Fuel Filtering

Bruce Smith

Facts and Fiction

"You wouldn't think of smoking your favorite pipe very long without a cleaning, yet the deposits you find in a pipe stem are mild indeed compared to the stuff you find collected, clogging and even passing through a long-neglected gas line filter."

Lifestyles are certainly different since this lead-in from a June 1958 *Popular Science* article about fuel line maintenance. Although many of us are too young to have been smoking in 1958, your Porsche probably had a few briar pipe tokers behind the wheel back in the day.

Most of the world surrounding our old cars has changed in the 60-plus years since this old DIY article was written. With regards to gasoline, modern fuel grades have evolved, carburetors have been replaced by fuel injection, metal parts have been traded for plastic, and countless regulations have been imposed on just about every aspect of the automobile. Meanwhile we're still driving these old cars with their old parts, some of which haven't aged as well as we'd like to believe.

In the early days of the automobile, the quality of gasoline was poor and contamination was common. Particle filtration and water separation were necessary to ensure that an engine could run on what came out of the tank. By the 1950s, modern leaded gasoline, with high octane and various additives, improved engine performance. But opportunities for contamination remained then, as today, from a gas station's tank and pump to the fuel tank, fuel lines, fuel pump, and carburetors.

In a perfect world, you've cleaned and maybe coated the inside of your gas tank. You've replaced every millimeter of your fuel lines. Your fuel pump and carburetor bowls are as clean as new. And you never use anything but ethanol-free gasoline from the most respected service stations. If so, the several fuel screens in your Porsche are possibly all it needs. But your car, like most, may have some rust or scale in the tank. The flexible fuel lines might be new, but the age of the hard lines is unknown. And although you might do your best to avoid ethanol, even pure, petroleum-derived gasoline has an affinity for water. Even small traces of water in fuel can lead to a reaction with metals in a car's tank, pump, and carburetors.

Was the fuel filtering that your car was built with ever really good enough? How about now, some 60 years later? What are the periodic maintenance requirements for an old fuel system? Is any additional filtering necessary? And, if so, what?

Filtering from the Factory

If you trace the fuel system of a 356 from the tank to the carburetors, you'll find three points of filtering original to the car. Each is a fine mesh screen; Solex carbs add one more internally. At the tank is a pair of screens located in the fuel valve or "petcock." The pore sizes are about 100 to 200 microns (0.10 to 0.20mm), which is sufficient to remove the relatively "big stuff" before it leaves the tank. With the valve installed, one of the screens sits inside the fuel tank. The other is housed in a removable sediment bowl that serves as a reservoir for the water and contaminants separated from the fuel by the screen. In other old cars, filter bowls like these were often combined with the fuel pump to remove contaminants just prior to the carburetor feed. But Porsche's early design was to remove water and particulates ahead of the fuel lines. That seems like a good idea, especially when it's easily accessible via a front-mounted fuel tank. (Modern filter-in-the tank concepts using mixed fiber media and near maintenance-free filters have brought this concept to popularity for many new car engines.)

Fig. 1 and 2: The 356 fuel valve or petcock, which includes a pair of filtering screens, one residing in the tank and the other in a sediment bowl.

The filtered fuel from the 356's fuel valve then travels through soft and hard lines to the fuel pump, either the early style (A/B) or the later style (C/912) depending on the car. Within the pump at the inlet side is the third screen of the fuel system. Mounted into discs, examples of these filters are shown in Figure 3 for each style pump. The early pump screens are made of brass. For later style pumps, they are usually plastic. The screen pores for A/B pumps are about 200 microns (0.20mm) while C/912 pump pores are about half of that.

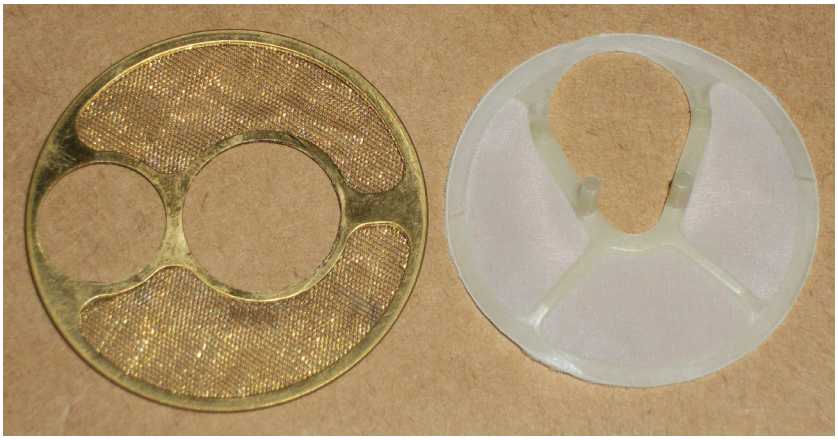

Fig. 3: Filter screens internal to 356 A/B (left) and C/912 (right) style fuel pumps.

In theory, the filtering designed by the factory should be sufficient to remove particulates that could be detrimental to the carburetors. Fuel injection systems and diesel engines are much more sensitive to fuel impurities than are carburetors, so in old cars like ours it can come down to figuring out the maximum size of crud could that lead to plugged carb jets. The smallest jets in Zenith and Solex carburetors are the idle and pump jets. Their openings range from about 0.4mm to about 0.6mm, or about two to six times larger than the filter screen pore size.

But even if these screens are in good condition, there are other concerns. Beyond plugged carburetor jets, fuel contaminants can also cause physical damage. Internal parts in carburetors and fuel pumps can be affected by impurities sized well below the dimensions of screen pores. Susceptible parts can include fuel pump valves, metering valves, and accelerator pump plungers—all of which become service items during rebuilding. Screening at one hundred microns or more doesn't provide protection against degradation from smaller contaminants.

Plus, the retention capability of a simple screen is quite poor. Once trapped, a particle will only be retained as long as it's not eroded below a filter pore size. Once particles escape, they pass through to the fuel pump and carburetors. Another inadequacy of a simple screen is the limited surface area available, and a reduction in flow with insufficient filtering capacity. For these reasons, it's important to clean all the accessible fuel filters (at least the screens in the separation bowl and in the fuel pump) as part of a regular maintenance schedule. Supplemental fuel filtering might also be considered.

Adding More

Since about the 1950s, alternative fuel filter elements have been used in place of simple screens like those in our old Porsches. Common options included porous ceramic cylinders, layers of paper disks, fiber media filters, and stacked brass disks. A few of these are shown in the old photograph in Figure 4.

Some of the filter types pictured in Figure 4 have fallen out of favor and most have been replaced by modern, in-line, pleated or V-shaped filter media. Examples of two modern versions are shown on the next page. These filters are quite sophisticated and consist of various combinations of treated fine cellulose pulp, polyester and other resin fibers, or multilayered materials. Filtering is accomplished not only by trapping but also by attracting and attaching contaminants into the media. Filtration from 50 microns down to about 5 microns is common, with high retention capacity resulting in long maintenance intervals. In-line filters are available in metal, plastic, and glass enclosures. The advantage of plastic and glass is the ability to see the inside of the filter. Any concern with using a combustible filter housing can be addressed by using either glass or metal canisters.

Adding an in-line filter to your fuel system achieves more than just redundancy. A modern filter can remove and retain much more than a simple screen is able to. There's been plenty of conversation about the best place to add an in-line filter. Although there are several locations along the fuel line where placement is possible, it boils down to two basic choices: somewhere before the fuel pump (on the sucking side) or somewhere after the fuel pump (on the pushing side).

The *Bosch Automotive Handbook* gives us the answer. My version, the 5th edition from 2000, says: "Fuel filters for spark-ignition engines are located between the fuel tank and the fuel pump and/or on the pressure side down-stream of the fuel pump." It can't get much more official than Bosch, so it's either side of the fuel pump or both sides. Everyone gets to be right.

The Maestro, Harry Pellow, used to say that it is easier for a pump to push than it is to pull, so he insisted on a down-stream installation. If all things are equal on both sides of the pump, and without advice from someone more knowledgeable about fluid mechanics, I'm not so sure he was right. But putting an extra filter after a fuel pump offers no protection for the pump valves, however minor the need may be. Either way, keep in mind that the added restriction of an extra filter at either side can impact pump volume. If your pump's output is borderline, volume might be reduced enough to starve the carburetors.

Effects of Water in the Fuel System

As a final note, it's worth saying something about how trace water in the fuel can affect old carburetors and fuel pumps, especially when they aren't used very often. This is something I wrote about in an earlier

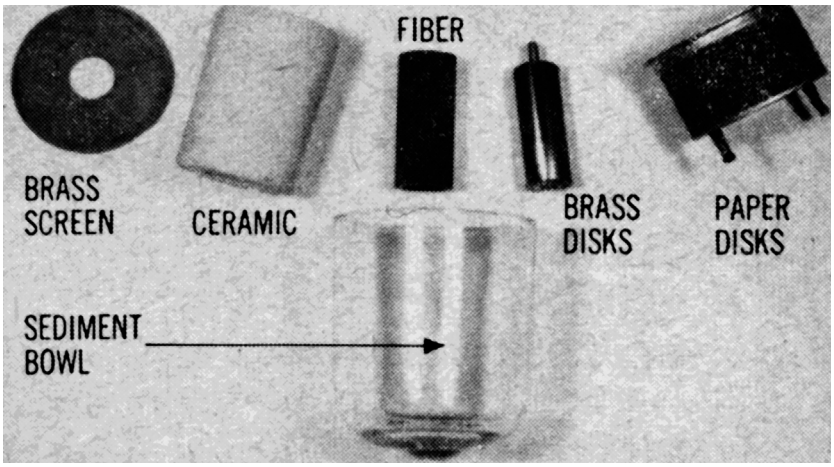

Fig. 4: Fuel filter types available circa 1950–1960, when our Porsche cars were new. Modern fuel filters using filter media that also attract contaminants have replaced many of these options.

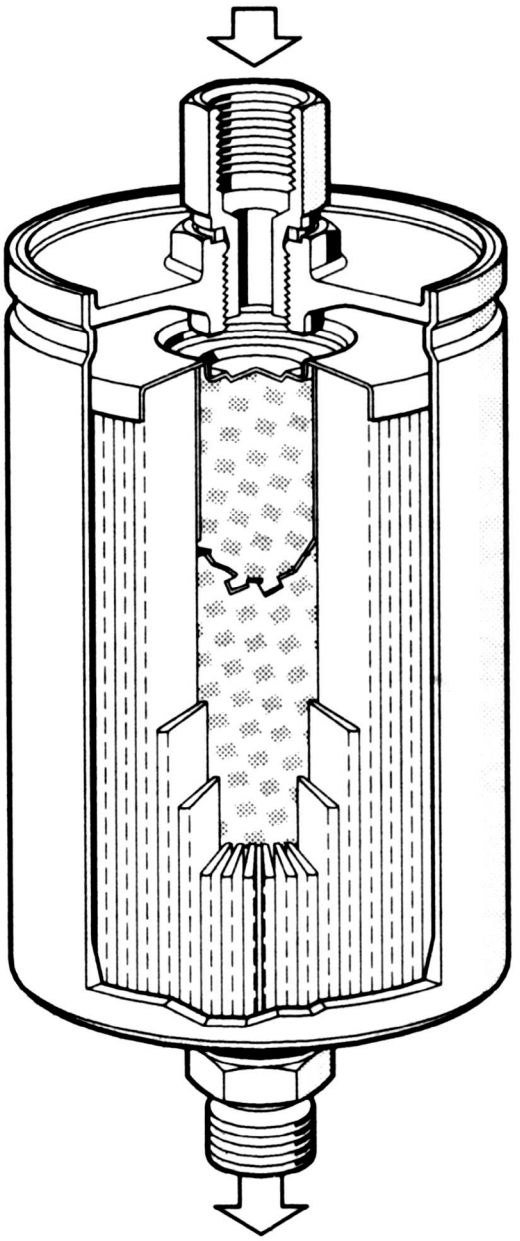

Fig. 5 and 6: A cut-away of a modern in-line fuel filter with radial V-shaped mixed fiber media (Fig. 5) and a fuel filter element using pleated paper fiber (cellulose) filter media (Fig. 6).

Registry article about carburetor cleaning (in the March/April 2014 issue). Water in fuel is a hot topic, more so as ethanol has been added to modern gas grades. Because alcohol and water readily dissolve in each other, when ethanol is added to gasoline it will carry water along with it. An ethanol fuel mixture can have up to 0.5% water before phase separation, compared to 0.02% for pure gasoline.

But trace water, even in pure gasoline, can pose problems when the fuel is left sitting for long periods of time. For instance, at a temperature of 100 degrees F, pure gasoline open to air will reach water saturation in less than 200 days. In the float bowl of a carburetor filled with gasoline, this assures a sufficient supply of water (albeit it at low level) for inorganic chemical reactions with the zinc metal to take place. This is the whitish powder, scale, and crust that you find in neglected old carburetors and fuel pumps. It will eventually clog things up real good. The situation is worsened as the protective oxide layer that normally forms on zinc is prevented because of the lack of free oxygen in the fuel, which allows corrosive compounds to continue to grow. The worst case scenario for a carburetor is to replenish the gasoline in the float bowl each time it evaporates, ensuring a good supply of water-saturated fuel. This is what happens when we drive our cars infrequently (i.e. every few weeks or months) with gas that's been sitting in the tank all season—we set up the ideal conditions to maximize corrosive reactions. This can actually be worse than not driving your car at all. Fuel filtering won't remove this stuff because it is created in the carbs and pumps themselves. Fuel additives don't help either, as they only deter the hydrocarbon breakdown of gasoline and the formation of organic compounds (i.e. gum or varnish).

The bottom line solution, then, is maintenance. The filter screens and sediment bowl built into your car's fuel system should be checked and cleaned periodically. Is adding another filter necessary? In a good, clean fuel system, probably not. But there is little harm in it, and certainly a good in-line filter added either before or after the fuel pump adds a little bit of insurance. Avoid ethanol in fuel if you can, and check the carburetor and pump bowls occasionally for residue. Drive your car often. And bond a little closer with your 356 on your next drive; light up a pipe full of some nice, aromatic blend tobacco. Using a pipe made by Porsche Design is optional.

Dr. Bruce Smith is an engineering professor at the Rochester Institute of Technology.