Tank-nically Speaking

by Marcel Moreau

Marcel Moreau is a nationally recognized petroleum storage specialist whose column, ***Tank-nically Speaking****, is a regular feature of* LUSTLine. *As always, we welcome your comments and questions. If there are technical issues that you would like to have Marcel discuss, let him know at* **marcel.moreau@juno.com.**

A Primer for the Next Generation of Tank People

Part 1 – Tank and Pipe Technology

While teaching a class for UST inspectors recently, I was struck by how incredibly young some of the new inspectors were. It occurred to me that for these new inspectors, the tank world, as I knew it when I first started in the tank business over a quarter century ago, has changed quite a bit. While, for some strange reason, the history of tank-system technology is not taught in history books, it is a very relevant subject for today's new generation of tank workers and tank inspectors, who ought to have some sense of where and how far we have come to get to today. So I decided it might be useful to those who are new to the business, as well as those who just like to reminisce, to take a brief stroll through the life and times of UST-dom in two parts. In this stroll we'll look at tanks and pipes. Next time, the other stuff.

Although underground petroleum storage systems are a ubiquitous and critical component of our nation's infrastructure, they are for the most part invisible. Outside the petroleum marketing and associated service and manufacturing industries, few people have given any thought to their existence…except when there is a release. So let's begin our stroll with a look at the tank and piping components of underground petroleum storage systems to gain a fundamental understanding of their construction, operation, and modes of failure.

How many of today's UST inspectors can remember seeing a bare-steel UST being installed – legally?

The Tank

Underground storage tanks (USTs) are large cylinders installed horizontally in the ground. In physical size, the tank is the largest component of most underground petroleum storage systems. In general, typical UST sizes have grown from around 4,000 gallons in the 1950s and 1960s, to 8,000-10,000 gallons in the 1990s. Today, 12,000- to 15,000-gallon USTs are not uncommon, and 20,000-gallon USTs are sometimes seen. This increase in tank size has been accompanied by an increase in the amount of fuel sold each month. Increases in tank size, and especially tank sales volume, have created a very challenging environment in which to conduct leak detection.

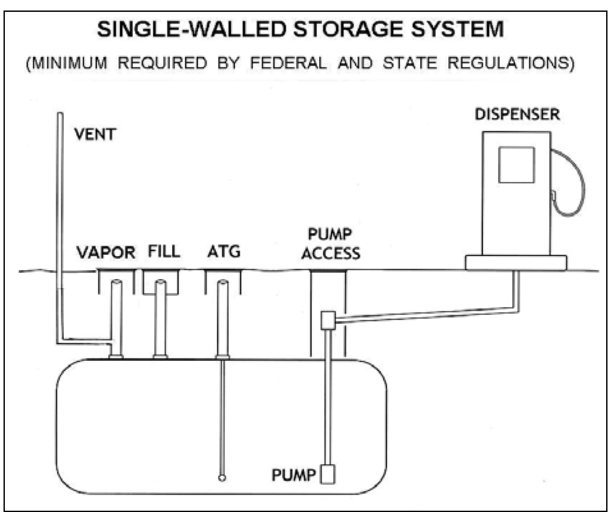

Figure 1. *Schematic diagram of the typical components of a single-walled underground storage system.*

A typical 4,000-gallon tank is approximately 6 feet in diameter and 19 feet long. A typical 8,000-gallon tank is approximately 8 feet in diameter and 21 feet long, a 10,000-gallon tank is 8 feet in diameter by 27 feet long, and a 15,000 gallon tank is 8 feet in diameter and 40 feet long.

Steel Tanks

Steel was the dominant material of construction for tanks from the early 1900s until the 1980s. Steel was readily available, easy to fabricate into tanks, structurally sound, and compatible with petroleum products, so it seemed an ideal material to use for underground petroleum storage.

Corrosion was the major weakness of steel tanks in the underground environment. Reaction of the steel with moisture in the environment outside the tank produced

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perforations in the tank wall. The tanks were typically coated with asphalt, which did little to mitigate corrosion. This type of tank was commonly known as a "bare" steel tank. Less frequently, small amounts of water inside the tank could also bring about corrosion on the inside surface of the tank. According to a study conducted by the American Petroleum Institute during the late 1970s and early 1980s, some 90 percent of steel tanks failed due to corrosion.

The typical life expectancy for bare-steel tanks was about 15 years before perforation from corrosion would occur, although some tanks failed sooner than this and others lasted for much longer. The proliferation of service station construction after World War II lead to a "boom" in storage tank failures 15 years later in the 1960s and again in the 1980s.

This "boom" in leaks helps to explain why the 1960s saw the introduction of several improved UST-system technologies, including fiberglass tanks (1965), fiberglass piping (1968), corrosion-protected steel tanks (1969), and the first specially designed tank-tightness testing equipment (1965).

In 1969, steel tank manufacturers introduced a corrosion-protected steel tank equipped with a durable, effective coating and cathodic protection, a technology for corrosion protection that was first developed in about 1824 by Sir Humphrey Davy. (See *LUSTLine* #23, Jan. 1996 – "Rust Thou Art and to Rust Thou Shalt Return, Unless…") Coatings and cathodic protection had been used for many decades to protect the nation's network of buried steel pipelines, but these techniques had been little used to protect buried storage tanks.

Another corrosion protection technique developed during this time period was the "clad" tank. These tanks were protected from corrosion by the application of a thick coating of resin reinforced with glass fibers. The cladding isolated the steel from the moisture in the soil, thus preventing external corrosion.

Although available, corrosion-protected tanks were more expensive than bare-steel tanks and saw relatively little use until federal law prohibited the installation of bare-steel tanks in 1985. The federal law included an exemption that allowed bare-steel tanks to be installed in soils with high resistivity, but this exemption was rarely used.

The federal law was known as the "interim prohibition" because it was designed to prevent the installation of more bare-steel tanks between the time when Congress initiated the federal tank program by passing Subtitle I of the Resource Conservation and Recovery Act (RCRA) in 1984, and the time when USEPA would promulgate the tank regulations, which turned out to be 1988.

Cladding and the combination of coatings plus cathodic protection applied to the outside surface of new steel tanks have been quite successful in preventing corrosion on the external surfaces of these tanks. However, little has been done to address internal corrosion issues resulting from moisture that may be present inside the tank. Though the failure rates are still low, internal corrosion is often a factor in the failure of steel tanks today.

Fiberglass Tanks

Underground tanks made of fiberglass were first introduced in 1965. Fiberglass tanks are not subject to corrosion, are chemically compatible with petroleum-based fuels, and are structurally sound when properly installed. However, they rely heavily on the support of the backfill material around the tank to maintain their structural integrity. In the early years following their introduction, there were a number of fiberglass tank ruptures attributable to improper installation techniques. Training programs for tank installation contractors by the tank manufacturers eventually overcame this weakness. Today, problems associated with structural failure stemming from improper installation are infrequent.

Like corrosion-protected steel tanks, fiberglass tanks were initially more expensive than bare-steel tanks and saw relatively little use until federal law prohibited the installation of bare-steel tanks in 1985. Many major oil companies adopted fiberglass tanks as their standard for new installations beginning in the early 1980s.

Double-Walled Tanks

Double-walled fiberglass and steel storage tanks (Figure 2) were introduced in the United States in the middle 1980s. These tanks consist of a tank within a tank and are designed to prevent releases by containing leaks in the "interstitial space" created between the two walls. Double-walled tanks in the United States were modeled after similar tanks that had been in use in Europe since the mid 1960s. Double-walled tank technology is generally acknowledged as the most secure form of storage for petroleum fuels. Releases from double-walled tanks are uncommon as long as the problem is promptly identified and addressed.

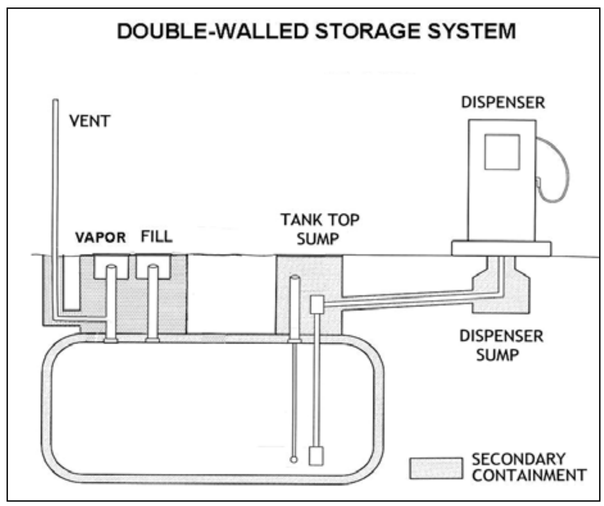

Figure 2. *Schematic diagram of the typical components of a double-walled underground storage system.*

Double-walled tanks can be fashioned with both walls made of either steel or fiberglass, but there are also hybrid tanks consisting of an inner steel tank and an outer containment vessel constructed of fiberglass or polyethylene plastic. These hybrid double-walled tanks are generically known as "jacketed" tanks.

Jacketed tanks tend to suffer from the same issues as corrosion-protected steel tanks. The outer wall has generally proven effective in preventing external corrosion, but internal corrosion can still cause tank failures. However, the presence of the external wall should prevent releases to the environment if a failure of the inner wall is promptly detected and addressed.

The Product Piping

Underground piping buried approximately two feet below the ground surface is used to transport petroleum products from the storage tank to the dispenser island. Although much attention has been focused on leaks from USTs, the leaking tank problem has largely been resolved by the widespread use of fiberglass and corrosion-protected steel technologies. Piping, however, has been and continues to be a much more intractable problem. Today's piping materials and technologies are much improved over what they were 20 years ago, but the basic fact remains that regardless of the quality of the piping materials, piping must be assembled in the field by personnel with varying levels of competence and varying standards of quality. The result is that releases today are much more likely to involve some component of the piping than the tank.

Steel Piping

From the early 1900s through the mid 1980s, UST system piping was typically constructed of 1.5- to 2-inch-diameter galvanized steel. Steel piping was assembled by cutting threads in the pipe and screwing it together using galvanized-steel fittings. Like steel tanks, steel piping was structurally sound and compatible with petroleum products, but it was susceptible to corrosion. In addition, threaded-steel joints were a frequent source of leaks because of improper assembly or subsequent ground movement that loosened the joints. (See *LUSTLine* #7, "An Emphasis on LUPs—The Weak Spots in Piping," December 1987.) Steel pipe is rarely used today as a primary piping material, but threaded fittings are often utilized at the tank top and inside of dispensers as a means of connecting various piping components. These threaded fittings can still be a source of leaks.

Fiberglass Piping

Piping made of fiberglass and resin was introduced to UST systems in 1968. The piping consisted of a great many strands of very thin glass fibers held together by a petroleum-compatible resin. Fiberglass piping is lightweight and capable of withstanding internal pressures of 2,000 pounds per square inch or more, but it is somewhat fragile and can be damaged by improper handling. Fiberglass piping consists of rigid lengths of pipe and various fittings that are glued together using epoxy-type adhesives. Like the fiberglass tank and the corrosion-protected steel tank, it was rarely used until federal law required the installation of corrosion-protected storage systems in 1985.

Fiberglass piping releases can often be traced to improperly assembled joints, though mechanical damage resulting when piping is struck during excavation activities or stakes are driven into the ground accounts for a fair number of failures as well. Releases resulting from mechanical damage are often catastrophic in nature, so they are usually discovered in a relatively short time.

Flexible Piping

In the late 1980s, flexible piping constructed of various thermoplastic materials was introduced. "Thermoplastic" means that the material will melt if heated. Because both steel and fiberglass piping were essentially rigid, numerous fittings and joints were required to distribute fuel to all the fueling positions at a facility. It was these joints, in both steel and fiberglass systems, that were seen as most troublesome in terms of leaks. The use of long lengths of flexible piping allowed the piping to be run in continuous lengths from the tank top to the fueling islands, eliminating a great number of field-assembled joints and greatly reducing the opportunities for piping leaks to occur.

Unfortunately, the materials used by some flexible-piping manufacturers have proven to degrade over time, and a number of flexible piping failures due to incompatibility of the materials, improper design or construction, and/or improper operation began to occur in the late 1990s. Most flexible-piping installations, however, have been of double-walled construction, so as long as the integrity of the outer wall was maintained and the problem promptly detected and addressed, releases could be minimized. Standards for flexible-piping systems have recently been upgraded in hopes of improving their long-term performance.

Double-Walled Piping

Since the mid 1980s fiberglass-piping systems have been available in single- and double-walled varieties. Fiberglass piping can be made double-walled by building a larger diameter piping system over the primary pipe. Fiberglass double-walled piping systems have proven to be durable and reliable, but they require a considerable amount of skill on the part of the installer and are fairly labor-intensive to construct.

Double-walled flexible piping systems have been available since the introduction of flexible piping in the late 1980s. There are two varieties of flexible double-walled piping systems: ducted and coaxial. Ducted piping consists of a large-diameter outer containment pipe (typically 4 inches in diameter) and a smaller diameter (typically 1.5 inch) inner pipe. The outer containment pipe and the inner product pipe are manufactured separately, and the inner pipe is installed within the outer pipe in the field. Coaxial piping consists of an outer containment wall that fits snugly over the inner product pipe. The two walls of coaxial pipe are manufactured together at the factory and installed as a unit.

One of the "features" of the ducted pipe is that the inner product pipe can be removed and replaced without excavation. In practice, this is a somewhat difficult operation, but it can be done. Not to be outdone, the coaxial flexible-piping manufacturers also offer a 4-inch diameter "chase" pipe. The coaxial pipe can be installed within the chase pipe in the field, thus allowing the coaxial pipe to be pulled out and replaced without excavation. The coaxial piping manufacturers call this large-diameter pipe a "chase" pipe rather than a containment pipe because of patent issues. To further avoid patent infringement claims, this outer pipe is sometimes perforated or else terminated just outside the tank-top containment sump so that it does not function as a containment pipe.

In addition to the actual piping, complete secondary containment of

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recover. If we don't send an NOI, we will send a Notice of Violation or a Secretary's Order with an administrative penalty (and usually include a threat to take over).

We do have a program called First Fund (named for the First State), where we can pay for investigation and remediation of sites that are considered orphan-tank sites. Some of the sites fall into this category because of the date the tanks were last used, or because of the details of ownership changes. We can also use LUST Trust money for some of the sites. Another option is a low-interest loan program that we have. I believe we've also managed to tap into some brownfields money on occasion.

I've been pleased with what we've managed to get done with this program, although I'll admit that it irritates me to offer free work to someone who pretty much ignored our requests to do the work originally. On the other hand, it has gotten many of them off the books so we won't have to mess with them in the future. Now we're at full staff, the goal is to keep more sites from becoming "oldie moldies," where they get handed off every time we get a new project officer. Every time we get a new hydrologist, we each get to hand off a few projects from our caseload. Last time we got a new hydrologist, our manager set a limit on how many oldies we could each dump…errrr… hand off to the new guy. At least some of the sites that we each handed off did not have mold on them! We're gearing up now to schedule a few sampling days when the weather gets warmer, and to get a new round of invitation letters sent out. ■

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piping systems must include liquid-tight sumps that contain the connections between the piping, pump, and dispenser. These sumps are most often constructed of polyethylene plastics or fiberglass. Installation typically includes cutting a number of holes in the sumps to allow piping and electrical conduit to pass through. These field-cut holes must then be made liquid-tight using various fittings and seals.

Achieving leak-tight secondary containment for piping systems, however, has proven to be somewhat difficult (See *LUSTLine* #35, "The Problem with Sumps," June 2000.) Because piping systems are assembled in the field, field conditions and quality-control issues along with inadequate testing at the time of installation have resulted in many secondarily contained systems that are not liquid-tight. As a result, secondary-containment systems often fail to capture liquids leaked from primary piping, thus falling short of their primary purpose: leak containment.

Well, that pretty much brings us up to date on UST-system tanks and pipes. In the next issue of *LUSTLine* I plan to describe pumping systems, vapor-recovery methods, fill pipes, deliveries, and maintenance. If there are any historical footnotes or anecdotes you'd like to add, send me an e-mail: marcel.moreau@juno.com. ■

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