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How to select and maintain an aeromechanical conveyor

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An aeromechanical conveyor can be a cost-effective solution for conveying applications that handle difficult-to-flow materials, require dust-free conveying at various conveying angles, or move material from multiple inlets or to multiple outlets. This article explains how the aeromechanical conveyor works, how to select this conveyor for your application, and how to maintain the conveyor. A sidebar gives a quick rundown of the aeromechanical conveyor's pros and cons to help you determine if the conveyor is right for your application.

An aeromechanical conveyor (also called a *rope-and-disc conveyor, hockey-puck conveyor,* or *aero conveyor*) provides enclosed, gentle, high-capacity conveying of dry bulk materials with an average particle size up to ⅝ inch, including powders, granules, pellets, flakes, and chips. Inside the conveyor's tubular housing, discs are attached at regular intervals to a continuous rope. A constant-speed electric drive moves the rope quickly through the tube, creating a conveying action that draws material into the slipstream behind each disc, much like dust is drawn into the slipstream behind a fast-moving car.

This aeromechanical conveying action fluidizes the material in a recirculating airstream, mimicking the fluidization provided by dilute-phase pneumatic conveying but without that method's high velocity. This gives the aeromechanical conveyor two major advantages for handling difficult materials: Its fluidizing action allows conveying of even notoriously cohesive materials like titanium dioxide, and its gentle, lower-velocity handling provides low shear, greatly reducing degradation of friable and other fragile materials.

Another advantage of the aeromechanical conveyor is its layout flexibility. The conveyor can move material vertically, horizontally, or at various angles from 0 to 90 degrees without losing capacity. It can turn corners around obstacles and can be configured with multiple inlets and outlets. Depending on the manufacturer and the application, the conveyor's maximum single-run conveying distance can be 60 or more feet. Two of the conveyors can also be linked end-to-end to span greater distances.

The aeromechanical conveyor is typically operated in batch mode because of its ability to provide total material transfer from the inlet to the outlet. Depending on the application, the conveyor can transfer materials at up to 120 tph.

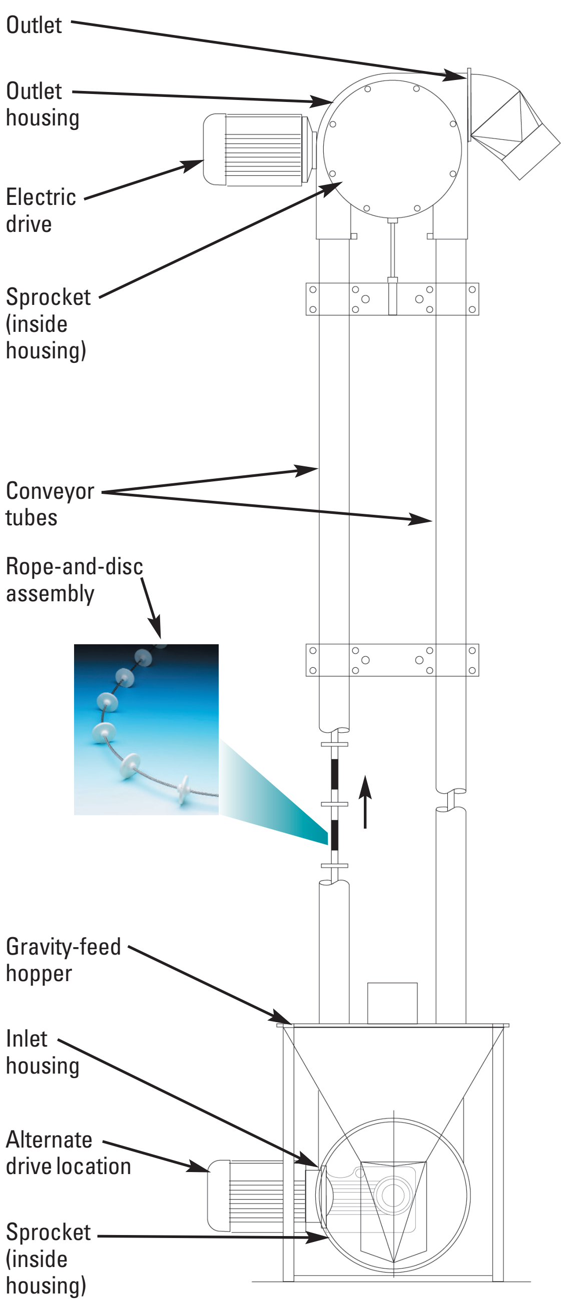
How the aeromechanical conveyor works

The aeromechanical conveyor's major components, as shown in Figure 1, are the conveyor housing (a pair of conveyor tubes), rope-and-disc assembly, electric drive, inlet housing (located at the conveyor's bottom and including a gravity-feed hopper), and outlet housing (at the top). The conveyor tubes completely enclose the rope-and-disc assembly, which is wrapped around sprockets at each end of the conveyor within the inlet and outlet housings. The typical rope-and-disc assembly includes rope constructed from stainless steel strands and plastic discs that are mounted on the rope at regular intervals, as shown in the inset in Figure 1. For a conveyor up to 20 feet long, the drive is usually mounted at the inlet housing; for a longer conveyor, the drive is normally mounted at the outlet housing. The inlet hopper is often equipped with a baffle that restricts the hopper outlet to prevent overfeeding and promote stream feeding — that is, feeding at a constant, controlled rate — into the conveyor.

Operation. A batch of material is stream-fed by gravity from the hopper through the inlet housing as the drive rotates the inlet or outlet sprocket at high speed. The rotating sprocket draws the rope-and-disc assembly around both sprockets and through the conveyor tubes, and the material from the inlet is gently picked up by the slipstream behind the fast-moving discs. Stream feeding allows the slipstream to easily entrain the material, preventing it from caking or forming plugs in the conveyor. The moving rope-and-disc assembly moves the fluidized material toward the outlet housing, where the material is ejected and centrifugally separated from the airstream without requiring the use of additional material-air separation or filtration equipment.

Figure 1

Typical aeromechanical conveyor



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More about the conveying speed and solids-to-air ratio. The rope-and-disc assembly moves at about one-quarter of the air speed of a dilute-phase pneumatic conveyor, but much faster than the operating speed of most mechanical conveyors (including the low-speed drag-link conveyor, which has a similar appearance to the aeromechanical conveyor but operates at much lower speed). When the aeromechanical conveyor is operating at full speed — typically from about 702 to 1,175 fpm — the solids-to-air ratio in the conveyor is about 15 percent solids to 85 percent air. Full-speed operation is ideal for conveying dense and difficult-to-fluidize materials without problems. Half-speed operation — typically from about 351 to 587 fpm — changes the solids-to-air ratio to about 30 percent solids to 70 percent air and works well for fine, easily fluidized materials.

How to choose an aeromechanical conveyor

To select an aeromechanical conveyor that will reliably transfer your material, you need to carefully assess your material characteristics and application requirements and then discuss these with the conveyor manufacturer. Before the selection process begins, the manufacturer will typically ask you to fill out an application data sheet to provide details about your material's characteristics, your conveying requirements (such as conveying rate and distance), and your plant conditions (such as layout constraints). The manufacturer can determine whether your material is suitable for aeromechanical conveying by checking information in a database of suitable applications for the conveyor or by testing your material in equipment in the manufacturer's test lab. Testing typically involves conveying a sample of your material in a pilot- or production-scale aeromechanical conveyor under conditions that simulate those in your plant.

The information you provide about your application, the manufacturer's experience with applications like yours, and the conveying test results (if any) will help the manufacturer recommend an aeromechanical conveyor with a custom-designed configuration and appropriate components for your application.

Conveyor configurations. Up to two sets of corner housings with sprockets, as shown in Figure 2, can be added to allow the conveyor to turn corners and provide a horizontal-vertical-horizontal conveying path. Other configurations are also possible, as shown in Figure 3, and can be designed to match your application requirements. For instance, the conveyor can be mounted on a mobile support frame with wheels (Figure 3e) so the conveyor can be moved to various plant locations. Two conveyors can be linked, with the outlet of one discharging into the inlet of the other (Figure 3f). The conveyor inlet housing can be mounted under a bulk bag discharger, or the conveyor outlet housing can be mounted on a bulk bag filler.

Additional inlets can be mounted at intervals on the conveyor tubes for batching applications in which different ingredients will be fed into the conveyor. Each tube-mounted inlet typically has a slide-gate valve to provide stream feeding. Additional outlets with slide-gate valves can be installed along the tubes to provide intermediate discharge points to multiple destinations. (If the conveyor has only one tube-mounted outlet, the outlet doesn't require a slide-gate valve.) A horizontal aeromechanical conveyor with a tube-mounted inlet and tube-mounted outlets for distribution to multiple destinations is shown in Figure 3d.

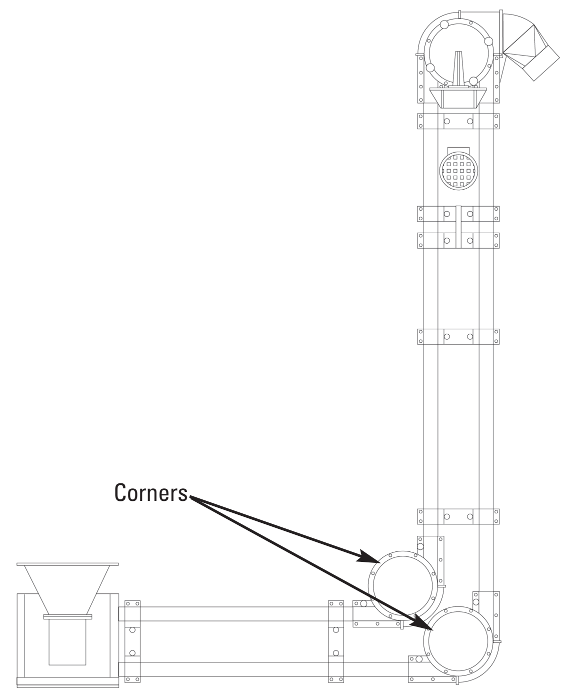
Component options. Options for aeromechanical conveyor components vary with the conveyor manufacturer. Many of these options are for the inlet housing and hopper, including large-capacity hoppers, hopper level indicators, hopper flow aids, dust hoods, bag-dump stations, and inlet valves and metering feeders. Another option, static bonding, applies to the entire conveyor.

Large-capacity hoppers: A large-capacity hopper can be fitted to the inlet housing for a high-capacity conveying application. Such a hopper requires a volumetric or gravimetric metering feeder (discussed later in this section).

Hopper level indicators: For batch applications, a hopper level indicator can be installed on the hopper to sense when the last material in the hopper has been fed into the conveyor. The level indicator is linked to the conveyor control system — typically a PLC — which uses the information from the level indicator to run the conveyor for an appropriate time interval after the last material has been fed, ensuring that the conveyor has conveyed and discharged all material in the batch. This avoids having to restart the conveyor with material in it, which can damage the rope-and-disc assembly.

Figure 2

Conveyor with corners



Hopper flow aids: A flow aid, which can be a vibration pad or fluidization membrane, depending on the manufacturer, can be mounted on the hopper to help prevent a cohesive or other difficult-to-flow material from bridging, caking, or ratholing in the hopper and to promote its flow into the inlet.

Dust hoods: A dust hood that draws dust-laden air into your plant's dust control system can be installed over the hopper to contain dust during feeding. The dust hood, which is custom-fitted to your dust control equipment, is typically equipped with a grate to keep foreign materials, such as empty bags, from dropping into the hopper.

Bag-dump stations: Installing a bag-dump station at the hopper can simplify feeding of material from small bags into the conveyor. To make the operator's job easier, the station usually includes a bag-breaking device and sometimes a bag-disposal mechanism. The bag-dump station can be used with or without a dust hood.

Inlet valves and metering feeders: In many applications, a rotary, butterfly, or other type of inlet valve is installed at the conveyor inlet to regulate the material feedrate and provide stream feeding from the hopper into the conveyor. But if the conveyor has a large-capacity hopper or requires an extremely accurate material feedrate, a volumetric metering feeder (such as a rotary valve or flexible screw feeder)

Figure 3

Conveyor configurations

a. Horizontal-vertical-horizontal

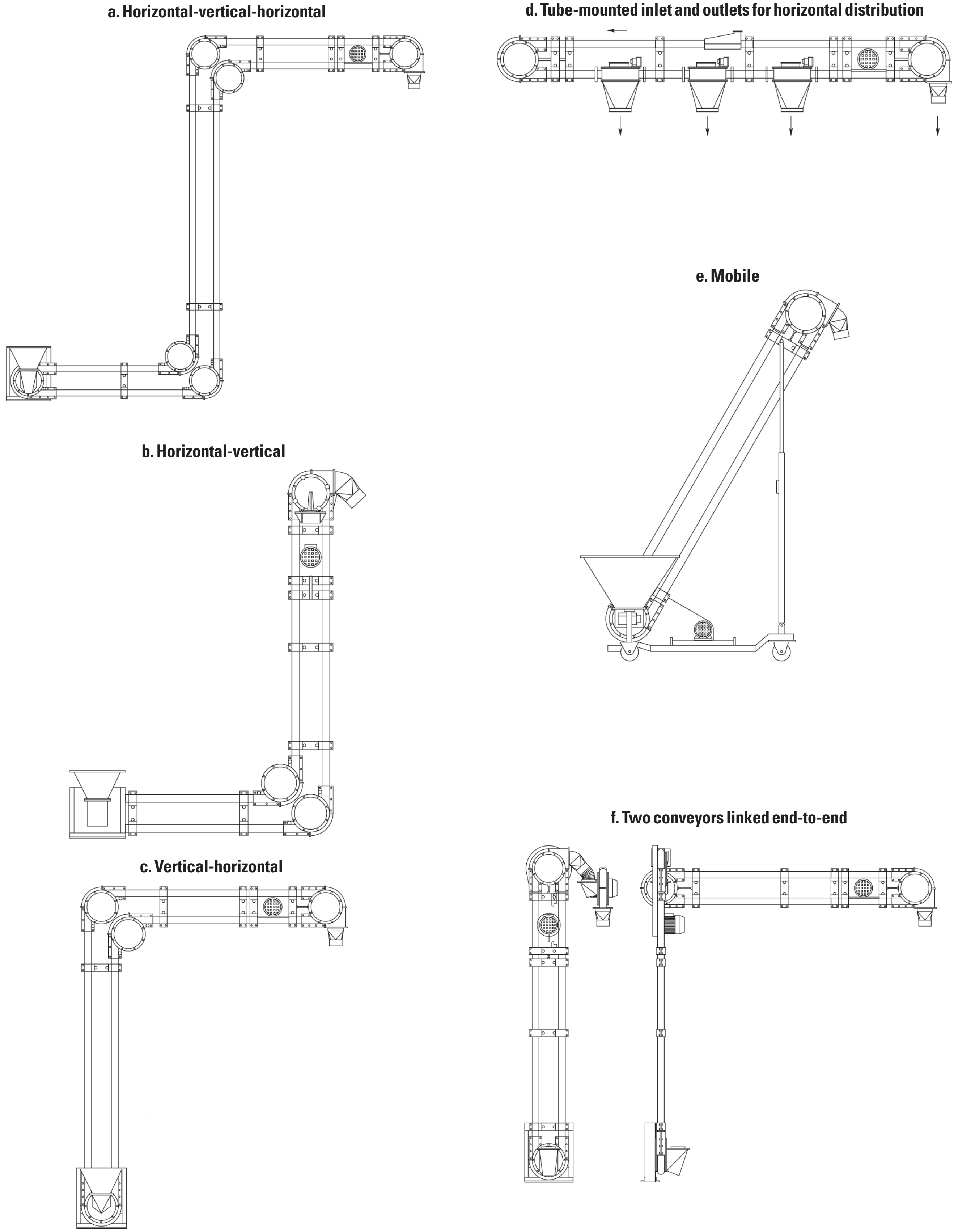
b. Horizontal-vertical

c. Vertical-horizontal

d. Tube-mounted inlet and outlets for horizontal distribution

e. Mobile

f. Two conveyors linked end-to-end



Is it right for your application?

Aeromechanical conveyor pros and cons

Are you weighing the trade-offs between the aeromechanical conveyor and other conveyors? This quick rundown of aeromechanical conveyor pros and cons can help you decide whether to consider this conveyor for your application.

Pros

The aeromechanical conveyor:

- Fluidizes material in a moving current of air, which allows the smooth transfer of cohesive and other difficult-to-flow materials and gentle handling of friable and other fragile materials.
- Provides enclosed, dust-free transfer of the total batch, with no material loss.
- Cost-effectively conveys materials at high capacity — up to 120 tph, depending on the application.
- Conveys material 60 or more feet vertically, horizontally, and at any angle without losing capacity.
- Can be configured in various layouts, such as with corners to bend around obstacles and with multiple inlets and outlets, and can be linked with another conveyor.
- Requires no cyclone or filtration equipment at the outlet to separate the material from the air, eliminating the initial and operating costs of such equipment and preventing any environmental contamination from filtration problems.

Cons

The aeromechanical conveyor:

- Requires — unless the conveyor is fitted with an automatic rope-tensioning system — a moderate to high level of maintenance, primarily for rope-tensioning, depending on the amount of time the conveyor runs and the material it conveys.
- Can have a reduced rope service life, depending on the conveyor run time and the number of starts and stops, the conveyed material, the conveyor length, the solids-to-air ratio, and the frequency of routine rope inspection and tensioning.
- Can be difficult to clean because of the rope's multiple-strand construction, which can make it unsuitable for an application with frequent material changes and in which no cross-contamination between batches can be tolerated.
- Isn't suitable for handling dense, highly abrasive materials such as rocks or materials consisting of long fibers.

—D.Hesketh

or gravimetric metering feeder (such as a loss-in-weight feeder) can be installed at the inlet. Using a metering feeder also eliminates the need for a baffle in the hopper.

Static bonding: Static bonding is a safety feature that prevents static electricity buildup in the conveyor. This requires interconnecting the conveyor's metal parts to form a single circuit that can be safely grounded.

How to maintain your aeromechanical conveyor

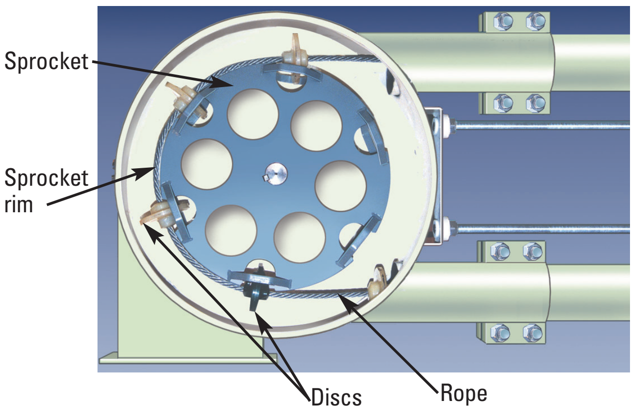
When the aeromechanical conveyor is installed in your plant, you'll receive an operations and maintenance manual from the manufacturer that provides comprehensive instructions for running and servicing the conveyor. All conveyor operators and maintenance workers need to understand and implement these instructions to ensure that the conveyor performs as it should over the long term. Regularly scheduled preventive maintenance should include lubricating the gearbox on the drive, inspecting the conveyor's moving parts, maintaining proper tension of the rope-and-disc assembly, and cleaning the conveyor. The latter two are particularly important for keeping your aeromechanical conveyor in good shape.

The amount of rope stretch is affected by such factors as the conveyor run time, start and stop frequency, the conveyor length, your material's characteristics, and the solids-to-air ratio.

Maintaining proper rope tension. The rope is initially tensioned to preload it with enough force to keep it in contact with the sprockets and to ensure that the discs mesh with the pockets in each sprocket rim, as shown in Figure 4. Incorrect rope tension — either too much or too little — can prematurely wear the conveyor parts. For instance, the discs on a loosely tensioned rope can hit the housing and become damaged. The rope tension tends to loosen as the

Figure 4

Rope in contact with sprocket and discs meshing with pockets in sprocket rim



rope stretches over time. The amount of rope stretch is affected by such factors as the conveyor run time, start and stop frequency, the conveyor length, your material's characteristics, and the solids-to-air ratio. Without regular inspection and tensioning, the rope can wear and break prematurely, resulting in unplanned downtime for replacing the entire rope-and-disc assembly or sections of it.

Properly tensioning the rope will ensure that the rope-and-disc assembly has a longer service life. Your operations and maintenance manual will include detailed instructions for tensioning the rope at proper time intervals. The conventional manual method for adjusting the rope tension typically requires a maintenance worker to check the rope tension at 1-, 4-, 8-, and 50-hour intervals after the conveyor is initially started, and then after every 100 hours of operation or as needed. Manually checking the rope tension is a multistep process: emptying and stopping the conveyor; opening the inlet (bottom) sprocket access door; examining the inlet sprocket to see if the rope is contacting the sprocket rather than sagging from it; opening the outlet (top) sprocket access door; and checking the outlet sprocket for slippage between the rope and sprocket. If the rope is loose, the worker must tension it manually, typically by sliding the outlet sprocket (which is usually the rope-tensioning sprocket) housing along the conveyor tube to stretch the rope until the rope at the inlet sprocket fits snugly on that sprocket.

An alternative to manual tensioning is a recently developed automatic rope-tensioning system[1] that keeps the rope properly tensioned while requiring significantly less time and labor than the manual method. The automatic system includes a tensioning device (an electric or pneumatic linear actuator), a load cell that can be integrated into the conveyor's control system, and a position control device. The tensioning device is mounted parallel to and between the conveyor tubes near the outlet housing, the load cell is mounted between one conveyor tube and the tensioning device, and the position control device is linked to the tensioning device. Each time the aeromechanical conveyor is shut down, the load cell automatically measures the rope tension, and, when the tension requires adjusting, the tensioning device moves the outlet housing to a position where the rope reaches the correct tension. The position control device provides feedback about the tensioning device's location and can also be used to indicate when the rope is worn. The automatic system's reduction of rope-tensioning time and labor results in lower conveyor maintenance and operating costs.

Cleaning your conveyor. Periodically, you'll need to clean out material residue from the empty conveyor. Dry cleaning the conveyor with a vacuum cleaning system is suitable in some applications, but in most applications the conveyor must be washed using an integrated clean-in-place system with a suitable cleaning fluid, then dried by running the conveyor for a period while it's empty. The conveyor typically has multiple access panels and doors that allow workers to insert dry cleaning equipment or connect and drain a clean-in-place system. The rope's construction of multiple steel strands can make the rope difficult to clean, but this is typically only a concern when you must frequently change materials and avoid cross-contamination between batches; another type of conveyor can be better suited to such an application. **PBE**

Reference

1. Dynamic Automatic Rope-Tensioning (DART) system, available from Spiroflow Systems Inc., Monroe, N.C. (www.spiroflowsystems.com).

For further reading

Find more information on aeromechanical conveyors in articles listed under "Mechanical conveying" in *Powder and Bulk Engineering*'s comprehensive article index at www.powderbulk.com and in the December 2006 issue.

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