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News and Notes for the Fuel Dispensing Industry Professional

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Chapter 2

Performance Differences between Stage II Vapor Recovery Balance vs. Assist

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In This Issue

Hello!

In part one of this special series, we described some of the differences between how a Balance System works vs. an Assist System. Currently, there is a great deal of discussion happening in the industry around the performance differences between these two systems.

With the Assist Systems having the sensitivity with the V/L requirement; the necessity of a good seal at the filler neck; and the need to detect the ORVR vehicles to operate properly, the complexity of the Assist System lends itself to performance issues if the equipment is not working as designed.

With the urgency of this topic, VST decided to pull this subject forward in this series and address it sooner rather than later.

Until next time,

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Performance Differences between Stage II Vapor Recovery: Balance vs. Assist

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PERFORMANCE ISSUES

Although all EVR vapor recovery systems and related components have to be tested and certified to the same performance standards for reducing vapor emissions, there are performance differences between the various systems and components that can, and do, create ISD (In-Station Diagnostics) alarms which add maintenance costs. One big difference that's becoming a prominent issue is something called "Over Pressurization" or OP for short. In order to reduce a source of vapor emissions referred to as "Fugitive Emissions," all EVR vapor recover systems are required to maintain the Underground Storage Tank(s) at or below a certain pressure. These UST pressure limits are being monitored by the ISD system, and OP alarms will result if the UST pressure limits are exceeded.

For the last few years, CARB has dealt with the OP issue, which shows up most prominently during the winter fuel period, by issuing Special Advisory 405. Since the cause(s) for OP were not clearly understood, and therefore the cure unknown, SA 405 has been a stopgap measure to allow GDFs to basically ignore/clear any OP alarms occurring during the winter fuel period. Although SA 405 applies to all GDFs, the OP issue has been almost exclusively an issue with GDFs using the Assist system. The situation has been further escalated within the last couple of years by the occurrence of Over Pressurization While Dispensing, or OPWD. OPWD occurs during normal operating hours, and is again, something exclusively associated with GDFs using the Assist system.

INTRODUCTION OF ON-BOARD REFUELING VAPOR RECOVERY (ORVR)

To understand the causes for OP and OPWD, we need to understand several things about how both the Balance System and the Assist System work, how they interact with the vehicles being refueled, and a little history. Starting in 1998, cars (with trucks following a few years later) in the US had to be produced with a new type of vapor recovery system, one that is on board the vehicle itself, called ORVR. Over the years since then, as new vehicles have been produced and have gradually replaced the older pre-ORVR vehicles, the percentage of ORVR vehicles that make up the vehicle population has increased. The current estimate has the ORVR population at about 75% - 80% of the vehicle fleet. Back in the pre-ORVR days, when a car was being refueled using a vapor recovery nozzle, as one gallon of gasoline was pumped from the UST (Underground Storage Tanks) into the vehicle fuel tank, a gallon of saturated gasoline vapor was pumped from the vehicle fuel tank into the UST. This 1:1 replacement ratio of liquid gasoline for saturated vapor in the UST kept the UST pressure more or less stable, thereby reducing the tendency to pressurize, or create a vacuum, in the UST. With an ORVR vehicle, there is no saturated gasoline vapor available to return to the UST, as that is all being captured and retained on the vehicle itself. With no vapor available to return to the UST, all that can be returned will be purely air.

So why does this matter? When air is introduced into the UST it will vaporize some of the liquid gasoline in the tank; that is, the volume of vapor will grow, or more correctly, it will try to grow. Since the UST is a rigid container and not a balloon, the volume cannot grow, so instead the pressure will increase. Winter fuel blends will vaporize more than summer fuel blends, with about 30-50% vapor growth for winter fuels and 20-30% vapor growth for summer fuels. As you can see, we now have a mechanism that will affect the UST pressure related to how the vapor recovery system deals with air being returned to the UST when refueling ORVR vehicles

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The next piece of the puzzle is to understand how an ORVR fill neck functions differently than a non-ORVR fill neck. The older non-ORVR fill neck is really just a big tube that the nozzle goes in. As gasoline is pumped into the filler tube, gasoline vapor from the vehicle tank can flow right back out of it, where it can then be captured by the vapor recovery nozzle. The ORVR fill neck is much different. It may look similar at the opening where you insert the nozzle, but past this visible portion, the fill neck tube reduces down to a very small diameter. This is done so that the gasoline being pumped into the filler tube will effectively block the tube and prevent any gasoline vapor from traveling back up through the tube to the nozzle. The vapor in the vehicle tank is instead forced to go into a vapor canister on the vehicle where it is captured. There is a phenomenon known as “air entrainment” that occurs because of the fluid dynamics of the ORVR filler neck design, which results in the gasoline flowing into the ORVR filler neck actually “pulling” a small amount of the surrounding air in with it. This air entrainment phenomenon is acting as a pump, and similar to any other type of pump, if the inlet is blocked, it will create a vacuum or suction.

How the Balance and the Assist Systems interact with an ORVR filler neck are very different. When a Balance nozzle is being used, the face seal of the nozzle will seal up against the face of the filler neck, and there will then just be a passage way from the nozzle through all of the vapor plumbing back to the UST. If there is no vapor being returned from the vehicle’s filler neck, then there is no flow back to the UST, and the V/L ratio will just be 0.0. With nothing being returned to the UST, as liquid gasoline is being pumped out of the UST, the pressure in the UST will be reduced, and the result is typically the UST being under a vacuum or negative pressure. It is because of this behavior that the Balance System is considered to be “ORVR Compatible,” which means it can be used to refuel ORVR equipped vehicles without causing the UST to pressurize.

How the Assist System interacts with an ORVR equipped vehicle is different because of the dispenser vapor pump. In the pre-ORVR days, Assist nozzles did not seal against the filler neck, but instead, just had a passageway in the spout whereby the vapor pump would draw in the gasoline vapor coming out of the non-ORVR filler neck, and pumped the vapor into the UST. Assuming the V/L was set to about 1:1, a like exchange of volumes in the UST would keep the UST from pressurizing, and the Assist System would operate very similarly to a Balance System when used on non-ORVR vehicles. With an ORVR equipped vehicle, there is no gasoline vapor available for the Assist nozzle to collect and return to the UST. Because the vapor pump is still pumping from the nozzle to the UST, an Assist nozzle will just collect air when used with an ORVR vehicle, and this air will be pumped into the UST. As mentioned previously, when air is ingested into the UST, it will vaporize liquid fuel in the UST and expand, which then causes the UST to grossly over pressurize. Something has to be done to limit this air ingestion into the UST to make the Assist System compatible with the ORVR vehicles.

ASSIST SYSTEMS COMPATIBILITY WITH ORVR

The current EVR Assist nozzle has a boot and face seal on it very similar to what is found on a Balance nozzle so that it too can now be sealed against the filler neck. This is purposefully done as a way to sense when the Assist nozzle is being used on an ORVR vehicle. As described earlier, the ORVR fill neck acts like a pump (from the filler neck opening into the filler tube) due to the air entrainment, and with the Assist nozzle now sealed against the filler neck, the vapor pump in the dispenser is trying to pump from the filler neck opening back to the UST. These opposing pumping actions create a high vacuum within the vapor passage in the nozzle. A diaphragm located in the nozzle senses the high vacuum present with an ORVR vehicle refueling, and it operates a valve to reduce the V/L and limit the amount of air being returned to the UST by the vapor pump. It is in this way that the Assist System was modified from the pre-EVR Assist system to make the EVR Assist system ORVR compatible.

Prior to the introduction of ORVR vehicles, CARB did a study to determine how to quantify and determine if a vapor recovery system is ORVR compatible. A maximum V/L of about 0.6 when refueling an ORVR vehicle was found to be required for a system to be considered ORVR compatible. This is fairly obvious when you consider winter fuel vapor growth values of 50%, a 0.6 V/L of straight air being introduced into the UST will result in an actual V/L of 0.9 when the vapor growth is taken into account (0.6 x 1.5 = 0.9), which is right at the threshold of what would cause UST pressurization. The Balance System will typically return a 0.0 V/L and the Assist System a 0.3 V/L when refueling ORVR vehicles, so it is the normal behavior of both the Balance System and the EVR Assist System to create a vacuum in the UST during normal daily refueling operations because of the ORVR compatibility of each system.

So what could go wrong? When EVR Systems, both Assist and Balance, were first introduced, OP and OPWD were practically unheard of, so something must have changed since then. There have been theories speculating it may be due to changes with the gasoline, but this cannot be a factor. Although the blend of components in gasoline has changed due to the elimination of MTBE and Ethanol mandates, the measure of the gasoline's volatility, RVP (Reid Vapor Pressure) has not, and this factor is closely controlled. It is true that the RVP increases for winter fuels and decreases for summer fuels, which does influence why OP is more prevalent during the winter fuel period. We will discuss the overriding factor with OP and OPWD first, then discuss some other less prevalent issues.

We described how the Assist System was modified from the early pre-ORVR version to make the Assist System ORVR compatible, which required that the Assist nozzle make a seal with the filler neck of an ORVR vehicle. VST has done extensive studies of all types of filler necks, both ORVR and non-ORVR, and it is clear that it would be nearly impossible for a nozzle to be able to make a seal on every variety of filler neck given the various manufactures and their different designs. If a Balance nozzle does not make a good seal on an ORVR vehicle, the result may be a small amount of air leakage into the UST, but the resulting V/L still remains well below the ORVR compatibility threshold, and the UST will remain at a vacuum. On the other hand, when the Assist nozzle does not make a good seal on an ORVR vehicle, it is a different story. Without a good seal, the ORVR detection diaphragm will not be able to sense the ORVR vehicle, and the V/L will not be reduced. There is a vapor pump running and the result is a full 1.0 V/L of air being pumped into the UST. The vapor growth will occur at a rate of 20-50% for each ORVR vehicle that is not detected.

VST has monitored Assist sites and found average ORVR recognition rates at the GDF as low as 40% for the Assist System, and as low as 25% for an individual nozzle. Since the actual ORVR population is closer to 75% - 80%, this means the miss-identification rate is about 50%, or ½ of all ORVR vehicles are not being identified as such by the Assist nozzle. Under these circumstances, the average ORVR V/L will work out to be above 0.6, and as expected, results in OPWD, typically with the site venting at 3 IWC. Since the site is at positive pressure all of the time, the CAS vapor processor is already full; and therefore, the vapor bypasses the CAS and vents out the PV Valve.

The circumstances for OP are basically the same issue. With poor ORVR recognition rates, the inherent tendency for the UST to be at a vacuum due to the refueling of ORVR vehicles is lost. Thus, the UST will be sitting at perhaps a very small vacuum, or at a positive pressure, as the site either closes for the night or activity diminishes. The way the CAS vapor processor functions is, (1) if there is any vacuum in the UST, the CAS is empty, and (2) if there is any pressure in the UST, the CAS is filling or may be full already, with no capacity left to absorb the overnight vapor expansion that will occur. With winter fuel and the high RVP/expansion rate, these conditions will make it difficult for the CAS to have the capacity to prevent OP from occurring.

SOLUTIONS FOR OP AND OPWD

Obviously the primary solution for this problem would be to correct the deficiencies of the Assist nozzle related to the ORVR recognition issue. Whether or not this is attainable is unknown.

The purpose of the vapor processor on a vapor recovery system is to adequately deal with UST pressurization so as to prevent OP alarms from occurring. The CAS is currently the only type of vapor processor that has been approved for use on the Assist System. However, this behavior of the Assist System related to poor ORVR recognition rates, prevents it from working as it was originally designed. The poor ORVR recognition would also negatively impact the ability of some other types of processors to function properly. For instance the Veeder-Root canister requires a certain level of continuous vacuum in the UST during the active daytime periods in order to purge properly after the night time pressurization periods. If this UST vacuum is not achieved due to the poor ORVR recognition of the Assist nozzle, the canister will not be purged, and it will not be able to prevent OP from occurring any better than the CAS is capable of doing. Certainly the passive processors are, or would be, challenged by the nozzle behavior causing the problem, and neither can work at all with OPWD. The only processor solution for the problem would require an active processor like the VST Green Machine, which can operate independently of the UST vacuum/pressure conditions, and has the capacity to even deal with OPWD.

The simple solution is to convert the Assist System to the Balance System. This option is already CARB certified and available. VST recognized the need to make this solution available a few years ago and came up with the VST ZERO System, which allows a GDF to keep their CAS in place, simply replace all of the Assist hardware with Balance hardware, and remove the expensive vapor pumps from the dispensers.

OP and OPWD have been escalating as the percentage of ORVR vehicles increases. The problems caused by improper ORVR identification by the Assist nozzle will only continue to increase as the ORVR population continues to increase towards 100% over the next several years.