A Nozzle Solution to a Vapor-Recovery Problem

When you want to make a nozzle better, where do you start? It all depends on the goal you have in mind. First in a three part series on nozzle technology today. Harco Industries’ Daniel J. Harrington and Healy Systems’ James W. Healy report.

An invitation to share technical information — improving Stage II and ORVR compatibility

The recent federal mandate for Onboard Refueling Vapor Recovery (ORVR) systems on new passenger cars and light duty trucks (being phased in between model years 1998 through 2006) created a dilemma for vacuum-assist Stage II vapor recovery systems. When a vacuum-assist Stage II nozzle meets up with a vehicle equipped with an ORVR system, the Stage II System has no vapor to recover from the fillpipe (assuming, of course, that the ORVR system does its job). So, rather than vapor from the vehicle fuel tank, the vacuum-assist Stage II system returns vapor-free air (referred to as pure air) to the underground storage tank (UST.)

Working against each other

When a vacuum-assist nozzle draws in pure air, vapor-recovery efficiency is reduced. Two factors are responsible for the efficiency reduction:

- First, the vacuum-assist system tends to draw in a larger volume of air than the volume of vapor that would have been drawn in if an ORVR system were not involved. This is because pure air is not as dense as gasoline vapor (lighter in weight per unit of volume) and has lower viscosity (the relative resistance to flow).
- Second, and most importantly, the air promotes evaporation of gasoline inside the underground storage tank.

Both of these conditions tend to overfill the UST’s vapor space, which causes a pressure increase inside the UST. When UST pressure is positive, vapors will leak from any breaches in the tank and piping system (fugitive emissions). And, if the pressure increases sufficiently, the UST’s vent valve will open and discharge gasoline vapors into the environment. Both of these conditions reduce the vapor-recovery efficiency of the total system.

Smart interface technology

Some major service station equipment manufacturers have been, and are, funding an array of
research and development projects to solve this problem. Most of these projects aim to provide a “smart” interface that enables a vacuum-assist nozzle to reliably detect the presence of an ORVR-equipped vehicle during refueling.

In addition, most of these projects focus on hydrocarbon concentration sensing as a means to identify ORVR vehicles. Other research has investigated the change in heat transfer rates of the gas in the vapor-return stream or variations in the electric current required by the motor driving the vacuum source to detect ORVR vehicles.

Once an ORVR vehicle is detected, it is a straightforward engineering task to design the necessary means to reduce the volume of air returned to the UST by the Stage II vapor pump to an acceptable level. To be acceptable, this level must accommodate the expected volume increase produced by introducing pure air into the UST.

Healy Systems, Inc., has developed and patented “smart interface” technology that solves this very perplexing problem. The technology is a simple nozzle-mounted device that senses the difference in the vehicle fillpipe pressure when fueling ORVR versus non-ORVR vehicles. When the ORVR vehicle is sensed, the air flow through the nozzle’s vapor return path to the UST is reduced.

The sensing system includes a small vapor escape guard (VEG) with atmospheric bleed holes that prevent sealing to the fillpipe. The pressure within the VEG will remain at atmosphere when refueling non-ORVR vehicles and will decrease when refueling ORVR vehicles. Figure 1 is a photograph of a Healy nozzle equipped with the ORVR sensor.

In conjunction with the VEG, a flexible pressure-sensing diaphragm is held in a clear or open position (by a spring) relative to a quarter-inch diameter orifice in the vapor return flow path. The diaphragm remains in the open position when non-ORVR vehicles are being fueled, allowing refueling vapor to be returned to the UST. See Figure 2.

Figure 2: Inside look at Stage II nozzle equipped with ORVR sensor as it is used to fuel a non-ORVR vehicle.
When fueling of an ORVR vehicle begins, however, a slight vacuum is created in the VEG, which overcomes the spring force.

This allows the diaphragm to move to a blocking position, thus closing the orifice and reducing airflow. When fueling of the ORVR vehicle is complete, the vacuum is gone and the pressure-sensing diaphragm goes back to the open position. See Figure 3.

Figure 3: An inside look at a Stage II nozzle equipped with an ORVR sensor as it is used to fuel a vehicle equipped with an ORVR system.
The system is designed to control the volume of air returned to the UST to less than 50 percent of the volume of gasoline delivered to an ORVR vehicle. Since the amount of air returned would be less than five gallons for each ten gallons of liquid gasoline removed from the UST, a slight vacuum will be produced in its vapor space. Negative pressure conditions eliminate the problem of fugitive emissions, thus enhancing the vapor recovery efficiency of the system.

This “smart interface” technology can be used on Healy and other vacuum-assist Stage II systems. The Healy Model 400 ORVR nozzle is currently certified under California’s Air Resources Board (CARB) Executive Order No. G-70-186. The Models 600X and 800 vacuum-assist nozzles with the ORVR-sensing feature are also certified to be ORVR-compatible under CARB’s Executive Order G-70-191. Both of the models include a VEG and ORVR sensor (see Figure 1).

James W. Healy was the President of Healy Systems, Inc. and is currently retired.