BEST COMPONENTS & BETTER SYSTEMS

THE RECIPE FOR PERFECT FOOD

coperion K-TRON

Application Example

Feeding and Conveying of Ingredients to Continuous Mixers for Food Applications

Background

Continuous mixing is often used in the food and pet food industries for the mixing of dry powdered ingredients such as additives, flavors, macro ingredients, grains, and cereals. The inherent advantages of continuous blending operations include the following:

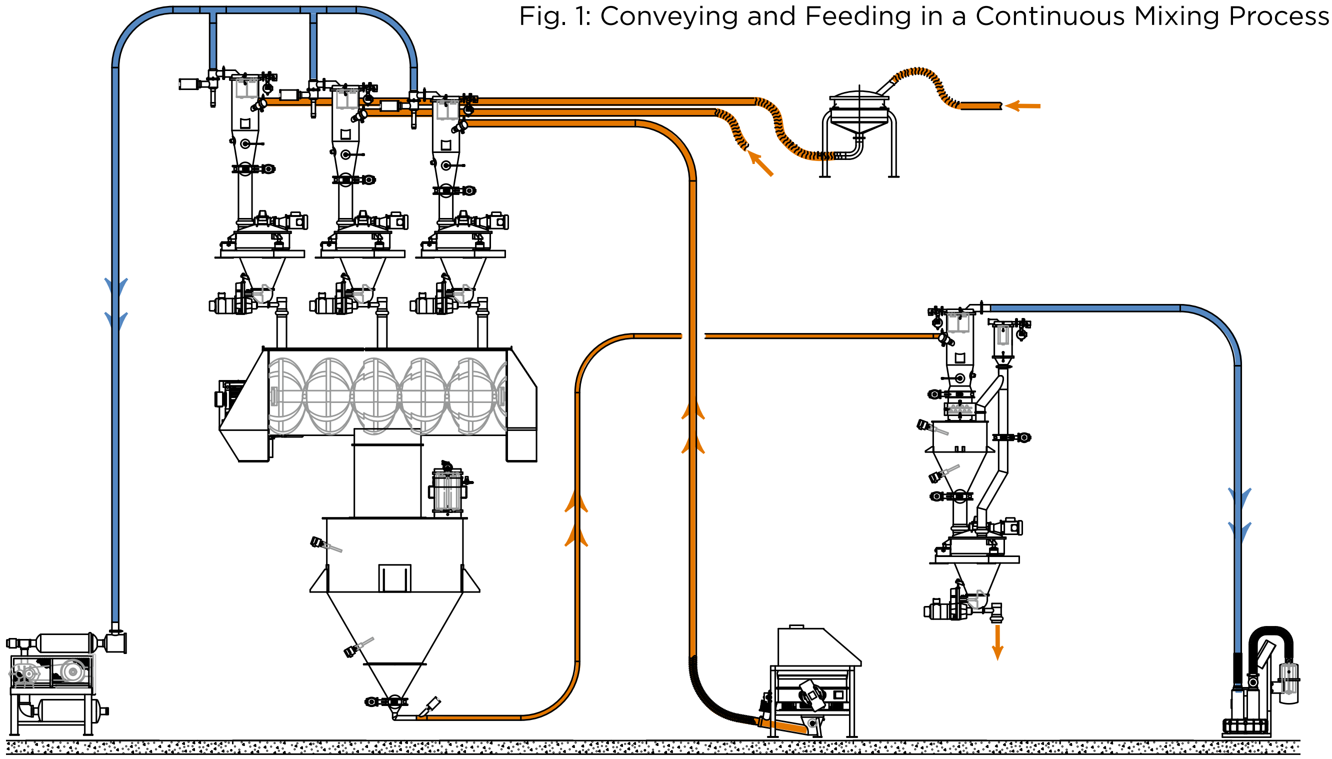
- Overall compact installation size, even for large throughput rates
- Gentle mixing of the product, due to the short material residence times
- Low energy expenditure since only a small mass of mixture is moved
- Reduced risk of demixing or segregation, since additional decanting or storage – which is typical after a batch process – is not required. Therefore, the output of the mixer can be integrated directly before the final product treatment process, such as packing or filling.
- Lower utility and operating costs
- Equipment in a steady state of automation results in labor cost reduction

Process Details

The task of the mixer is to evenly distribute separate raw materials in the shortest possible time. A continuous mixer comprises mechanisms for both transverse and longitudinal mixing. The mixing of units of mass that enter at the same time is defined as transverse mixing. The mixing of units of mass that enter at different times is defined as longitudinal mixing. Traditionally, in order to get uniform longitudinal mixing, a longer blender with higher overall residence times is required. When designing the continuous blender, the more consistent and stable the dosed mass flows are (directly related to the accuracy of the feed device), the more compact the blender design can be. This is due to the resultant requirement of only short, intensive transverse mixing without pronounced longitudinal mixing to get the same blend uniformity.

Photo 1: Coperion K-Tron Loss in Weight Feeders Feeding Spice Ingredients to Continuous Mixer

Fig. 1: Conveying and Feeding in a Continuous Mixing Process



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Loss-in Weight Feeders and the Continuous Process

As stated above, when designing the continuous mixing process, the method of delivery of the individual ingredients to that process is critical to the resultant product quality. For this reason, highly accurate gravimetric feeders are the feed method of choice. By definition, gravimetric feeders measure the flow's weight in one fashion or another, and then adjust feeder output to achieve and maintain the desired setpoint. Volumetric feeders do not weigh the flow; they operate by delivering a certain volume of material per unit time from which a weight-based flow rate is inferred by the process of calibration.

The most popular type of gravimetric feeder used in continuous processes is the loss-in-weight feeder. Loss-in-weight feeders directly measure and control to the process variable of flow rate and can fully contain the material within the confines of the feeder. Loss-in-weight feeders are typically either mounted on weigh scales or suspended from load cells. The Coperion K-Tron load cell, for example, is a highly accurate instrument, designed specifically for the rate and accuracy requirements of dynamic feeding, and features a resolution as high as 1: 4,000,000 in 80ms.

As shown in Figure 2, a loss-in-weight feeder consists of a hopper and feeder that are isolated from the process so the entire system can be continuously weighed. As the feeder discharges material, system weight declines. The speed of the metering device is controlled to result in a per-unit-time loss of system weight equal to the desired feed rate. A typical loss-in-weight feeder controller adjusts feeder speed to produce a rate of weight loss equal to the desired feed rate setpoint.

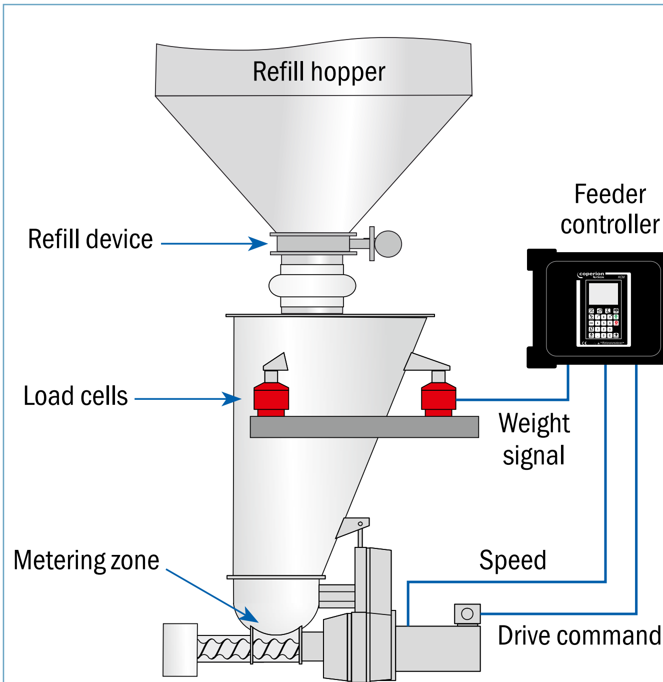

Fig. 2: Loss-in-Weight Feeder

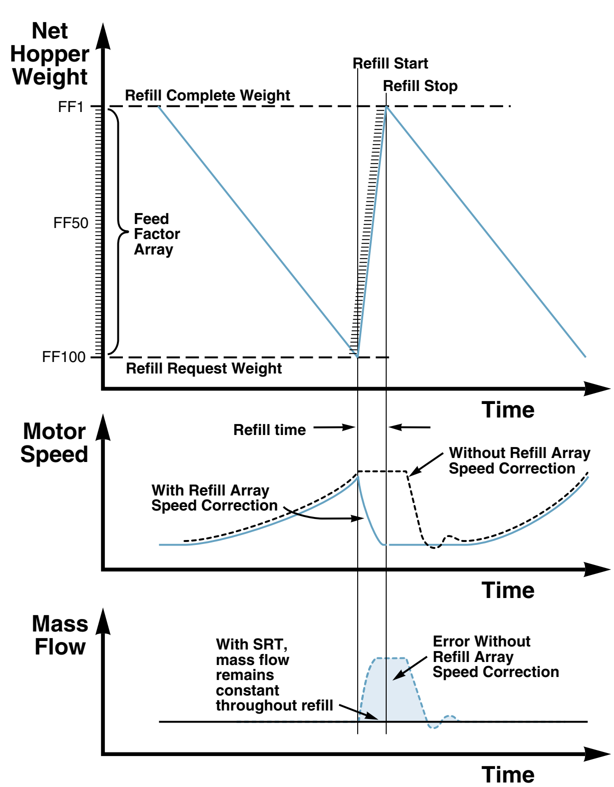

Fig. 3: Refill Array

Efficient Refill Operations

Two basic ways exist to refill the feeder hopper: the manual method and the automatic method. The manual method is generally such that a quantity of bulk solids is tossed into feeder hopper by the plant operator and the process continues. In the automatic method dosing machinery under control of the feed system will add material to the feeder hopper from an upstream supply.

Smart Refill Technology

In order to maintain overall feeder accuracy throughout the refill process, a controlled method of storing and trending the weight to speed relationship was developed. This method, referred to as Smart Refill Technology (SRT) and illustrated in Figure 3, discards the approach of maintaining a constant metering speed. In automatic refill, the feeder control system switches to volumetric control, relying on the trending data obtained while the hopper was emptying of product in gravimetric mode. As the hopper is emptied, the corresponding speed of the motor is trended. When the refill is in progress, this same speed is used for the corresponding hopper weight.

SRT enables metering speed to be gradually lowered during refill to precisely counterbalance the effects of increasing material density occurring within the metering zone as the hopper weight increases. The slower rate is determined by storing in the controller's memory an array of indices, called Feed Factors. These values correspond largely to material density and its mechanical behavior within the feeder, and are computed during the entirety of the gravimetric feeding cycle. Then on the basis of

Fig. 4: Pneumatic Refill - Sequence of Operation

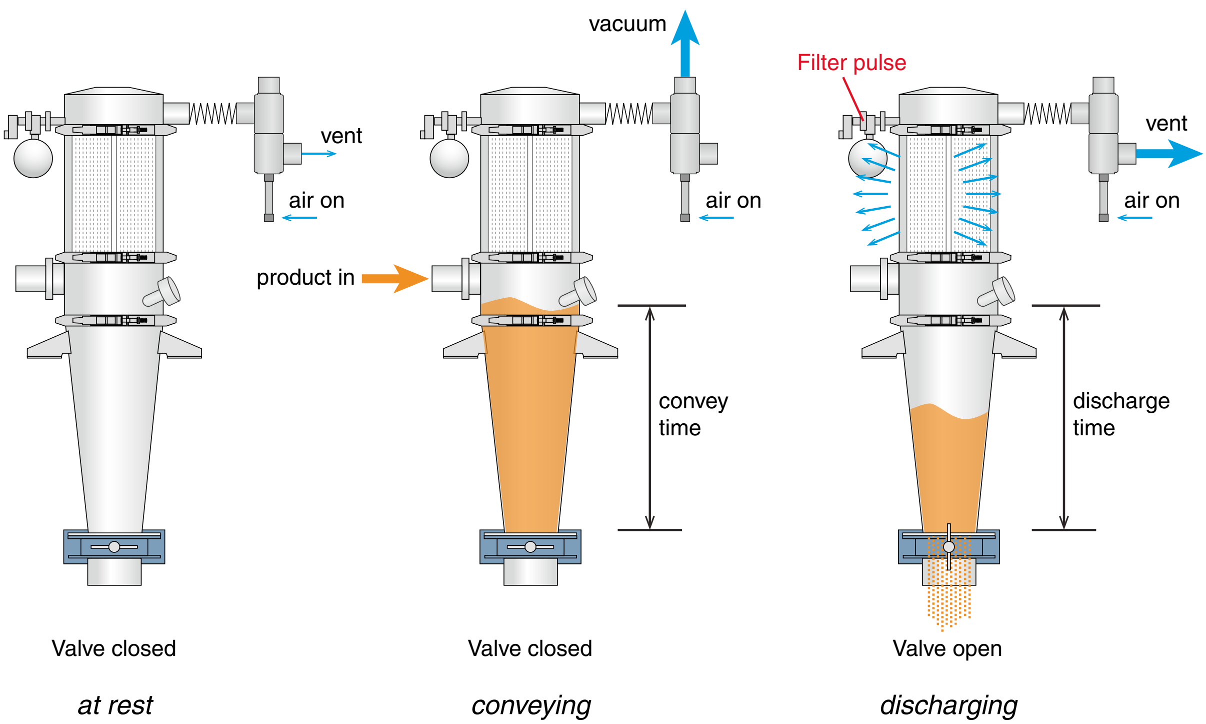


Photo 2: Coperion K-Tron Feeders with Dinnissen Continuous Blender

sensed hopper weight at each array point during refill, material density within the metering zone may be inferred, and a metering speed corresponding to its Feed Factor array value may be correlated. In this way, gravimetric feeding accuracy may be maintained during the brief refill.

Selection of the Refill Device

There are several choices of refill device available to be utilized above the feeder hopper. Options include knife gates, butterfly valves, rotary valves, or in cases where extreme control is required – such as in microfeeding – alternate metered devices such as volumetric screw feeders may be used. In addition, pneumatic loaders are often used above the butterfly valve or rotary airlock to transfer the material to the feeder hopper.

Vacuum Receivers as Refill Devices

Pneumatic receivers which operate under a dilute phase vacuum transfer principle are often used as refill devices, particularly for continuous operations. The pneumatic system utilizes negative pressure to suck the material required to refill into a separate mounted and supported vacuum receiver. As shown in Figure 4 on page 3, the receiver is filled to a determined level and then holds this material charge until the feeder below requests a refill. The level of fill in the receiver is determined by level sensors. At the point of refill request by the feeder below, the discharge valve opens and the receiver contents are discharged into the feeder hopper. At the same time of this release, a gas pulse is sent through the filter housed in the vacuum receiver, in order to release any entrained particulate or material which may have settled on the filter. The filter material can vary,

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including options on laminated membrane type materials, for quick release and easy clean properties.

After dumping the material into the feeder hopper below, the valve is shut again and then the receiver vacuum cycle immediately begins, in order for the pneumatic receiver to be instantly ready for the next refill request. The use of pneumatic receivers as refill devices allows for an uninterrupted source of refill from either bags, drums, IBC's or supersacks.

Summary

In order to produce consistent blend uniformity in short residence times, the use of high accuracy Coperion K-Tron loss-in-weigh feeders is imperative. In addition, the use of Coperion K-Tron pneumatic receivers as refill devices ensure quick and efficient refill cycles to maximize process quality.

Typical applications for the continuous mixing process include but are not limited to the following:

- Infant Formulas
- Powdered Drink Mixes and Bases
- Nutritional Protein Blends
- Soup Mixes
- Bakery Mixes
- Pet Food Mixes

Coperion K-Tron Advantage

- For continuous feeding, Coperion K-Tron's patented SFT digital weighing technology delivers the high accuracy requirements needed for maintaining control of the addition of costly ingredients
- SFT weighing technology features a resolution of 1:4,000,000 in 80 ms, as well as built in immunity to fluctuations in plant vibration and temperatures
- Coperion K-Tron's extensive line of pneumatic conveying designs ensures quick and efficient delivery of ingredient to the continuous process
- The Coperion K-Tron Systems Group can supply integrated systems of Coperion K-Tron and ancillary products, with one source management and complete recipe and process control
- Each Coperion K-Tron Feed and Refill Systems solution is custom developed according to the process application and based upon Coperion K-Tron's extensive experience providing material handling solutions

Fig. 5: Feeder and Refill Stackup over Continuous Mixer

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