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 haveMarcel discuss, let him know at **marcel.moreau@juno.com.**

Can ATGs Find Leaks in Manifolded Tanks?

I recently received an e-mail from a perplexed regulator who was trying to determine which automatic tank gauges (ATGs) could be used for in-tank leak detection on manifolded tank systems. There has also been a trend lately for petroleum marketers to install blending dispensers to produce the mid-grade product. In some parts of the country, installers are converting three tank/three product storage systems to three tank/two product systems by installing a tank manifold rather than a piping manifold. So this seems like a good time to address the issues surrounding the use of ATGs for leak detection on manifolded tank systems.

Note that newly installed UST systems must use secondary containment and interstitial monitoring for leak detection. This discussion only applies to single-wall UST systems installed before the implementation of the secondary containment requirement.

What Exactly Is a Manifold?

In the UST world, the term "manifold" can be applied to several different aspects of UST systems. Three that come readily to mind are:

- **Tank manifold –** A piping connection between two tanks that allows fuel to freely flow from one tank to another. A tank manifold allows one submersible pump to draw product from two or more tanks, thus increasing the storage capacity for that product (see Figure 1).
- **Piping manifold –** Two submersible pumps provide fuel to a single piping run that supplies fuel to several dispensers. If the two pumps operate together, a piping manifold increases the flow rate through the piping. If the two pumps operate separately, a piping manifold, like a tank manifold, can be used to increase storage capacity.
- **Pump manifold –** A term used to describe the part of the submersible pump located above the top of the tank.

Each of these types of "manifold" brings leak detection issues to mind, but in this article I'd like to focus on tank manifolds and how they affect the ability of ATGs to detect leaks when the ATG is conducting in-tank testing. During an in-tank test, the ATG is monitoring the liquid level in the tank during quiet periods to determine whether a leak is present. This discussion does not apply if the tanks involved are double-walled and the ATG is monitoring interstitial sensors.

How a Tank Manifold Is Set Up

In a typical tank manifold, there are two tanks installed next to one another. Each tank is equipped with its own fill pipe and vent pipe. Ideally, each tank also has the same diameter and the two tanks are installed at exactly the same level in the ground. If an ATG is to conduct testing, each tank will also have a probe to measure the liquid level.

The two tanks are connected together by a piping run that begins near the bottom of one tank, runs out the top of the tank, horizontally over to the adjacent tank and then vertically down to near the bottom of the adjacent tank. This piping run contains no pump mechanism and usually contains no valves. It is often referred to as a "siphon bar." When both tanks have fuel in them and the siphon bar is also full of fuel, the surface level of the fuel in the two tanks will always be exactly equal. If the tank bottoms are at slightly different elevations, the depth of fuel in each of the tanks will be different, but the surface elevation of the fuel will always be exactly the same. Now, if a delivery has just occurred and different volumes of fuel have been delivered into each tank, it may take a while for

■ continued on page 22

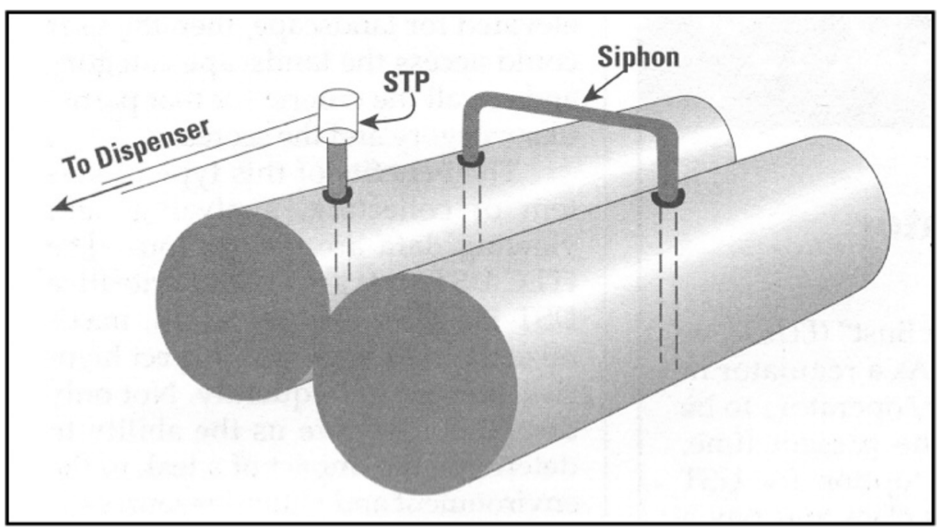

Figure 1. ***Tank manifold.*** *A tank manifold connects two tanks so that product can flow freely from one tank to the other. A tank manifold allows one submersible pump to draw product from two tanks, thus increasing the storage capacity for that product.*

■ **Manifolded Tanks** *from page 21*

the fuel to flow through the siphon until the liquid levels are in equilibrium, but as long as the siphon bar is air tight, this will happen.

What Causes Fuel to Move Through the Siphon Bar?

Though the siphon is simple to construct, there is still some controversy as to exactly what makes a siphon work. For our purposes, let's just say that the weight of the fuel in the vertical part of the siphon above the fuel level in each tank is what drives the siphon. If the level of the fuel surface in each tank is not exactly the same, one leg of the siphon will have a taller column of liquid above the surface, and this taller column of fuel will weigh more than the fuel in the other leg of the siphon.

Gravity exerts a stronger pull on the fuel in this longer column of fuel than it does on the shorter column of fuel. This extra pull on the longer leg of the siphon reduces the pressure in the horizontal portion of the siphon. Think of this lower pressure as pulling the fuel up the shorter leg of the siphon; technically it is the atmospheric pressure pushing down on the surface of the liquid in the tank that moves the fuel up through the siphon and into the tank at the lower level. When the two liquid surfaces are equal, the movement of the liquid stops because now both legs of the siphon contain columns of fuel that are of equal length and equal weight.

Whenever the liquid level in one tank changes, whether it is due to fuel being added during a delivery, fuel being pumped into a vehicle, or a leak, liquid will flow from the higher to the lower liquid level until the two liquid surfaces are again at exactly the same height.

Why Doesn't a Siphon Bar Require Leak Detection?

A siphon bar routinely contains product and at first blush would seem to require leak detection, according to the federal rule. However, the siphon bar operates very much like safe suction. If a hole develops in the siphon bar, the product in the siphon bar piping will flow into each of the tanks and air will be drawn into the siphon, but there should be no leakage into the environment under ordinary circumstances. I can imagine a scenario where a tank is overfilled and fuel is pushed into the siphon bar and potentially out into the environment during the course of a delivery, but this should be a rare event. As a practical matter, no additional leak detection needs to be applied to siphon piping.

How Is a Siphon Bar Filled with Product?

The siphon bar will only work if it is full of liquid. In the days before overfill regulations, this was accomplished by overfilling one of the tanks, thus pushing fuel through the siphon bar into the adjacent tank. In the days of suction pumps, one of the issues with siphon bars was that they would cease to work after a while. This was because even very small leaks in the siphon bar connections would eventually allow enough air to enter the piping and "break" the continuous column of liquid that must be present in the siphon piping for it to work.

Submersible pumps addressed the problem of small leaks in the siphon bar through the addition of a siphon port on the submersible pump. The siphon port is a fitting in the submersible pump manifold that uses the flow of fuel through the pump to create a vacuum. A copper line is run from the siphon port of the submersible pump to the high point of the siphon bar. The submersible pump can generate enough vacuum to remove the air from the siphon bar when the system is first started up, and continues to remove air from the system whenever the pump operates. If no air is present, fuel is drawn through the copper siphon tube.

How a Manifolded Tank System Works

Let's look at an example of how a tank manifold is supposed to work. Imagine you have two tanks manifolded together with a siphon bar between the tanks. There is one submersible pump in Tank #1 (the "master" tank) and Tank #2 has no pump (the "slave" tank). The tanks have been inactive for a while, so the fuel levels in the two tanks are exactly equal. Then a motorist drives up and buys 10 gallons of gas. Ten gallons are pumped out of Tank #1, but as the level of the fuel in Tank #1 goes down, fuel from Tank #2 transfers over to Tank #1. That is the whole purpose of the siphon. After the pumping activity is completed and fuel levels in the two tanks have stabilized, both tanks #1 and #2 will contain five gallons less of fuel.

What's the Problem with Testing Manifolded Tanks?

Now imagine that Tank #1 has a 0.2 gph leak in the bottom of the tank. Assuming no pumping activity, after a period of one hour, 0.2 gallons will have flowed out of the hole in the bottom of Tank #1. This will have lowered the fuel level in Tank #1, so some fuel has also transferred over from Tank #2. How much fuel moves over the siphon from Tank #2? Assuming everything is working properly, at the end of the hour there will be 0.1 gallons less fuel in Tank #1 and 0.1 gallons less fuel in Tank #2. From this example we see that a 0.2 gph leak in one tank of a two-tank siphon system will produce a volume change of 0.1 gallons each hour in each tank. So in a siphon system, if there is a leak in one tank, the observed leak rate in each tank is half the actual leak rate in a two-tank system, and a third of the actual leak rate in a three-tank system.

In order for an ATG to correctly identify leaks in a manifolded tank system, it will have to compare what is happening in all tanks that are manifolded together. Let's assume that there is a 0.2 gph leak in one tank of a tank manifold consisting of three tanks. Over a period of one hour, 0.2 gallons flows out of the bottom of one tank. Because the leak rate is divided among the three tanks, the leak will appear as a 0.067 leak in each of the three tanks ($0.067 \times 3 = 0.2$).

A measured leak rate of 0.067 gph in a single tank would normally result in a passing 0.2 gph test because the 0.067 leak rate is less than the typical threshold leak rate of 0.1 gph required to fail a test. In order to identify the leak, the ATG must be measuring what is happening in each of the three tanks and comparing the results to arrive at a leak rate for the manifolded tank system, not just what is happening in each individual tank. So if an ATG measures leak rates of 0.067 (plus or minus a bit for inaccuracies in the measurements) in three tanks that are manifolded together the test result should be "fail" for a 0.2 gph test for the three tank system. The ATG will fail the manifolded system, but will not be able to identify which of the three tanks has a leak. To identify the leaking tank, the siphon bars between the tanks would need to be disconnected and Individual tank tests would then need to be conducted.

So How Do You Know if a Tank Gauge Can Test Manifolded Tanks?

So now which ATGs can test manifolded tank systems and which cannot? To answer this question, we have to turn to the manufacturer's certification of equipment performance, commonly known as the third-party evaluations. A review of the evaluation summaries presented on the National Work Group for Leak Detection Evaluation (NWGLDE) website reveals that some ATGs have been evaluated for their ability to find leaks in manifolded tanks and some have not. Only ATGs whose evaluation include results for manifolded systems are certified by the manufacturer to find leaks in manifolded systems, so according to the federal rule, these are the only ATGs that can be used for leak detection on manifolded systems.

A review of the evaluation summaries presented on the NWGLDE website reveals that no ATGs that conduct periodic tests were evaluated for their performance in manifolded tank systems. But several brands of ATGs that conduct continuous tank tests did include manifolded tank systems in their evaluations. Remember that ATG testing software can be divided into two types: "periodic" and "continuous." Periodic tests require the system to be shut down for several hours, while continuous tests don't require pumping activity to be interrupted to conduct the test.

Essentially what this means is that the testing software in ATGs that conduct periodic tests is only able to look at the liquid level changes in individual tanks. ATGs that conduct periodic tests do not have the capability to compare the liquid level changes in several tanks that are manifolded together to see if all the tanks are experiencing the same (or nearly the same) level change. ATGs that conduct continuous tests have more sophisticated software that is able to evaluate the leak rates in multiple tanks and accurately determine whether a leak is present in the manifolded tank system.

The Bottom Line

So the bottom line is that ATGs that conduct continuous testing and have used manifolded tanks in their evaluation process can be used for leak detection on manifolded tank systems because their software looks at what is happening in the entire system rather than individual tanks.

ATGs that conduct periodic tests cannot be used for leak detection on manifolded tank systems because their software only looks at individual tanks and not the manifolded system.

Unless...

That said, an ATG that conducts periodic tests can be used on manifolded tanks if the tank manifold is disabled while the test is run. Disabling the manifold can be done if there is a valve in the siphon bar that can be closed to prevent the flow of liquid through the siphon, or if there is a valve that can be opened to allow air into the siphon bar so that the two tanks are now separate. Once the tank manifold is disabled, a periodic ATG can conduct leak detection because the liquid levels in the two tanks will now vary independently of one another.

At least one periodic ATG manufacturer provides a remotely operated valve that is controlled by the ATG. When it's time to conduct a test, the ATG opens the valve to allow air into the siphon bar so the tanks are separated, conducts the test, and then closes the valve so that the submersible pump can re-establish the siphon the next time the submersible pump comes on.

Any More Questions?

If you have more questions about tank manifolds or any other questions involving leak detection issues, send me a note at: marcel.moreau@juno.com. I'll answer you privately if I can, and your question may become the prompt for a future *LUSTLine* article. ■

Ken Wilcox Made Honorary Member of the UK-Based Association for APEA

Ken Wilcox (right) was made an honorary member of the UK-based Association for Petroleum & Explosives Administration (APEA) for his services to Leak Detection this November at APEA's Annual Conference in Coventry, England. According to Jamie Thompson (left) APEA Member and all round UK tank guru, "Ken has been very instrumental around the world and especially in the UK for bringing credibility to leak detection. He has provided useful comments on our standards on leak detection and in the past has spoken at our conferences." APEA Chairman Killian Tallon (center) presented the award.

Back in the states, Curt Johnson, speaking on behalf of members of the National Work Group for Leak Detection Evaluation (NWGLDE), says the work group considers Ken Wilcox to be "the father of petroleum tank leak detection evaluations." According to Johnson, "Ken has performed 78 percent of all leak detection evaluations listed by the NWGLDE."

Congratulations Ken! ■