APPLICATION REPORT

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# Low Pressure Continuous Dense Phase Conveying of Dry Pet Foods

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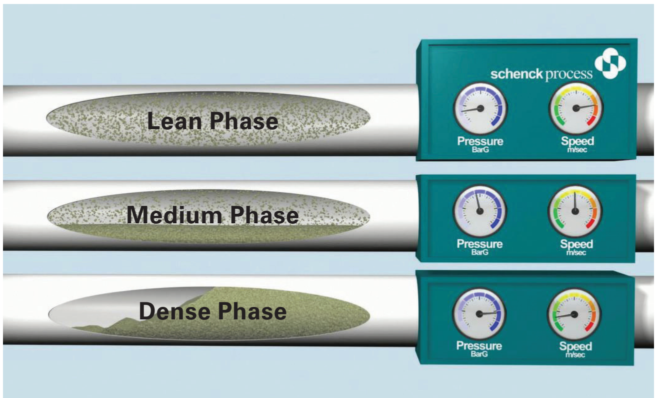
**The pet food industry has long searched for a method to convey finished product from process to storage and packaging in a reliable, inexpensive, maintenance-free system that yields little or no breakage.**

In the past the industry has relied heavily on mechanical methods. There are many advantages and disadvantages to conveying with mechanical and pneumatic systems.

Mechanical Handling is fairly inexpensive if conveying a short distance or transferring between process operations. However, the equipment - bucket elevators, conveyor belts, chain conveyors, and screw conveyors - have many moving parts. In addition to being high maintenance, they also provoke serious cross-contamination concerns, produce high amounts of breakage and occupy large amounts of space within the plant. In addition, the ability to change from horizontal to vertical with a mechanical system poses design layout problems.

Pneumatic conveying methods are fairly well known but typically misunderstood and disregarded due to the perceptions of breakage. Advances in system design and control makes low pressure continuous dense phase (LPCDP) a simple way to pneumatically convey dry pet foods with minimum product breakage and cleanliness unmatched by mechanical conveying methods.

## Pneumatic system options




**3 Phases of Pneumatic Conveying**

Pneumatic systems include both dilute phase and dense phase systems. Dilute phase systems convey at air velocities high enough to keep the particles suspended in the air stream. The high velocities required to convey in this manner often generate high amounts of breakage. Dense phase systems convey particles below the minimum velocity for suspension flow characteristically in a slug or moving bed. Low velocities are gentler on all kinds of product and therefore produce less overall breakage. The air requirements for dense phase systems are significantly less than dilute phase.

Dense phase systems can be further categorized into batch dense phase and continuous dense phase. Batch dense phase is the classic method of conveying at low velocity. The material is dropped into a pressure vessel and then the material is forced into the convey line using relatively small volumes of compressed air. Although this method can result in reduced product breakage, it is a batch process, it can have greater headroom requirements and is not so flexible for varying rates and products. Continuous dense phase employs a precision machined airlock to continuously introduce material into the convey line, requires a relatively low amount of headroom and is still able to gently convey at low velocities. A disadvantage of using an airlock is that leakage of air through the airlock can generally result in unstable systems. However, stable dense phase systems are attainable when using an airlock, if the leakage air is accounted for in the air supply controls.

Slug formation in a dense phase system is the key to minimizing product degradation. Slugs of material that gently form and move through the system are stable and are less likely to break products such as kibble. A system that constantly forms and breaks plugs in a convey line is said to lack stability and can damage the product as much or more than mechanical methods.

## Maintaining consistent product feed

Stable dense phase systems are a result of consistent product and air supplies that are fed to the convey line. Consistent product feed is managed by way of an airlock rotating at a constant speed. Maintaining consistent convey air supply (QS) is difficult because the leakage through the airlock (QL) is constantly changing as a result of the pressure below the airlock. For a constant QS, where QL is constantly changing, then the convey air (QC) will be constantly changing as well. However, a system that varies QS according to the pressure below the airlock to account for the varying QL can deliver a constant supply of air to the convey line. (See Figure 1) This can however be accomplished by linking pressure transducers at the material feeder (airlock)to a variable air flow valve downstream of the blower unit. The air flow valve "Macturi" automatically adjusts to pressure fluctuations at the feed point, and therefore instantaneously expands and retracts the supply air to account for fluctuating airlock leakage. Consistent material and air feed at proper material-to-air ratios produce proper slugging and therefore a stable dense phase conveying system.

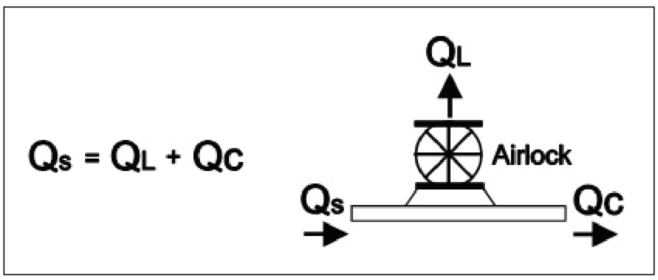



**Figure 1**

The characteristic of a LPCDP system that designates it as low pressure is the friction associated with moving a slug of material through the system. By minimizing the friction generated by the slug, the differential pressure needed to move the slug down the convey line is minimized. This in turn ensures a minimal convey pressure considering the convey pressure is essentially the sum of the individual differential pressures of the slugs. Much of the friction minimization is material intensive. Products such as pet foods have porous surfaces and low densities. Together these characteristics indicate the product will naturally generate very little friction. Further measures are taken to reduce the friction in these systems including: polished stainless steel piping, seamless pipe joints and long radius elbows.

**Receiving area for raw materials**

A concern when debating the use of a low pressure dense phase system can be the compressed air source. High pressure plant air is generally required as the motive force, as opposed to a Roots type blower due to the pressures involved. Low Pressure Continuous Dense Phase (LPCDP), however, characteristically conveys under 1 barg. The air source is then optional depending on the individual plant needs. A plant that is running low on high pressure air can opt to employ a Roots type blower. Conversely, a plant that has an ample supply of high pressure compressed air can reduce their capital expense by using their existing air so long as the compressed air quality is acceptable.

With many of the misconceptions and mysteries of LPCDP addressed, one can then look at the pure advantages this system possesses as compared to its mechanical counterparts. With many pet food plants functioning more as a human food plant, housekeeping becomes a significant issue. While most mechanical methods are hardly dust free and often uncovered, pneumatic lines are completely enclosed and filter out dust at the destination. This feature results in great leaps in cleanliness and sanitation.

Maintenance is a huge issue when comparing pneumatic systems to mechanical methods. Very few moving parts means less parts that can wear, break or come off track. Rather than thousands of bearings, rollers and belts, the moving parts on an LPCDP system include only an airlock, variable orifice and an automatic valve. Properly designed and operated systems can eliminate plugging issues. Changing product in the convey line is accomplished by a simple purge with nearly zero cross contamination. Thousands of man-hours can be saved on this point alone.

## Reduced pet food breakage

LPCDP systems convey pet food products gently and with consistently less breakage or fines generation than either dilute phase systems or mechanical methods. The reduced amount of product degradation that occurs in the LPCDP system benefits the overall process. Reduced amounts of fines that are screened off the product equate to less reworked material. Less reworked material equates to a more efficient process and higher quality product. Likewise, packaging lines also benefit when less fines are generated, because fewer fines are actually packaged. This is perceived as the most substantial advantage.

The final step to assessing the viability of incorporating an LPCDP system is analyzing the ease of system integration. The inlet of the system requires only a minimal headroom. This is often ideal for feeding off other pieces of equipment such as dryers, or conveying from storage such as bins or silos. The convey line can then run to any destination desired, through nearly any path required. Pneumatic convey lines run horizontally, vertically, through walls, through floors and across ceilings as needed. Prototypical PLC configurations and equipment are used to control LPCDP systems. Thus, controls are easily integrated to work with other processes and the states and alarms of other systems. Lastly, the capacity and flexibility of LPCDP systems are superior to other convey methods. Altering rates is often as simple as altering the speed of the airlock and changing the air supply to match. Conveying a product with very different characteristics is usually as simple as changing a few constants in the PLC configuration. This can be done automatically for systems that routinely convey various products through the same convey line.

**All things considered, LPCDP is more versatile, gentler to the product and requires less maintenance than dilute phase conveying or any of the several mechanical conveying methods. With the recent swing the pet food industry is making toward improving efficiency, cleanliness and sanitation of their plants, LPCDP is a sound investment. The Schenck Process E-finity LPCDP system has been installed in many Pet Food factories providing the full range of benefits outlined in this report.**

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