Tubular drag chain conveyors: How they work and how to select one

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A tubular drag chain conveyor can simplify your bulk solids handling life in several ways: It can convey materials at any angle and in any plane around equipment and other obstacles in your plant. The conveyor can handle friable and other delicate materials without particle degradation. The unit can be equipped with a range of specialized components to handle tough material characteristics and process requirements. Learn more in this article, which covers the tubular drag chain conveyor and how it works, application and component details, and selection tips.

The tubular drag chain conveyor (also called a *tubular drag link-chain conveyor* or *tubular drag conveyor*)[1] provides gentle, enclosed continuous transfer of bulk solid materials, including fine powders, granules, pellets, and moist sludges, at any angle, in any plane, and around any obstacle. How? The chain links in the conveyor's chain-and-disc conveying mechanism function like universal joints, enabling the conveyor to simultaneously move material in multiple directions and planes. The conveyor also has a low-profile, flexible design that allows it to fit into tight spaces around existing plant equipment.

Widely used in chemical, food, pharmaceutical, mineral, plastics, and other industries, the tubular drag chain conveyor can be equipped to handle highly abrasive or hot materials, meet sanitary requirements for transferring foods and pharmaceuticals, and safely convey potentially explosive materials — all at a much lower operating cost than that of a comparable pneumatic conveyor.

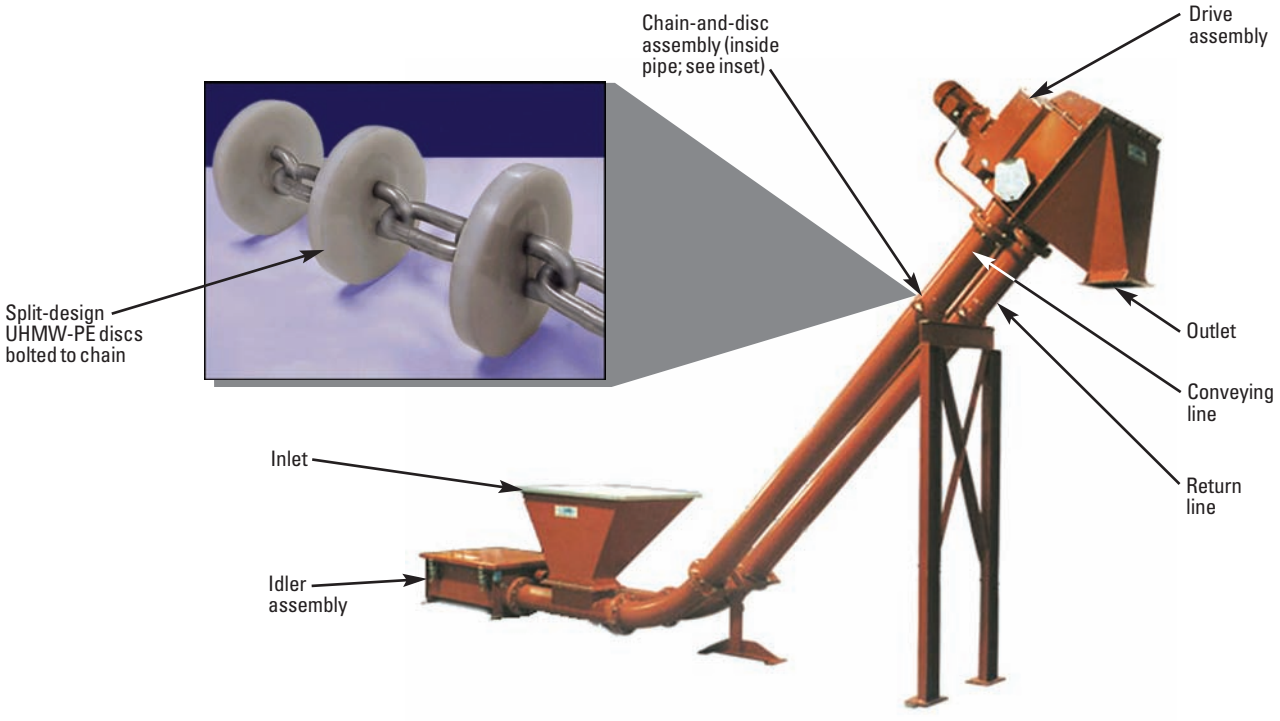
How the conveyor works

Components. The tubular drag chain conveyor consists of a tubular housing enclosing a continuous chain mounted with solid circular discs (or *flights*), often called a *chain-and-disc assembly,* as shown in Figure 1. The housing can include straight and curved sections constructed of carbon steel or stainless steel pipe with a typical nominal diameter of 2 to 12 inches. The housing forms conveying and return lines that can be arranged in multiple configurations, including complex loops with several turns, to suit the application layout.

A drive sprocket engages the chain-and-disc assembly at the turn at the conveying line's end. A shaft-mounted motor, often equipped with a variable-speed drive, powers the drive sprocket; the drive sprocket and motor form the *drive assembly*. An idler assembly (sometimes called an *idler station* or *tension station*) is located at the end of the conveyor's return line. The idler assembly consists of a housing enclosing an idler sprocket or other rotating mechanism and, in some cases, a chain-tensioning device. A conveyor with a complex loop arrangement can have a combination of several 90-degree turn assemblies (also called *turn stations*) and less-than-90-degree elbows, which allow the chain to turn and bend with minimal friction. Each turn assembly contains a sprocket or other rotating mechanism, which can be a powered or idler mechanism, as shown in Figure 2; the elbows don't require a rotating mechanism. Brushes or other devices can be located at the drive assembly and at various points inside the conveyor housing to clean material off the chain-and-disc assembly and prevent carryback in the return line.

Figure 1

Typical tubular drag chain conveyor



The conveyor can have one or multiple material inlets and outlets. When it has one inlet, the inlet is located near the idler assembly; additional inlets can be located along the conveying line. When the conveyor has one outlet, the outlet is located at the drive assembly; additional outlets can be located along the conveying line prior to this point.

Operation. In operation, material enters the inlet (or inlets) and, as the drive assembly pulls the chain through the housing, the material is picked up and conveyed in the spaces between the discs. The material is gently carried toward the outlet (or outlets), where it falls by gravity out of the conveyor. As the drive assembly turns, the chain moves continuously through the housing, around the drive assembly, along the return line, and through the idler assembly and any turn assemblies. The powered or idler turn assemblies assist the chain movement through the bends, which reduces frictional drag and the conveyor's power consumption. The close clearance between the discs and pipe walls prevents material from building up inside the conveyor.

Speed and capacity. When the conveyor is equipped with a variable-speed drive, the chain speed can typically be adjusted over a range from 4 to 88 fpm. This allows the conveyor to handle a range of materials at various capacities without degradation or segregation. The conveyor can also start under full load after shutdowns. Conveyor capacity typically ranges from 85 to 2,800 ft^3/h, depending on the material's bulk density and the conveyor's pipe diameter and chain speed.

Figure 2

Turn assembly (idler type)

Configurations. One tubular drag chain conveyor can typically move material up to 180 feet horizontally and up to 120 feet vertically. Several conveyors can be arranged in series to provide longer horizontal and vertical conveying distances. Multiple conveyors are also commonly used to move materials from different sources, such as storage vessels, bulk bags, and manual bag dump stations, to one destination, as shown in Figure 3. Most tubular drag chain conveyors have modular construction with interchangeable components, allowing the conveyor to be expanded or modified to handle changing production requirements.

Power consumption. The tubular drag chain conveyor consumes relatively little electrical power because it typically uses one low-horsepower motor and doesn't require ancillary equipment such as a filter-receiver and rotary valves, as a pneumatic conveyor does. [***Editor's note:*** Find more information in the sidebar, "Comparing operating costs: Tubular drag chain conveying versus pneumatic conveying."]

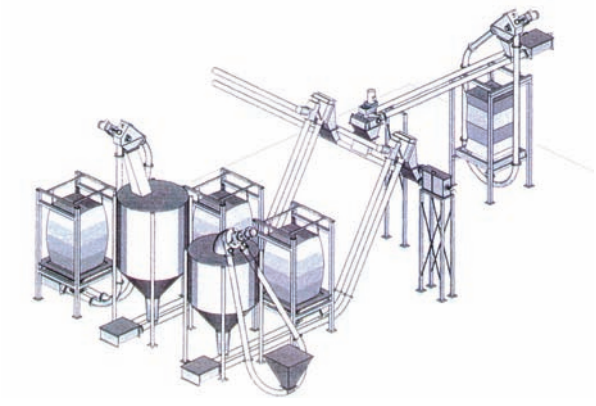
Application details

The tubular drag chain conveyor's gentle handling makes it ideal for moving friable and other delicate materials without degradation and for transferring blended materials with minimal segregation. When properly equipped, the conveyor can handle highly abrasive or hot materials and safely transfer foods and other sanitary materials. The enclosed conveyor reliably contains dusty and hazardous materials. The enclosed design also enables the conveyor to resist internal pressure buildup caused by explosions and to contain propagating flame, making the conveyor suitable for handling potentially explosive materials.

The tubular drag chain conveyor isn't suitable for handling a material containing rocks larger than 1½ inches in a vertical conveying arrangement or in a configuration with multiple turns.

Figure 3

Multiple conveyors transferring materials from several sources to one destination



More about the components

Chain. The chain can be constructed of carbon steel or stainless steel. Several chain designs are available to suit various material characteristics and operating requirements. Individual links in the chain function like universal joints, allowing the chain-and-disc assembly and the material it conveys to bend and move through multiple directions and planes.

Discs. The discs are mounted at regular intervals along the chain by various methods and can be made of ultrahigh molecular-weight polyethylene (UHMW-PE), polyurethane, cast iron, or other materials to suit the application. The disc design can also be adapted to the application. For instance, some discs have a cost-saving split design with two semicircular halves, allowing maintenance workers to replace only the bottom (material-contact) half when the discs are worn. UHMW-PE discs for food-grade applications can be molded to stainless steel chain to form an integral part of the chain. Other discs are available in oversize diameters or with squeegee-type edges to promote full cleanout of sticky materials from the conveyor.

Chain-tensioning mechanism. The conveyor is equipped with some type of chain-tensioning mechanism to take up slack in the chain and adjust for tension changes caused by

A tubular drag chain conveyor, here for transferring material from a truck trailer to a storage silo, provides gentle, enclosed conveying for a range of bulk solids applications.

Comparing operating costs:

Tubular drag chain conveying versus pneumatic conveying

Tubular drag chain conveyors and pneumatic conveyors are often considered for the same applications because they both offer enclosed conveying, can cover short and long distances in a variety of layouts, and can be custom-designed to handle material and process requirements. But they differ in one major respect: annual operating costs.

Each conveyor's annual average operating cost is based on the costs of the conveyor's electrical power consumption and required maintenance.

The following example shows the difference in power consumed by a tubular drag chain conveyor and a pressure dilute-phase pneumatic conveyor in the same application, with identical conveying distances and paths, as shown in Figures A and B. Both conveyors transfer wheat flour with a 75-micron average particle size and a 40-lb/ft^3 bulk density from a screener to a storage silo at an 80,000-lb/h capacity. The conveyors operate 24 hours a day, 340 days a year, and the electrical power cost is 11 ¢/kWh. For the tubular drag chain conveyor, the pipe diameter is 10 inches, the brake horsepower is 9, and the connected horsepower is 10; for the pneumatic conveyor, the pipe diameter is 8 inches, the brake horsepower is 96, and the connected horsepower is 125.[a]

The results? The power consumed by the tubular drag chain conveyor in this application costs $6,411 per year, while that consumed by the pneumatic conveyor costs $68,386 per year — more than 10 times as much. A look at the motors for each conveyor reveals why: The tubular drag chain conveyor has two small motors, one at the drive assembly and one at the turn assembly. The pneumatic conveyor has a very large motor for the blower and two small rotary valve motors, and it also requires compressed air for the filter-receiver's filter-cleaning system. In this case, selecting the tubular drag chain conveyor will save $61,975 a year.[b]

While the maintenance costs are harder to specifically calculate for this example, the tubular drag chain conveyor generally requires less maintenance than a pneumatic conveyor. Maintenance for the tubular drag chain conveyor typically involves replacing wear items, such as the discs, every 2 or 3 years or more, depending on the conveyed material's abrasiveness and other characteristics. When the tubular drag chain conveyor is equipped with a manual takeup, the chain tension must also be manually adjusted at regular intervals to remove slack. In a pneumatic conveyor, several components require regular maintenance, including the blower, rotary valves at material feedpoints and discharges, and the filter-receiver and its filter-cleaning system.

—N. Jagan

Figure A

Tubular drag chain conveyor

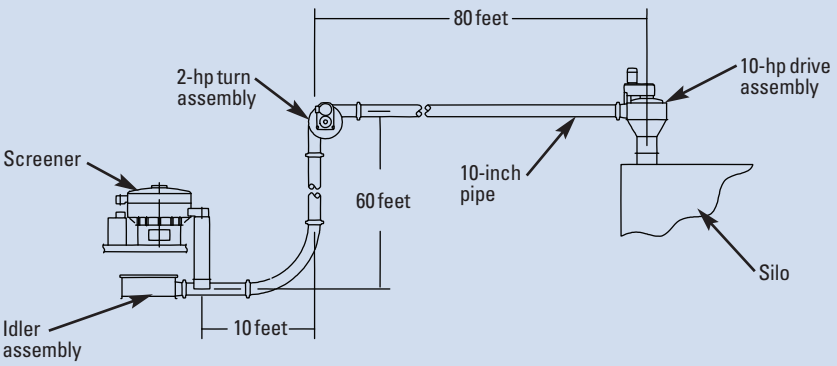
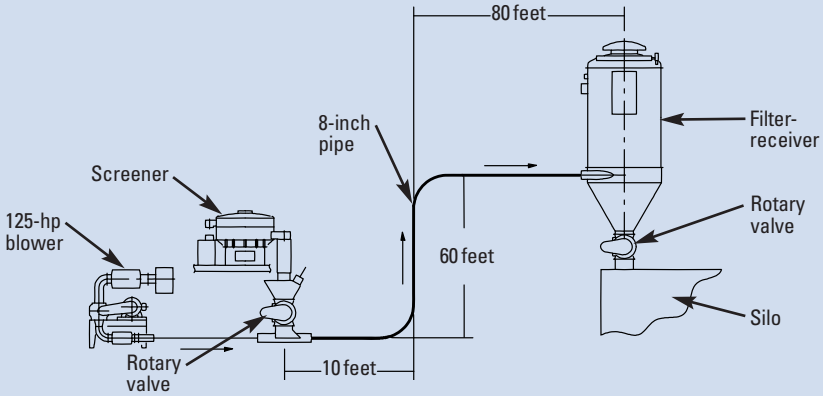


Figure B

Pressure dilute-phase pneumatic conveyor



References

a. *Brake horsepower* (bhp) is the actual power at the motor (or blower) output shaft without the loss in power caused by gears, differentials, and other auxiliary components. *Connected horsepower* is the amount of power available at the electrical power source.

b. More information about the power cost calculations is available from the author.

friction, flowrate changes, variations in air and material temperatures, chain and disc wear, and other factors. Keeping the proper chain tension minimizes wear to the conveyor's chain, discs, and housing, reducing production downtime and maintenance costs. Depending on the conveyor manufacturer, the chain-tensioning mechanism can be a manually adjusted takeup located near the drive or idler assembly, or it can be an automatic device incorporated into the idler assembly, which then serves as both an idler and an automatic, continuous chain tensioner. Some takeups and the automatic tensioning device also keep the chain in the return line under slight compression (that is, slightly loose) to facilitate cleaning material off the chain and to eliminate frictional drag on the chain's return line, which reduces wear on the chain and discs.

Available options

The tubular drag chain conveyor can be operated under pressure or vacuum. To handle a potentially explosive material, the conveyor can be purged with inert gas, such as nitrogen, and it requires less inert gas for this purpose than a pneumatic conveyor of comparable size.

The conveying pipe can have an abrasion-resistant lining, such as basalt, to handle highly abrasive materials. The pipe can also be fitted with jacketing that circulates a heat-exchanging fluid to cool hot materials during conveying.

The conveyor can be designed for frequent washdown in clean-in-place applications, such as transferring foods and pharmaceuticals, with components such as quick-disconnect joints, FDA-approved UHMW-PE discs molded directly to a stainless steel chain, and stainless steel sprockets or other rotating mechanisms. Various clean-in-place components and drying-air supply systems to minimize cleaning downtime and labor are available from tubular drag chain conveyor manufacturers.

Some selection advice

To choose a tubular drag chain conveyor, take advantage of the conveyor manufacturer's expertise in designing conveyors for a range of bulk solids applications. Provide the manufacturer with detailed information about your material, including its particle size distribution, bulk density, flowability, temperature, friability, abrasiveness, explosibility, and other characteristics. The manufacturer will also need to know what conveying capacity you require, the available space and location of existing equipment and other fixtures in the area where the conveyor will be installed, and any special requirements the conveyor must meet, such as FDA or other sanitary standards.

Determining which tubular drag chain conveyor components and options are best for your application typically requires testing your material in equipment in the manufacturer's lab. You can witness the tests in person, or you can send a material sample to the lab and have the lab send you a videotape and written report detailing the tests.

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After testing, you're ready to work with the manufacturer to customize a tubular drag chain conveyor for your application. This includes choosing the pipe diameter, the chain-and-disc assembly's design and construction materials, the chain speed, and the conveyor configuration itself, including the number and location of powered and idler turn assemblies and inlets and outlets. The result should be a tubular drag chain conveyor that reliably and efficiently transfers your material for years to come. **PBE**

Reference

1. Other sealed tubular mechanical conveyors are also available, including tubular drag cable conveyors and aeromechanical conveyors. The tubular drag cable conveyor operates similarly to the tubular drag chain conveyor but uses a cable and discs (or flights) rather than a chain and discs to move the material through the conveyor. The cable moves at a much higher speed than the chain, which can lead to degradation or segregation problems with some materials. The aeromechanical (or *aero*) conveyor also has a cable and discs and combines mechanical with pneumatic conveying features; the cable and discs move at high speed, fluidizing the material as aerodynamic effects and mechanical assistance from the discs help move the material through the conveyor. This conveyor is typically limited to use with fluidizable materials. For more information on these conveyors, see the following section, "For further reading."

For further reading

Find more information on tubular drag chain conveyors and other mechanical conveyors in articles listed under "Mechanical conveying" in *Powder and Bulk Engineering*'s comprehensive article index at www.powderbulk.com and in the December 2007 issue.

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