tce

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stop accidents before they happen

PROCESS SAFETY | PUMPS | PROCESS AUTOMATION & CONTROL | PERFUMES

A better way to transfer powder

Chris Broadbent explains how dense phase conveying can prevent dust explosions

NO READER of this magazine will need an introduction to the dangers of dust explosions – it is well known to anyone in the process industry that fine particles can explode with devastating consequences.

dense vs dilute

The vast majority of pneumatic powder conveying systems on the market are so-called dilute-phase conveying systems. They use low powered suction or positive pressure fans combined with high surface area filters, which lead to high velocity lean phase conveying. This type of conveying mixes the powder with air within the conveying line providing a perfect condition for the propagation of an explosion should there be a potential source of ignition. Unfortunately, the particles of powder are moving at such velocity within air that they crash into each other and create a static charge, which provides this potential source of ignition leading to a possible explosion.

Dense phase conveying on the other hand uses almost full vacuum to move large quantities of material at relatively low velocities. One such dense phase conveying system, the PTS powder transfer system, is unique because it uses a patented flat filter membrane to promote dense phase powder transfer. This removes the need to use nitrogen as a conveying medium. The low velocity transfer and high concentration of powder plugs also makes sure that the powder is not damaged during transfer and the homogeneity of the powder is not affected.

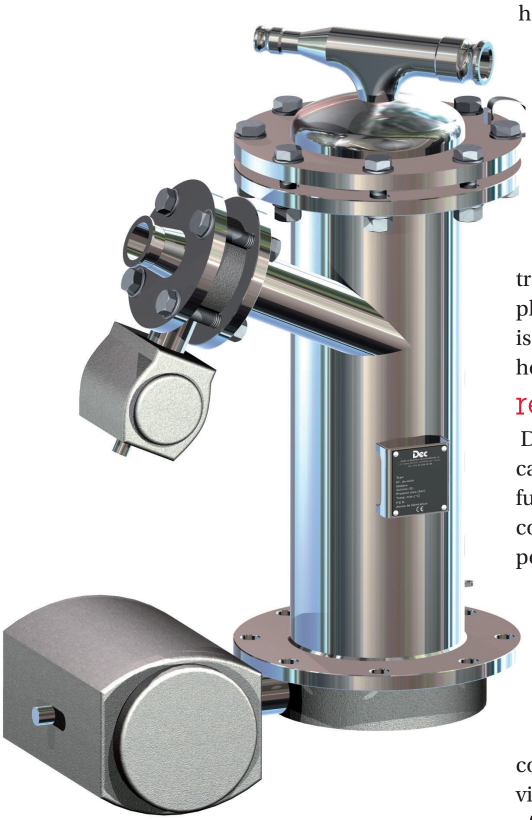


Figure 1: The Powder Transfer System

reducing the risk

Dense phase powder conveying systems can be designed to reduce the explosion risk further. By using only earthed, conductive components, it is possible to exclude most potential ignition sources, especially when the system has no moving parts to prevent sparks and without electricity or motors, precluding electrical sparks or hot surfaces.

The remaining potential ignition source is electrostatic discharge. But by conveying the powder in the dense phase via plug flow it is possible to keep the ratio of powder at more than 100:1, which is well above the upper explosion limit of most powders. The low conveying velocity creates insufficient energy to form an electrostatic discharge and powders with MIE <1 mJ can be safely conveyed.

Most powder transfer systems have an inherent risk that the recipient vessels could become enriched with oxygen, which creates the potential for explosion. But a combination of plug flow (dense phase) conveying, vacuum within the transfer chamber and inertion by nitrogen can keep the oxygen concentration in the reactor below the threshold of an explosion risk.

This combination means that such a system does not have an inherent potential ignition source. Indeed Tammo Redeker, scientific and managing director of Germany's safety technology institute IBExU, confirmed that companies using the PTS, which follows the above setup, only need to consider further safety measures if there are extra risks, such as the transport of high-temperature products which could be subject to spontaneous combustion on contact with air, or when there is the possibility of an accidentally imported smouldering combustion.

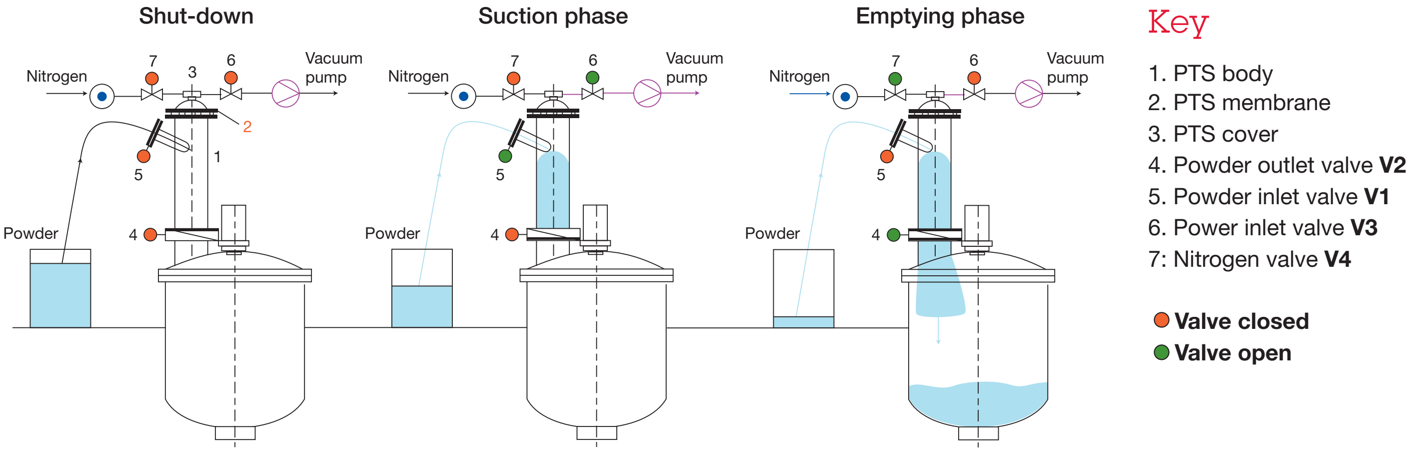
When they have been designed as a completely closed system, powder transfer systems are also very practical for the transport of highly toxic materials.

small bags – big problem

It is amazing that even today, many fine chemical and pharmaceutical plants are still charging powders via open manways, which exposes operators to inhalation and dust explosion risks. But when a company needs to safely charge large quantities of small bags of powder, open manway charging has been the traditional solution. A contained bag station is an alternative.

Contained bag stations can be designed to combine laminar flow technology with a glove box isolator to provide the operator with the protection of a gloved visor and the flexibility of an open laminar flow booth. Consisting of a bullet-shaped stainless steel chamber, which is open to one side enabling the easy loading of bagged powder, such a bag station makes it possible to charge a reactor with powder with the chamber door open, while maintaining a required containment level of 1 μg/m^3.

Figure 2: Operation of the PTS



Powder Transfer System

The PTS is used to automatically introduce toxic, explosive or any other types of powder to closed vessels containing dangerous vapours and liquids at any temperature without exposing the operator or the environment to any hazardous conditions.

The PTS is pressure rated and installed directly onto the receiving process equipment, predominantly reaction and mixing vessels. By using a source of absolute vacuum and pressure, the PTS can safely transfer powders in the same way that liquids can be conveyed, over large distances (horizontal and vertical), in a variety of volumes. This means that a powder room on the ground floor can be used to charge reactors large distances and several floors up. The PTS works for all powders regardless of their characteristics, even those that are extremely fine, lumpy or even solvent wet. During the transfer of such materials the PTS will not modify the homogeneity of the powder.

Full vacuum draws powder from the storage container such as drums, bags, flexible intermediate bulk container (FIBCs), hoppers, etc via a simple lance or suction hopper, and conveys it into the PTS cylindrical chamber. A flat filter membrane separates the chamber from the vacuum line preventing powder reaching the vacuum pump. When the chamber is filled with powder, the vacuum valve closes and pressurised nitrogen or other inert gas is supplied to the chamber. Once the gas has created an overpressure within the chamber the outlet valve opens and the powder is pneumatically discharged into the designated vessel. The overpressure also prevents gas and vapour that may already be present within the reactor from rising back up into the PTS chamber. Furthermore the source of pressure also serves to clean the filter membrane at the top of the chamber via a reverse jet after every cycle of the PTS thus ensuring each cycle (approximately 15 s) performs under optimum conditions (see Figure 2). Depending on the size of PTS, a huge range of transfer capacities can be accommodated.

DEC has developed such a chamber to provide an inlet air velocity of 0.7 m/s at the open end. The chamber size increases along its length, which results in a steady decrease of air velocity until it levels out at approximately 0.3-0.4 m/s at the point of opening the bag of powder. This ensures that there is a one-way only air transfer from the room, through the chamber, exhaust plenum, filters, fan and finally out to atmosphere. Smoke tests show that eddies are created as the cross sectional area of the chamber levels out but as soon as they move back along the slope of the chamber the increase in air velocity quickly pulls them back to the centre of the chamber and through the plenum.

Of course there are many ways in which process plants can reduce the risks of dust explosions, and there is no single technology that will be suitable to every situation. But companies should not be blind to the advantages of an intrinsically safe system. **tce**

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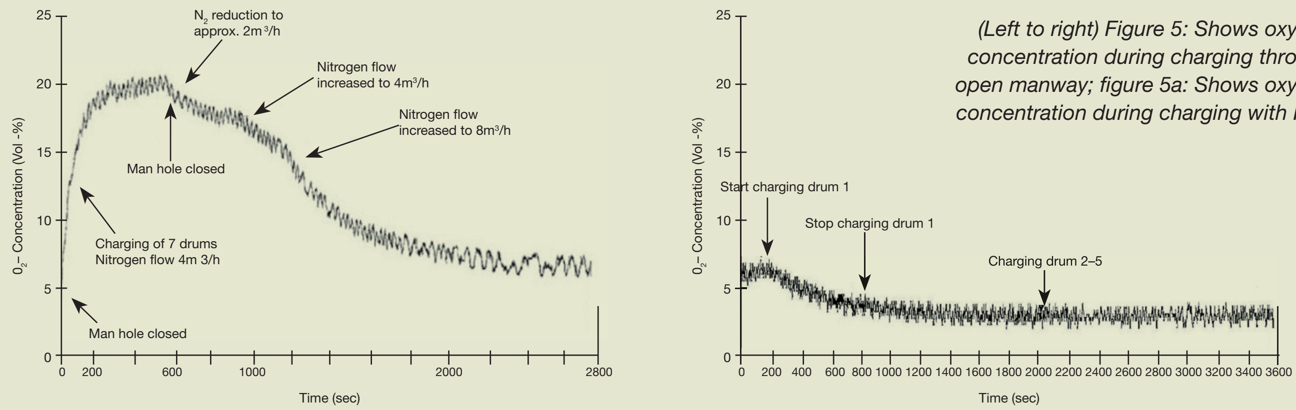
Figure 3 and 3a: Comparison of oxygen concentrations during charging



(Left to right) Figure 5: Shows oxygen concentration during charging through open manway; figure 5a: Shows oxygen concentration during charging with PTS