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All you’ve ever wanted to know about hose selection

Materials of construction, media compatibility and end connections are among considerations

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Hose selection requires attention to application variables such as temperature, pressure and flow, as well as requirements ranging from chemical compatibility to drainability. Hoses “cost” more than their purchase price. Be sure to consider hose longevity, maintenance and replacement costs and other cost-of-ownership factors.
A hose has four main parts: core tube material and construction; reinforcement layers; covers; and end connections.

When selecting a hose, start with the core tube, the hose’s innermost layer that comes into contact with the system media.

• Is the material chemically compatible with the system media? Will it corrode or deteriorate over time?

• Can it tolerate the temperature range of the system media?

• Will the material prevent or limit permeation and absorption? All materials, even metals, are subject to such, so this question is one of degree. Permeation occurs when media passes through a material, whereas absorption is when media absorbs into and becomes part of a material. Neither is necessarily an issue.

• Will the core material stand up to the cleaning practices for your system, both in terms of temperature, pressure and material compatibility with any solvents and cleaning agents employed?

First, let’s review the materials that core tubes are made of; then, we will review some choices for core tube wall construction.

Metal cores (commonly 316L stainless steel) are good for general needs. They are usually rated for temperatures between -325 F and 850 F, which makes them an especially good choice — sometimes the only choice — for system media at extreme temperatures. A metal core is also good when there is little allowance for permeation or absorption. With the advent of fluoropolymers, metal is usually not chosen for highly caustic or acidic media because of issues with corrosion.

Sanitary, high temperatures

Historically, silicone has been a common choice for sanitary applications. A typical temperature range for silicone is from -65 F to 500 F. Silicone became the material of choice for sanitary applications because of its flexibility. However, that advantage has disappeared with advancements in fluoropolymer hose construction.

Silicone, which is incompatible with common solvents, has limited chemical compatibility overall. In addition, it is absorptive, which can lead to contamination. If a fluid is absorbed into the walls of the core tube, it may remain there for a period of time before leaching out, at which point it may contaminate media then in the system.
With silicone, removing the absorbed fluid is usually not possible. Steam cleaning, one of the most common sterilization methods for silicone, may not remove it, and high temperatures may cause premature failure. The hose will become brittle and break down.

In place of silicone, fluoropolymer cores are becoming the material of choice for sanitary applications. PTFE, PFA, and FEP are three common fluoropolymers, with a typical temperature range from -65 F to 450 F. Fluoropolymer cores are the most chemically inert available. They are non-aging, nonstick, easy to clean, and can withstand repetitive steam cleaning. Like metal, fluoropolymers also have a low absorption rate.

In addition, reinforcement layer advances allow fluoropolymer cores to overcome their stiffness and gain flexibility comparable to that of silicone. Bonding technology allows a fiberglass braid to be added as a layer for increased flexibility. The glue-free process means it isn't present to be absorbed into the core walls. PTFE cores comply with FDA regulation 21CFR Part 177.1550, USP <88> Class VI and 3-A.

Inevitable drawbacks

One drawback of fluoropolymers is that they are highly permeable. If an application can't tolerate permeation, specify a less permeable core material, such as metal.
With many fluoropolymer hoses, you can specify a carbon black-filled core if your process requires static dissipation. Carbon allows the charge to travel to the end connections and exit. Static dissipative cores are important because fluid can generate electrostatic as it passes through the hose. Static sparking can damage hose and pose a safety hazard.

Thermoplastic (nylon) hoses, which can contain high pressures, are often chosen for hydraulic applications. They are available in sizes up to 1 inch and have a typical temperature range from -40 F to 200 F.

Rubber hoses are economical general-purpose hoses with a typical temperature range like that of thermoplastic. They are only for low-pressure uses. An advantage of rubber hoses is their ability to be crushed without permanent damage. They are also made in sizes above 2 inches. The other hoses described typically range in size from 1⁄8 or 1⁄4 inch to 2 inches.

Before choosing core-tube material, understand core-tube wall construction. Decide whether the core tube wall should be smooth or have "convolutions" that allow it to bend like a flexible straw. Application requirements for hose bendability will guide the decision.

Smooth-bore cores

In a smooth-bore core, the tube's inner wall is smooth. All core materials except for metal are offered in smooth bore.

Choose smooth bore if precise flow control is a priority. With smooth bore, precise flow control is possible because no irregularities in the wall can cause interruptions. Smooth bore also promotes drainability. The primary disadvantage is kinking, particularly in larger diameters. Reinforcement layers help solve kinking.

Convoluted tube walls are folded in a pattern that increases bending without kinking. Metal and fluoropolymer can have convolutions and are chosen when flexibility is the priority.

Convoluted cores come in two types: helical and annular. Helical design, found primarily in fluoropolymer cores, is a single convolution that spirals down the length of the hose. A helical design promotes better flow downstream than annular convolutions.

Annular design, typical in metal cores, is a series of connected rings. Annular metal cores come with deep convolutions for maximum flexibility. Despite their flexibility, convoluted metal hoses are not well suited to operations involving repetitive movements, which can cause metal fatigue and breaking.

Reinforcement layers

In most cases, the core tube is reinforced by a flexible, stainless steel woven braid layered on top of the core tube. Proper reinforcement improves hose pressure containment and flexibility. To compare pressure ratings among hoses, consult product catalogs. Comparing flexibility is trickier. To do so, you need to understand bend radius. All hoses have a minimum bend radius, which measures how far a hose can bend before kinking. Specifying minimum bend radius is standard in industrial hose literature.

However, there's more to flexibility than bend radius — and many in the industry do not understand this. Also consider the force required to bend an unpressurized hose. A hose with a good bend radius is not much help if the force required to bend it is too great. Is the hose so stiff that an operator can't bend or has difficulty installing it? Will it slow down or break a machine in dynamic operation?

Force-to-bend is just as important as bend radius but not as easy to measure, and guidelines don't exist across hose manufacturers.

Special covers

The cover is an outer layer that protects what's underlying, personnel and surrounding equipment. Covers come in materials such as silicone and rubber and are integral to the hose.

The most common general-purpose cover is made of silicone. Silicone covers help prevent fraying of the braids in stainless steel reinforcement layers, which can happen from abrasion. Frayed braids weaken the hose and create a burst threat, and can injure operators' hands. Silicone covers can provide enhanced burn protection for operators who inadvertently grab or bump hoses carrying very hot fluids. They provide temperature insulation as well.

Silicone covers are a particularly good choice for sanitary applications. Smoothness makes them easy to wash down. And by covering the stainless steel reinforcement layer, they eliminate bacteria buildup in the braid's crevices.

Other covers are for specialty applications. For maximum burn protection, consider a fire jacket, a fiberglass cover coated in silicone rubber. Keep in mind, however, that fire jackets connect loosely to the hose and can snag and rip. Another cover type, bend restrictors, help prevent hose from being bent beyond its bend radius. On the downside, covers add cost, restrict flexibility and make the hose larger, a concern for routing and angling. In most applications, the goal in cover selection is to achieve the smallest diameter and not decrease hose flexibility.

Nearing the end

End connections, usually made of metal, are where most leaks occur.

Metal hose connections are welded, which completely and permanently seals the product. There are a variety of end connections.

For fluoropolymer hoses, the choice is between swaging and crimping. Swaging puts pressure on the hose itself, while crimping squeezes the end connection. While both methods are widely accepted, crimping has a slight advantage in that it is less likely to damage the hose because the pressure is exerted in a carefully controlled manner.

Many chemical applications require that fluoropolymer-wetted surface end connections be used. The industry has devised some creative solutions. One is called "flare-through" because the core tube is flared such that it covers the entire inner surface of the metal end connection. There is no step or drop between the core tube and fitting, ensuring smooth flow, and the result is an all fluoropolymer-wetted surface. However, flare-through is costly and fragile and not recommended for high-temperature applications.

Another common solution is called "encapsulation" because the stainless steel end connection is entirely encapsulated in fluoropolymer, inside and out. Advantages are cost and availability. Disadvantages are reduced orifice size, raising the possibility of reduced flow and entrapment.

To make the best hose selection, consider your choices in the main parts of a hose: core tube material and wall construction, reinforcement layers, covers and end connections. Application variables, including the temperature, pressure and flow of your system media, will direct decision-making.

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