Simply Plug and Convey

Pneumatic vacuum transfer is the smart choice for powder and bulk material transfer

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Various production steps in the process industries require a safe and maintenance-free method for transporting raw and auxiliary products as well as finished powders, granules and tablets. To handle such diversity efficiently and cost-effectively, a vacuum conveying system should be flexible and have the ability to integrate easily into production processes such as loading mixers, unloading sacks or drums, filling bulk-bags or silos, and supplying product for filling or packaging machines.

The situation gets complicated for smart vacuum transfer when one considers the range of materials to be conveyed. Bridging powders; explosive, superfine dusts; hygroscopic, toxic and cohesive compounds with poor flow properties require the same transfer as larger, particle-sized bulk materials with complex geometries. Compounding the issue are materials such as titanium dioxide, sodium azide, silicon dioxide and fine, activated carbon dusts — well known in industry for their difficult conveying characteristics based on their composition as well as explosion risks.

Therefore, dust-free conveying also is critical to the transfer solution. This article addresses how pneumatic vacuum conveying is best used and the key features to examine when selecting such a conveying system.

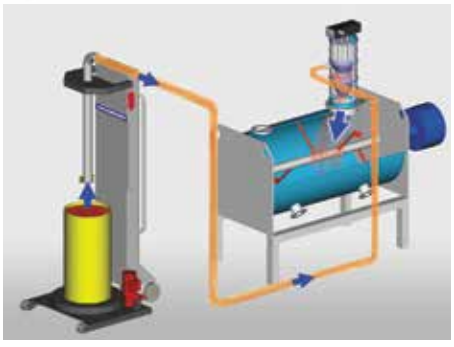

Figure 1: Material flow in a Vacuum Conveying system: Emptying of drums (left) and loading of a mixer (right) with powders and bulk materials.

Why transfer via pneumatic vacuum

Pneumatic vacuum conveying is best used when material capacities range between 100 lbs.- 13,500 lbs./hr. and, under extraordinary circumstances, can reach up to 12 t/hr. Effective conveying distances can range from just a few feet to up to 300 horizontal feet and up to 150 vertical feet. Material pick-up can be accomplished automatically through feeding hoppers (e.g. tote bins) or manually by an operator with suction wands.

The volume of the bulk material receiver and the vacuum pump capacity dictate the conveying parameters. Assuming an average atmospheric pressure of approx. 1013 mbar, a vacuum of -910 mbar could lift a closed water column approximately 30 vertical feet. However, because powders and bulk materials are always conveyed with a certain amount of feeding air, greater conveying heights are possible. Depending on the characteristics of the material being conveyed, heights of more than 150 feet have been been realized. Achievable throughputs/capacities are strongly dependent upon the properties of the powder and bulk materials. Bulk density, adherent or bridging characteristics, particle size, surface shape, humidity and/or fat content, design of the pick-up point, feeding air supply, and of course, the total conveying distance, height and number of bends are crucial parameters of specific conveying tasks. For different products, alterations in throughput are common and can reach up to 4500 lbs./hr., even with the same type of conveyor.

In the case of harmful powders or potent pharmaceuticals, vacuum is the preferred choice in enclosed systems to achieve required containment levels. Volkmann offers a series of PPC Vacuum Conveyors currently used in production areas where an occupational exposure band (OEB) of 4 with occupational exposure limit's (OEL) from 1-10 pg/m3 are monitored.

Figure 2: Stainless steel vacuum conveyors in a variety of designs and sizes

The bulk material receiver

In vacuum conveying, material is drawn by vacuum through a suction hose or pipe into the bulk material receiver (Fig. 1). Because many production processes require multiple powders or granulates to be conveyed with the same equipment, it is important to have a receiver with a simple assembly to allow quick and easy manual dismantling and cleaning to avoid cross contamination. The Volkmann VS and PPC series of vacuum conveyors feature a unique, stainless steel modular design with clamp rings allowing no-tools assembly and disassembly for cleaning and fast product changes. Alternatively, the vacuum conveyor can be designed to allow washing in place (WIP) or even cleaning in place (CIP). For example, manufacturers of paints and coatings use Volkmann systems to convey different dye powders (particle sizes 0.2 to 50 microns) or even toner, where major color changes from black to white are possible without difficulties.

All units offer stainless steel construction and fulfill the stringent hygiene demands of the pharmaceutical and food industry (Fig. 2). Stainless steel construction is also very durable and robust, allowing up to 90mbar absolute vacuum, while being lightweight and fully mobile as needed. Volkmann conveyors feature stainless steel construction combined with design modularity permitting individual vacuum conveyor configurations to meet specific conveying tasks. Such customization might include modules with special suctions inlets or integrated cyclones which can be crucial for successful conveying.

A bulk material receiver equipped with a choice of powder process valves and optional fluidization and discharging aids will allow even bridging and sticky powders to be fed into the process (Fig. 3). In most cases the compact design allows the bulk material receiver to be mounted directly above the plant vessel or equipment which has to be loaded. A case in point would be a small vacuum conveying system for sugar. The complete conveyer could have a height of only 18 inches, a diameter of eight inches and a total weight of only 14 lbs. and be able to convey 1,100 lbs. sugar per hour into a mixer at a height of 14 feet. When space is limited, the small profile of these powder transfer systems plays an important role.

The optimum configuration for a vacuum conveyor to meet a specific application is often found by means of practical, one-to-one scale trials. Because modular, stainless steel systems are very easy to handle and integrate, trials can be performed in test laboratories or directly at the on-site process.

If the bulk-material-receiver is combined with either stationary or mobile hoists, its ability to serve other applications increases. It is therefore no surprise that these pneumatic powder-transfer systems are replacing more and more conventional mechanical conveying methods like screws, augers, lifts, belts and bucket conveyors.

Vacuum pumps

In vacuum conveying, the driving force for powder transfer is pure vacuum. Therefore, choosing a pump with the proper function and size for the process at hand is just as important for a working conveyor as the optimum selection of the bulk material receiver configuration. Vacuum pumps can be either electrical or air-driven, and specific models should be chosen based on the application. Criteria such as maintenance-free operation, small proportions and lightness, as well as easy adjustment and control are also important considerations.

Multiple stage ejector pumps are frequently used in vacuum conveying. Volkmann offers a patented Multijector® pump (Fig. 4) functioning under Venturi principles. Generally speaking, compressed air is not recognized as the most economical source of energy; however, the Multijector pump offers an effective conversion ensuring cost-effective performance. ***The Multijector pump is five times more efficient*** than conventional single stage ejectors and because they offer cyclic, non-continuous operation, they compare in energy usage with electrical pumps forced to run continuously by design. Their air flow above vacuum performance is actually comparable to an electric positive displacement pump rather than a conventional, limited single stage ejector.

Figure 3: Vacuum conveyor (front, right) for the feeding of powders into a process vessel (beneath)

Multijector pumps operate by creating large volumes of suction air flow (e.g. for dilute phase conveying) and are also able to generate extremely high levels of vacuum of up to -910 mbar (used for dense phase and plug flow conveying). The amount and pressure of the compressed air supply are also easily adjusted to allow application-specific control of conveying a wide variety of powders and other bulk materials. They build up and break the vacuum rapidly, thereby providing intermittent conveying, filling and discharging the bulk material receiver in cycles. Energy costs are minimized as the pump consumes no energy during the discharging cycle. The wide range of available pump sizes in combination with the range of receivers, enables further energy optimization in relation to individual conveying applications.

In addition, pumps with no revolving parts such as the Multijector, require no lubrication or maintenance, and generate no heat. On the contrary, a cooling effect is measurable on the surrounding air. Noise levels are low, always less than a comparable electrical pump due to the lack of moving mechanics, even with generated air flows from 1 - 450 scfm.

If a Multijector vacuum pump is combined with a Volkmann bulk material receiver, the complete conveying system works pneumatically and allows operation in explosive zones without difficulties. Volkmann vacuum conveying systems are unique in their ATEX certification for all relevant powder and gas EX zones.

Filter systems

In all vacuum conveying systems, solids are drawn into the bulk material receiver before being fed into the production process. To avoid contamination of the environment and potential explosions during this material transfer, a dust-tight operation is optimal. In actuality, the physical principle of vacuum is the first step in avoiding contamination of the environment. Where a leakage in a positive pressure conveying system will inevitably lead to dust emissions, a vacuum system just draws in air in the face of a leak. Volkmann takes safeguarding the environment a step further by featuring special filters within their receiver to ensure dust-tight operation, providing filtration capabilities for even superfine dusts like toner powder (particle sizes down to 0.3 µm). For this reason, a fabricator of carbon black and soot changed his positive pressure system to that of vacuum conveying, dramatically increasing plant cleanliness.

For best operation, filtration systems should be largely maintenance-free, and easy-to-clean when product changes occur. Volkmann offers filter choices to suit the application. For chemical or lacquer applications, the intermittent conveying provides effective filter cleaning through back-blowing air shocks. This avoids gradual blocking of the filter. In food and pharmaceutical industry applications, solid filters constructed out of polymers or stainless steel are also offered. This ensures wear-resistant operation and permits wet cleaning with warm water or steam when needed.

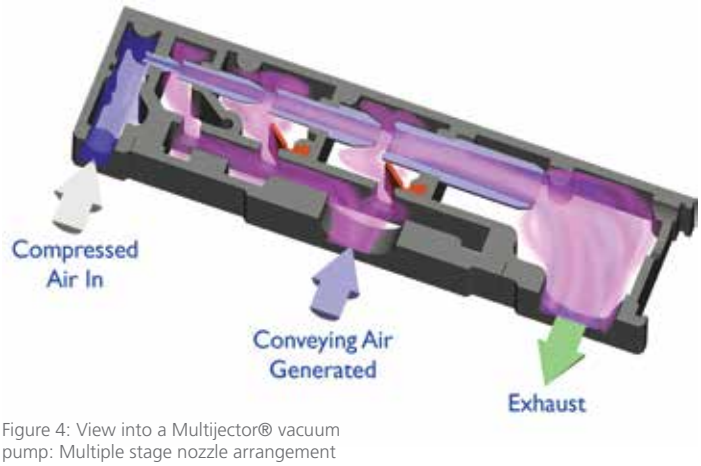

Figure 4: View into a Multijector® vacuum pump: Multiple stage nozzle arrangement

Filtration of the conveying air is also critical during vacuum transport. Volkmann achieves this by reducing the material's velocity with an increased diameter in the receiver. The majority of the loose powder drops out of suspension and is collected in the bottom of the receiver above the discharge valve. Additional collection of the fines takes place with tangential suction modules with internal cyclones. Residual fines are held in the receiver at the filter unit, just below the Multijector vacuum pump.

Depending on the application, filter lifetimes of 2 years or more are not uncommon. If standard filter cleaning is not sufficient for exceptionally adherent materials, it is possible to vibrate the filter unit and the bulk material receiver to remove the material.

Optimizing vacuum conveying

By using the appropriate vacuum receivers, pumps and filters, complex transport and feeding devices are possible. For example, multiple product feed locations can be supplied with various receivers having a single control and one central vacuum pump. All product sources – bulk bags, sacks, silos – can be connected to all possible destinations – mixers, reactors, sieves – by means of pipes or hoses and respective diverter valves. It's equally possible to pick up the materials with only one conveyor on multiple charging locations.

The range and variety of vacuum conveying systems allow successful adaptation to nearly all process requirements.

Sanitary. Safe. Trouble-Free.

Volkmann high quality, vacuum conveying systems will deliver your product just right, no matter where it needs to go. Dense phase vacuum conveying free of segregation, damage or abrasion.

Simply the best vacuum conveyor.

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