What Specifiers Need to Look for in Flexible Piping

Many differences exist between various flexible piping systems out on the market. Flexible piping consultant Andy Youngs reviews what qualities separate a good system from a great one—and how you can tell which is which.

UL and ULC listings important—but not all you need

This article, which provides an overview on some of the key issues in flexible piping, is the first in a three-part series on flexible piping systems by Andy Youngs. It is based on a paper presented by him at the API Materials Compatibility Roundtable. The July issue will address who makes what and how, based on updated information provided by flexible piping manufacturers. The third article, to be published in August, will address flexible piping components and connectors.

Flexible piping simplifies the construction of dispenser islands. Here is a typical framing arrangement for a flexible piping installation.
Courtesy of Environ Products.

In specifying components for an underground fueling system, particular attention must be paid to the piping system. Over the years, leaky piping has released far more product than have underground storage tanks (USTs).

Evolution of flexible piping

Today, technical advances in piping systems have significantly lessened the possibility of product releases. However, at the same time, the sheer proliferation of technology and piping suppliers has made it more difficult for the specifying engineer to select the best system for each particular piping application.

Historically, flammable liquids were handled using piping and piping system components constructed of rigid, metallic materials—primarily steel pipe and malleable iron fittings. This rigid piping has been replaced by non-metallic FRP (fiberglass reinforced plastic) piping to eliminate product releases due to corrosion.

The addition of secondary containment further serves to prevent product releases by providing containment and a monitorable interstice for any product that would have otherwise leaked from the primary piping. Secondary containment may be in the form of submersible pump chambers (tank

sumps), dispenser sumps and double wall tanks and piping.

Underground non-metallic piping for the petroleum and chemical industries comes in rigid (FRP pipe) or semi-flexible (flexible) pipe. Each system offers unique features and benefits. This article will discuss attributes of flexible piping systems.

Early flexible piping systems relied on materials that were resistant to conventional unleaded gasolines and diesel fuels. Some manufacturers claimed their product was “compatible” with alcohols and alcohol/gasoline blends. However, the definition of “compatibility” varied from company to company, thus leading to confusion.

Evaluating flexible piping

Third party laboratories, such as Underwriters Laboratories, Inc. (UL) and Underwriters Laboratories of Canada (ULC), provide the petroleum equipment industry with minimum performance standards and product certifications for many products, including flexible piping. UL and ULC provide listings for the flexible piping systems that meet specified requirements discussed later in this article. Knowing exactly what the designations mean will help you determine if a particular piping system is appropriate for a given application.

To ensure that a flexible piping system has been thoroughly tested, it should carry a UL or ULC listing. This is, however, only a first step. Although these listings should be considered necessary, they do not, in and of themselves, provide sufficient information to make a sound selection of a flexible piping system.

A systems designer or owner should look at other factors unique to the particular system. These factors include how the system is manufactured and what quality assurance is employed; the method of fitting attachments; the ease of installation and potential for installation errors; the installed system cost; the warranty (including the financial strength of the company backing the warranty) and technical support.

For easy handling, flexible piping is typically shipped in reels.
Courtesy of APT.

Tests and test methods

The table below shows the UL and ULC test fluids used for the current UL and ULC listings. Many of the fluids, like pure toluene, are not expected to be encountered, but are used because they are very aggressive and accelerate testing. Testing with certain test liquids at elevated temperatures is done for the same reason.

For most polymers, pure toluene, pure methanol and a 50 percent fuel C/50 percent methanol blend are the three most aggressive fluids that can be tested. A common myth is that “pure alcohol” is tougher on most materials than hydrocarbon/alcohol blends. For the vast majority of polymeric materials, a 50 percent fuel C/50 percent methanol blend will be much more aggressive than the pure hydrocarbon or the pure alcohol. Therefore, the test result with the 50/50 blend may be the most

critical to study when comparing piping systems.

The testing protocol (tests used and test methods) on the UL and ULC standards is very similar, although not identical. Here are two differences:

• The ULC protocol requires higher temperatures for immersion (namely, compatibility) testing, thus making it more stringent in this area. However, ULC uses a smaller range of fluids for compatibility testing than does UL, thus making ULC listings easier to obtain than UL listings.
• For secondary containment piping, UL requires permeation testing, while ULC does not—making UL the tougher standard here as well. (Several manufacturers have ULC multi-fuel listings on both primary and secondary piping. Many also have a UL listing on the primary piping; fewer have a UL listing on the secondary piping.)

Flexible piping manufacturers have used a variety of construction materials in striving to meet usage requirements and UL/ULC standards. Pipe liner materials include fuel line grade nylon 12; polyvinylidene fluoride; nylon 11; polyketone and nylon-doped polyethylene. These materials have been used to provide compatibility with the fuels used.

To reduce permeation, the most common strategy is to use low permeation materials in the liner. In addition, the use of impermeable barrier layers in the piping construction can effectively eliminate permeation of fuels through the walls of the piping.

Testing results for any specific product will vary from test to test. The specific results of the UL listing tests, such as fluid immersion, are not routinely published. The listing itself only indicates UL's minimum standard was achieved for all tests so the system designer should consider other characteristics of the products in making the final buying decision.

This table shows the fluids that must be tested for permeation and immersion to receive one or more of the indicated listings for a particular flexible piping system.

Test Fluid	UL 971 Petroleum Products Only	UL 971 Petroleum Products, Alcohols, and Alcohol-Gasoline Blends	ULC Petroleum Alcohol Blends
Premium Leaded Gasoline	Yes	Yes	No
Premium Unleaded Gasoline	Yes	Yes	No
Regular Unleaded Gasoline	Yes	Yes	Yes
Toluene	Yes	Yes	Yes
#2 Fuel Oil	Yes	Yes	Yes
#3 Fuel Oil	No	No	Yes
#6 Fuel Oil @ 150ºF	Yes	Yes	No
ASTM Fuel C	Yes	Yes	Yes
ASTM Fuel A	No	No	Yes
100% Methanol (MeOH)	No	No	No
100% Ethanol (EtOH)	No	Yes	No
50% Methanol/50% Fuel C	No	Yes	No
50% Ethanol/50% Fuel C	No	Yes	No
30% Ethanol/70% Fuel C	No	Yes	No
15% Methanol/85% Fuel C	No	Yes	Yes
10% Ethanol/90% Fuel C	No	Yes	Yes
20% MTBE/80% Unleaded Gasoline	No	No	Yes

System components

Much of the environmental protection obtainable from flexible piping systems can be attributed to the complete containment system—not just the primary piping itself. Therefore, an examination of the

suitability of flexible piping for multi-fuel use must include all of the system components.

Materials and design for secondary containment piping should be selected as carefully as the materials and design for primary piping. Many of the tests of ducted secondary piping are similar to those for primary piping, but the standards for acceptability may be lower since the secondary piping is intended to contain product only if the primary piping has failed.

Containment chambers, or sumps, are found at the tank and under the dispensers. The design of these units must minimize the possibility of fuel release from the inside and the ingression of groundwater from the outside—while being as easy as possible to install out in the field. Other factors include the degree of physical strength necessary to withstand external pressure and prevent (or minimize) distortion; the system's potential for vapor generation; and the need to control fire and explosion hazards.

A wide variety of designs have evolved, and each must be examined for its technical merits and cost effectiveness.

Currently, UL has testing protocols on dispenser sump mounting frames to assess their performance in properly mounting impact valves, as well as the chemical resistance of sump materials and bulkhead fittings. ULC ORD-C107.21 and ULC ORD-C107.19 have been used by UL and ULC as protocols for tank and under dispenser sumps.

These two protocols address chemical resistance of sumps, seals and bulkhead fittings as well as the mechanical requirements of the sumps. Permeation and retention of tensile strength after fluid immersion are part of these test protocols. Testing of elastomeric seals and bulkheads are part of the listing protocol for both organizations, and are a critical area for examination. Testing for external exposure to contaminated soils is also significantly important.

UL system listings

Some flexible piping suppliers advertise a UL "systems" listing. UL has a "systems" listing protocol, but it only encompasses primary and secondary containment piping when supplied as a single unit (usually referred to as coaxial flexible piping), where both the primary pipe and the secondary jacket meet UL 971 requirements.

UL provides listings under the following categories:

- Nonmetallic Underground Piping For Flammable Liquids
- Nonmetallic Secondary Containment Piping For Underground Piping For Flammable Liquids
- Nonmetallic Secondary Containment Piping Systems For Underground Piping For Flammable Liquids
- Miscellaneous Dispensing Device Accessories
- Flammable and Combustible Liquid Tank Accessories

In the past, specifiers cared primarily about UL/ULC listings on primary piping and fittings. With the

emergence of listing protocols for sumps and accessories, one would be prudent to require UL or ULC listings on secondary containment piping, bulkhead fittings, tank sumps and dispenser sumps as well as on primary piping.

Dispenser pan with access cover removed for convenience during installation.
Courtesy of Containment Technologies.

Surveying the manufacturers

The U.S. EPA has commissioned independent third-party surveys to study flexible piping every two years since 1993. The next survey will be completed in 1999. The 1997 survey provides an overview of the flexible piping manufacturers, which includes the standards they meet and the location of their installations in place at the time of the survey (Spring 1997), as contacted by the survey firm, ICF Inc. The survey also provides contact numbers, piping construction details and information on UL/ULC listings as well as a discussion on the fuel additive MTBE.

The sumps in the foreground have vent piping (white) going back to the building. The cross piping between the vent and product piping (blue) is critical to the success of the project.
Courtesy of Total Containment, Inc.

Third generation results

An excerpt from the conclusion of the 1997 survey commissioned by EPA provides some security for the engineers choosing to specify flexible piping: “Most manufacturers are now marketing third and fourth generation products. Problems with these systems have been infrequent, and manufacturers have stood by their products. From an environmental protection standpoint, the performance of this technology to date has been excellent.”

Specifying flexible piping systems is a complex task for the system designer. UL and ULC listings provide guidance in product selection but comparisons of product characteristics, sumps, bulkhead fittings, and the applicability of each type of system to the particular installation are essential.

Flexible piping has evolved to handle current oxygenated fuels, and most systems are designed to handle anticipated future fuels that are liquid at standard temperatures and pressures. Selection of systems with complete compatibility with current and anticipated future fuels can be accomplished by a study of materials and designs of the flexible systems that are available.

The next article in this series will address the differences in the piping construction and fitting technology of the major flexible piping suppliers.

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