From Source to Destination, Vacuum Conveying Gets It Done

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Modern vacuum technology has been at the forefront of manufacturing technology since the beginning of the industrial revolution. From the first manually operated vacuum pumps of the late 1800s, to the first industrial use air-powered vacuum cleaner in 1964, the first vacuum conveying system designed to deliver powders for ordnance in 1965, and current twin venturi technology, vacuum conveying is the most sophisticated method of handling powders and bulk solids today.

Vacuum conveying has always been used for plant efficiency, material protection and safety, lending to its advancement and wide-spread use across most industries including pharmaceutical, chemical, food processing, non-wovens, additive manufacturing, and the aerospace industry.

Today's vacuum conveying systems employ essentially the same concepts as the first systems of the 1950s, yet with more sophisticated components and advanced knowledge gained through practical experience.

Each industry poses different problems in terms of materials, regulations, and safety. Materials in the pharmaceutical and cosmetics industries utilize materials with particles so small you can barely feel them between your fingers; yet both industries have vastly different regulations, safety concerns, and quality control challenges. Other industries work with highly abrasive powders, hygroscopic materials, or utilize powders that are incredibly heavy at 250 to 350 pounds per cubic foot, like metal powders for additive manufacturing.

Some applications with relatively unproblematic materials like sugar, plastic pellets, rice and coffee are more straight-forward and may not need the level of engineering that challenging powders such as iron oxide, zinc oxide, calcium carbonate, or toner demand. However, even unproblematic powders can pose unique challenges, relative to process, that require custom engineered components. Likewise, some difficult-to-convey powder applications may be suitable for turnkey off-the-shelf systems.

Starting with a properly designed pick-up point with phase-density control impedes future issues with line plugging and inconsistent material flow.

Why Vacuum Technology?

As vast as material behavior is, so are the reasons why manufacturers employ vacuum technology. Some users want more automation, others are seeking to improve ergonomics or create a cleaner work environment, or manage materials cost. Increased throughput is the primary objective for others.

Seasoned vacuum conveyor manufacturers translate information, passed down through time, between industries to engineer custom, semi-custom and off-the-shelf solutions that work on start-up.

Although the process of conveying the wax chips is straightforward, similar in nature to conveying plastic pellets, the melting point of wax poses challenges. Wax that melts at very low temperatures becomes sticky and adhesive requiring provisions to ensure the wax melts in the tank and not in the equipment being used to convey.

Vacuum Technology Applications

When International Converter, a division of Novolex, a leader in foil laminates, multi-web lamination, and specialty barrier and sealant coatings for use in a wide range of high barrier consumer and industrial applications, requested a quote for a vacuum conveying system to eliminate manual transport of wax chips to a raised platforms where workers dumped 40lb bags into a hopper, its ideal solution was a completely automated system that would allow it to change from using 40lb bags to super sacks.

There are numerous ways to engineer pneumatic conveying systems and previous experience with this type of arrangement, common across most industries, as well conveyor installations with other wax applications at Candle-Lite and JB Fuller, facilitated several design choices on the path to final design that met the customer's ergonomic, production and financial needs.

Although all pneumatic conveying systems require some bit of human interaction, the first system iteration proposed the ideal solution to eliminate worker effort and risk, coming as close to a fully automated system as possible, complete with automated super sack unloading equipment and dual material receivers to facilitate the delivery of both gloss and matte wax beads to their respective tanks. The cost, however, was outside of what International Converter had to work with.

Although the automated bulk bag unloader would have further reduced worker interaction in the process, and therefore worker risk, it did not add much to the package otherwise. Had International Converter, which operates three shifts five days per week, wanted to increase throughput from its average of 1500 pounds of wax beads per shift, a bulk bag unloader would have been a more viable option.

Since the volume of pellets through the system was lower capacity, rather than using a bulk bag unloader, a wand was implemented as the pick-up point. Now, workers use a wand to suck material out of the super sac rather than suspending it. Though it is more labor intensive than using a bulk unloader, using a wand to remove material from bulk vessels eliminates the exertion, repetitive motion, and awkward positions that occurred with manual handling of 40-pound bags, and has the same outcome as using a bulk bag unloader.

In addition to backing down the automation in the system design, instead of using two receivers to deliver both matte and gloss chips to the system, the facility's high ceilings supported the use of a gravity diverter valve that acts like a splitter valve. The gravity diverter valve has a blade inside that switches from one direction to another, allowing material to be diverted to the appropriate tank.

To ensure heat, rising from melting tanks, didn't make the conveying equipment hot enough to melt the wax while conveying, a Sparge Ring provided some isolation from the process to the conveying equipment. Sparge Rings are transition pieces with small fittings that create positive pressure and used most often with heat sensitive equipment or vapor control.

Bulk Bag Unloaders also known as Bulk Bag Discharge Systems, provide an easy, clean, and controlled way to discharge the entire contents of bulk bags.

Still on a mezzanine level, the pellets are transferred, via wand, from a Gaylord up 20 feet to the receiver. Where it used to take two workers per shift, and require equipment to be shut down while loading, a single person can do it, eliminating the risk, which was the primary goal.

While wax and plastic pellets are free flowing materials, hygroscopic materials are not and tend to gum up and clog the system. Additionally, fugitive dust of hygroscopic materials, when released into plant environment, makes housekeeping a time-consuming task.

Pneumatic Conveying System Replacement

When Ramsey, NJ-based Okonite Co, producer of premium insulated wire and cable since 1878, needed a pneumatic conveying system for their Orangeburg, SC plant, its goal was to replace its in-house designed to reclaim super absorbent polymer (SAP) and control the environmental end of its proprietary process.

The proprietary three-step process coats wire cable with SAP. The SAP serves as a blocking agent so water cannot run inside the conductor if the cable or wire insulation system is breached in an underground or wet environment.

While the fine powder is very responsive to moisture and effective at protecting wires, and therefore systems from shorts, in production it is prone to gumming up with exposure to moisture. Exposure of SAP to the humid air of South Carolina alone can cause clumping affecting efficiency and productivity.

The process at the South Carolina plant runs between 400 and 600 feet of cable per minute through a four-foot long atomizer chamber that blows the SAP around in a cloud which coats the wires. The original system used a single filter housing to capture product for reuse; however, each time the filter needed cleaning the chamber would switch from negative pressure to positive pressure and powder would escape into the plant atmosphere through the openings where cable entered and exited the chamber.

Based on previous applications with hygroscopic materials, and SAP in particular, information about how much powder they were moving, the CFM, and the amount of powder wasted on overspray is what led to the design of a dual conveyor system with automatic changeover and a filter large enough to recover material.

Dual-Conveyor System

The dual conveyor system works essentially like that of a pumping heart. First, cable enters a chamber at about 400-600 feet per minute while an atomizer simultaneously injects positive air and SAP into the chamber wherein it coats the cable fibers. At that same time, the dual conveyor system sucks air out of the chamber at a faster rate than enters into the coating chamber, creating the negative pressure system wherein SAP cannot escape into the air external to the coating chamber.

From there, material enters the first of two valve chambers for a programmed amount of time. After that the first valve closes while opening the second valve and chamber. When the first valve closes, air is blasted into the filter to release particulates to

Floor-mounted Column-Lift Vacuum Receivers are ideal for applications requiring from-floor conveying up to 25 ft above processing or packaging equipment

the bottom of the system where another routing system returns the SAP back into the hopper for reuse. This filtration cleaning process is repeated for a few seconds until the first filter is entirely clean, and then the second valve closes for its own identical process.

Where Okonite was losing about 7 percent of its material per shift with their original system, the dual conveyor system has brought loss to nearly zero.

In addition to the dual conveying system, a bag unloading station with enough negative pressure to remove the SAP before it has a chance to enter the air around the operator and plant environment further eradicates moisture from the system and reduces housekeeping.

Ready-to-Operate Systems

Automation does not always require complicated or custom designed solutions. In many industries, even those with difficult powders like the pharmaceutical industry, long term experience has led to the development of complete ready-to-operate systems.

Pharmaceutical materials tend to be very fine and prone to segregation, especially during manual transfer of materials in containers and from machine to machine throughout the production process. The vibration, caused by moving containers, promotes segregation, threatening batch quality. It is this reason that pharmaceutical manufacturers primarily use mass flow methods that move all particles at the same velocity, minimizing segregation.

Blenders, mixers and reactors are common types of equipment used in pharmaceutical processing facilities; and, just like many other types of equipment, require a mezzanine level for manual loading or specialized equipment like drum loaders or vacuum conveying equipment.

Although drum loaders are better than manual loading, limitations, such as the ability to load only one drum at a time, make the delivery of materials to the blender or reactor time-consuming. In some circumstances, it may also be necessary to load multiple ingredients into drums prior to loading blenders and reactors, further slowing the process by increasing processing steps.

Packaged Conveying Systems

One of the most efficient advances in loading blenders, mixers, reactors, or any vessel capable of withstanding vacuum, is packaged conveying systems designed specifically for direct charge loading of blenders. With a processer's blender or mixer as the primary receiver, the conveyor manufacturer provides the rest of the system: power source, filters, controls, and adapters.

Configured specific to each application with standard equipment, direct charge blender loading systems come with the option of either floor standing, or suspended blender loaders designed to significantly reduce the amount of carry over, eliminating product loss and ensuring batch integrity.

Standing units are readily accessible for cleaning and can be equipped with casters, allowing them to service more than one blender. In addition, once the blender is loaded and equalized, carry over releases into an airtight vessel that preserves product integrity allowing for reuse or safe disposal.

With suspended units, once the blender is loaded and equalized, material automatically discharges back into the blender eliminating the need to handle product manually. Because the units are easy to take apart without tools, clean up between batches and products takes only 30-45 minutes to wash down equipment and change out bags, filters and hoses (when using different hoses for every product).

Vacuum Receivers are designed and available in stainless steel or carbon steel, with a variety of features including cone-designed hopper to ensure full self-emptying feature, and straight-sided tube hoppers for fast and efficient handling of non-free flowing materials.

Summary

From fully automated custom systems, to more economical plug and play solutions pneumatic conveying solves safety hazards, production slowdowns and material loss while moving product gently and quickly from point to point, with nothing in the way to impede the efficiency of movement.

For over 65-years, VAC-U-MAX has been the leader in designing and manufacturing innovative pneumatic conveying systems and support equipment for the conveying, weighing, and batching of dry materials in Belleville, NJ, and is a pioneer with many industry firsts including air-powered venturi power units, direct-loading of vacuum-tolerant process equipment, and vertical-wall Tube Hopper material receivers. The primary technology for conveying is vacuum, but positive pressure pneumatic systems, as well as mechanical conveyors, are also used as the specific applications dictate. An equally important activity is the design and manufacture of heavy-duty industrial vacuum cleaners, which range from small air and electric-powered drum-styled units to large electric portable and central systems.