Pneumatic Vacuum Conveyors for the Highest Standards

Transportation of bulk materials in the pharmaceutical and chemical industries

VOLKMANN Inc.

In process technology there is a frequent requirement for a suitable transport system to load various bulk materials into vessels and process equipment. For powders, fine dusts and granules Vacuum Conveyors, which work in a closed system, have proven to be a particularly effective choice when compared to conventional conveying methods.

The technique is not simply related to the transport of poorly flowing products such as silicon dioxide, color pigments or cellulose fibers, but also to a host of applications where an enclosed dust tight and economic solution is of benefit. Until recent years the special demands for the immediate environment such as cross contamination issues or explosion risk have restricted the applications, this article presents innovative new developments to solve even the most difficult problems associated with powder handling.

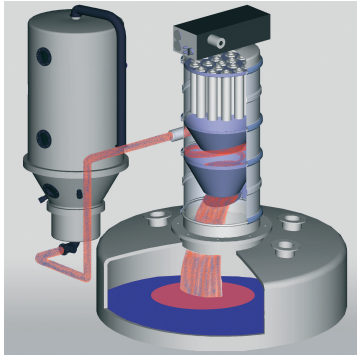

Figure 1 Typical Pharmaceutical Requirement

Modular Vacuum Conveyors

Vacuum Conveyors can be used for a plethora of applications with particular emphasis in the chemical, pharmaceutical and food industries. Even such notables as color pigments and metal powders are among the usual products to be conveyed. Conveying of the bulk material is achieved by pulling a vacuum on a suitable pipe line beneath bulk bags, drums, sacks or similar containers and thereby transporting the product pneumatically to a filter receiver. This separator vessel, receiver, is integrated with a vacuum pump and filter unit situated directly above the product destination, such as a mixer or reactor **(figure 1)**. Product discharges under gravity via a suitable valve system.

Traditionally, Vacuum Conveyors have been used as pure conveying agents for a wide variety of bulk materials. In particular the stainless

steel module design of the VR range has proven to be very effective. On one hand this design allows an accommodation to powder specific data such as bulk densities and particle sizes and on the other specific structural conditions can be accommodated for example where there is often limited space above mixers and silos.

After determination of the conveying parameters (figure 2) the application engineer can select the arrangement of the various modules as part of the initial the design phase using an expert system based on application experiences. Because the modular design concept provides a large array of single components available for modular conveyor assembly the range of solutions is extremely large, as a result so is the number of applications served.

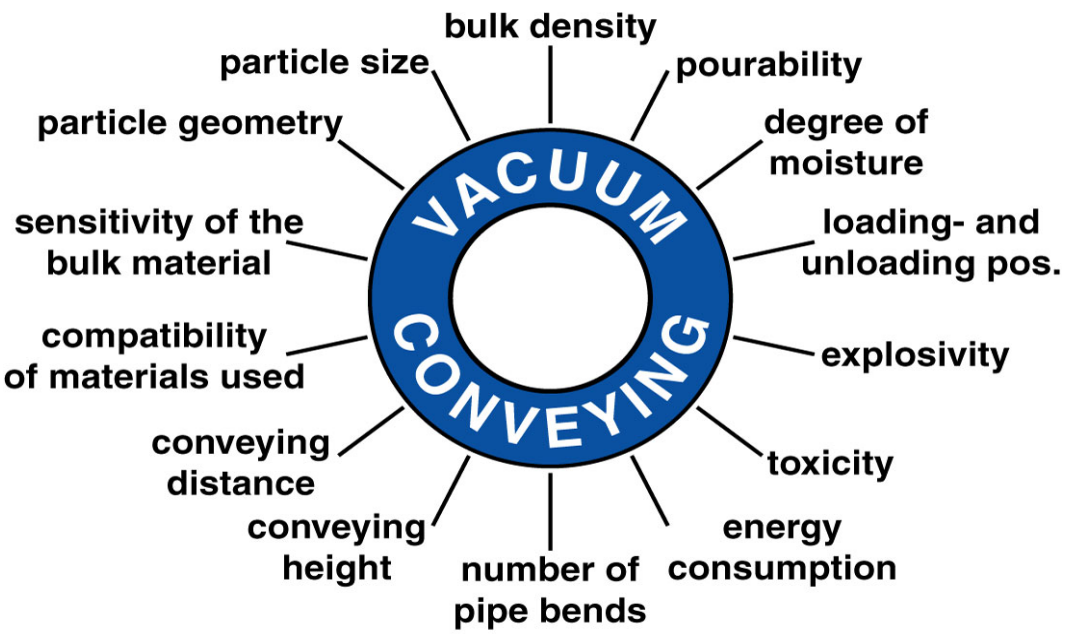

Figure 2 Conveying Characteristics to be considered

Depending on the specifics of pneumatic vacuum conveying (dilute phase, dense phase or plug flow conveying) and the desired throughput, selection of the vacuum generator (Multijector pump) can be made from the 60 variants vacuum generators available. Similarly, for the filter module a selection between various filter media, for example, PTFE, Polyethylene, stainless steel or cellulose, is made to suit particle size, conveying capacity, material characteristics and the individual determination based on the application of the filtering surface. For the most stringent requirements secondary HEPA filtrations is also available. Associated with the filter selection is the nature of the respective filter cleaning device.

The actual pneumatic transport of the product is achieved in a cyclonic discontinuous manner with a basic Vacuum Conveyor. The cycle consists of a convey-discharge-clean-convey sequence. The transported product volume per conveying cycle can be varied by increasing the filling volume of the separator container with an additional or larger standard module.

A further specialty of the modular design is the possibility to choose between various suction modules:
Deciding on the correct conveying is not limited to the determination of the correct diameter of the conveying line and the suction port, but also the type of flow design in the separator container (Figure 3).

Figure 3 Radial or Tangental flow options in the Filter Receiver

The tangential suction port is used primarily for dry, free flowing fine and superfine dusts. These are for example toner powder, soot, tungsten cobalt, pigments or silicon dioxide. By the centrifugal forces generated with this inlet an optimum separation of the conveyed product-air-mixture is effected, the filter load remains low. For more difficult products, an additional funnel is inserted (double cyclone effect).
For damp and adherent products such as barium sulphate, titanium dioxide or cream-fat-powder, a radial suction port is recommended. This type of inlet avoids product layers forming in the vessel associated with the distinctive swirl in the separator and as a result gives improved flow characteristics at discharge. This loosening

affect is also advantageous if a dispersion of the solid in a liquid is required downstream.

In particular for the pharmaceutical arena the risk of segregation has to be considered. With very different bulk densities and/or particle sizes of base material and active ingredient, the appropriate suction port is determined by testing. Further considerations to the nature of the conveying, in terms of velocity, are also determined in the test laboratory.
In addition, the modular design offers many individual configuration possibilities to enable the installation of the Vacuum Conveyor to be achieved easily and economically.

Optimization of the design concept using the modular principle has a further advantage; the compact Vacuum Conveyor can be dismantled extremely easily, and without tools.
This provides for easy, wet or dry, cleaning essential during product changes; important under cGMP for the pharmaceutical application as well as good housekeeping for food or in the color powder area. Where cross contamination of allagen, pigments or metals need to be avoided.

Enlarged module concept

In addition to the demonstrated adaptability to the most different conveying tasks a modification of the module concept can also be useful for specific applications. Decades of experiences gained in the pneumatic transport of solids lead to particular configurations proven to be applicable for an especially large number of conveying tasks. Such construction details as diameter-height-ratios, filter surfaces, vacuum performances, filling volumes and suction port diameters have all been determined. Other examples involving a CIP-able Vacuum Conveyor developed will still utilize the advantages of the modularity as far as practical.

The new **PPC (Pneumatic Pharma Conveyor)** series (picture 3) builds on the concept. In contrast to the VR design the product contacting part of the separator is a single piece. Such a design provides an internal surface free from potential hang up points allowing cleaning in process (CIP) with for example a washing nozzle. All product contacting parts correspond to the FDA

regulations with polished stainless steel parts the usual qualities in the chemical or pharmaceutical area as dictated by the application.

A further specialty is the new, external driven discharge valve of the PPC-Conveyor.
Unlike commonly available designs the complete pneumatic actuator is situated outside the product contacting area. This butterfly valve can both be cleaned in process and dismantled easily without tools. The valve itself consists of three parts: plate, gasket and tension system with pneumatic actuation.
Where conveying is required to vessels containing solvents, a further advantage of this butterfly valve is the fail safe spring closing and thus closed when not operated design providing a gastight separation of the container from the Vacuum Conveyor.

Reactor charging

Aside from the large application potential in the pharmaceutical area, reactor charging in chemical process technology can be addressed without difficulty with the new PPC Vacuum Conveyors. First, the PPC-Conveyors are just as the modular VR Conveyors free from ignition sources. In both systems the suction air is created by multiple stage, gas jet driven Vacuum Pumps which provide an EX (explosion proof) safety. At the same time the dissipation of the electrostatic charge caused by the conveying process is ensured because all product contacting parts are fully electrically conductive. Normally the PPC, VR and VS Conveyors are considered too small and compact

for a critical charge density. If a borderline case occurs precise measures are determined by tests.

Where the explosion risk comes from the process, which has to be supplied and therefore e. g. a reactor formulation is inert with Nitrogen, the PPC can both be used as conveyor and as product lock. Towards the end of the suction cycle a valve upstream of the suction port is closed. By further operation of the MULTIJECTOR® Vacuum Pump the pre-evacuation of the solid in the PPC receiver is achieved allowing the oxygen portion in the separator container to be reduced.
With the multiple stage, gas jet driven MULTIJECTOR® Vacuum Pumps end pressures of up to 100 mbar absolute are possible. Typically 500 mbar absolute is considered a non-critical oxygen concentration. After the pre-evacuation is completed, the Vacuum Pump is switched off and pressure compensation takes place usually via the reverse jet air shock; here of course with nitrogen and not with compressed air. Simultaneously, the discharge valve opens and the transferred product safely enters the inert reactor or stirrer boiler.

This principle is freely expandable enabling the PPC Vacuum Conveyor to be used as an air lock when suitable modifications are made. In this case pressure rated separator containers and valves are utilized.
Alternatively the conveying process and the inward transfer can take place separately. This is particularly interesting for applications when initially it is not certain if the inward transfer assistance is needed. The product lock feature can be retro-fitted at any time because of the modular design.

Complete material handling from one supplier

The PPC, VR and the VS modular series conveyors can be combined easily with additional powder handling solutions of the manufacturer. With automatic bin discharging system (AGES) drums, sacks, octabins or other small packing drums can be discharged without the need for annoying transfer into another container and without laborious manual handling. The transfer is achieved with e. g. a PPC Vacuum Conveyor.

Where an accurate measurement of the quality of metered conveyed is required the VR, VS or PPC Conveyor becomes the vacuum

weighing and dosing system (VAWIDOS). Here the separator container is mounted in a special compensating holding frame. The sucked product is recorded gravimetrically by load cells. In addition to residue optimization and trickle or dribble feed the intelligent control unit is also able to retain up to 256 different powder data allowinwg even complex recipes to be conveyed.

Illustrations:

Picture 1: Vacuum Conveyor sectional drawing, mounted on a reactor

Table 1: Parameters for the determination of a suitable Vacuum Conveying System

Picture 2: Flow conditions in the separator container with a tangential or radial suction port

Picture 3: The PPC (Pneumatic Pharma Conveyor) – series

For more information, contact Volkmann at:
1900 Frost Road • Suite 102
Bristol, PA 19007
609-265-0101
email:usa@volkmann.info
www.volkmannUSA.com