Five factors to consider when choosing a screw conveyor for a high-temperature application

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Many bulk solids processes require conveying high-temperature materials. Properly selected, a screw conveyor can be a good solution for such an application. This article discusses five factors you need to consider when choosing a screw conveyor to convey your high-temperature material.

The screw conveyor is probably the most common mechanical bulk solids conveyor. It's a relatively simple and reliable device, with few moving parts to replace or maintain, and it's compact, taking up very little floor space. The screw conveyor can convey material horizontally, at an incline, or even vertically and can be configured to handle a wide range of challenging materials and applications.

The screw conveyor typically consists of a screw mounted in an enclosed U-shaped trough (or tube). The screw can have one or several sections and is supported by bearings at each end. If the conveyor is long enough to require more support, hanger bearings can be suspended from the top of the trough to support the screw at points between the screw sections. The screw is connected to a motor and gear reducer assembly at one end. In operation, material enters the trough at one end and fills the space between the screw flights. As the motor drives the screw, the screw's flights push the material along the trough to a discharge opening at the other end.

The screw conveyor's versatility and simplicity make it ideal for many high-temperature applications, whether it's feeding lime to a kiln or removing ash from a boiler. Choosing a screw conveyor to convey a hot material does present a unique set of challenges, however. Handling a high-temperature material (typically above 200°F) can lead to premature failure of the conveyor's structural and mechanical components, thermal expansion, and worker safety concerns. To ensure that your conveyor will successfully transfer your hot material for many years, work closely with your supplier and pay close attention to the following factors.

1 Construction material

The conveyor's screw and trough are typically made of steel. Choosing the right steel for these components is critical for a high-temperature application. Your conveyor's operating temperature will affect the steel's mechanical strength, mechanical creep (or deformation) tendency, and corrosion rate, as well as its economic viability for your application. Although many steel alloys can handle high-temperature applications, some are too expensive to be practical for use in screw conveyor components. The steels most commonly used in high-temperature applications and the maximum recommended operating temperature for each are listed in Table I.

Table I

Maximum recommended operating temperatures for common construction materials

Steel type	Maximum recommended operating temperature
A-36 carbon steel	700°F
SA516 Grade 70 carbon steel	1,000°F
Type 304 stainless steel	1,500°F
Type 316 stainless steel	1,500°F
Type 310 stainless steel	2,000°F

2 Structural strength

Steel's *yield strength* (stress at which it begins to deform permanently) decreases as the operating temperature rises. This in turn decreases the steel's load-carrying capability. For a high-temperature application, you need to ensure that your screw conveyor's structural components are designed based on the steel's yield strength at your worst-case operating temperature.

For example, Type 304 stainless steel has a yield strength of about 30,000 psi at 70°F but only about 15,000 psi at 1,000°F. If you use the 30,000-psi yield strength to design a screw conveyor with Type 304 stainless steel components but then convey hot ash from a boiler at 1,000°F, the components will prematurely weaken from metal fatigue and possibly fail. To account for the steel's reduced strength at the elevated operating temperature, you must use thicker structural components.

High temperatures also affect the steel's *modulus of elasticity* — that is, its relative stiffness. Using the example above, the modulus of elasticity decreases 20 percent when the temperature increases from 70°F to 1,000°F. Again, using larger structural components can overcome this problem.

3 Thermal expansion

When hot material enters the screw conveyor, the screw and trough expand lengthwise. The amount of thermal expansion will vary depending on what steel the screw and trough are made of, the temperature change (from ambient to operating temperature), and the conveyor's length. To ensure that your screw conveyor will operate properly, it's important to choose components — particularly the conveyor supports, the bearings, and the material inlet and discharge — that can accommodate this expansion.

Conveyor supports. The screw conveyor's drive end is typically rigidly mounted to the floor or other structure, but the conveyor's intermediate and tail-end supports must allow the trough to expand along its length with increasing temperature. Ways to achieve this include simply leaving the anchor bolts loose and allowing the supports to slide on the floor or designing a special support system with expansion capabilities.

Bearings. While the lengths of the screw and trough are similar, they may thermally expand at different rates (called *differential expansion*). At the drive end the screw is fixed to the trough, but if the conveyor has hanger-bearing assemblies, they need to allow for the differential expansion of the screw and trough. The tail-end bearing assembly must also allow for differential expansion, with either a spherical roller-type expansion bearing, a sleeve bearing, or a bearing with a sliding expansion base, as shown in Figure 1, that allows the bearing to move with the shaft.

Material inlet and discharge. In a high-temperature application, the trough's thermal expansion can cause the inlet and discharge to become misaligned with connected process equipment. To accommodate this expansion, you can use a high-temperature flexible transition or a specially designed expansion transition to connect the inlet or discharge to process equipment. Consult with your conveyor supplier to select the type of flexible or expansion transition that will suit your application and operating temperature.

4 Power transmission

High operating temperatures can also cause seal and oil failure in your screw conveyor's power transmission components. You can prevent this by isolating the gear reducers and bearings from the hot conveyed material in the trough. For example, locate the gear reducer away from the trough by using either an inline gear reducer and a low-speed coupling, as shown in Figure 2, or a sprocket and chain arrangement. You can also locate the tail- and drive-end bearings on pedestals away from the trough. If the ambient temperature will be above 125°F or the gear

Figure 1

Sliding expansion base at tail end

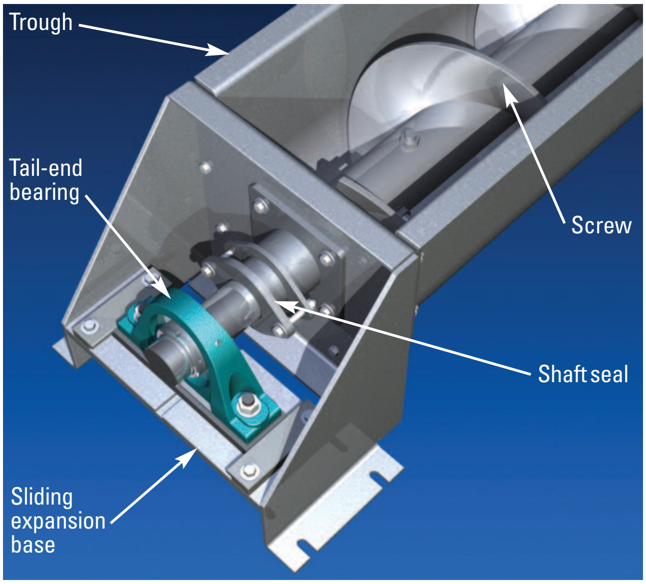
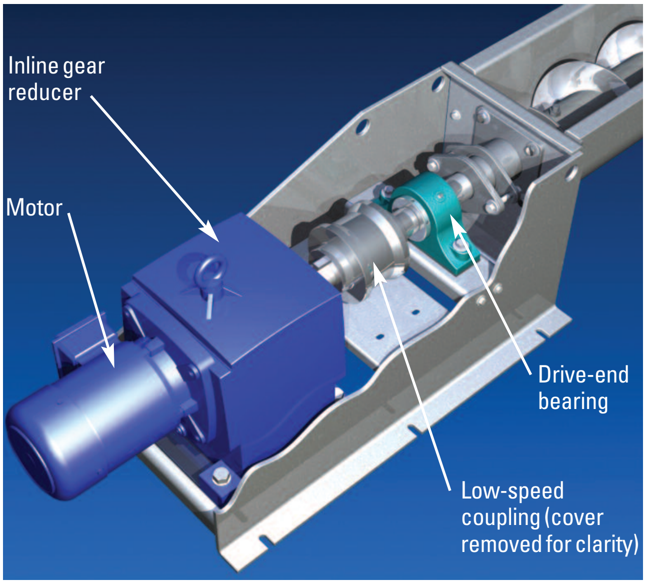


Figure 2

Inline gear reducer at drive end



reducer's or bearing lubricant's temperature will rise above 200°F, use high-temperature shaft seals made of either Viton or metal along with synthetic lubricants specially formulated for longer life at high temperatures.

5 Safety

Keeping workers safe near your hot screw conveyor should be your top concern. While "high temperature" is typically considered to be above 200°F, temperatures below that can still be hazardous to workers. Protecting workers requires installing proper guarding around your conveyor, and which type is best depends on the conveyor's location. The Conveyor Equipment Manufacturers Association (CEMA) offers best practice guidelines for selecting guarding and other safety features (at www.cemanet.org), but you should work with your local OSHA representative to ensure that your conveyor meets OSHA regulations.

While it's ultimately your responsibility to safeguard workers, your conveyor supplier can provide safety labels and conveyor insulation to help prevent injuries.

Safety labels. The supplier should provide appropriate safety labels that warn of hot surfaces on your screw conveyor (and all other high-temperature equipment). CEMA's standard safety label for hot surfaces is shown in Figure 3.

Figure 3

CEMA hot surface safety label

Insulation. OSHA may require that your high-temperature screw conveyor be insulated to prevent worker injuries. Several types of insulation are available, including fiberglass, wool, and ceramic, and the supplier can help you choose one depending on your conveyor's operating temperature and site conditions. Conveyor insulation is usually installed onsite to prevent damage to the insulation during the conveyor's shipping and installation. Consult your local OSHA representative for more information about selecting insulation for your conveyor. **PBE**

For further reading

Find more information on screw conveyors in articles listed under "Mechanical conveying" in *Powder and Bulk Engineering*'s article index in the December 2014 issue or the Article Archive on *PBE*'s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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