Using aeromechanical conveyors for difficult-to-handle materials

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An aeromechanical conveyor combines the simplicity and energy efficiency of common mechanical conveying methods with the capacity and effectiveness of a pneumatic conveying system. This article describes how the aeromechanical conveyor works and explains why this conveyor type can be a good choice for conveying difficult materials.

Aeromechanical conveyors are sometimes overlooked but can be an excellent equipment choice for batch conveying difficult-to-handle bulk solid materials with particle sizes up to around ⅝ inch. Aeromechanical conveying addresses many of the problems associated with pneumatic conveying systems and mechanical conveyors, such as flexible screw conveyors, tubular drag conveyors, or bucket elevators. While each application is different and has its own unique challenges, if you're handling a material that's typically considered difficult to convey, the aeromechanical conveyor is a proven solution that's simple to operate, easy to maintain, and may be a good fit for your plant.

Difficult-to-handle materials

A difficult-to-handle material has inherent properties that make the material abrasive, dusty, or prone to caking, packing, or smearing. Abrasiveness can cause excess wear to conveying equipment, requiring frequent maintenance and changeout of worn components. Dust generation can increase plant housekeeping requirements, create a health hazard for workers, and may present a dust explosion risk. Caking, packing, and smearing are usually caused by binding between the material's particles and can impede or block material flow through a conveyor, requiring downtime to clear the blockage and restore flow.

Difficult materials come in a range of particle sizes and shapes, including powders, granules, pellets, and flakes. Some common examples include:

Titanium dioxide (TiO_2). Widely used as a pigment, titanium dioxide's small particle size causes the material to cake and pack. In addition, titanium dioxide particles readily deposit or smear onto conveyor surfaces.

Carbon black. Carbon black is another fine particle pigment material with handling characteristics similar to titanium dioxide.

Cement powder. Cement powder is very fine, highly abrasive, and easily forms cohesive bridges, which impede flow. Cement powder also tends to create dust, which can be highly irritating and hazardous to workers.

Calcium carbonate ($CaCO_3$). Commonly known as limestone, limestone flour, or chalk, calcium carbonate is a fine powder that readily cakes and packs.

Tin oxide (SnO). Used in electronic ceramics and as a glazing opacifier, tin oxide is highly abrasive, resists flow, and tends to smear and bridge easily.

Aeromechanical conveyor basics

The aeromechanical conveyor's design and operating principle allow the conveyor to overcome many of the challenges associated with conveying difficult materials. A basic aeromechanical conveyor, as shown in Figure 1, consists of a feed housing with a material inlet, a conveying tube with two parallel legs (a conveying leg and a return leg), a discharge housing with a material discharge chute, and a drive motor. A continuous-loop wire rope with disks mounted to it at evenly spaced intervals, as shown in Figure 2, runs through the conveying tube and housings, and each housing has a sprocket inside to guide the wire rope.

The drive motor is typically mounted at the conveyor's feed end on conveyors up to around 20 feet long and at the discharge end on longer conveyors. The conveying tube is typically 3, 4, or 5 inches in diameter, and the tube, housings, and wire rope are made of carbon steel or stainless steel depending on the application. The disks are generally made of nylon or polyurethane, and the disk spacing along the rope (called the *pitch*) varies depending on the conveying tube diameter. The disks are sized to maintain a small (commonly around ¼-inch) gap between the disk edge and the conveying tube wall.

In operation, the drive motor turns the drive sprocket, causing the rope assembly to move rapidly through the conveying tube and generating a high-speed airstream inside the conveyor. Material is fed into the material inlet and drawn into the conveying tube by the high-speed airstream. The material becomes aerated and fluidized as it enters the conveying tube and is carried in the airstream to the discharge housing, where it's discharged through the discharge chute by centrifugal force into a vessel or downstream process.

Figure 1

Basic aeromechanical conveyor

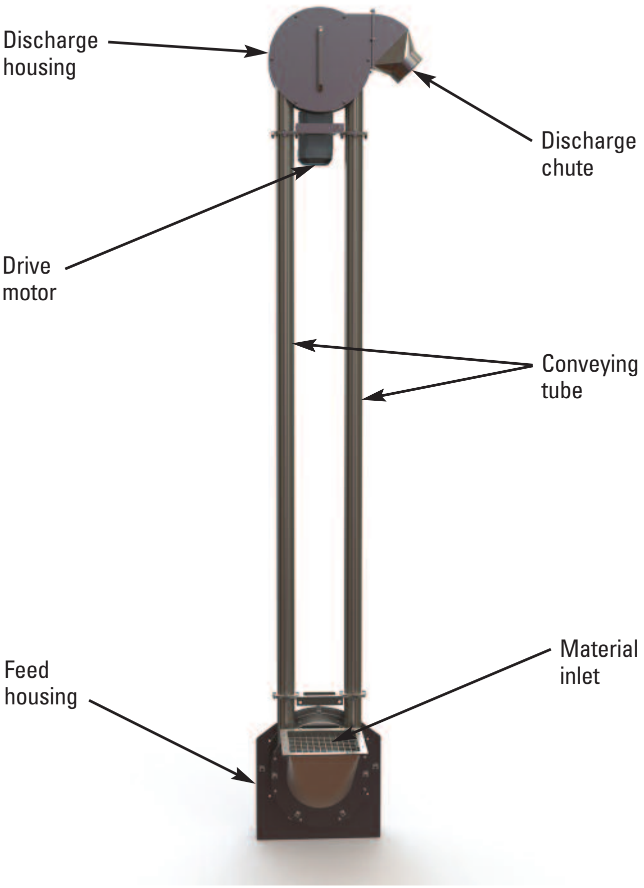
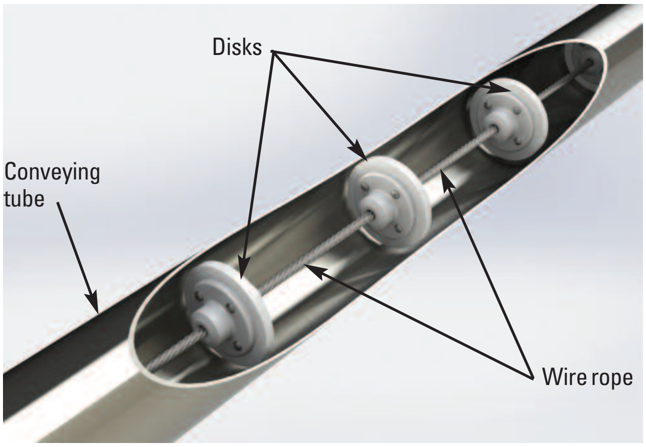


Figure 2

Aeromechanical conveyor wire rope assembly



Benefits of aeromechanical conveyors for conveying difficult materials

Fluidization. The aeromechanical conveyor avoids many of the problems associated with conveying difficult materials because the high-speed airstream fluidizes and carries the material through the conveying tube. The material "rides" through the conveying tube quickly, making little contact with the tube wall and discharging completely during operation. This greatly reduces the likelihood of caking, packing, or smearing and prevents material deposits or buildup inside the conveying tube and housings.

Reduced material buildup and complete material discharge minimizes material waste and means that the aeromechanical conveyor is typically easier and faster to clean than mechanical conveyors. The gentle conveying action also reduces abrasion and particle degradation. Flexible screw conveyors and tubular drag conveyors use mechanical means to push material through the conveying tube, resulting in grinding or rubbing action between the conveying tube and the material. In abrasive applications, this grinding can accelerate wear to the equipment.

A dilute-phase pneumatic conveying system also fluidizes the material in the airstream, but the conveying velocity is generally much higher than in an aeromechanical conveying system, increasing the likelihood of particle degradation when conveying friable materials. A pneumatic conveying system also requires an air mover to generate the airstream and an air-material separator to remove the material from the airstream at the destination, which generally makes a pneumatic system more expensive to purchase and operate than an aeromechanical conveying system. The aeromechanical conveying system also prevents blend segregation during conveying better than a pneumatic system and can more easily accommodate multiple material inlets and outlets.

Efficiency and capacity. Aeromechanical conveyors are generally more energy efficient than other conveyor types and capable of higher material throughput rates compared to similarly sized mechanical conveyors. Throughput rates are a function of the conveying tube diameter and rope assembly speed, which is typically between around 600 and 1,150 fpm, depending on the conveyor manufacturer, the conveying tube diameter, and the application. Table I shows typical aeromechanical conveyor throughput rates for common difficult-to-handle materials.

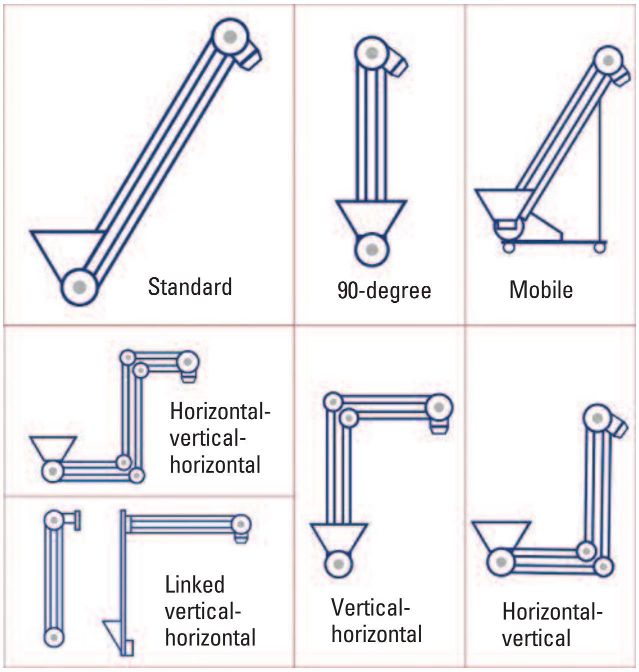
Table I

Typical aeromechanical conveyor throughput rates for common difficult-to-convey materials

Material	Bulk density (pounds per cubic foot)	Throughput rate (pounds per minute)		
		3-inch	4-inch	5-inch
Adipic acid $[C_6H_{10}O_4]$	39	244	495	787
Calcium carbonate $[CaCO_3]$	50	310	630	1,000
Carbon black	35	213	433	687
Cement powder	60	371	756	1,200
Lime powder	42	263	535	850
Rubber crumb	45	282	575	912
Sulphur	100	623	1,268	2,010
Talc $[Mg_3Si_4O_{10}(OH)_2]$	38	232	472	750
Tin oxide [SnO]	220	1,363	2,772	4,400
Titanium dioxide $[TiO_2]$	40	283	575	912

Figure 3

Aeromechanical conveyor configurations



Dust containment. Material is fully contained in the conveying tube, preventing fugitive dust from escaping into the workspace. To prevent dust escaping at the material inlet and discharge, flexible ducting can be used to connect the conveyor inlet to upstream feeding equipment and the conveyor discharge chute to the downstream vessel or process. For applications where the conveyor is fed via a bag dump station, a dust collection hood is typically installed to contain fugitive dust.

Configuration flexibility. Aeromechanical conveyors are available in various configurations, as shown in Figure 3, enabling the conveyor to transfer material at any angle from horizontal to vertical or at multiple angles using an additional sprocket and housing where the conveying angle changes. For long conveying distances (generally greater than around 60 feet), multiple conveyors can be arranged in a series.

No conveyor can move material that doesn't flow into it, and difficult-to-handle materials often experience difficulty flowing into conveyor inlets. The aeromechanical conveyor can overcome this problem by using a steep-walled infeed hopper that encourages material flow along the hopper walls and prevents bridging and ratholing. Many suppliers also offer optional vibratory flow-aid devices that can be installed on the feed hopper to promote flow. These features may be important options to consider when using an aeromechanical conveyor to move cement powder or other materials that tend to bridge hopper openings. **PBE**

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