News and Notes for the Fuel Dispensing Industry Professional

The Voice

Chapter 3 **SPECIAL EDITION** **April 10, 2015**

BALANCE EVR SYSTEMS:

650 Pleasant Valley Drive * Springboro, OH 45066 * www.vsthose.com * (937) 704-9333

Hello!

In Chapter 3 of our "Voice-Special Edition" series, we are going to discuss another buzz word that has been going around: "Reverse Flow," or a "negative V/L," which is related to something that occurs with a Balance System when refueling some ORVR vehicles.

Although some in the industry have criticized the Balance System for this phenomenon, it is perhaps done without understanding what it really is and why it occurs. These "negative V/Ls" are just a function of the fluid dynamics taking place, and they do not represent any failure of the Balance System.

This phenomenon has been known to those with access to the ISD data since the first EVR Balance System certification about 10 years ago, so it is really nothing new.

Reverse Flow does not create any emissions, and if anything, will actually work to help create vacuum in the Underground Storage Tank (UST).

Until next time,

Rodger

Rodger Grantham
Vice President, Research & Development

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ORVR VEHICLE FILL NECK – AIR ENTRAINMENT PHENONMENON

As we described earlier in Chapter 2, the design of the ORVR filler neck makes it function as a pump due to the air entrainment phenomenon. When the Balance nozzle is sealed against an ORVR filler neck, there is now just an open passageway between the ORVR filler neck and the UST. As gasoline is pumped into the ORVR filler neck, the air entrainment can literally pump (positive) or pull (negative) vapors from the UST into the ORVR equipped vehicle.

There is a very basic rule in fluid dynamics that fluid flow will only occur in one direction, from the higher pressure value to the lower pressure value. As long as the ORVR filler neck is creating a lower pressure than what is in the UST, vapor can flow from the UST to the ORVR filler neck.

Typically the negative V/L or Reverse Flow value will not be very high, usually on the order of -0.1 to -0.2, and the instances of Reverse Flow are actually limited in number and do not occur with every ORVR filler neck. As you can see, the mechanism that creates a negative V/L is really very straightforward and easily understood.

THEORIES OF THE CAUSES OF REVERSE FLOW - MATCHING ISD DATA TO VEHICLE INFORMATION

Some who have looked at ISD data and have seen these occasional occurrences of Reverse Flow have conjectured some theories of what is going on, perhaps attempting to attach a negative connotation to the Balance System.

To truly understand the meaning of the ISD data, and to therefore arrive at the correct conclusions, the ISD data cannot be viewed alone. The ISD data does not directly identify the type of transaction occurring, i.e. ORVR vehicle, non-ORVR vehicle, gas can, motorcycle, etc., so to complete the picture, each ISD transaction has to be correlated with vehicle survey data of the transactions occurring during the day.

Of course this requires a lot of work, with someone physically at the GDF recording all of this information, but this is something that VST has actually done. On the next page, in Table 1 ,is a brief snapshot of this type of survey work, showing some of the Reverse Flow that was recorded by the ISD and the corresponding vehicle survey information.

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DATE	TIME	DUR	A/L	VAPOR	FUEL	FPS	VEHICLE TYPE	UST Pressure
9/10/2014	10:41:48	158	-0.28	-3.7	13.3	8	2012 Hyundai Sonata	-1.57
9/10/2014	9:48:57	162	-0.23	-3.4	15	9	2003 Jeep Liberty	-1.376
9/10/2014	10:47:00	188	-0.11	-1.6	15.1	8	2015 Buick Enclave	-1.622
9/10/2014	11:06:01	129	-0.05	-0.6	10.3	4	2008 Nissan Sentra	-1.727
9/10/2014	11:37:05	171	0	0	9.9	4	2008 Toyota Highlander Hybrid	-1.619
9/10/2014	10:04:30	120	0	0	10.8	6	2013 Ford Escape	-1.412
9/10/2014	11:07:06	137	0	0.1	13.1	1	2012 Toyota Venza	-1.728
9/10/2014	11:49:46	139	0.01	0.2	13	9	2011 Mitsubishi Endeavor	-1.554
9/10/2014	11:42:11	33	0.08	0.2	2.2	8	2004 Mazda 3	-1.566
9/10/2014	11:34:24	160	0.09	0.9	10.8	3	2014 Honda CR-V	-1.688
9/10/2014	10:22:20	209	0.14	2.5	17.5	8	2007 Mercedes E350	-1.447
9/10/2014	10:23:43	56	0.15	0.4	2.6	1	2013 Chrysler 200	-1.449

Table 1: ISD Transaction Data Correlated to Vehicle Information

As you can see from this data sample, each occurrence of Reverse Flow coincides with refueling an ORVR vehicle.

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THEORIES OF THE CAUSES OF REVERSE FLOW – FLOW OUT OF THE BALANCE NOZZLE

One of the theories that has been proposed would have Reverse Flow being caused by leakage from the UST, out of the nozzle, and into the air. Again this probably stems from a lack of understanding of how the ORVR fill neck functions.

Referring to the ISD data in Table 1, we can see that the Reverse Flow has occurred while the UST is at a vacuum. As mentioned previously, a basic rule of fluid dynamics requires that flow will occur only in one direction, from the higher pressure to the lower pressure. If there had been any leakage between the nozzle and the fill neck, any flow would have to be from the outside air into the UST, resulting in a positive V/L.

POSITIVE UST PRESSURE AND PASSIVE PROCESSORS

Up to this point in the discussion of Reverse Flow, we have considered the normal operating condition of the UST with a Balance System having a vacuum present in the UST.

There are times when the UST can be at a positive pressure, which is of course why some type of vapor processor has been required on all EVR Systems. As described earlier, the interaction of the Balance System with ORVR equipped vehicles will create a vacuum in the UST. Having a positive pressure in the UST requires a lack of activity, such as when a GDF shuts down over night, or when it has very little activity during the overnight period.

The tendency of the UST to have a positive pressure is mostly limited to the winter months when the high RVP gasoline is required, and it is limited to the passive type processors. The VST active processors will operate when the UST pressure becomes positive and will immediately reduce the UST pressure back to a vacuum. The Franklin Clean Air Separator (CAS) and Veeder-Root Canister, both passive processors, actually need the positive UST pressure to operate, since the pressure is needed to drive the vapor flow into these processors. What the passive processors try to achieve is to limit the positive pressure to about 0.25 IWC so to avoid the Over-Pressure Alarm threshold.

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So, we have these scenarios where we could see Reverse Flow:

1. A good seal at fill neck of ORVR vehicle and positive or negative UST pressure
2. A bad seal at fill neck of either ORVR or non-ORVR vehicle and positive UST pressure
3. No seal on a gas can or motorcycle and positive UST pressure

Scenario 1) has been explained already, and it makes up about 97% of all –V/L transactions. There are no requirements or standards for Scenario 3) to even consider for this discussion.

Let's take a look then at Scenario 2). Of course it will be difficult to have Reverse Flow occurring at a GDF that shuts down at night. During the period while it is open, the transactions with ORVR vehicles will create negative UST pressure. When it is closed and the UST pressure may become positive, there will be no transactions taking place. ISD data was analyzed from some 24-hr. GDFs to see what sort of Reverse Flow had occurred during periods of positive pressure (these sites have a passive processor).

As an example, six months of data was analyzed from a GDF, from the end of May to the end of December, encompassing both summer and winter fuel periods. During the six months, there was:

1. A total of 79,771 transactions that took place,
2. A total of 1,015,755 gallons were dispensed, or an average of 169,290 gallons/month.

In order to analyze the impact of scenario 2), the ISD data was filtered to find only those transactions with:

a. Negative (-) V/L,
b. Positive (+) UST pressure, and
c. Transactions over 4.5 gallons
d. Not during a fuel drop

The criterion of c) was used to eliminate the transactions of scenario 3), gas cans and motorcycles. Additionally, all transactions that occurred during fuel drops were eliminated per CARB practice. Fuel drops are short duration events that typically produce some large swings in UST pressure, both positive and negative. UST pressures of over 5 IWC are not uncommon for short durations during fuel drops.

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A small sample of the data examined is shown below:

Date/Time	V/L	Vapor	Fuel	FP	UST Pressure
11/26/14 5:31	-0.1	-1	9.7	1	0.284
11/28/14 5:14	-0.1	-0.9	9.1	2	0.163
12/5/14 6:31	-0.1	-0.9	9.2	9	0.062
11/18/14 1:48	-0.1	-0.7	6.5	7	0.039
12/8/14 22:12	-0.1	-0.7	6.6	3	0.031
12/19/14 22:00	-0.1	-0.7	7.6	4	0.071
12/19/14 5:35	-0.1	-0.7	6.8	8	0.076
11/29/14 5:47	-0.1	-0.6	6.5	1	0.079
11/22/14 23:09	-0.1	-0.5	5	4	0.013
12/13/14 6:57	-0.09	-1.8	19.3	0	0.113
11/8/14 7:36	-0.09	-1.7	17.9	1	0.01
12/2/14 1:06	-0.09	-1.6	17.6	9	0.17
11/22/14 23:22	-0.09	-1.4	15	2	0.137
12/1/14 21:58	-0.09	-1.4	15.3	1	0.026
12/1/14 21:15	-0.09	-1.4	16.5	9	0.163
11/14/14 21:32	-0.09	-1.3	14.1	7	0.013
11/17/14 23:26	-0.09	-1.3	14.5	6	0.085
11/27/14 0:08	-0.09	-1.3	15.4	6	0.066
11/26/14 6:41	-0.09	-1.2	13.9	1	0.159

Table 2: Sample of the 6 Months of ISD Data (May to December)

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A review of all of the data, draws the following conclusions:

- There were a total of 827 transactions that met the criteria of –V/L, +UST pressure, more than 4.5 gallons was dispensed, and no fuel drop was occurring, out of 79,771 total transactions.

- Essentially, 100% of these transaction occurred over a 60-day period from the end of October to the end of December, which is of course the winter fuel period. Additionally, almost all of these transactions occurred during the "slow period" for the GDF, roughly between 10:00 PM and 7:00 AM, which is when we would expect a positive UST pressure to occur.

- The most current estimate of ORVR vehicle population by CARB and the Federal EPA, based on gasoline dispensed, is 85% (vs. about 80% for the actual number of cars), so 85% of these transactions will statistically be for ORVR vehicles, and 15% can be credited to non-ORVR vehicles. Therefore,
    - The average of non-ORVR vehicles/day is 2.07
        - (827 transactions*15% Non-ORVR vehicles /60 days), and
        - 11.72 ORVR vehicles/day, i.e. for the +UST pressure time period
            - (827 transactions*85% ORVR vehicles/60 days).

- The total negative vapor flow over this 60 day period was 1547 gallons, or an average of 25.8 gallons/day. This equates to 3.87 gallons/day of vapor loss from the UST due to Reverse Flow while refueling non-ORVR vehicles.

- The average vapor recovery efficiency for a Balance System refueling non-ORVR vehicles is 98.5%. If the daily transactions between ORVR and non-ORVR were divided by the volume dispensed (85% and 15%), there would have been a total of 66.5 non-ORVR transactions/day, with 64 of these at 99% efficiency, and 2 at what amounts to a -18% efficiency when we count in the 3.87 gallons of vapor loss due to Reverse Flow. This reduces the average non-ORVR daily collection efficiency to 95%. By looking at it this way, the worst case scenario is seen by assuming the Reverse Flow vapor loss is corresponding to two non-ORVR refuelings with a 0% efficiency. This is not likely to actually happen, but it emphasizes the minimal impact this Reverse Flow is having on the Balance System efficiency.

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- With a stated ORVR System efficiency of 98%, the overall system efficiency (during the winter fuel period) would be 97.5%. During the summer fuel period, the overall system efficiency would be 98.2%.

The conclusion is that the Reverse Flow effect on the system efficiency is very small. It is projected that the percent of the ORVR vehicle population by volume of fuel dispensed will increase to about 95% within 5 years, so the overall occurrences of Reverse Flow with non-ORVR vehicles will decrease over time. It is perhaps interesting to note that the decrease in non-ORVR vehicles (projected to occur by 2020) will have very little effect on the system efficiencies we have investigated here with the overall system efficiency remaining at around the 98% level. Any changes that do occur will be positive in nature, which is quite the opposite of the assist ORVR recognition problem discussed in Chapter 2. Increases in ORVR population will increase the tendency of a Balance site to have negative UST pressure. Decreases in non-ORVR population will decrease the opportunity for Reverse Flow to happen even during winter fuel periods. The Balance System will stabilize towards the 98% ORVR System efficiency.

Any Reverse Flow that does occur with non-ORVR vehicles, or even gas cans or motorcycles, is driven by a positive UST pressure, so all of this could conceivably be eliminated by always having a negative UST pressure. Just using an active processor, like the VST Green Machine, vs. the passive processors would achieve this almost in entirety as any time periods spent at a positive UST pressure would be very small, but the current operating conditions and allowable limits on UST positive pressure utilized by the passive processors are within the CARB approved EVR standards.

In closing, these "negative V/Ls," or Reverse Flow, are just a function of the fluid dynamics taking place, and they do not represent any failure of the Balance System. Reverse Flow does not create any emissions, and if anything, will actually work to help create vacuum in the UST.