Efficient Vacuum Conveyors Deliver Cost-Effective Solutions

Pick-up, conveying and feeding of powders, granules and other bulk materials

VOLKMANN Inc.

In the past, the flat price of a conveying system was the business criteria for purchase; however, modern cost/benefit analysis goes much deeper. Total Cost of Ownership (TCO) and OEE (Overall Equipment Effectiveness) are now more important considerations for industrial items than a supposedly low purchasing price. For example, if maintenance and mounting costs for a simple control valve make up 70% of the life cycle cost and, at the same time, the original purchasing price accounts for up to 25% of the overall total cost, a new approach is recommended. Especially when dealing with the transfer of powders and bulk materials. Volkmann vacuum conveyors, with their stainless steel modular design and Multijector® technology, are especially durable and cost effective because of their simple mounting and maintenance-free design.

Bulk Material Receivers

Starting at the pick-up point, the material to be conveyed is drawn by the vacuum through a suction hose or pipe into the bulk material receiver. From there the material drops into its destination point (**Figure 1**). The result is an active, dust-tight feeding from the top without positive pressure. Following this principle, a variety of bins, big-bags and processes are able to be supplied with powders and bulk materials.

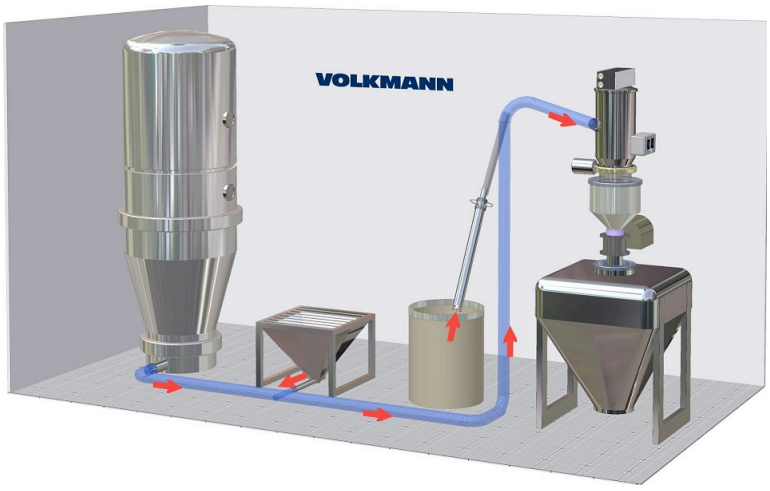

Figure 1: Exemplary layout of a Volkmann vacuum conveying system including three different pick-up points, conveying line, conveyor and the material's destination. (A container is shown.)

Often various processes require that multiple powders or granulates are to

be conveyed with the same equipment. Therefore it is desirable to have a simple construction, which allows for easy manual disassembly and cleaning avoiding cross contamination. For example, manufacturers of paints and coatings that use this technology are able to convey different colored dye powders (particle sizes 0.2 to 50 microns) or even toner, whereby major color changes from black to white are possible without difficulties.

Figure 2: Overview of modular Vacuum Conveyors in different designs and sizes

Consequently, a stainless-steel modular design ensures fast product changes while still fulfilling the most stringent hygiene demands of the pharmaceutical and food industries (**Figure 2**). Additionally a stainless-steel modular design permits individually tailored vacuum conveyor configurations in accordance with specific conveying tasks; e.g. suction modules with special suction inlets or integrated cyclones that can be crucial for successful conveying. The stainless-steel arrangement also leads to robust (up to 90 mbar absolute vacuum is possible), lightweight and fully mobile versions. This compact design enables, in most cases, the bulk material receiver to be mounted directly above the plant vessel/equipment, which has to be loaded.

If the bulk-material-receiver is combined with either stationary or mobile hoists, the application field increases even further. 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. The optimum configuration of the specific vacuum conveyor is often found by means of practical, one-to-one scale trials. Modular stainless steel systems are very easy to handle and integrate allowing performance trials either in the technical center of the manufacturer or directly at the process on site. The bulk material receiver is equipped with a choice of powder process valves and optional fluidization and discharging aids to allow even bridging and sticky powders to be fed into the process.

Vacuum pumps for pneumatic conveying

The driving force for the powder transfer is pure vacuum. Therefore, the correct functional principle, as well as size of the pump are equally important considerations for establishing an optimal working conveyor of bulk material. Depending on the application, specific pumps are selected. The vacuum pump can be either electrical or air driven. Often the heart of the Volkmann vacuum conveyor is a multiple-stage, Multijector® pump. Important criteria such as maintenance-free operation, small proportions and lightweight construction are just as vital to users as easy adjustment and control. Generally speaking, compressed air is not recognized as a cheap source of energy; however, specially designed multiple-stage Venturi's, offer effective energy conversion, ensuring economical performance. Multiple-stage (Multijector®) ejectors are five times more efficient than conventional single-stage ejectors and because of their cyclic, non-continuous operation they have running costs often comparable with electrical pumps, which are forced to run continuously by design.

Further advantages are evident upon installation in a production plant. The Multijector® has no revolving parts and therefore needs no lubrication or maintenance, and there is absolutely no heat generation. On the contrary, with the expanding compressed air, a cooling effect is measurable.

A wide range of powders and bulk materials can be conveyed because the multiple jet-pumps create large volumes of suction air flow (e.g. for dilute phase conveying) and also, if required, are able to generate enormous vacuums of up to -910 mbar (e.g. for dense phase and plug flow conveying). The performance characteristic (air flow at vacuum level) is more comparable with an electric positive displacement pump rather than a conventional single stage ejector. If a Multijector® vacuum pump is combined with the bulk material receiver as described above, the whole conveying system works pneumatically, which allows operation in explosive-zones without

Figure 3: INEX Vacuum Conveyor for feeding bulk materials into a reactor

difficulties. These Volkmann vacuum conveying systems are the only ones fully ATEX certified for all relevant powder and gas EX zones. There is even an inerting system available **(Figure 3)**.

Multijectors® build up and break the vacuum rapidly. This principle harmonizes with intermittent conveying, because the bulk-material-receiver is filled and discharged in cycles. The pump does not consume energy during the discharging cycle. Adjustment of the compressed air supply pressure ensures an application-specific control of the conveying operation. Even with generated air flows from 15 to up to 1200 m^3_N/h the noise level is always less than that of a comparable electrical pump due to the lack of moving mechanical parts. The wide range of available pump sizes, when applied to the different bulk-material-receivers, enables an optimization of energy consumption in relation to conveying capacity.

As an experienced manufacturer, Volkmann has been in the pneumatic vacuum transfer business for nearly 40 years and continues to be a market leader. As a result, Volkmann can identify the right solution for the application. For example, one of the smallest available conveyors, a VS 200, is able to convey 540 kg of sugar per hour into a mixer at a height of 4 meters. The complete conveyor itself has a height of 450 mm, a diameter of 210 mm and a weight of only 9 kg. Where space is limited, the small size of these powder-transfer-systems plays an important role.

The volume of the separator-container and choice of vacuum pump determine the main application areas of Volkmann vacuum conveyors. Assuming an average atmospheric pressure of approx. 1013 hPa, a vacuum of -910 hPa could lift a closed water column approx. 9 meters vertically. However, powders and bulk materials are always conveyed with a certain amount of feeding air and are therefore capable of conveying to much greater heights. Depending on the characteristics of the material to be conveyed, more than 40 meters of vertical conveying height has already been accomplished.

Actual throughputs/capacities are strongly dependent upon the properties of the powders 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. With different products a variance in throughput rate up to 1000 kg/h, is common even with the same kind of conveyor.

Figure 4: Volkmann vacuum conveyor (right) for feeding powder into a mixer

The majority of conveying tasks for pneumatic Volkmann vacuum conveyors are for capacities between 10 and 6000 kg/h **(Figure 4)** whereas under extraordinary circumstances occasionally up to 16 t/h can be reached. Distances vary from just a few meters to up to 100 horizontal and up to 40 meters vertical.

At the beginning of the conveying line, product pick up is achieved either automatically through feeding hoppers (e.g. tote bins) or manually by an operator equipped with a suction wand.

Modular filter systems

In all vacuum conveying systems the solids (or even liquids) are drawn into the bulk material receiver and collected before they are fed into the process. To ensure a dust-tight operation special filters are used within the receiver.

Additionally, the physical principle of vacuum helps to avoid contamination of the environment. A leakage in a positive pressure conveying system will inevitably lead to dust emissions, whereas with a vacuum system, additional atmospheric air is drawn in. Consequently, in order to improve the cleanliness in his production plant, a fabricator of black carbon and soot changed his existing (old-fashioned) positive pressure system to vacuum conveying. Vacuum is the preferred choice for harmful powders or potent pharmaceuticals, since the enclosed system maintains a high containment level. Special PPC vacuum conveyors are already used

in production areas where an OEB (Occupational Exposure Band) of 4 with OEL's (Occupational Exposure Limit's) from 1-10 µg/m³ are monitored.

After vacuum transport through the conveying line, fine filtration of the conveying air must be achieved. First the material's velocity is considerably reduced by the increased diameter of the receiver. The majority of the powder is therefore collected just above the discharging valve. Additional collection of the fines takes place with tangential suction modules with internal cyclones. Residual fines are held in the receiver on the filter unit, just below the Multijector® vacuum pump.

The filter systems should work largely maintenance-free and be easy to clean if product changes occur, but at the same time, be capable of filtering superfine dusts like toner-powder (particle sizes down to 0.2 µm), and in addition should fulfill hygiene regulations in the pharmaceutical and food industries.

Cleaning during operation is achieved using different procedures. Initially, the intermittent conveying permits effective filter cleaning by means of back-blowing air shocks. Gradual filter blocking is therefore avoided. In food and pharmaceutical applications for example, solid filters manufactured from polymers or stainless steel are used. This ensures wear-resistant operation and permits wet cleaning with warm water or steam if product changes occur. Depending on the application, filter lifetimes of 2 years or more are not uncommon. If the standard filter cleaning device is not sufficient for exceptionally adherent materials, it is possible to vibrate the filter unit and the bulk-material-receiver. Again the choice of modular filter designs allows the best solution for the specific individual application.

Practical Optimizations of the Individual Task

On the basis of the modules shown, complex transport and feeding devices are feasible. For example: multiple product feed destinations are supplied with various receivers having a single control and one

central vacuum pump. All product sources (Big-Bags, sacks, silos) can be connected with all possible destinations (mixers, reactors, sieves) by means of pipes or hoses and respective diverter valves. It's also possible to pick-up from multiple bulk containers with only one conveyor for loading a mixer with a variety of ingredients.
The range and variety of available vacuum conveying systems allows specific design solutions to meet nearly all practical requirements. Usually conveying trials are performed at the manufacturer's testing facilities or at site. The pre-selection of the right configuration is also possible with the extensive vacuum conveying trial-database, held by the manufacturer.

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