DOUBLE FLAP AIRLOCK VALVES

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Abstract

From a financial perspective, all cement plant operators know they have a lot riding on the efficiency of their pneumatic conveying systems.

From a technical perspective, however, it is what is riding in the system and how well it is being conveyed that is the key focus. When the system works well to convey raw meal, finished cement or baghouse dust, the plant can efficiently meet its production and financial objectives. When it does not, the costs can be high.

Often problems with pneumatic conveying systems can be traced to the line charger. This article will discuss the inherent performance challenges cement plants face in conveying various materials throughout the plant. It will also discuss how the unique design of double flap airlock valves can help cement plant operators to overcome problems in their pneumatic

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conveying systems. Finally, advice is given for cement operators who are considering installing double flap valve technology to improve the efficiency and reliability of their pneumatic conveying systems.

Introduction

Double flap airlock valves are emerging as a leading technology to be utilised as line chargers for pneumatic conveying systems in the cement industry and other industries with comparable material handling challenges. Typically, double flap airlock valves are utilised on pneumatic conveying systems by cement plants to reduce energy cost per tonne of material transported and/or to solve a problem with an existing pneumatic conveying line charger. When certain parameters exist, retrofitting an existing system with a double flap valve can be easy and straightforward. For either a completely new installation or a retrofit of an existing system, a double flap valve will often significantly outperform alternative line feeders.

The role of a line charger

The line charger is an integral part of a cement plant pneumatic conveying system. Its primary role is to introduce the material being conveyed into the system in a manner that addresses key system parameters such as pressure differential, material mass flow rate, and product temperature (Figure 1).

Line charger selection and performance is affected by the following:

- *The material that is being conveyed.* Line chargers are impacted by material characteristics such as particle size, density, particle shape, moisture content,

  abrasiveness, and how easily the product quality can be changed due to degradation. The product quality of raw meal, finished cement, and baghouse dust is not the critical concern in a cement plant pneumatic conveying system. Instead the major concerns that must be addressed are material abrasiveness, temperature, and the varying densities.

- *How the material is being conveyed through the system.* There are three primary modes of conveyance in cement plant pneumatic systems (Figure 2).

• *Dilute Phase*: The material is suspended in the airstream. All conveying takes place above the saltation velocity – the threshold speed required to prevent material from dropping out of the moving air stream and beginning to deposit on the bottom of the convey line. This is also referred to as stream flow.

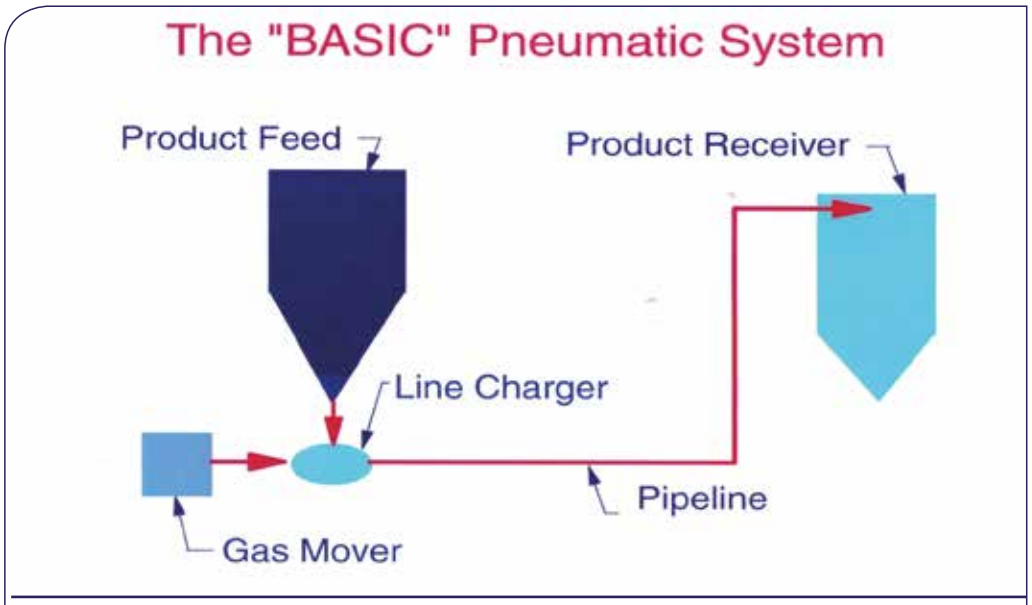

Figure 1. The line charger introduces the material into the pneumatic conveying system. (© Pneumatic Conveying Consultants, LLC.)

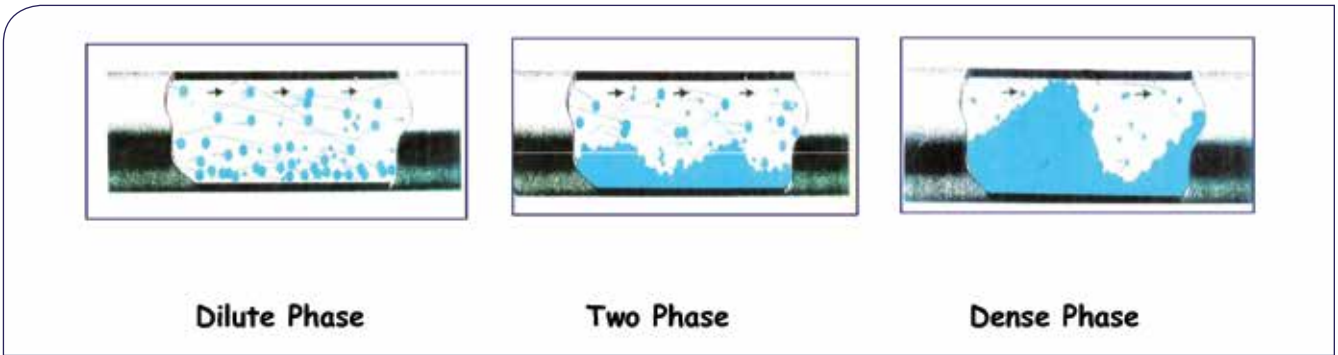

Figure 2. There are three primary modes of conveyance in a cement plant pneumatic system. Double flap valves are best suited for conveying in the Dilute or Two Phase modes. (© Pneumatic Conveying Consultants, LLC.)

- *Two Phase*: In this mode, some of the material is suspended in air and some is moved along the bottom of the conveying line in a fluidised bed fashion.
- *Dense Phase*: In this mode, the majority of the material can be conveyed in randomly formed waves or dunes because of the permeable nature of the products.

The application of a double flap valve is best suited for conveying in the Dilute or Two Phase modes.

- *What are the before and after conditions*? The type of line charger that is best will be determined in part by the pressure and temperature differential across the line charger. How the material is delivered to the line charger – whether it is choke fed or starve fed – will also be a factor.
- *How much material must be moved*? Based on the system design requirements, what mass rate of material flow is required.

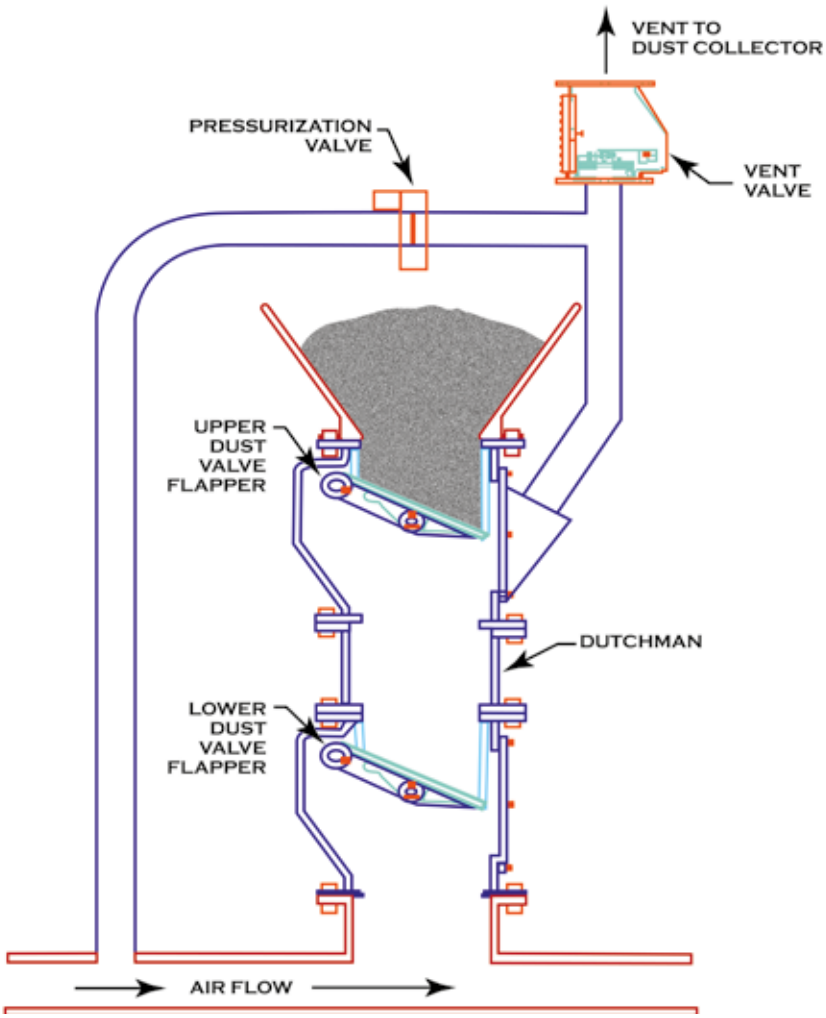

Figure 3. A double flap valve maintains an airtight seal because one of the two flaps is always closed. (© Plattco Corporation.)

Advantages of using a double flap valve as a line charger

Because of the unique design of double flap airlock valves, they can deliver significant performance advantages when used under the right conditions as a line charger in a cement plant pneumatic conveying system. With a double flap valve, one flapper is always closed throughout the valve sequence to maintain the integrity of the airlock seal. For example, with the flap above the lower chamber closed, the flap above the upper chamber opens to allow material to enter the top valve. The top flap closes and then the lower flap opens, allowing the material to enter the lower chamber for discharge. The valve sequence is typically 10 seconds, but can be adjusted for different metering requirements (Figure 3).

When implemented with due consideration to parameters such as the effect on pressure differential and conveying velocity profiles, double flap valves can contribute significantly to the safe, low-cost operation of pneumatic conveying systems in cement plants.

There are three unique advantages to utilising a double flap valve as a line charger.

1. *Reduce maintenance time and labour*. Double flap valves are designed so they can be rebuilt in place. Using front access covers,

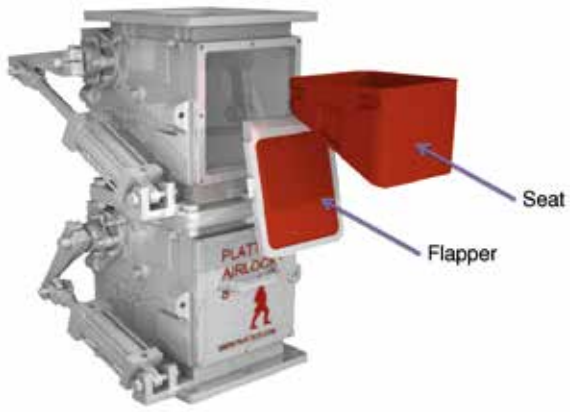

Figure 4. Double flap valves feature front access covers, which makes it possible to remove and replace or recondition internal wear parts such as seats and flappers. (© Plattco Corporation.)

the internal seat and flapper, the two main sealing components, can be removed and then renewed to new condition quickly and efficiently (Figure 4). Compared to rotary valves, pressure tanks and screw pumps, the design of double flap valves requires fewer man-hours to maintain and maintenance projects can be completed more quickly to minimise downtime. During a shutdown, a double flap valve can be virtually overhauled – replace the flap gates and seats – in four hours or less. By contrast, replacing the screw and barrel liners in a screw pump can take on average six hours.

2. *Reduce energy costs*. Double flap airlock valves used as a pneumatic conveying system line charger run with air cylinders, which require little air volume. As a result, double flap valves require little energy to operate and consequently can reduce energy costs. Compared to a typical screw pump installation, double flap valves have proven to yield US$20 000 to US$70 000 in annual energy savings because the need to power a screw pump motor is eliminated.
3. *Improve reliability*. Double flap valves are known for their reliable operation and higher degree of availability compared to other line charger options. This is due in part to the ability to access the valves quickly and easily for inspection and maintenance on regular intervals. Additionally, unlike other line chargers, the double flap valve shaft rotation speed is very slow, allowing for bearing and shaft seal methods far superior to other line chargers.

Case histories

As the leading provider of double flap airlock valves to cement plants worldwide, Plattco Corporation has extensive experience successfully addressing and correcting pneumatic conveying system line charger problems. Here are three case histories where double flap airlock valves were installed in pneumatic conveying systems to correct operational problems or enhance the design of new construction.

Case history #1

Problem: At a cement plant in the Central US, the rotary airlock valves used as line chargers underneath a large baghouse were wearing out and had to be replaced every 12 to 18 months due to leakage. In addition, the valves were unable to handle the 15 tph of cement kiln dust that needed to be collected during start up.

Solution: The plant replaced all rotary valves with one Plattco Double Flap Airlock® valve – model H-1295.

Benefit: The replacement allowed the plant to increase the capacity of the system to match the required flow from the baghouse. Additionally, the installation of the double flap valve increased reliability and availability of the equipment, which only needed to be worked on during the one annual shutdown. Maintenance costs were reduced as compared to the rotary airlock valve.

Case history #2

Problem: During the 2008 construction of a new cement plant in the Southeastern US, the company designing and building the plant wanted a more reliable way to move kiln baghouse dust from the baghouse to the storage silo. The traditional design is to use screw conveyors or airslides to collect material from each individual pyramidal hopper and discharge to one central pneumatic conveying line charger.

Solution: The plant was built using six individual Plattco Double Flap Airlock valves in series on the kiln baghouse. All the valves feed a common pneumatic conveying line.

Benefit: The new design approach using double flap valves is reported to have reduced capital costs by more than US$500 000. The reliability of the installation since startup in 2008 has been exceptional, as indicated by the fact that the plant has not needed to purchase any spare parts for the valves since then.

Case history #3

Problem: The original design of the coal transfer system at a cement plant in Ontario, Canada, utilised a screw pump as the pneumatic conveying line charger. The cost to run the screw pump was exceptionally high when considering the electricity costs and the frequency of maintenance required on the pump.

Solution: The plant installed two Plattco model H-1295 double flap airlock valves in place of the screw pump. The valves are installed in series and feed a common pneumatic conveying line.

Benefit: Since the installation in 2004, the valves have saved the plant many thousands of dollars in electrical and maintenance costs. These valves have run 24/7 – approximately 300 days per year at 6 cycles per minute, which is nearly 26 million cycles. The reduced electrical and maintenance costs of the new valves save the plant US$20 000 per year.

When to consider installing a double flap valve to retrofit an existing system

Double flap valves are often installed as a retrofit to an existing pneumatic conveying system line charger as a means to increase equipment reliability, lower annual maintenance costs, and decrease energy usage. To determine the suitability of the double flap valve retrofit, there are several parameters of the existing system that must be evaluated. Each of

these parameters will be considered below and their importance in the evaluation will be described.

1. Energy usage comparison: A major consideration when analysing a retrofit is the potential electrical energy savings. A double flap airlock valve utilises relatively little energy to operate as compared to alternative line chargers. Some key questions to guide the analysis are:
   - What is the drive method of the current line charger?
   - How many horsepower and what is the cost of this drive annually?
   - What is the comparison in annual energy consumption between the double flap airlock valve and the current method?

2. Annual maintenance cost comparison: Annual maintenance time and costs can be a significant factor in determining suitability of a double flap airlock valve retrofit. The design of the double flap airlock valve will often result in a significant savings in annual maintenance time and money. Some key questions to guide the analysis are:
   - What is the current annual cost of maintenance?
   - How many man-hours are spent annually?
   - What is the comparison in annual maintenance time and money between the double flap airlock valve and the current method?

3. Overall system reliability: A reliable line charger for a pneumatic conveying system is of high importance to any cement production operation. Often, the cost of downtime can be significantly more than the cost of the actual equipment repairs. Due to the design of the double flap airlock valve, reliability and overall equipment availability is typically increased. Some key questions to guide the analysis are:
   - What is the current failure rate and mean time between failures?
   - What is the current equipment availability or uptime?
   - How will this compare to the double flap valve line charger and what does this mean in terms of production costs?

4. System design considerations: The various line chargers available today all have slightly different system operating requirements. It is recommended that prior to any system change, the system design parameters be analysed to ensure proper application. This can be a relatively simple analysis that will help to optimise system design. Below are a few of these considerations.

Material delivery:
- How is the current system fed with material?
- Will the delivery of material cause a flood feed to the valve or a starve feed, or will both conditions exist?
- Is there an opportunity to simplify the material feed system to the double flap valve?

System air mover (compressor or blower):
- Is the current air mover capable of discharging more or less air volume if needed?
- Is the air mover discharging air at its rated capacity – has the airflow capability been field verified?

Physical space requirements:
- What is the overall height available in the existing system?
- If necessary, is it possible to gain additional height? If yes, how much?

Material flow capacity:
- What is the current design capacity for the line charger?
- What is the material flow in normal operation?
- Are any upgrades planned that will require additional flow capacity?

System temperature:
- What is the material temperature at the line charger?
- Have there been any unique challenges due to material temperature?

Material properties:
- What is the material particle size distribution?
- What specific challenges does the material pose for the current line charger?

System pressure and velocity (often analysed using pneumatic conveying software):
- What is the current system's pressure and velocity profile?
- Does the system experience plugging with the current line charger?
- Does the system experience excessive pipe wear with the current line charger?

Conclusion

Double flap airlock valves are an ideal line charger for many cement plant pneumatic conveying systems. Under the right conditions, double flap valves can provide reliable operation, a high degree of availability, lower maintenance costs, and lower energy costs.