The Role of Flexible Connectors in a Piping System

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Flexible Solutions:
Flexible connectors provide a safe, long lasting and cost-effective means of making a piping connection. They are an integral part of an underground storage tank (UST) system—and its first and last connections.

Flexible beginnings
Originally, swing joints were used to solve the challenge of satisfying a piping connection and, at the same time, relieving stress. To work, one threaded connection must tighten, and another one loosen. The swing joint consisted of a series of carbon steel 90-degree elbows. The elbows were installed in a stair-stepping fashion. However, with the numerous threads involved, the potential for leakage existed. Also, this method afforded only limited flexibility, and exposed bare steel in the ground created a corrosion problem.

Then, the B.F. Goodrich Company produced a product consisting of rubber hose, steel-threaded pipe ends and band clamps. The product was UL listed; however, given its lack of flexibility and the potential of long-term fuel compatibility problems of rubber, the door was left open to change.

The Resistoflex Company offered the first Teflon flexible connector to the market. Resistoflex sold similar types of Teflon products in other industries, as well. This product seemed to be the right fit given its flexibility, fuel compatibility and user friendliness.

Today, we enjoy the benefits of Teflon and stainless steel connectors. To better understand how the product works, let's first look at the construction of each. The Teflon connector consists of Teflon corrugated hose with stainless steel braid. The hose is manufactured through a tape-wrapped process. The end fittings are typically crimped or swaged.

Illustration 1: Hydraulically formed hose. Courtesy of Hose Master.
Stainless steel connectors consist of a stainless steel corrugated hose with a stainless steel braid. The hose is formed either mechanically or hydraulically.
Hydraulically formed hose is more forgiving and flexible in shorter lengths because the process of hydroforming (hydraulically forming) involves less stress on the steel during manufacturing. The end fittings are welded. (See Illustration 1).

Both Teflon and stainless steel connectors are UL listed for fuel compatibility (petroleum products, alcohol and alcohol-gasoline mixtures). However, stainless steel connectors are also fire-rated (UL 842). This indicates that the connector has been tested in a fire condition and survived. It may be installed aboveground or in underground dispenser sumps, unlike the Teflon connector, which is listed for underground use only due to the material’s low melting point.

**Why are flexible connectors used?**
The primary uses of the flexible connector are twofold: (1) to extend the life of a piping system by relieving the hydraulic shock created when a submersible pump turns on or when a fuel dispenser nozzle is “clicked” by the consumer when topping off a tank; and (2) to facilitate piping connections.

Rigid fiberglass-reinforced plastic (FRP) pipe lends itself to the use of flexible connectors because the pipe is rigid. The role of the flexible connector in a fiberglass piping system is to provide a connection to the shear valve and the submersible pump; reduce pipe stress by absorbing hydraulic shock and ground movement; and aid in contractor installation. Flexibility is essential in providing maximum life in a piping system.

**Illustration 2:**
*Side view of flexible pipe installation*
Flexible connectors facilitate pipe and fitting connections in the field. They are suited to handle offsets and misalignments because of their flexibility. (For example: As piping enters a sump, the connection made to the shear valve or submersible pump will be made with a flexible connector. The length of the flexible connector varies to facilitate the desired bend radius to make a threaded connection.)

Flexible connectors are offered with a wide variety of end fittings that compliment fiberglass pipe. The most traditional and cost-effective connection for our company has been a 1-1/2 inch integral hex male swivel threaded into the bottom of the shear valve and a two-inch hex female accepting a fiberglass male pipe adapter. See Illustration 2.

This connector provides the benefits of an integral hex male swivel that enables the installer to make a thread attachment to the shear valve without torquing the hose. Also, the female provides a safe, long-lasting internal thread attachment to capture the fiberglass male pipe thread.

The connection to the submersible pump typically involves a two-inch flexible connector with a two-inch integral hex male swivel threaded into the submersible pump and a fiberglass male pipe adapter threaded into a two-inch hex female. Some installations may include additional hardware such as elbows and ball valves. (See Photo 1.) Flexible connectors are also used in applications that involve vapor and vent piping.

**Photo 1: Flexible connectors are also used in applications that involve vapor and vent piping.**
*Courtesy of Hose Master.*
**Flexible piping**

Flexible connectors also play a significant role in providing a safe and easy way of making a piping connection with flexible piping. It was once thought that flexible piping did not require the use of flexible connectors. However, after some time and experience, oil companies are specifying, and installers requiring, the use of flexible connectors with flexible piping systems for the following reasons: (1) There is too much “hydraulic hammer,” line shock and vibration in a flexible piping system; (2) flexible piping is installed with few threaded connections and, hence, installation is very fast.

Some installers use a carbon steel pipe riser to make a connection from the bottom of the shear valve to the transition tee or terminating elbow. This is a quick and cost-effective way to make the connection. However, there is still a tremendous amount of line shock created as fuel consumers “click” the nozzle as they top off the tank. The line shock created here is not dampened by the steel pipe, rather it is absorbed—with the weakest link being the threads and this is where leaks occur.

Flexible connectors are better suited to reduce line shock. Further, the steel pipe riser has to be fabricated; this involves time and labor.

Making a connection becomes difficult if there is offset (between the shear valve and the flexible pipe fitting connection). Also, in my opinion, there are two other questions to consider. Is there a liability issue since steel pipe typically is not UL listed and warranted? And do we maintain the consistency of a complete UL approved system when using steel pipe?

Hose Master’s most commonly used flexible connector in this installation is a 1-1/2 inch hex male integral swivel threading into the shear valve and a 1-1/2 inch hex male threading into the flexible pipe fitting. The flexible connector will forgive movement created in this area, and installation time is significantly reduced.

**Photo 2: Installation Instructions. Courtesy of Hose Master**

**Installation of flexible connectors**

To achieve full working performance of a flexible connector, proper installation is important. Manufacturers generally provide an installation instruction label with each flexible connector. (See Photo 2.) Hose Master Inc. provides the following guidance for installing a flexible connector.

- Do not twist the connector; twisting the connector during installation or service must be avoided. Torque will lead to premature failure of a connector.
- Do not wrench on hose; wrenches must only be used on the hex part of the fitting.
- Do not overbend the connector; the installed radius of the connector must be larger than the minimum bend radius defined in the table. See Photo 2.
- Do not abuse the connector; avoid placing the connector in contact with other components during service.
Also, installations should be made in accordance with standard piping practices recommended by PEI RP100 and API 1615.

**Challenges and solutions**

It bears repeating that there are three items to consider when installing a flexible connector: the installer, the flexible connector and the pipe fittings. All three items have to be taken into account when discussing success—or failures.

Flexible connector failures occur typically from mishandling and improper installation. Typically, installation failures occur if the wrench is applied to the hose or braid collar. Wrenching on the hose or braid collar will lead to premature failure. Flexible connectors should be made available with hex fittings and warning labels on the braid collars. The wider hex fittings enable the installer to apply an open end wrench.

Installing a flexible connector requires the proper length of hose and proper end fittings. When installing a flexible connector with fiberglass pipe, the connectors should be installed with a maximum 90-degree bend. The installation instructions indicate the minimum length for a 90-degree bend. See Photo 3. Also, integral swivel fittings minimize the torque created when installing a flexible connector. I recommend the use of a factory installed integral swivel on all flexible connectors.

Flexible connectors can provide a safe, long lasting and cost-effective means to connect a piping system. They should be thoroughly factory tested before shipping, with an integral swivel fitting on one end to minimize the potential for torque. (The connector should accept a containment boot or cathodic protection if not being installed in a sump.)

Flexible connectors have a proven track record. They connect pipe and fittings, and make up for offsets and misalignment. The evolution of flexible pipe and new designs in FRP pipe have even created an opportunity to introduce “custom designed” flexible connectors into the marketplace. Find out about the capabilities of the manufacturer with whom you do business. It pays to get the best.

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