Automated dispensing of highly reactive powders into reactors and tanks via Loss-In-Weight feeders

Figure 1

Metered dispensing of toxic or 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 load cell weighing technology, and a contained and sanitary feeder design provides for an ideal automated method of powder delivery, without the dangers and inefficiencies of traditional manual powder loading techniques.

Application and process details

As shown in Figures 2 and 3, 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 powders 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.

Figure 2

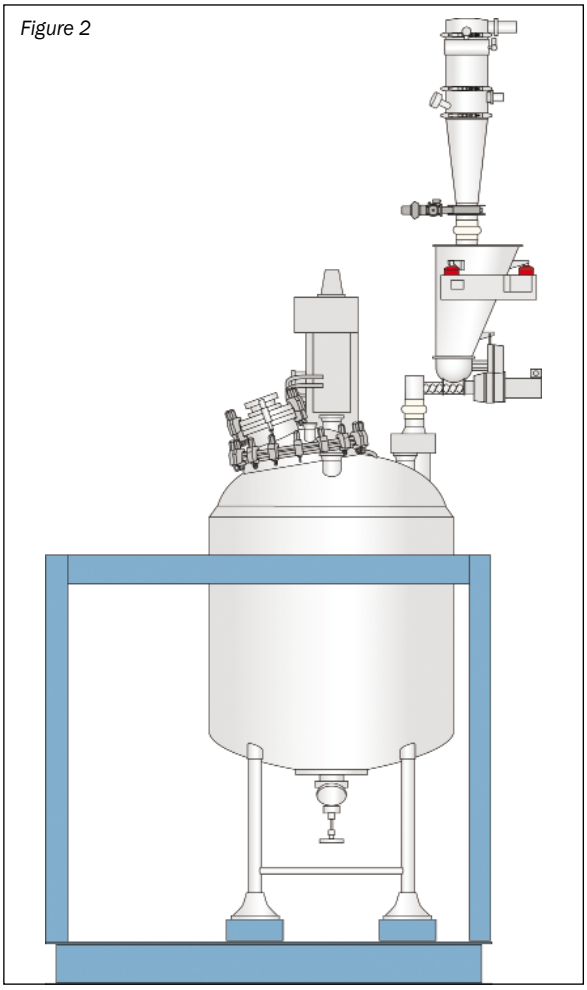
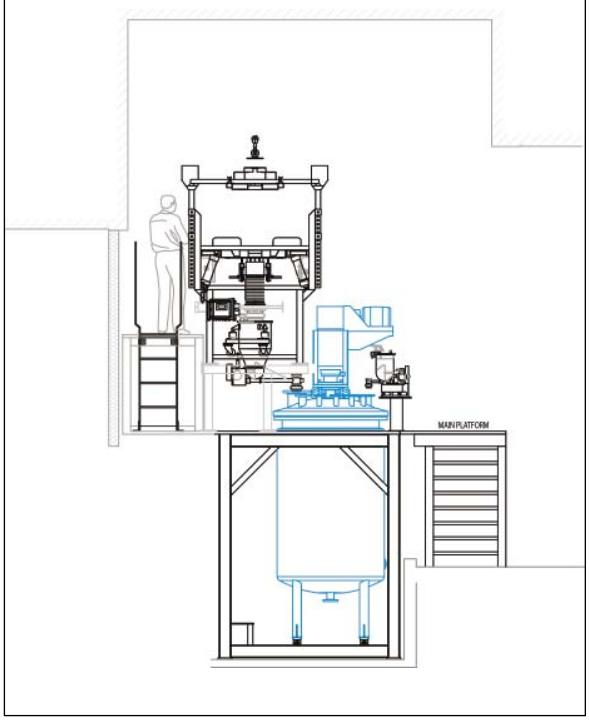
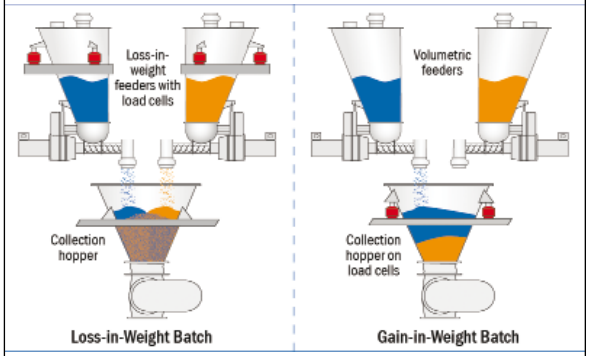


Figure 3



In order to provide the maximum in flexibility, all feeders are equipped with a special caster system on tracks, which enables the feeders to be rolled in and out of place as required. The feeders shown include both a three point suspension design from the load cell frame, which is often used for higher batch sizes, and also a scale mounted feeder, for dispensing of much smaller amounts. The efficient batching program included in the feeder controller is designed for a metered flood flow of material out of the feeder until a weight is detected within 90% of the batch weight set point. When this weight signal is received by the feeder, it automatically is put into a slower 'trickle feed' mode in order to accurately reach the final set point weight.

Figure 4



Why Loss-in-Weight (LIW) batching?

Batch size, number of materials, material characteristics and accuracy requirements will all influence which type of batching — via loss-in-weight (LIW) or gain-in-weight (GIW) — is best used. Typical accuracies which can be expected with the 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%, LIW feeders are typically used with the feeders mounted on high speed digital load cells with 1 part in 4 million resolution. A LIW batch controller monitors material weight loss from the feeder hopper and controls the start/stop function of the feeder to control the achievement of batch weight set point. (Accuracies mentioned are based on K-Tron brand feeders.)

Figure 5

Significance of the weighing system on LIW feeder performance

Any Loss-in-Weight 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. There are two types of weighing technology typically used in LIW feeders. They are:(1) Analogue strain gauge technology and (2) Digital vibrating wire technology.

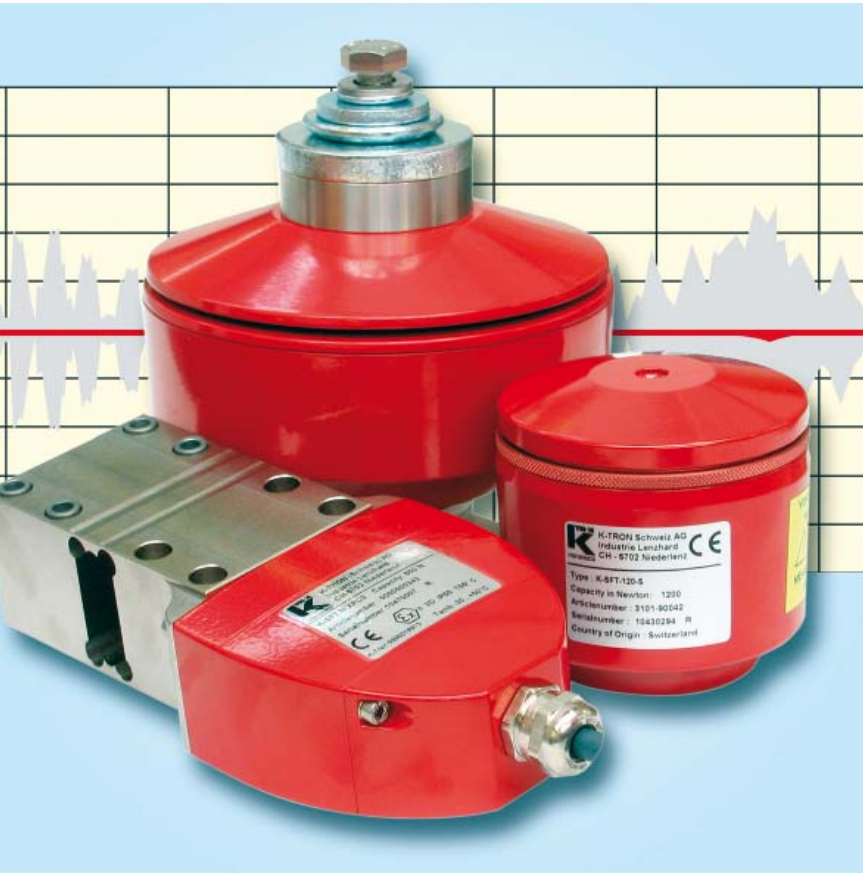


Figure 6

The key to accurate batching are the higher resolution of weight measurement and the faster those weight measurements are taken, the better the information that will be provided to the control algorithm to work, 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, K-Tron load cells utilize a unique 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. Force, when derived from an applied weight, is transferred mechanically to the wire. The resonant frequency is measured to determine the weight. In K-Tron's patented Smart Force Transducer (SFT), 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 KCM controller.

The most recent improvements to the Smart Force Transducer 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 4 000 000:1 weight resolution in 80 ms and comes with a 5 year warranty.

System design execution – Options in cleaning 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. The use of stainless steel for the contact components in a variety of finishes can be provided to allow 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, the use of split butterfly valves at the product outlet can also be incorporated to insure complete containment of the powder when the batching is complete and the feeder moved away for 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, containment requirements, and any issues with height limitations, as the design requirements for these situations can greatly affect the overall system cost.

Conclusion

Properly weighing and accurately delivering the ingredients without manual intervention can result in a number of process advantages, including improved product quality and savings of manufacturing costs. In addition, utilizing devices and systems which involve highly accurate weighing and metering of precious, expensive and even toxic ingredients can result in lower overall costs due to maximized yields.

When choosing a material handling supplier, it is important to ensure that their personnel can provide a wide variety of design and layout options in both powder transfer and delivery, in order to assist in lowering process costs but also to maximize efficiency and product quality.