, tank, or large process vessel. Figure 1 illustrates a single feeder, complete with a vacuum receiver mounted directly above the feeder, for transfer of the powder from the floor below. Figure 2, however, illustrates the ability to also incorporate a bulk bag frame system above the feeder for delivery of the powder to the feeding/dispensing system. It also illustrates the use of a second, smaller LIW feeder on a portable weigh scale which is used to dispense even smaller amounts of a second powder to the tank.

In order to provide the maximum in flexibility, feeders can be equipped with a special caster system on tracks, which enables the feeders to be rolled in and out of place like the feeder on the left in Figure 2. Alternatively they can also be placed on pneumatic lifts. The feeder in Photo 1 can be moved forward and back as well as up and down, and the entire unit can also be moved in and out of position. In all of these LIW batcher designs, the efficient batching program included in the feeder controller is designed for a metered flood flow of material out of the feeder until the total weight of the material fed is within 90% of the batch weight set point. At this point the controller automatically switches the feeder into a slower "trickle feed" mode in order to accurately reach the final set point weight. Based on the maximum achievable speeds determined with calibration, the feeder controller also calculates the minimum batch time for the specified material.

Photo 1 - Feeder on mobile lift system for maximum accessibility

LIW Batching

Batch size, number of materials, material characteristics and accuracy requirements will all influence which type of batching — loss-in-weight (LIW) or gain-in-weight (GIW) — is best used. Figure 3 illustrates the differences in equipment setup for these two modes of batching. Typical accuracies which can be expected with the Coperion K-Tron GIW method of batch weighing are +/- 0.5% of the full scale capacity. In other words, when batching into a reactor or vessel mounted on a scale or suspended from load cells, the full weight of the vessel and its contents must be reflected in the full scale capacity. Most floor scales or high capacity load cells do not have sufficient speed and resolution to detect small amounts of batched products relative to the larger overall weights of the tanks, reactors, or process vessels. If accuracy requirements on powders are in the range of 0.1 – 0.5%, individual Coperion K-Tron LIW feeders are typically used with the feeders mounted on high speed digital load cells with 1 part in 8 million resolution in 20 ms. A LIW batch controller monitors material weight loss from the feeder hopper and controls the speed and start/stop function of the feeder to control the achievement of the batch weight setpoint.

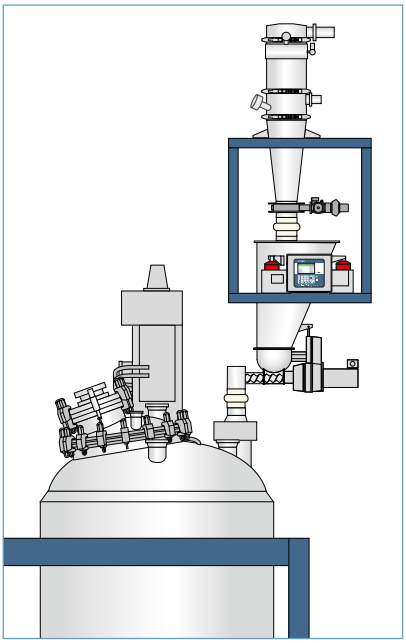


Figure 1 - Feeder with refill loader

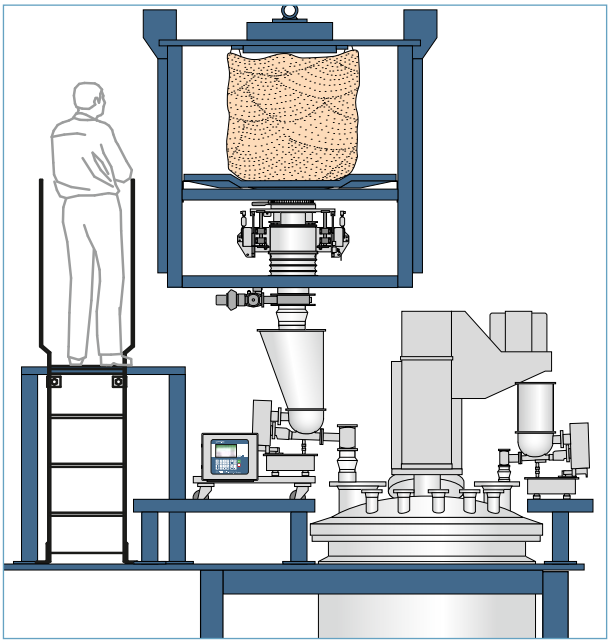


Figure 2 - Two feeders, one with bulk bag refill

Automated Batch Dispensing of Highly Reactive Powders into Reactors and Tanks via LIW Feeders

Weighing System & Feeder Performance

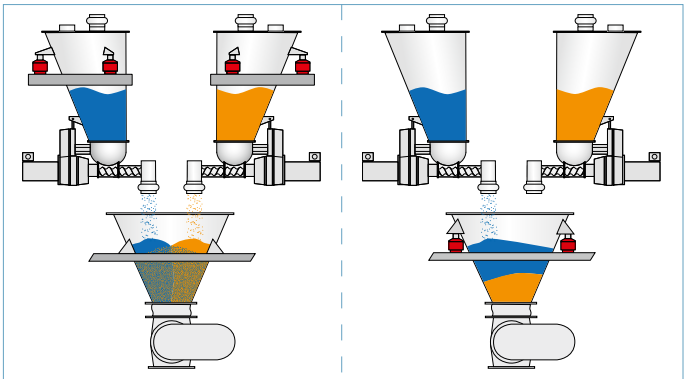
Any LIW process controller requires accurate high speed measurement of material weight changes in order to provide optimal feeder control and performance. The weighing system must also be able to filter out erroneous measurements due to in plant vibrations or disturbances and be stable over changes in process room or process material temperatures.

The keys to accurate batching are the higher resolution of weight measurement and speed of the controller. The faster those weight measurements are taken, the better the information that will be provided to the control algorithm, and the better any vibration filtering algorithm will work.

The advantages of weight control through custom technologies can certainly be a factor in the product quality and overall manufacturing costs. For example, Coperion K-Tron load cells, as shown in Photo 2, utilize a proven vibrating wire technology which is based upon the theory that the resonance frequency of an oscillating wire depends on the wire tension produces when a load is applied. The force of an applied weight is transferred mechanically to the wire. The resonant frequency is measured to determine the weight. In Coperion K-Tron's patented Smart Force Transducer (SFT) technology, the signal is directly converted into a digital weight signal by a built-in microprocessor. The signal is then communicated noise free via RS485 to the feeder controller. The new KCM-III controller includes a powerful and fast microprocessor, which is ideal for optimizing the batch weight measurements and their control.

In addition, the most recent improvements to the SFT technology are the result of a new custom integrated circuit which allowed continuous measurement and digital filtering capability at even higher sample rates. Previously there were short gaps of time between capturing the wire frequency, processing the weight, and restarting the frequency capture. The new system is able to capture an integer number of periods of the weight frequency using a 30 MHz reference frequency and never miss a single pulse. The result is truly continuous measurement. Every SFT provides a true 8,000,000:1 weight resolution in 20ms and comes with a 5-year warranty.

Photo 2 - SFT load cells



Loss-in-Weight Batch

Loss-in-weight feeders feed simultanously into a collection hopper.

Gain-in-Weight Batch

Volumetric feeders feed sequentially into a weighed collection hopper.

Figure 3 - Batching comparison

Photo 3 - K3-PH twin screw feeders

Options in Cleaning, Containment and Construction

Dependent upon the powders to be batched and frequency of batching, a variety of design executions can be provided for the equipment to reduce the overall cleaning or changeover steps. In the case of pharmaceutical applications the new versatile Coperion K-Tron K3 line of pharmaceutical screw feeders, shown in Photo 3, can be used for optimal modularity and cleanability. The use of stainless steel for the contact components in a variety of finishes allows for ease in cleaning and corrosion resistant operation. Feeders and conveying receivers can be designed with in-place retractable spray balls for wash-in-place cleaning to ensure quick changeover and minimal contamination between material runs. In addition, for toxic pharmaceuticals, the use of split butterfly valves at the product outlet can also be incorporated to insure complete containment of the powder when the batch is finished and the feeder moved away from the vessel or reactor. When designing for a batching system, it is important to discuss all aspects of the design requirements, including the expected changeover and cleaning times, optimal batch times, containment requirements, and any issues with height limitations, as the design requirements for these situations can greatly affect the overall system cost.

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