



White Paper

Selecting Dilute Phase Pneumatic Conveyors

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SELECTING DILUTE PHASE PNEUMATIC CONVEYING SYSTEMS

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Pneumatic conveying of dry bulk materials is still considered an art in reliable circles, rather than an exact science. Admittedly, there are established formulas, which can be applied. These, together with the proper numerical figures substituted in the formula, have eliminated a great deal of the guesswork in the application of pneumatic conveying to specific commodities. Application for the proper system and the right numerical figures used in the formulas, are still a matter of combining common sense and certain other factors which can be gained only through experience.

You should first consider your product characteristics.

First consideration naturally should be given to the product being handled. No one can possibly know all the characteristics of every material, under all conditions. It is, therefore, necessary to obtain as much information as possible about the material. A guide for this, is a customer's checklist for pneumatic conveying systems. Laboratory test facilities should be available for further testing of the material. The handling characteristics of the material have a very definite bearing the selection of the type system. For example, some materials being sluggish with sever bridging tendencies, would feed unreliably to a pressure type pneumatic conveying system, but may not offer any problem, whatsoever, when handled with conventional feeding equipment to a vacuum type pneumatic conveying system. Normally, the materials that present the greatest bridging problems are in the powdered form. However, a pressure system must have adequate provisions for venting the inlet blowback air regardless of the product being fed into it. On the other hand, with all leakage being inward, the vacuum system often times has to be airlock at the inlet to prevent the material from flushing and overloading the system.

The layout of the components is the next consideration for system selection.

The next major factor is the system layout. Let's consider, first of all, the simplest of conveying problems that is to convey from one point, such as storage silo, to one other point, for example, an in-plant use bin. Assuming the product will flow readily out of the bin into a pressure line regardless of the distance involved, the simple

pressure system is going to be the most applicable from a cost standpoint as well as component sizing. A suitable air supply, suitably vented airlock as a metering device under the storage silo, a collector or separator at the use bin and the necessary connecting duct work complete the system. On the other hand, suppose the material has severe bridging tendencies. It may be somewhat more costly, but the vacuum system, even with larger components, could eliminate a feeding problem as well as possible venting problems at the use bin. All the system leakage is inward. A good portion or the entire cost differential may be offset by the cost of special feeding equipment for the pressure system.

Positive pressure systems are normally the lowest cost.

Expanding the problem further, suppose we are asked to convey from the single pick-up point to a multiplicity of in-plant use points. This is where the pressure system really comes into its own, from a cost standpoint. It is not difficult to see how costly it would be to accomplish this with a vacuum system. Because each use point must be equipped with a suitable separator and airlocks as opposed to only using a lower pressure separator for the pressure system. Thus far, we can draw the following conclusions: for the simplest of conveying applications, it is at times a toss-up in comparing a vacuum system to a pressure system. The decision resting entirely on the characteristics of the material being handled. When conveying to multiple points, the pressure system has no equal, practically speaking.

Vacuum Conveying is best when you have multiple inlet points and a single discharge point.

Having given consideration to multiple delivery points, let's look briefly at the opposite possibility. One delivery point being fed from multiple sources. We have already pointed out the obvious flow problem when feeding materials into a pressure line from one pick-up point. When trying to introduce materials into a pressure line from multiple points, we simply compound the problems. Every entry is a potential air loss point and may result in the system being short-circuited and under-powered. Unless additional equipment is incorporated, the vacuum system is the obvious answer to the problem. Some means must be provided to introduce the material into the line at each point. This can be accomplished mechanically with simple open and shut cut-off valves or a

rotary feeder or star-valve. These will act as a combination air seal and metering device. In any case, will be less costly than the equipment required for feeding into a pressure line with all leakage now being inward to the system and no additional venting required. There are numerous mechanical feeders available, such as screw feeders, belt conveyors, vibratory feeders, etc. In the case of very free-flowing materials, such as plastic pellets, and various PVC Resins, a simple orifice control will provide a uniform metered feed.

On any vacuum system, product is transported from a feed point to a receiving device. A cyclone separator is used for non-friable granular materials having very little dust or continuous-cleaning filter collector is used for powder materials. Suitable airlocking becomes important at this point. The rotary airlock valve is the answer, but there are other devices available, such as gate locks, etc., for special applications. Since the material is often times aerated at this point and an well-engineered system will handle intermittent slugs of material, designing the airlock device for over-capacity is a necessity.

Combination vacuum/pressure systems provide the flexibility of connecting multiple inlet points to multiple discharge points.

Thus far, we have been talking about either straight pressure or straight vacuum systems. This leads us into the combination pull-push or combination vacuum pressure type systems. The combination system affords us the flexibility of being able to pick-up from and discharge to multiple points in the most economical manner. Many times, it is more practical to split the system at the transfer points, depending on distance and capacity, by powering the suction and pressure side separately, but essentially, it is still a single system. This allows us to keep components to a minimum size. The combination pull-push system is many times supplied on simple one pick-up, one delivery point projects, where the distance or capacity requirements would otherwise rule out an all vacuum system. However, the nature of the material necessitates the suction pick-up. The pick-up in this case could be a bag dumping station, for example, wherein the blowback due to the pressure system would present an extremely severe venting or dusting problem. Power consumption on the pull-push system will naturally be higher than conventional pressure or vacuum systems since the material is accelerated twice. The material is accelerated once at the system pick-up point and again at the point of transfer from vacuum conveying to pressure conveying.

Any of the different types of pneumatic conveying systems can be used to unloading railcars.

Up to this point, we have talked only about in-plant materials handling systems and have not touched at all on the unloading of railroad hopper cars into bulk storage facilities. There are several ways to unload cars by means of pressure type pneumatic conveying systems. One method is to use a portable over the track apparatus that is attached directly to the car outlets. These units convey material from the car outlets by mechanical means to the inlet of an integrally mounted rotary feeder. With such a unit, exact positioning of the railcar is not required, since connections to the power unit and stationary piping are accomplished using flexible hoses. The same blowback or bridging problems is inherent in this type of system, just as they are in any other pressure type system. Another common way to unload railcars with a pressure type pneumatic conveying system involves the use of an under-track screw conveyor. This is a permanent installation, necessitating a pit under the track with flexible canvas spouts between car outlets and the inlet of the screw conveyor. A rotary airlock feeder is required at the discharge of the screw conveyor. Another arrangement consists of an under-track hopper equipped with flexible canvas spout, which discharges directly into a rotary airlock feeder. The under-track pit for this arrangement involves considerable expense. In either case, where a pit is required, adequate drainage and de-watering equipment is necessary for the pit itself, as well as watertight covers for the flexible connectors. In all three arrangements, the inlet feeder needs adequate venting as is required for any pressure type pneumatic conveying system. In the latter two arrangements, exact spotting of the car above the unloading apparatus is required.

It would appear then, that a pressure system is not the most desirable way to unload railcars. Logic indicates that vacuum unloading is preferable. When unloading into a single bulk storage container is required; the all-vacuum system is generally the answer. Even though the separator must be elevated to the point where it will gravity discharge into the storage vessel. In isolated instances, an all-vacuum system is recommended for unloading even into multiple storage vessels with some means provided to distribute the material mechanically from the discharge of the separator to the proper container. This occurs generally, when it is not the most

desirable way to handle certain commodities more than once in an air system.

Most often when unloading railcars to storage, the combination vacuum-pressure system is used whether it involves a single or multiple silos. It is desired from the customer's standpoint to have equipment such as receiver collectors and rotary valves which require periodic maintenance be located at grade for accessibility. For pneumatic boxcar unloading, the suction system is a must and one of the most important features of the combination vacuum-pressure system is the ease of connecting to a hopper bottom or rail car. This can be accomplished very readily with a simple unloading attachment for the outlets of the car and a sufficient quantity of flexible hose. Here again, the vacuum system can also be an aid in withdrawing sluggish materials from the car. The exact positioning of the car or bulk shipping container is not required with a suction hook-up nor is any special preparation of the area at the car-unloading site. Such as hard surfacing of the area, as in the case of a portable over-the-track unloading, and a pit of any type is not required. The dust-control problem for the pressure side of the combination vacuum pressure car unloading system must be treated the same as for any in-plant-conveying problem whether the storage area is indoors or outside.

Specialty systems for solving unique problems.

Having limited our discussion, up to now, to the application of conventional pneumatic conveying systems, we should at least touch briefly upon the other types of systems. Specifically, these are blow-tank and closed circuit systems. The blow-tank system is first of all a type system that was originally developed for the manufacture of PVC Resins. These manufactures have a particularly concerned with the development of agglomerates in their product, such as "fish-eyes" or "fingernails", caused by the heat generated from the rubbing action in rotary vane type feeders. The blow-tank system has no moving parts in the product zone, other than open and shut valves at the inlet and discharge of the pressure tank. This has been found to be very advantageous also, not only in the plastics industry, but on systems handling abrasive and/or somewhat friable materials.

In addition to blow-tanks, we frequently overlook the advantages obtained with closed-circuit system mainly due to the lack of information on the design and behavior of these systems. The closed-loop pneumatic system

is not as well known as the other types of pneumatic conveyors. Although a closed-circuit arrangement may be adapted to many of pneumatic conveying requirements, the closed circuit is most frequently used for process requiring a gas medium other than air, such as inert gas. Also, hygroscopic materials are easily handled with a closed-circuit system. By re-using the conveying air, moisture is not added to the system and conveying is accomplished without excessive moisture pick-up. Dusty products may be conveyed with a closed-circuit system without using cloth filters. With dusty products, a high efficiency cyclone collector is used to collect the product with only a small quantity of fine dust recirculating. The closed-circuit system would be equipped with a centrifugal blower capable of handling the light concentrations of dust recirculated within the return air. In most applications, rotary positive displacement blowers are used. If the system is conveying a dusty product, a suitable cloth filter should be used ahead of the blower for blower protection. Systems of this type are used where high pressure closed circuit conveying is required.

In summation, because of the numerous variables encountered in pneumatic conveying and the fact that each and every system must be applied and designed to suit the requirements of individual users, this dissertation is a means to be used as a general guide. We, at Young Industries, are always available for consultation on specific questions not answered in these brief paragraphs and similarly welcome your comments and/or constructive criticism.

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