

## Fuel Injector Cleaning

By [Dusty Sharp](#)

My fuel injection system sat around for about 4 years before I finally got around to installing and cranking it up. Needless to say, the injectors were gummed up something fierce! Here's what I did to get mine clean.

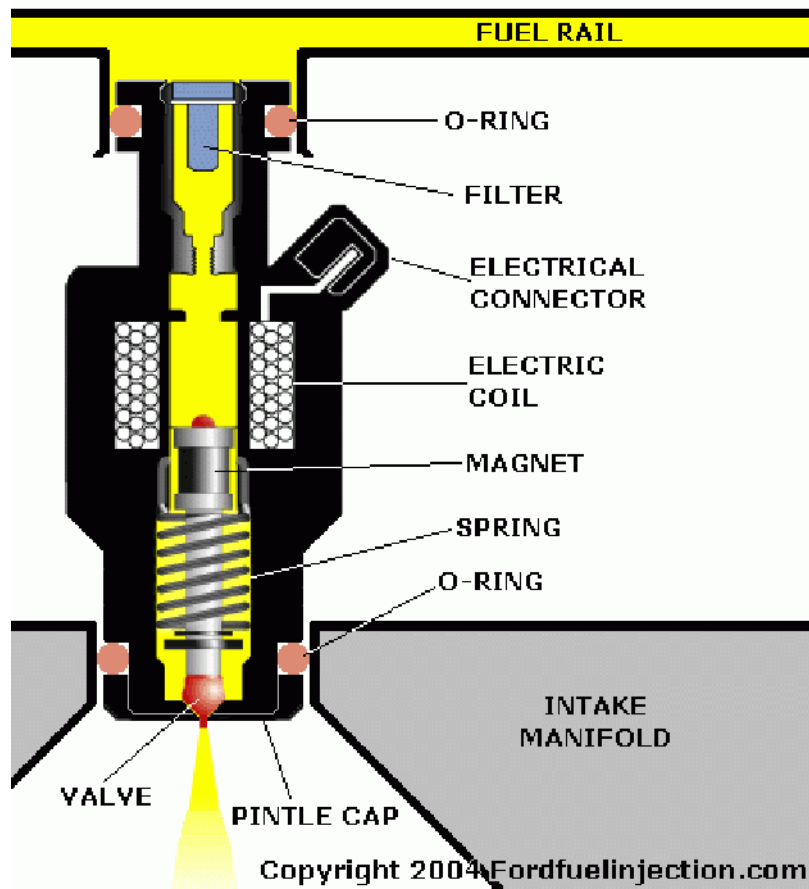


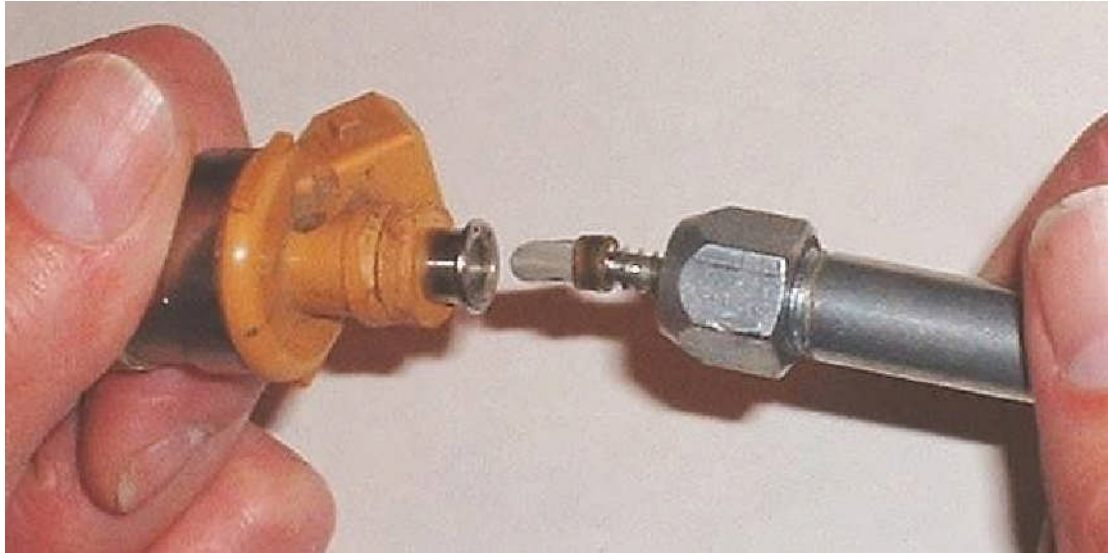
Injector Parts / Tools ([available from Mr. Injector](#)):

- 16 O-Rings
- 8 Spacers
- 8 Pintle Caps
- 8 Filters
- #10 Machine Scre



Use the #10 machine screw to remove the internal filter from the injectors.





The next morning the fluid will be full of gunk and slime from inside your injectors. As you take each injector out of the cleaner, place it into the test wire harness, place a compressed air nozzle at the spray end (backwards) and throw the switch while you give it a blast of air. Point it away from you because more gunk and slime will spew out. If you don't have compressed air, you can blow into the end of the injector, but use short piece of clean fuel or vacuum hose between your lips and the injector to avoid getting any of that nasty cleaner in your mouth. Repeat this procedure with each injector, rinse once more in clean cleaner, then dry them off and reinstall the o-rings.

First, put together a simple injector test circuit with some alligator clips, wire, a momentary toggle switch, and a spare injector harness plug (you can buy one new for a couple dollars or from a junkyard harness). Put each injector in the makeshift harness and check it with the switch. You'll here it click when you throw the switch unless its gummed up too bad. Even if they do click, they could probably still use a cleaning. Next, get a bottle of professional injector cleaner from the parts store meant for the cleaning machines. Remove all the O-rings from the injectors are place them in a bucket. Pour the cleaner in until they are all covered and let them soak over night. The next morning the fluid will be full of gunk and slime from inside your injectors. As you take each injector out of the cleaner, place it into the test wire harness, place a

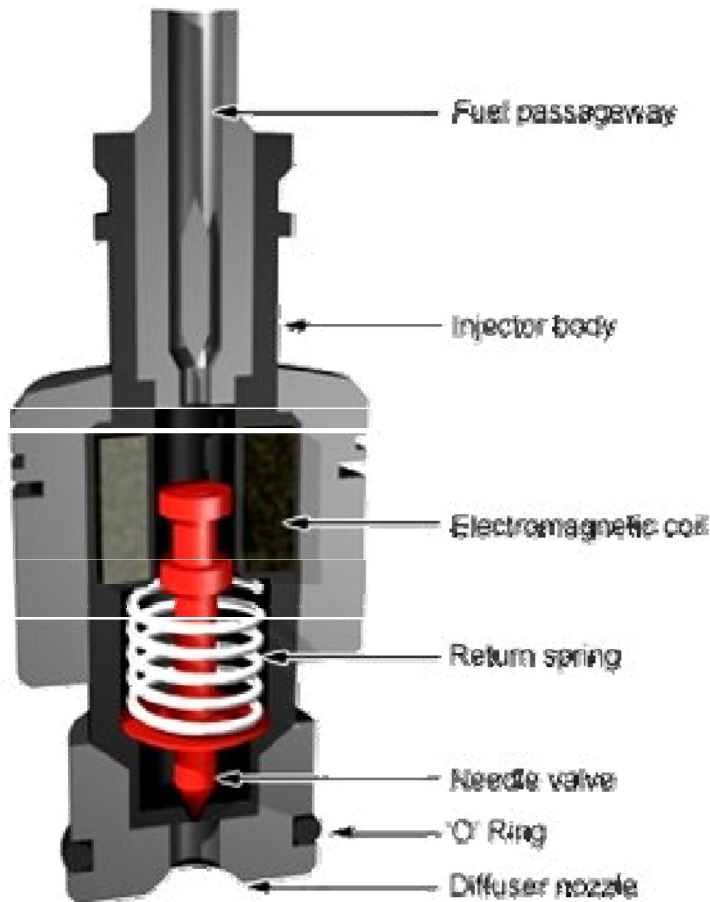
compressed air nozzle at the spray end (backwards) and throw the switch while you give it a blast of air. Point it away from you because more gunk and slime will spew out. Do this with each one, rinse once more in clean cleaner, then dry off and reinstall the o-rings.

After I did this my motor ran great and has ever since. Hope this helps.

# Fuel Injection Service, Not Just Cleaning

Posted 6/8/1998

By Jim Linder



After many years of fuel injection "service," I think that some service technicians still misunderstand the process of proper fuel system handling. Much has been said over the years in regard to when and how to perform injector cleaning. Some manufacturers have suggested methods of cleaning while others have issued bulletins to disregard any cleaning at all.

For this reason, I offer the following suggestions on the proper process for injector service on today's vehicles.

To begin, all engines using fuel injection do in fact require some slightly different fuel system maintenance! The normal wear and tear with today's underhood temperatures and changes in gasoline quality suggests some buildup of olefin wax, dirt, water and many other additives. Unique to each engine is an air control design that also may suggest different levels of carbon deposits, such as oil control or just the location of the component or control device itself.

To simplify the approach, I will use the word "service" since the phrase "injector cleaning" is misleading as to the real function needed to maintain the vehicles of today!

## **Fuel Injetor System Service**

(Note the words "system" and "service" in the subtitle, and not "cleaning!")

The proper steps in fuel injector system service are:

- Check fuel pump operating pressure and volume.
- Test pressure regulator for operation and leakage.
- Flush entire fuel rail and upper fuel injector screens to include pressure regulator.
- Clean fuel injectors.
- Decarbon engine assembly.
- Clean throttle plate and idle air control (IAC) passages.
- Check minimum air flow rate and adjust if needed.
- Relearn onboard computer.

All eight steps may be performed using one of the "two-line" fuel injector service units. (Carbon Clean, Injector Test, DeCarbon and Motor-Vac, to name a few.)

### **Check fuel pump operating pressure and volume**

The missing link here is volume, as most working technicians assume that if the pressure is correct, the volume is OK also! By hooking up a fuel pressure tester to the fuel rail inlet and return, and using the pressure side feed t-Ed into the fuel unit, we can quickly test the fuel pressure with engine running but also at the same time test the volume of the pump by stealing fuel into our holding tank (one pint in 30 seconds is the usual specification). When proper volume is flowed into the tank, we would shut down the engine and change hose connections to allow the machine to be put in control of the fuel supply system. The two line system would be attached to inlet and return on the fuel rail, with the vehicle's onboard system being "looped" and returning fuel to the tank. This prevents disabling of the factory unit.

### **Test pressure regulator for operation and leakage**

At this time, the regulator would be tested for operational pressure and proper regulation including leakage. (This works well as the operator has total control of rail pressure with the unit control valve.)

### **Points to Ponder:**

- Good pressure doesn't mean proper volume! Example: A clogged filter may test OK on pressure, but restriction may not allow proper volume under load!
- There is some logic to using the vehicle's gasoline to service the system as opposed to a can of shop gasoline that has been around for some time!
- Pressure regulators do fail and a lot more of them don't properly shut off the fuel, causing higher-than-normal pump wear and shorter life!

### **Flush entire fuel rail and upper fuel injector screens to include pressure regulator**

At this time, I would suggest raising the input pressure to a point above the regulator setting to allow a constant flow of fuel through the inlet pressure side of the system - through the fuel rail and out the open fuel pressure regulator. In most cases, the apply pressure is 75 psi to 90 psi but will be maintained by the presence of a regulator. At this point, a cleaning chemical is added to the fuel mixture at a 5-1 mixture and allowed to flow through the system for 15 minutes to 30 minutes. (I have some GM dealers that use one hour per vehicle with great re-sults!) Results are best on a hot engine, and fuel supply is looped with the vehicle's engine not running.

### **Points to Ponder:**

- This flush is the "fix" that most vehicles needed to begin. The difference is that you are effectively removing the deposits to a remote tank and filter vs. attempting to soften and blow through the upper screens.
- Most injectors use a 10 micron final screen.
- A 25 percent restriction in the upper screen would increase the injector on-time approximately 25 percent!
- Injectors have a working "duty cycle" like a welder. Extending the duty cycle equals a shortened life of the coil or bobbin.
- Each engine has a "pattern failure" in the system. Example: Buick V-6 engines have problem injectors on the rail curves and the injector next to the exhaust gas recirculation (EGR) valve. Those three injectors will always show a restriction to flow first! Cylinder No. 5 is the pattern failure on 4.9L Ford in-line 6s. (Study the rail design and look for the problem areas.)

### **Clean fuel injectors**

At this point in the "service," we start the engine and adjust the output pressure somewhat closer to regulator pressure or somewhat lower. Adjusting lower will cause the pulse width to open up somewhat longer and allow the injectors to be cleaned. Slow speed (idle) position will take a longer time frame and operating temperature will be reached. This is one place where time is required. Did you ever wonder how a can of injector cleaner could clean the entire injectors in nine minutes? (It can't!) Remember, not only do we want clean injectors, but we also want the chemical to decarbon the engine valves, pistons and O2 sensor.

### **Points to Ponder:**

- Time is required to perform this service.
- Internal pintle cleaning is performed during this cycle.
- Fuel control is always in direct response to O2 response. Example: Slow O2 = slow fuel control = poor performance.

### **Decarbon engine assembly**

On most vehicles, the injector spray is going to help the decarboning process. On others, we may need to enhance the operation with an external addition of mixture through PCV hoses, throttle plates or idle air controls.

### **Points to Ponder:**

- Most technicians (especially very young ones) think carbon is a 1990s problem. The older guys (especially the very old ones) remember throwing rice through a flathead at 2500 rpm and watching the black specs fly out of the exhaust. This is still a problem in the '90s (although rice is not suggested). We have a lower fuel volatility, and in some cases too high of a compression may cause a no-start situation.
- Proper compression = 14.6 x compression ratio.

### **Clean throttle plate and idle air control passages**

Just this "service" alone on most late model engines will show a manifold vacuum increase of up to two. You may stop the engine and clean the areas as needed, but my suggestion is to use an extra hand-held fuel injector hooked in parallel with the pressure hose along with a pulser to allow a cleaning of throttle plates with the same chemical as the injectors are running on. This has proven to work very well as air drawn into IAC passages on a running engine will clean the passages without IAC removal. Neat trick!

**Points to Ponder:**

- A manifold vacuum increase tells the technician that the engine "liked" the service.
- Using the hand-held injector usually will lower a General Motors IAC count from 40 to 15 without touching a thing! (Think about this.)

**Check minimum air flow rate and adjust if needed**

Most vehicles' "stall" problems are due to a misadjusted throttle plate or incorrect minimum air rate. Check service manuals for specs.

**Points to Ponder**

- ACDelco makes a set of small "tuneup" booklets that do an excellent job of covering minimum air rate adjustment procedures.

**Relearn the vehicle's onboard computer**

Some vehicles may have been running in such a poor state of operation that the onboard computer may need to be relearned! Consult the OEM-suggested relearn procedures per make.

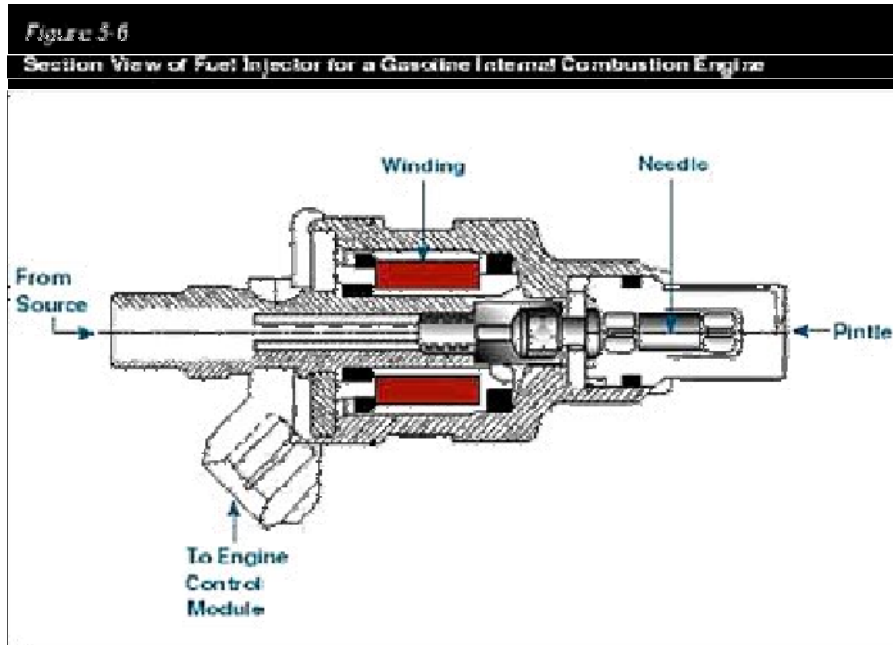
Fuel injection system service is complete! This "service" usually takes approximately one hour for the vehicle to run out of fuel and the entire service to be performed. The good thing is that the technician may do other services while this is being performed! Some of my customers put in a set of plugs while the engine is flushing or change the fuel filter or do the brakes. Charges are up to the individual shop, but the performance gained is absolutely amazing.

In reality, all you are doing is exactly what should be done with mileage, and that is restoring the system to original operations.

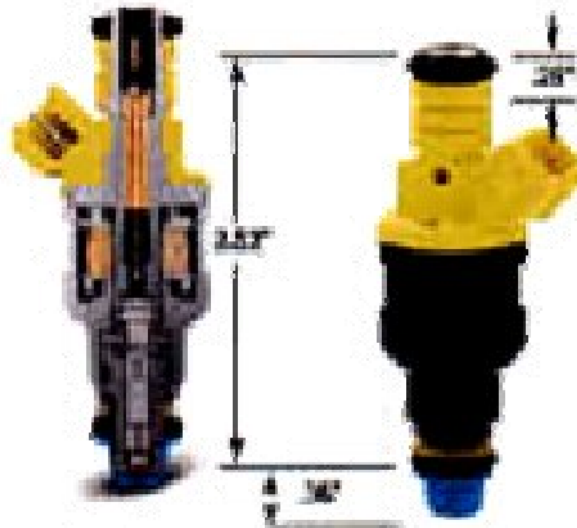


## Injectors... Facts, Fictions, & Figures

One look at the fuel injectors on your car, and you'll wonder how they work at all, not to mention for tens of thousands of miles. Fuel injectors allow us to get gas mileage at the same time we develop additional horsepower and cleaner emissions.



The only thing your fuel injectors require in return is a steady supply of clean gasoline. That's why the fuel filter is so important to your fuel injectors--even a tiny piece of dirt or crud can foul up the mechanism inside your fuel injectors, so replacing your fuel filter regularly is essential. When your car left the factory, it may have been equipped with fuel injectors that leaned more towards the economy side of the equation than the performance side. With aftermarket fuel injectors, like our ACCEL fuel injectors, you can swing that equation over to the power side.



In trying to keep up with emissions and fuel efficiency laws, the fuel system used in modern cars has changed a lot over the years. The 1990 Subaru Justy was the last car sold in the United States to have a carburetor. The following model year, the Justy had fuel injection. But fuel injection has been around since the 1950s, and electronic fuel injection was used widely on European cars starting around 1980. Now, all cars sold in the United States have fuel injection systems.

### **Frequently asked questions and facts**

#### *How does a fuel injector work?*

A fuel injector is nothing more than a high-speed valve for gasoline. An engine computer or controller is used to control the fuel injector. Contrary to popular belief, this is not done by sending power to the injector. Fuel injectors are normally fed power whenever the ignition key is on. The computer controls the negative, or ground side, of the circuit. When the computer provides the injector with a ground, the circuit is completed and current is allowed to flow through the injector. This energizes an electromagnetic coil inside the injector, which pulls a sealing mechanism (pintle, ball, or disc) away from its seat. This makes it possible for fuel to flow through the injector and into the engine. When the computer removes the electrical ground to the injector, the electromagnetic coil becomes demagnetized and a spring forces the pintle, ball, or disc shut to cut off fuel flow. Even at an engine speed of just 1000 RPM, this is done hundreds of times per minute.

#### *What do the terms “static” and “duty cycle” mean?*

An injector in an engine turns on and off very quickly to control the amount of fuel delivered. The amount of time an injector is turned on and delivering fuel is known as the duty cycle. This is measured as a percent, so 50% duty cycle indicates that the injector is held open and held closed for an equal amount of time. When the engine needs more fuel, the time that the injector stays on (its duty cycle) increases so that more fuel can flow into the engine. If an injector stays on all the time, it is said to be static (wide open, or 100% duty cycle). Injectors should not go static in a running engine. If an injector is static in a running engine (open 100% of the time), that injector is no longer able to control fuel delivery. This could be an indication that the injector is too small for the needs of the engine. Injector duty cycle should usually not exceed 80% in a running engine at any time.

#### *What is impedance?*

Impedance is the electrical resistance of the electromagnetic coil inside the injector. This is measured in ohms and can be determined with an ohmmeter. Injectors are classified as either high-impedance (also known as “saturated”) or low-impedance (known as “peak and hold”). High-impedance injectors usually range from 11 to 16 ohms of impedance, while low-impedance injectors usually range from 0.7 to 5 ohms of impedance (these impedance numbers are based on what is currently available in the consumer market and are subject to change). Most OEM engine computers are designed to control high-impedance fuel injectors. Low-impedance injectors are generally preferred for racing or ultra-high performance use because they respond more

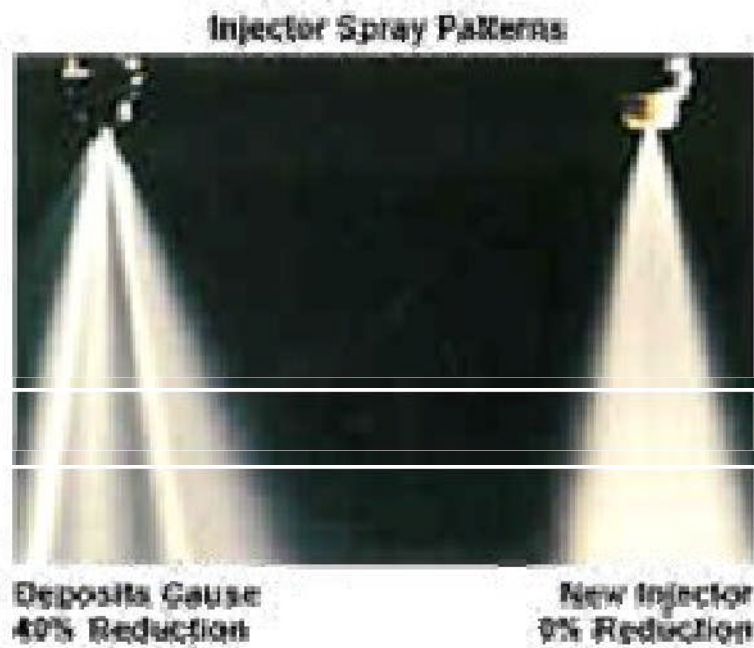
quickly, but aftermarket engine controllers are usually required to control them.

*What is an injector's static flow rate?*

Manufacturers rate fuel injectors by the maximum amount of fuel that they can flow in a given amount of time. This measurement is taken with the injector on 100% of the time (100% duty cycle, or wide open) and with the fuel at a given pressure (usually 43.5 psi). For example, a 19 pound per hour (Lb/Hr.) injector flow 19 pounds of fuel in one hour at 100% duty cycle and 43.5 psi of fuel pressure. Injectors in imported vehicles are often rated in cubic centimeters per minute (cc/min) instead of pounds per hour. This is also done at 100% duty cycle.

*If injectors should not exceed 80% duty cycle under operating conditions, why do manufacturers rate them at 100% duty cycle?*

A test at 100% duty cycle is used to determine the maximum amount of fuel that will flow through an injector in a given time. This test is useful for determining whether an injector's internal fuel passages were machined properly, but it does not check an injector's ability to cycle on or off. It is usually not recommended to run an injector at more than 80% duty cycle under actual driving conditions. This 80% duty cycle operating limit is taken into account to make sure the injector will be large enough to feed the engine under actual operating conditions and will not starve the engine for fuel.



*Do you remanufacture fuel injectors?*

No. As part of our fuel injector service, we clean and test a customer's injectors and replace the serviceable components (o-rings, inlet filters, etc.) We do not modify or alter any of the internal components of the injector. These internal components (windings, pintle, etc.) are usually not serviceable. If they are damaged, the injector should be replaced.

*Can you alter injectors to increase their static flow rates?*

Absolutely not. It is sometimes possible to increase an injector's static flow rate at a given pressure by machining or enlarging the pintle or internal passages of the injector. However, this procedure is usually not a good idea! A fuel injector cycles on and off thousands of times per minute to feed an engine the proper amount of fuel. Because of this, the electromagnetic coil and pintle of an injector are very carefully matched to one another. Modifying the pintle or other portions of the injector may cause it to flow more fuel at its limits (wide open or statically), but at lower engine speeds the injector will be extremely inconsistent. This creates drivability problems, idle fluctuations, higher emissions, rich/lean conditions, etc. We have performed extensive laboratory tests on many modified injectors and have yet to find one that performs as well as an unmodified injector of the same capacity.

*What is included in injector service?*

Injectors are tested to see if they function properly. Its flow rate and fuel spray pattern are checked to determine if it is working properly, and its impedance is tested. The injector is then cleaned and flushed, and any serviceable parts, such as o-rings, seals, and plastic pintle caps, are replaced. After this, the injector is re-tested to note any improvements in performance due to the service. All of the measurements and information gathered during testing is recorded on an analysis sheet that is shipped to the customer along with the injector. When multiple injectors are provided, the injectors are also checked against one another to make sure that they are matched in performance.