BOOSTING PROFITABILITY AND REDUCING SAFETY RISKS WITH VACUUM CONVEYORS

Vacuum conveying systems are useful for transporting powders and bulk solids throughout a plant. But these systems do more than just move material. Vacuum conveying systems also make the work environment safer, reclaim material from dust collectors, and make mixer loading easier. This article discusses how different vacuum conveying systems can benefit your plant and reduce costs.

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Vacuum pneumatic conveying systems, which move material via suction, have many uses within the powder and bulk solids industry. The primary use of vacuum conveyors is to transfer material to and from processing or packaging equipment. One use that's gaining in popularity is loading large-scale mixers with vacuum conveying systems. From chemical applications to sanitary design processes, loading large mixers, which are often 6 to 7 feet tall and have open and close hatches, can be challenging and risky to personnel's safety. Traditionally, processors have used manual and mechanical means to load mixers, but more and more facilities are turning to vacuum conveying systems. Along with transferring material into mixers, these conveying systems help to rein in fugitive dust, eliminate hours of laborious sanitation protocol, mitigate safety hazards, and combat rising material costs.

Vacuum conveying systems are fairly simple and consist of five basic parts: a pickup point where material enters into the conveying system; conveying tubing that transfers material between equipment; a vacuum receiver that's typically equipped with a filter, and therefore often referred to as a filter-receiver, which is an intermediate holding vessel for materials; a vacuum source that powers the system; and a control panel that tells the system how to operate. A vacuum conveying system and a vacuum receiver are shown in Figure 1.

Increased safety is one of the more common reasons processors seek vacuum conveying systems for material transportation, as manually handling materials is hazardous. Manually loading mixers typically requires operators to climb stairs to a mezzanine to load the materials. This arrangement presents fall, exertion, repetitive motion, and awkward position hazards. In addition, manually loading bulk solids and powders into a vessel creates a dust cloud that can be hazardous, get into operators' breathing zones, and settle on nearby equipment.

Comparing mechanical and vacuum conveying

Although there are still many processors that opt for manual ingredient transfer into mixers, some use mechanical conveyors as a remedy for the associated hazards. Dollar-for-dollar, mechanical conveyors are less expensive to operate than vacuum conveyors because they only require a power source, unlike vacuum conveyors that need a power source and an air source.

FIGURE 1

A vacuum conveying system (left) minimizes manual lifting, stairclimbing, and dumping material into mixers, and includes a vacuum receiver (right), which acts as an intermediate holding vessel for materials.

The main differentiator between mechanical and pneumatic conveying is that mechanical conveying, which includes conveyor belts, horizontal-motion conveyors, aeromechanical conveyors, flexible screw conveyors, and bucket elevators, uses a mechanical device that's in direct contact with the transferred material. A pneumatic conveying system, which includes pickup points, conveying lines, vacuum receivers, and system controls, uses gas (usually air) to transfer suspended material through tubes.

Secondly, mechanical conveyors typically operate in one plane, whereas pneumatic conveyors can accommodate changes in direction and elevation if needed. While minimizing changes in direction is desirable no matter what system you're using, a pneumatic conveyor can be designed to convey materials in the X, Y, and Z axes without transfer points or additional motors and controls.

While mechanical conveyors have lower operating costs than vacuum conveyors, mechanical conveyors have much higher maintenance costs than vacuum conveyors because mechanical conveyors have several moving parts, bearings, and drives that need regular maintenance, making them more susceptible to unscheduled downtime. Mechanical conveying is sometimes more suited for specific applications, such as coal and limestone, and routinely has lower capital costs. However, the equipment life and associated costs typically offset any difference. Pneumatic conveying's lack of moving parts makes it very popular within high-purity industries like food and pharmaceuticals due to the conveying system's ability to prevent material contamination. Also, the NFPA recommends vacuum conveying for moving combustible dusts because if the system were to leak, it would do so inward and not outward into the plant.

Reclaiming materials

Another use for vacuum conveying systems that's becoming more common is using them to reclaim materials from dust collectors for reuse. When one thinks of dust collection, the assumed idea is to capture fugitive dust and debris as a waste product. However, ancillary equipment and innovative system engineering turns the task of straightforward dust collection into fully integrated systems designed to reclaim expensive ingredients and preserve quality formulations. Broadly used throughout the powder and bulk solids industry, especially where manual powder handling occurs, dust collection systems improve air quality, increase worker safety, protect equipment from dusts that can hinder operation, and reduce labor cost associated with housekeeping.

In an ongoing effort to amplify safety and get ahead of rising raw materials costs, a major paint manufacturer needed to solve a dust issue occurring during the mixing process where operators manually add multiple fine powders to liquids to produce latex-, oil-, or water-based liquid paint. The paint producer was handling approximately 3,000 pounds of powder per batch through a combination of bulk bags and 50-pound bags. The dust collector was discharging the dust into 55-gallon drums, which operators would then have to manually bring back to the mix tanks. This project's purpose was to better control the dust and return the captured dust to the material handling process.

In the paint industry, approximately 50 percent of costs are from raw materials. The paint producer in this example wanted to account for that material — not just to control costs but also to preserve product quality by ensuring all formulation weights made it into the process.

There are several powders — mostly fine powders — that make up a paint's formulation and one of the most challenging is titanium dioxide, which has a reputation of sticking, bridging, plugging, clogging, and ratholing. Without an optimized vacuum conveying system incorporated into the paint-mixing process, the dust collection system that was already in place was susceptible to experiencing backups.

A vacuum conveying system was installed into the paint manufacturer's process. The vacuum conveying system for this application was able to collect up to 200 pounds of dust per hour, which is on the low end for pneumatic transfer systems but was considered a higher-volume system since it was just transferring collected airborne dust. As part of the system, the dust collector outlet included a rotary airlock that discharged dust into a pickup point of the vacuum conveyor system. The discharged material was then sucked into the conveying line through a flexible hose to a compact vacuum receiver that discharged the material back into the mix tanks.

The conveying system included a compact vacuum receiver with a single cartridge filter that was able to fit into the limited headroom directly above the mix tanks. The transitions from the vacuum receiver back into the tanks were customized for the process. The conveying system used a compact regenerative blower with a low-horsepower motor that was easily incorporated into the existing system. Now the paint manufacturer is able to reclaim expensive materials while eliminating potentially dangerous physical labor and a respiratory hazard that had previously required operators to wear masks.

Maintaining sanitation

Vacuum conveying is by far the most hygienic conveying method for dry bulk powders and solids. The inherent nature of a fully enclosed vacuum conveying system prevents loose powder and dust from becoming airborne, creating an all-around cleaner and safer environment. The vacuum conveyor's enclosed nature also assists in compliance with the FDA's Food Safety Management standards by preventing both intentional and unintentional food contamination events.

When production throughput demands a high cleanliness level but using minimal labor and time, *clean-in-place* (CIP) equipment can eliminate hours of downtime. Cleaning downtime can be devastating to a company — sometimes taking 1 to 2 days to tear equipment down and clean it. CIP is a procedure designed to clean all or parts of a process system without needing to completely disassemble or move equipment. CIP is the strategic placement of spray balls or nozzles within a vessel that circulate water and cleaning solutions. This procedure is automatic and has consistent performance.

Although CIP has been around for a while, it's still a leading-edge technology that's gaining traction in the food, pharmaceutical, nutraceutical, and cosmetics industries — so much so that the acronym is being used like a verb these days with customers saying they need "CIPable equipment." In CIP vacuum conveying systems, operators remove filter elements and replace them with insertable spray ball assemblies for cleaning, saving on downtime and making the task safer for workers. Good sanitary vacuum conveyor design includes a package of simulated spray ball positioning and surface coverage documentation to ensure the nozzle's spray pattern reaches all parts of the equipment's interior surface.

For example, when a nutraceutical beverage producer landed a large contract, it needed to increase throughput and reduce the 8-hour cleaning cycle that occurred between batches in order to meet demand. To achieve this, the beverage producer replaced its 90-cubic-foot mixer with a 160-cubic-foot CIP mixer and added a vacuum conveying system equipped with a CIP vacuum receiver and CIP bag-dump station. The larger mixer replacement allowed the company to increase its material mixing capacity, and the CIP equipment reduced sanitation time from 8 to 1.75 hours, giving the company an additional 6.25 hours of production time and reduced labor costs every day. The CIP system also averted the need to develop a confined-space plan with the new larger equipment since the sanitation team didn't need to enter the process vessel for cleaning.

FIGURE 2

A vacuum conveyor mounted on a column lift device features an electric lift mechanism controlled via a remote device to easily raise and lower the vacuum receiver above process equipment.

Designing conveyors for safety

Because increased safety is a major factor in companies investing in vacuum conveying systems, vacuum conveyor manufacturers are engineering innovative systems with safety in mind. Even with the most sophisticated vacuum conveying systems, equipment that's located out of reach still poses hazards for operators who need to clean or service the vacuum conveying equipment that's permanently installed above process machinery.

Vacuum conveyors mounted on a column lift device and mobile vacuum conveyors are complete conveying systems that raise and lower vacuum receivers in order to load mixers, reactors, and other process equipment and also bring the vacuum receivers back down to ground level for cleaning or sanitizing.

A vacuum conveyor mounted on a column lift device, as shown in Figure 2, uses an electric lift mechanism with a remote device, controlled by an operator standing a safe distance away, to raise and lower a vacuum receiver above mixers, blenders, reactors, and other process vessels with fill ports 15 feet or more above the floor. This conveying system that's on a col-

FIGURE 3

A mobile vacuum conveying system can service mixers and other process equipment by allowing for varied discharge heights, discharge rates, mobility between process equipment, and easy floor-level cleaning.

umn lift device, with top and bottom anchors, is able to load side-by-side process vessels from paper bags, drums, intermediate bulk containers, boxes, bulk bags, silos, storage containers, and feed bins.

A mobile vacuum conveying system, as shown in Figure 3, operates in the same fashion as a vacuum conveyor mounted on a column lift device but is movable with one operator and is able to service multiple process vessels at varying discharge heights. When not in use, operators can roll the mobile vacuum conveying system from the work area to save on floor space.

These two conveyor types are compatible with OSHA's Walking-Working Surfaces standard to protect against falls and slips and back injuries from repetitively carrying bags and boxes upstairs to load or clean equipment. The ability of operators to bring equipment down to floor level for cleaning reduces downtime, labor costs, and potential injury costs. And when constructed within the FDA's Food Safety Modernization Act sanitation regulations, the vacuum conveyor mounted on a column lift device and mobile vacuum conveying system are ideal for food, nutraceutical, and pharmaceutical applications. **PBE**

For further reading

Find more information on this topic in articles listed under "Pneumatic conveying" and "Safety" in the article archive on *PBE*'s website, www.powderbulk.com.

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