Getting Rid of Nozzle Splashback

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When the nozzle “won’t shut off”
Gasoline nozzles today have safety and pollution control features undreamed of 50 years ago. They demonstrate an understanding of disciplines ranging from metallurgy to molecular biology. They also represent years of experience, field work and attention to detail. Two common field complaints — the nozzle is “clicking off” and the nozzle “won’t shut off” — arise from the same phenomenon, and can be corrected with the appropriate technology. (A nozzle that is perceived as one that “won’t shut off” is usually accompanied by a “splash-back spill.”) Let me explain both the problem and the solution by starting with a simplified description of how an automatic nozzle shuts off when filling a car.

Automatic shut-off design
As gasoline flows through a nozzle, it passes through a venturi that creates a vacuum. This vacuum is bled off through a tube inside the nozzle spout. Turn a spout over and you’ll see the sensing hole that connects to this tube. Look inside the spout and you’ll see this connection. As gasoline flows through the venturi, the air is being sucked in through this sensing hole, through the tube and back up to the venturi. So as gasoline is flowing out the nozzle, air is flowing in the sensing hole (bleeding off the vacuum), getting mixed into the gasoline at the venturi and moving back out with the gasoline. Everything is in balance.

When the car’s tank is full, the level of gasoline rises in the fill pipe of the car and covers the sensing hole. The flow of air is effectively shut off and the venturi sets off a chain reaction in the automatic shut-off portion of the nozzle. As the vacuum in the venturi area builds, the diaphragm (which is connected to the venturi) begins to sense a higher vacuum. Once this vacuum reaches a pre-set level, the diaphragm moves, causing the nozzle to trip off. We refer to this as an automatic shut-off mechanism. Once again, everything is in balance.

Figure 1: Model of a conventional gasoline nozzle. Courtesy of Husky Corporation.

Figure 2: Blow-up of a vacuum recovery and conventional nozzle spout. Courtesy of Husky Corporation.

The problem

Now the problem. Picture what really happens when a car is being refueled. After the nozzle has correctly shut off, doing everything it was supposed to do (shut off when full), some customers try to second-guess the nozzle and add more fuel (“topping off”). Since the tank is already full, this additional gasoline rushes back up past the sensing hole at such a velocity that, while the nozzle will shut off again, there may be “splash-back spillage” out of the car onto the customer’s shoes. Next ensues a colorful conversation between the customer and station attendent regarding the “fact” that the nozzle didn’t shut off.

Why would the customer second-guess the nozzle’s ability to determine whether or not the tank is full? Well, when spouts experience wear over their lifetimes, the ends of most spouts are damaged by being rolled in. This rolling in or peening in makes the opening at the end of the spout smaller and smaller (see photo).

This decrease in the size of the spout’s opening increases the velocity and turbulance of the fuel entering the fill pipe — just like when you stick your thumb over the end of garden hose (and spray anybody within shooting distance). When the turbulent flow hits the sides of the fill pipe at this increased velocity, the fuel may be shot up to the sensing port and prematurely simulate a full tank, thus causing the nozzle to shut off.

The customer tries again, knowing he didn’t get enough gas the first time, and still gets the same result—what we would call “clicking off .” The customer may then second-guess the nozzle and “click on” when the tank really is full. Now he’ll get a different result—what we would call “splash-back spillage” or a perceived “won’t shut off.”

On the left is a worn spout with stainless steel bushiing. In the middle is a new spout with bushing. On the right, a used aluminum spount without bushing shows the extreme rounding resulting in a hook-like effect

The solution

Husky’s solution is to prevent the spout from rounding in. To do this, Husky has added a stainless steel spout bushing inside the spout outlet of unleaded nozzles. The outlet end of the spout is counter-bored to accept the stainless steel bushing, and the bushing is produced from a solid bar of stainless steel. A groove is machined on the outside of the bushing, and the inside is tapered in for the purpose of directing the flow in a smooth stream.

Assembly consists of press fitting the bushing into the spout and then staking the spout to the bushing groove. The bushing eliminates rounding in because the steel is harder than aluminum and adds thickness to the end of the spout. In this manner, the steel supports the aluminum. Now, as the end of the aluminum spout thins out due to abrasion and impact, it can no longer round in because of the support of the bushing.

This simple bushing accomplishes several things:

• First, it prevents the spout from rounding in, minimizing possible reductions in the size of the spout opening and potential “clicking off” scenarios.
• Second, by its interior design, the bushing directs the flow (similar to a choke on a shotgun), thus reducing turbulance.
• Third, the bushing reinforces the aluminum spout and stops it from going “out-of-round” because of dropping or abuse (such as using the nozzle spout to raise the lever to activate the dispenser). While the bushing can’t stop a customer from topping off, it will decrease the unintended results of doing so.

Unleaded spouts are supposed to be manufactured to 13/16” (.812”) outside diameter because the inside diameter of the leaded restrictor (inside the fill pipe) can be as small as .840 inside diameter. Should a spout become out-of-round (oblong) and become larger than .0840 in one dimension, customers will force the nozzle through the leaded restictor. The spout is then stuck.

After the nozzle shuts off, the customer will then have to “jerk” the nozzle out, thereby applying tremendous forces upon the area where the spout is attached to the nozzle body. Because of this stress, you are creating a potential for a leak area. Any potential leak is a safety, fire and emissions control issue. A simple Husky stainless steel bushing would help prevent this rounding in and subsequently eliminate a multitude of problems.

The applications of technology discussed above are so simple. But it’s the attention to detail that matters if manufacturers are to meet the performance requirements envisioned by the California Air Resources Control Board and auto manufacturers in their quest for achieving stringent emissions controls.

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