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Application Example

Conveying Sensitive Microwave Popcorn Kernels via Combined Vacuum and Pressure Transfer System

Introduction

The popcorn processing and packaging industry typically relies on low velocity, dense phase pneumatic conveying to transfer popcorn kernels. This is primarily due to the friability of the popcorn kernel. If hull damage to the kernel occurs while being pneumatically transported, the internal pressure of the kernel is compromised, and it will not pop. Typical methods of conveying used to date often result in low process efficiencies because of the limited volumes and longer conveying times required to avoid damage to the popcorn kernels. By combining the respective advantages of both pressure transfer and vacuum sequencing systems, along with some specific design additions to ensure gentle action on the popcorn kernel, the experienced Systems Group at Coperion K-Tron was able to provide an economical and custom designed solution for the transfer of this extremely sensitive product.

Process Details

The complete process of conveying the product from pickup point all the way to the packaging line is provided as two subsystems. The first is a pressure transfer system to unload bulk bags and transfer the kernels to storage tanks. As shown in Figure 1, the super sack or bulk bag discharges popcorn kernels into the top assembly of a Coperion K-Tron bag dump station. From there, the kernels drop through a maintenance slide gate, past a magnet and fall via gravity into a Coperion rotary valve fitted with a shear protector to assure smooth flow into the valve. Fines and dust from the bag dump action are continuously drawn into an automatic bin vent that discharges through a rotary valve and into a fines collection barrel.

Once the material passes through the rotary valve, a pressure blower pneumatically conveys the popcorn with a low pickup velocity so the hull is not damaged. The product is then transported into either one of two in-plant storage tanks. These tanks are mounted on load cells for inventory tracking. The tanks are designed with a special low profile in order to accommodate the low head room available. In addition, as shown in the detail inset in Figure 1, the inlet line to the storage tank includes a special expanded flexible hose design, which is essential for slowing the kernel velocity down and reducing any hull damage. The overall system design pressure accounts for both the higher friction in the flex hose as well as the greater pressure drop across it.

A similar flexible hose transports the exhaust air to an automatic bin vent filter. The flexible hoses allow for unrestricted up and down movement as the weight changes in the tanks. This isolation permits the load cells to produce accurate weighments without interference from the conveying system. At the bottom of the storage tanks, the popcorn kernels drop through a slide gate and are then picked up by multiple probes in a probe box.

Vacuum Sequencing to Packaging Lines

The vacuum lines from the storage tanks were provided with specialized insulation, as requested by the end user, in order to reduce the conveying noise caused by the kernels traveling through the system.

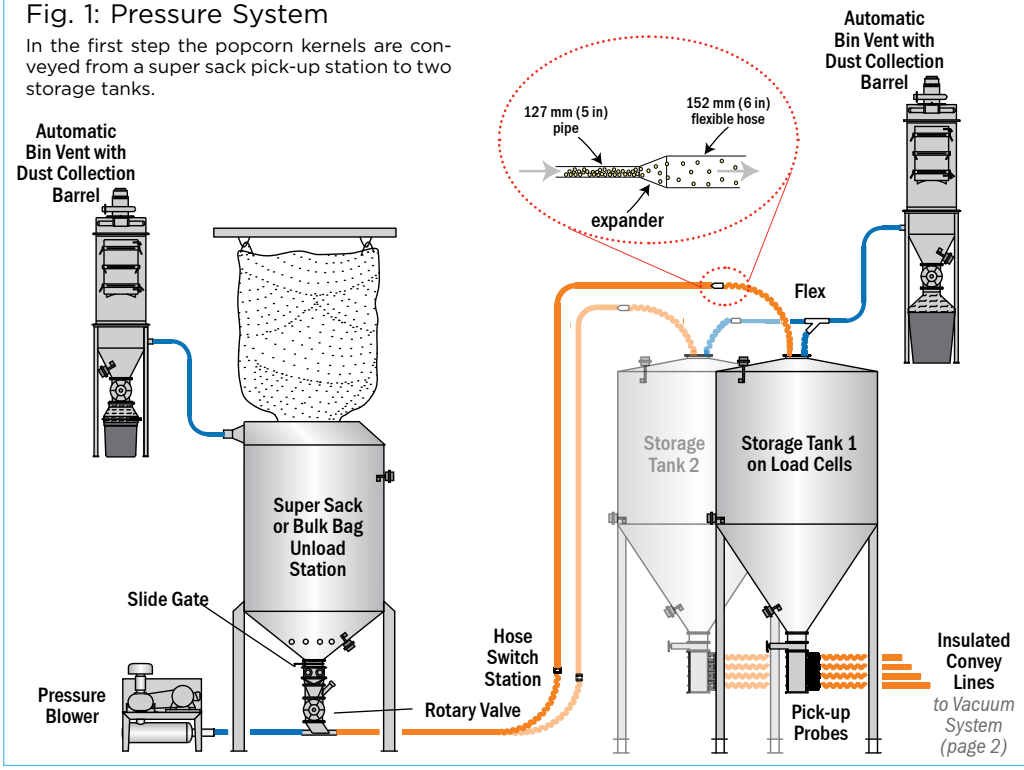
As shown in Figure 2, the final destination of the popcorn kernels is manually selected at a hose switch station, sending the kernels to the appropriate Coperion K-Tron 2415 vacuum sequencing receivers with perforated aluminum filters. Each of the receiving hoppers is also fitted with specialized insulation to help minimize noise levels. The vacuum for the receiving hoppers is supplied by separate vacuum blower packages with microprocessor controllers located near the receivers they service. As explained in the next section, the sequencing design of the receivers allows for multiple packaging stations and in turn causes less degradation to the popcorn kernels.

Pressure Conveying Versus Vacuum

Pressure conveying systems are typically used for long distances and high throughputs. Applications which involve pressure conveying often include loading and unloading of large volume vessels, such as silos, railcars, trucks, and bulk bags. A disadvantage of pressure systems can be in the leakage of the system, which is outwards. In a vacuum system the leak-

Fig. 1: Pressure System

In the first step the popcorn kernels are conveyed from a super sack pick-up station to two storage tanks.



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age is inwards. This is one of the reasons why these types of systems are often used in sanitary applications. Another advantage of vacuum systems lies in the ease in design for multiple pickup points. However, due to the limitations in vacuum available, the distances and throughputs on a vacuum system can be limited.

Often a combination of pressure and vacuum is used for a system, in order to take advantage of the process and efficiency advantages of each technology.

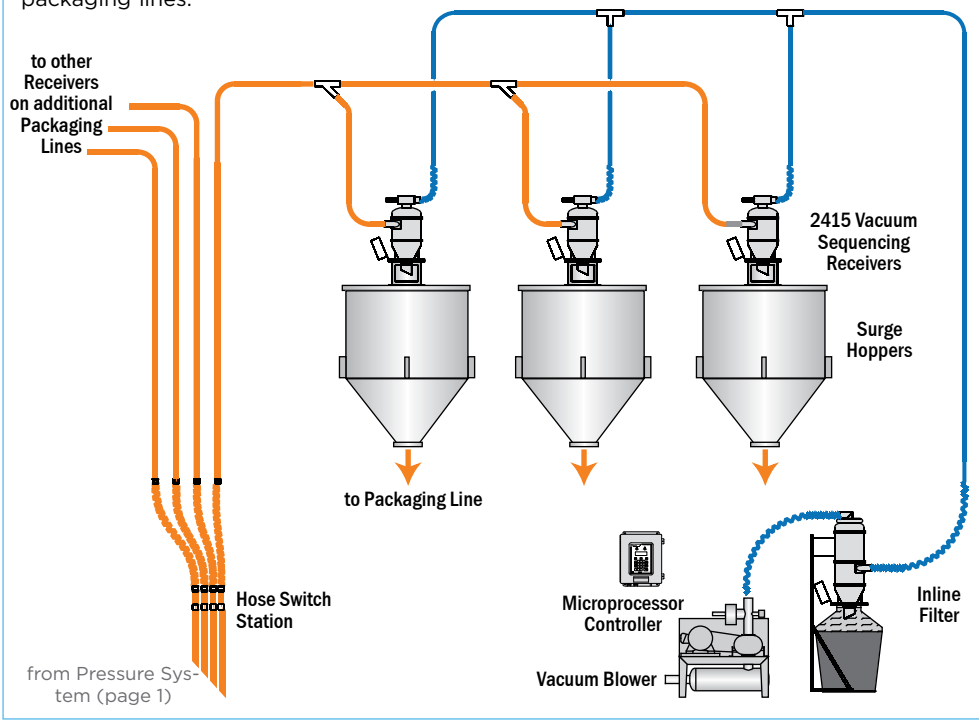
Advantages of Vacuum Sequencing

A continuous vacuum system utilizes a continuous vacuum source and a rotary airlock at the base of the receiver to keep the vacuum within the receiver while maintaining constant output. In a vacuum sequencing system the vacuum receiver is fitted with a discharge valve. When closed, the system transfers the material until a preset time or fill level is reached. Once the vacuum receiver is full, or the time elapsed, the vacuum is broken, and the discharge valve on the receiver opens and discharges the material. In the case of the Coperion K-Tron sequencing receivers, a pulse of air is blown thru the filters within the receiver during this discharge, in order to avoid material build up on the filter media and optimize conveying efficiency. The process is sequenced and repeated until the destination hopper is full.

Vacuum sequencing systems typically allow for more versatility in product pickup and destinations, and also can often utilize a single vacuum source for several receivers, depending upon the demands of the downstream process.

Fig. 2: Vacuum Sequencing System

In the second step the popcorn kernels are drawn from the storage tanks on load cells to various vacuum receivers in the packaging lines.



Systems Experience

The Coperion K-Tron Systems Group can provide a wide variety of design solutions to handle a wide variety of material and process requirements. As shown in this application, custom-engineered options are available and can be discussed with the end user. Custom solutions can also be provided for a wide range of gentle conveying food applications.

Coperion K-Tron Advantage

- The 2400 Series vacuum receivers are designed to handle a wide variety of materials, from free flowing to difficult flowing fine powders
- All receivers and components are designed for ease of maintenance and accessibility for cleaning
- The P-Series pneumatic receivers offer additional design options for specialty sanitary applications
- Coperion rotary valves are available in a variety of sizes and design options depending upon the application, and meet CE and ATEX 3D classifications
- Each pneumatic solution is custom developed for a specific process application, based on extensive experience in providing material handling solutions
- The Coperion K-Tron Systems Group can supply integrated systems that include ancillary products, with one source management
- Trained and certified service engineers located around the world provide twenty four hour technical support to solve your problems, any time, any day.

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