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Application Example

Pneumatic Conveying and High Accuracy Batch Weighing for the Bakery Industry

Background

A typical bakery manufacturing system encompasses a variety of processes including mixing, forming and finally baking. The mixing process is a crucial operation, in which dry ingredients (sometimes a premix base) are combined with liquids (water, milk, etc.) and blended to form a homogenous dough. Traditionally, manual batching methods have been used for material handling and feeding ingredients to the mixing process. However, bakeries around the world are now opting to automate their operations in order to increase productivity, save time and improve overall product quality as well as process safety. In the automation of these plants, Coperion K-Tron implements pneumatic conveying systems for major, minor and micro ingredients as well as integrating high accuracy automated batching and weighing systems into the mixing process. By utilizing automated transfer methods for the raw ingredients along with highly accurate means of batching, a bakery manufacturer can realize lower overall manufacturing costs, lower overall manufacturing time as well as increased savings on individual raw ingredients as a result of reduced waste.

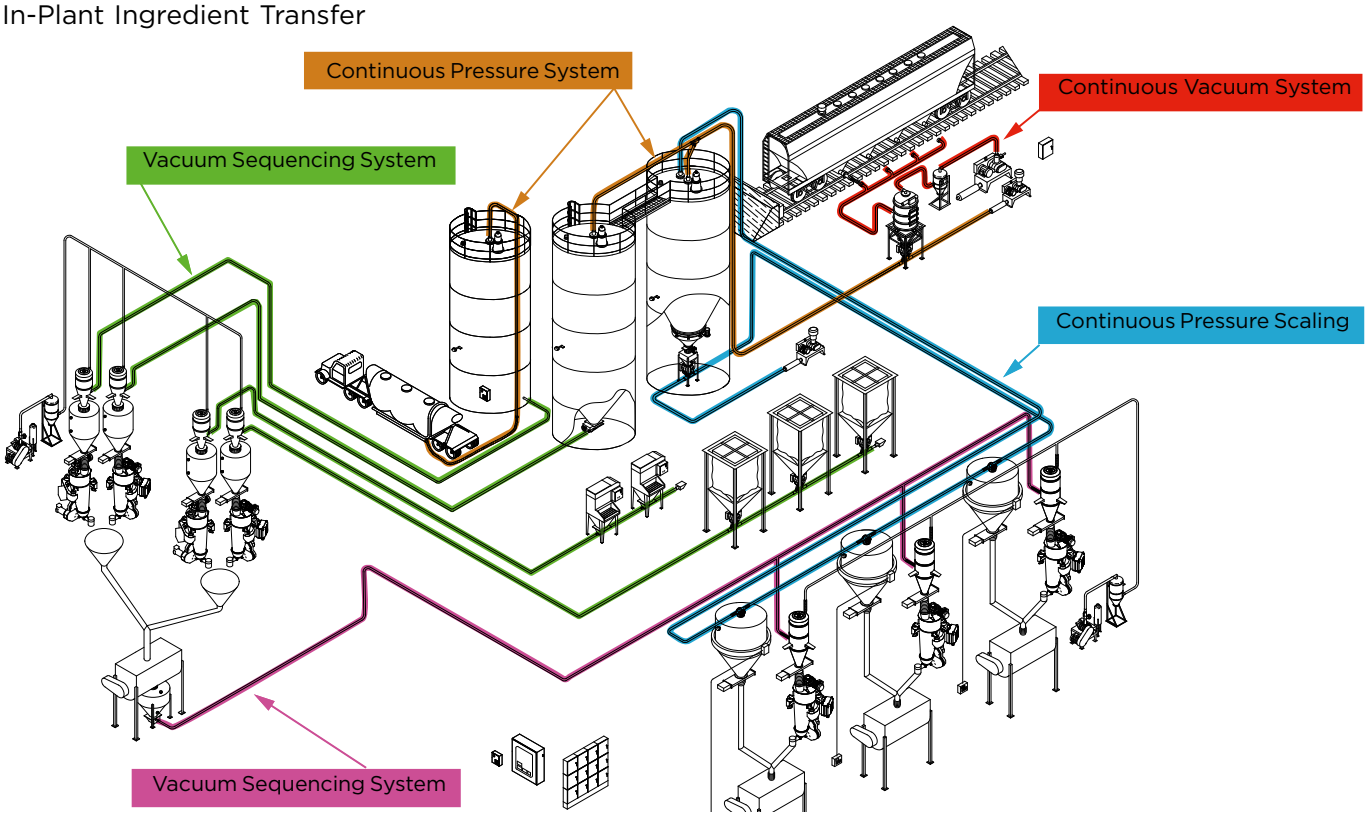
Application Details

The production of any blended bakery product typically involves the intermediate process steps of transfer and weighing or "batching" of individual ingredients based upon their weight percentage in a blend. Depending on this percentage, ingredients are usually categorized as majors, minors and micros. In many cases, the transfer and weighing of these majors, minors, and micros to the blending step can be a manual and labor intensive process. The automation of this

process includes the transfer of the raw ingredients to the batching system, where either Gain-in-Weight (GIW) or Loss-in-Weight (LIW) batch systems are used to accurately and efficiently deliver the combination of raw ingredients to the mixer.

Major ingredients such as flour can arrive to the plant in a variety of forms, such as railcar, truck or bulk bag systems.

In-Plant Ingredient Transfer



Pneumatic Conveying and High Accuracy Batch Weighing for the Bakery Industry

These major ingredients are transferred to specialized storage silos. From there they are then conveyed to the specific weigh batch stations as required for the blend. These transfer systems can easily be integrated into a plant PLC system featuring recipe control for multiple ingredients and processes, in order to provide maximum control and flexibility.

Ingredient Transfer

The transfer of major ingredients into and within a bakery plant is generally achieved via various types of conveying systems. Pressure Differential (PD) trucks and railcars use positive pressure to unload material, whereas other types of delivery to the batching process can often be achieved by either positive pressure or vacuum pneumatic conveying.

The mode of transfer of ingredients is dependent upon a wide variety of process parameters, including material characteristics, distance to be transferred, required rate of transfer, and the type of source and destination containers and/or process.

PD Transfer

Upon the arrival of a PD truck at the plant, a flexible hose is connected from the PD truck to the conveying line. If the truck does not have a built-in blower, a second line is connected to a pressure blower on site. The system operator selects the desired destination (e.g. silo 1 for starch or silo 2 for flour) on the truck unload control panel.

When the system is started, the blower pressurizes the PD truck and pushes material out of the truck via positive pressure through the conveying line and directly into the silo. Many times, an inline magnet is installed in the conveying line to remove any metal particles which may be present in the conveyed material. When the high level sensor in the silo is activated, the operator closes the material flow gate on the truck and allows the system to purge the conveying line before finally stopping the operation.

Dilute Pneumatic Transfer: Vacuum or Pressure?

Other possible sources of ingredient delivery include boxes, sacks, bulk bags or super sacks. In all of the ingredient transfer steps, pneumatic conveying systems can be used to transfer these ingredients. These systems can utilize either positive pressure or vacuum dilute phase conveying. Positive pressure conveying systems are typically used to transport bulk materials over long distances and at high throughputs. Applications which involve pressure conveying often include loading and unloading of large volume vessels such as silos, railcars, trucks, and bulk bags.

Vacuum (negative pressure) systems are generally used for lower volumes and shorter distances. One of the advantages of vacuum systems is the inward suction created by the vacuum blower and reduction of any outward leakage of dust. This is one of the reasons why vacuum systems are often used in higher sanitary or dust containment applications.

Another advantage of vacuum systems is the simple design for multiple pickup points. It should be noted, however, that the distances and throughputs possible with a vacuum system are limited due to the finite level of vacuum that can be generated.

Often a combination of pressure and vacuum conveying designs is used for a process, taking full advantage of the benefits and efficiencies of each technology.

Batch Weighing Principles

After transfer from the material source, the ingredients are usually delivered to the batching station. This station may consist of volumetric metering devices, such as screw feeders or valves, which deliver the product to a

Gain-in-Weight batching station for a bakery installation

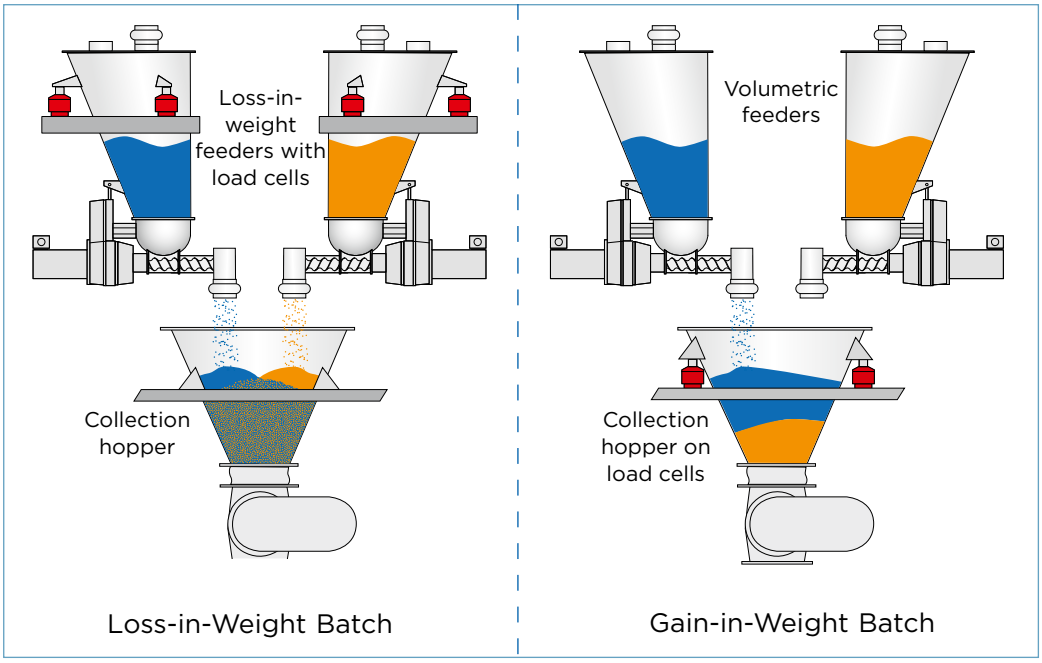
hopper mounted on load cells. This method is called Gain-in-Weight (GIW) batching. Alternatively, the station may consist of gravimetric feeding devices, such as screw or vibratory feeders, mounted on load cells or scales, which deliver the product to the process by means of Loss-in-Weight (LIW) batching. As outlined below, in some cases where small amounts of micro ingredients are required for an overall large batch, both methods are employed: LIW feeders for the micros and minors, and GIW batchers for the major ingredients.

Gain-in-Weight Batching

In GIW batching volumetric metering devices sequentially feed multiple ingredients into a collection hopper mounted on load cells. Each feeder delivers approximately 90% of the ingredient weight at high speed, slowing down towards the end of the cycle to deliver the last 10% at a reduced rate to ensure higher accuracy. The GIW controller monitors the weight of each ingredient and signals each volumetric feeder to start, increase or reduce speed, or stop accordingly. Once all the ingredients have been delivered, the batch is complete and the mixture is discharged into the process below. The photo on page 2 illustrates this type of batching station. It should be noted that this type of batching method is sequential for each ingredient, and therefore generally results in a longer overall batching time than with LIW batching.

Loss-in-Weight Batching

LIW batching is used when the accuracy of each individual ingredient weight in the completed batch is critical or when the batch cycle times need to be very short. Gravimetric feeders operating in batch mode simultaneously feed multiple ingredients into a collection hopper. Adjustment of the delivery speed (on/off, fast/slow) lies with the LIW feeder controls and the smaller weighing systems deliver highly accurate batches of each ingredient.



Once all the ingredients have been delivered, the batch is complete and the mixture is delivered to the process below. Since all ingredients are being delivered at the same time, the overall batch time as well as further processing times downstream are greatly reduced. This method of batching is often used for micros (such as trace elements and vitamin fortification) due to the high accuracy requirements and cost of these ingredients.

Vitamin Fortification Process

The mixes used in production of baked goods are often fortified with vitamins, which are generally added to the process in the form of a dry premix. Vitamin A is most commonly used in the fortification of flour. However, other vitamins, such as thiamin, riboflavin, niacin and folic acid may also be added. Coperion K-Tron LIW twin screw feeders are generally used to dose a highly accurate amount of premix of these enrichment compounds into the flour.

Multi Destination Majors Batching

When major ingredient batching requires a single ingredient to be delivered to multiple stations (see process diagram on page 4) or multiple ingredients delivered to a single destination, scale hoppers with special Aeropass™ valves mounted on top can be used. After the fluidized material is discharged from a source such as a silo or bulk bag, it will typically drop through an Aerolock™ rotary valve, through a sifter (if required), and is then metered into the conveying line by another Aerolock rotary valve. Once in the convey line, it is then transported to the Aeropass valve, located above a scale hopper.

Aeropass: Principle of Operation

The Aeropass valve operates on a diverter type principle and is ideal for diverting material directly into a hopper from a conveying line. Due to the valve's low-clearance height, it is ideal when the installation is in tight spaces. As shown in the figure on page 4, the valve includes an internal wafer type device which allows for the discharge of material into the hopper below. When the scale hopper below indicates the batch is complete based on the weight signal, the Aeropass valve can be immediately shut. Excess material in the conveying line then passes either to the next process or scale hopper, or back into the original source. This closed loop design offers a more efficient method of product transfer with higher product yields.

Batch Weighing with Scale Hoppers

Scale hoppers are receiving hoppers suspended on load cells for ingredient batch weighing. The material resides in the scale hopper until the precise weight and/or combination of materials is achieved. Weighing accuracies of +/- 0.5% of the full scale capacity can be expected.

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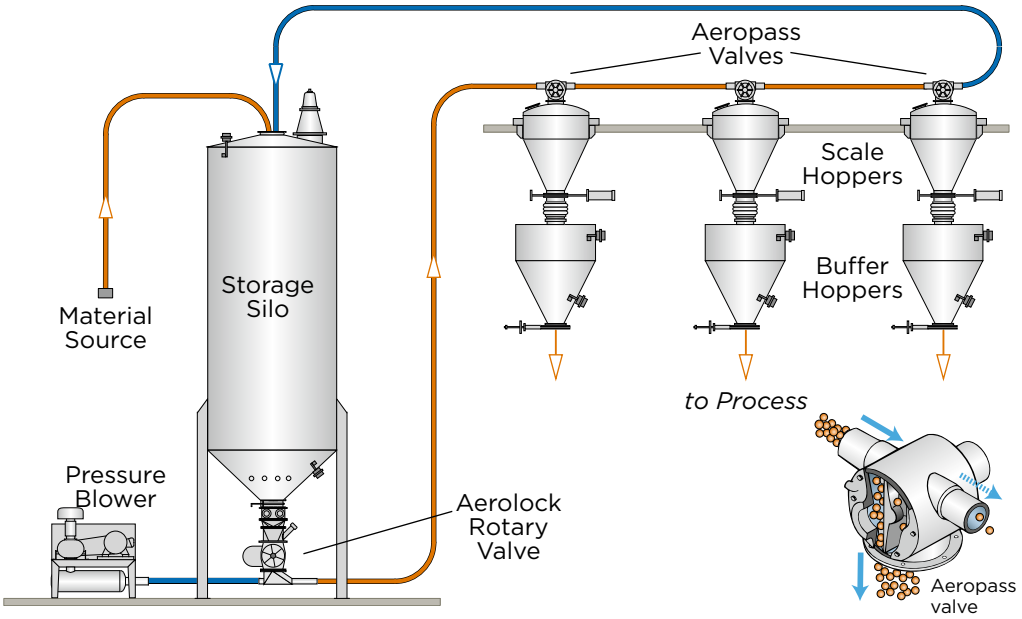
Scaling System for Multi Destination Batching



The bulk material is conveyed from the silo to a group of scale hoppers fitted with Aeropass valves.

Once the desired weight has been achieved and the mixer calls for material a discharge valve opens and the material in the scale hopper is discharged into the process below.

Conclusion

Properly weighing and accurately delivering the ingredients to the mixing process without manual intervention can result in a number of process advantages, including fewer mistakes, better accuracy, lower bulk costs, improved product quality and savings in manufacturing costs.

Coperion K-Tron's highly experienced engineering staff can provide a wide variety of design and layout options in both ingredient transfer and delivery to help manufacturers lower process costs while improving efficiency and product quality.

Coperion K-Tron Advantages

- The Coperion K-Tron Systems Group can supply integrated systems of Coperion K-Tron and ancillary products, with one source management and integrated controls
- All receivers and components are designed with ease of maintenance and accessibility for cleaning in mind.
- A Coperion K-Tron Systems Engineer is assigned to a project at the proposal development stage and continues to be responsible for the project through installation and commissioning thus providing a single contact for the customer.
- Coperion K-Tron's state-of-the-art SFT digital weighing technology delivers the high accuracy requirements needed for maintaining control of the addition of costly ingredients.
- Trained, certified service engineers located around the world provide 24-hour technical support to solve your problems any time, any day.

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