Vacuum Conveying – Multijector Pump vs. the Alternatives
An energy comparison

VOLKMANN Inc.

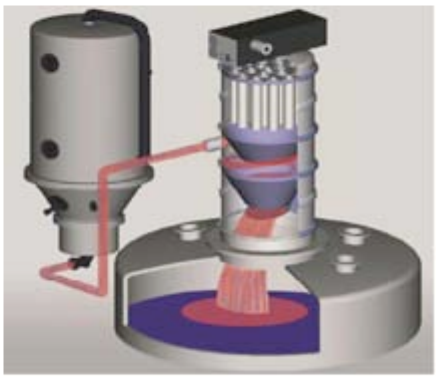

Fig 1 Typical Vacuum Pneumatic Transfer System

When it comes to the transport of powders, granules and even some slurries a vast array of options exist ranging from simple screws, dating back to the days of Archimedes, through to the modern high efficiency pneumatic systems offered today. With the ever-tightening health & safety regulations there is ample evidence the need for a dust-free powder transfer solution has become a major decision point. To meet such market requirements, Vacuum Conveyors have established themselves as the most suitable, utilizing their inherent "closed system" function and thereby providing easy & safe transfer to process plant, machinery and containers. In the simplest and most basic of terms under vacuum conveying, should a leak occur, it is always inwards! This obvious advantage is but one associated with vacuum transfer where the negative pressure advantage, and the control thereof, can be put to additional effective uses.

It is important to understand; however, that not all vacuum systems are created equal. This paper identifies the differences, as well as some common misconceptions, of various vacuum transfer systems.

Powder Conveying with Vacuum

Let's consider the selection of the vacuum generating source:

Some examples and features of vacuum generation are:

Type	Features
Centrifugal Fan (Blower)	Large Volume flow, Restricted Vacuum level, High Noise.
Regenerated Blower	Large Volume flow, Restricted Vacuum level, High Noise
Piston Type Pump	Generates Heat during pumping, Restricted Vacuum Level
Vane Pumps	Large Volume, Good Vacuum, Expensive, Generate Heat
Roots Type Blower	High Volume, Generate Heat, Very Loud, Expensive.

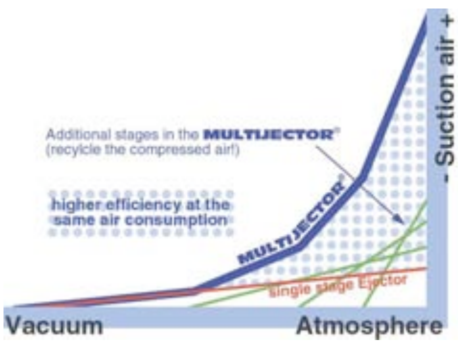

Fig 2. Typical Pump performance of a Venturi Based Multijector®

All of the above units are vulnerable to powder entering the moving parts of the pump and therefore filtration and protection are critical. All the electric motor driven units also remain running continuously since three phase motors are very limited in their ability to start and stop on a frequent basis.

By contrast the Multijector® Venturi Vacuum Pumps and Conveyors have advantages over these alternative technologies, in that they are able to transport the material with a substantially higher negative pressure (Fig. 2) which in turn provides conveying options not always available to typical electric motor based systems.

As a result not only does a far larger application field exist but once purchased greater options exist for changes to material properties that might otherwise adversely affect the conveying system. The nature of modern business is such that what begins as a discrete single application conveying system often changes as end user product lines or formulations change.

Further advantages exist; for example, while basic suction conveyors can suffer suction line blockages when moving difficult and poor flowing bulk materials, this is not the case with Multijector® Vacuum Conveyors. The high negative pressure differential of up to 960 mbar (28.3” Hg) is easily able to draw agglomerates and plugs through the conveying pipeline. Additionally, the low available pressure differential of conventional suction conveyors permits only Dilute (Lean) Phase Conveying which, owing to the high velocities involved, leads to strong mechanical stresses on the material to be conveyed and/or to extensive abrasive wear on the conveying line itself.

Lean Phase conveying is often discussed with limited understanding of the implications. Typical velocities are given as between 4000 – 6000 ft/min and accepted with little thought. However, if we consider this in terms of material traveling at 45 to 68 miles per hour through a pipeline and then requiring a change of direction at a bend, one might be more inclined to pause and consider the issues of degradation and abrasion.

Furthermore, high velocities lead to the segregation of particles according to size. Many clients are unaware that Multijector® systems can convey effectively at low velocities in Dense (plug flow) conditions. The high vacuum level required for Dense (or-Plug) Flow, where conveying velocities are much lower, is available, and thus ensures gentle and separation-free material transport (fig. 3b).

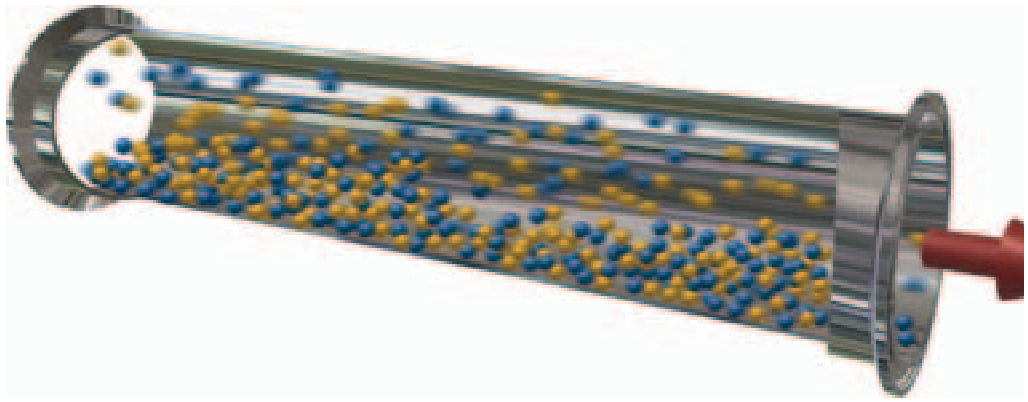

Fig 3a – Lean Phase Conveying – High Velocity

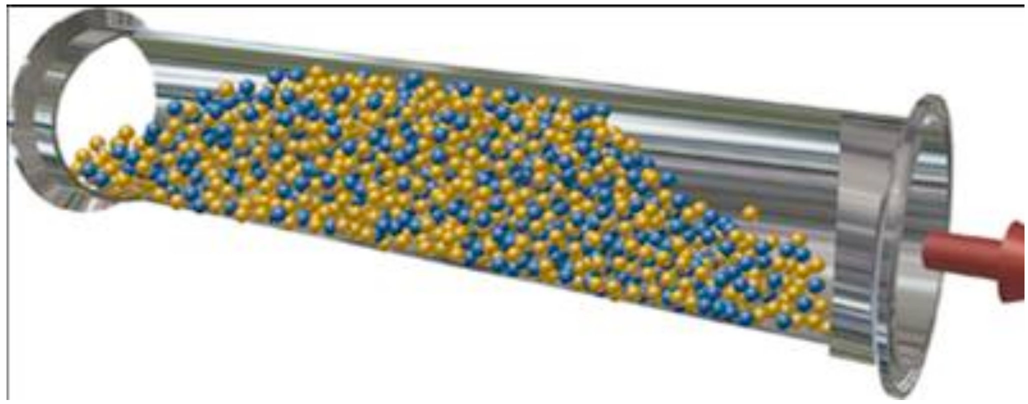

Fig 3b – Dense Phase or Plug Flow Conveying – Higher Vacuum, Lower Velocity

Efficient Vacuum Production

A Common misconception when comparing a traditional Regeneration Blower or Positive Displacement driven vacuum conveyors is that the Multijector® uses a high amount of energy in the form of compressed air. While this is true of the older single venturi units commonly found, it is not so for the Volkmann Multijector®.

Both high negative pressures and large suction air-flow rates are available from multiple-stage, gas-jet-driven Multijector® Vacuum Pumps. These powerful ejectors are characterized by maintenance and wear-free operation, cyclic running (energy saving, since energy is only consumed when the suction part of the cycle is occurring, as opposed to continuously running electric pumps), compact and extremely simple installation. Power requirements are minimal because the supplied driving gas (usually compressed air) is used up to four times (in four stages) in the Multijector® Vacuum Pumps. (Fig 4.)

The generated suction airflow created in one stage of the pump is recycled in the following stage to create an even larger total flow. The Multijector® Vacuum Pump contains no ignition sources (no electrical parts, no heat generation, no mechanical friction and spark impact, no electrostatic loadings) and therefore does not fall under that area of the new ATEX guidelines for explosion risk thereby illustrating the suitability for Explosion proof applications. The specific advantages of the Multijector® Vacuum Pumps can be utilized in many other processing areas.

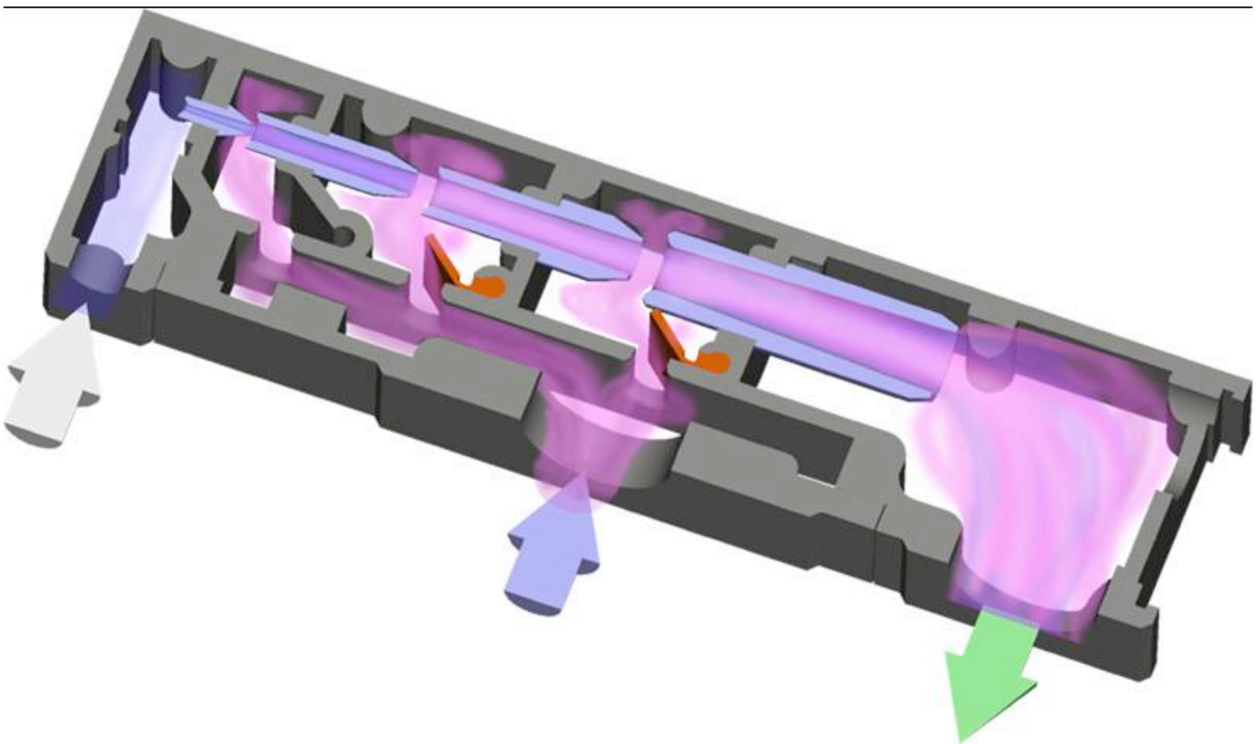

Fig 4 Volkmann Multijector Vacuum Pump – left Arrow is gas in, center arrow is vacuum generated, green arrow is exhaust gas. Diagram shows progressive venturis, each adding to the volume flow and vacuum generated (see also Fig 2 blue line).

Energy Use Comparison

Let's consider an application:

Energy Costs for Vacuum Conveying - Example

Conveying task: Conveying of Lactose powder
Total conveying length: 16 ft
Conveying height: 9ft
density: 45 lbs/ft3
particle size: 5 – 500 μm
material property: dry, good flowability
suction out of loading hopper

Vacuum Conveyor: PPC170 with Multijector Vacuum pump M 540 GLA KV
operating pressure: 5.5 bar (80 psig) compressed air
suction: 4 seconds (=44.44% of cycle)
unloading : 5 seconds (=55.56% of cycle)

Conveying capacity: 3500 lbs/hr

Energy consumption:
1. Multijector Vacuum pump M 540 (consumption only during suction cycle)
18.2 scfm and 44 % of the cycle = 8.02 scfm = 481 sft³/h.
2. GLA – filer cleaning (0,75 Liter*5,5bar) every 9 seconds = 58.3 sft³/h.
3. KV – pneumatic piston vibrator (during discharge cycle)
1.41scfm and 55.56 % of the cycle= 47.0 sft³/h.

Complete Compressed-Air Consumption: 586 sft³/h.
Cost of Compressed-air: ca. $0.25/mcf = 0.25 * 586/1000 = 14.5c/hr

For this application with a conveying capacity of 3500 lbs/hr the energy costs are 14.5c/hr, or 8c per ton material transported.

Note: A comparable electrical pump for the vacuum Conveyor would be 2 kW size and would operate both during suction and discharge cycle. Thus the costs of the electric motor system would be between 10 and 20c / hr. However, compressed air would still be needed for the filter air-shock and the piston vibrator, adding further to the total cost.

Case Study Silo Loading:

Required energy for Pneumatic Vacuum Conveying with one intermittent run, compressed air driven, multiple-stage, *Multijector Vacuum Pump*

Feeding point – Drier Outlet

Loading: two silos

Total Conveying Distance: 167 ft

Conveying height: 50 ft in two 25 ft sections

Bulk Density: 68 lbs/ft3

Particle size and shape: Irregular pieces 1/16th inch

Temperature: 212ºF

Throughput 450 – 3300 lbs/hr

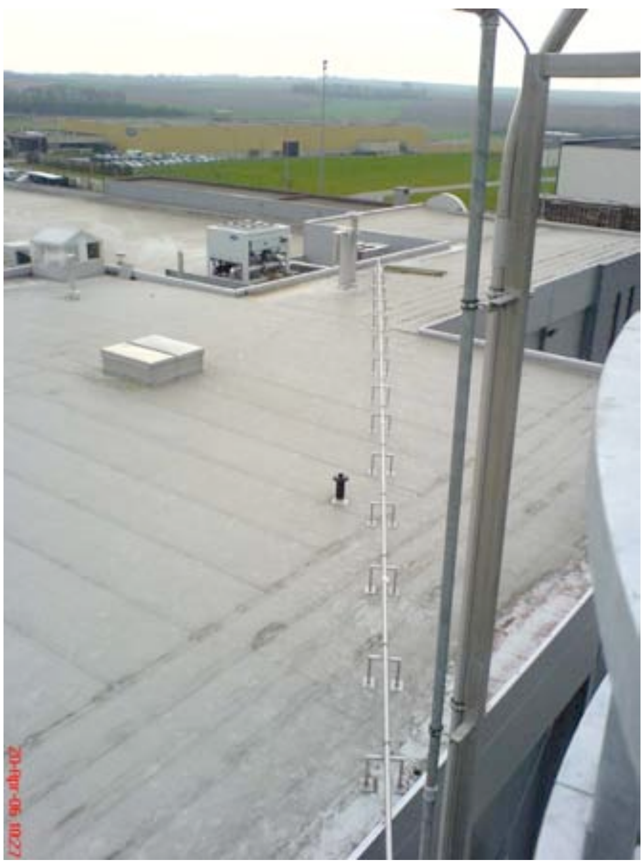

Fig 6 Total elevation of 50 feet in two sections

Fig 5 Long Horizontal Conveying Run

Selected Vacuum Conveyor VR450 with G2700 Multijector Pump

Drier output at 450 lbs/hr
Material transfer per conveying cycle: 30 lbs
Number of suction cycles per hour: 17
Time to complete one cycle: 24 seconds

G2700 pump @ 80psig, 91scfm maximum
Pump in operation for 17 x 24 seconds per hour = 6.8 minutes (only 11.3 % per hour)

Compressor power for G2700 pump = 20hp

Actual Equivalent Compressor power required – 11.3% x 20hp = 2.26 hp.

Other issues associated with Electrical Pumps

As mentioned previously electric motor driven pumps have other constraints resulting from the inability to be able to stop and star them on a frequent basis. In order to overcome the limitations they require additional equipment.

It is necessary to provide and use a three-way valve on top of the receiver (or very close to the conveyor-head). One side of the three-way valve is connected to the external vacuum pump, one side to the top of the receiver (i.e. to the main filter within the conveyor) and one side via a non-return valve and filter to atmosphere.

This allows the electric motor and pump to run continuously, wasting energy by pulling air into the pump and discharging to atmosphere. This occurs during the discharge and cleaning cycle. Furthermore, a compressed air supply is still needed for the cleaning of the filters.

Additional equipment such as vacuum relief valves and vacuum gauges, motor starters and plc controls are also needed.

There is a further advantage to using compressed air in that if indeed an additional compressor should be required for the installation it provides additional resource for the facility, not just for the conveyor but for other air uses. An electrical based vacuum pump has no other practical use.

It is therefore apparent that the sometimes used cry of "it uses a lot of compressed air" is somewhat based on the older inefficient single venturi systems and would be akin to saying cars use a lot of oil based on the technology of 50 years ago. Modern Multijector® pumps are highly efficient.

When considering the merits of a compressed air driven system it is important to consider the true costs both of the new high efficiency pumps as well as the TOTAL cost of the alternative systems.

For more information, contact Volkmann at:

3855 Sylon Blvd., Hainesport NJ 08036

609-265-0101

email:usa@volkmann.info

www.volkmannUSA,com