



Tech Tip

FUEL SYSTEM 169

AERATED POWER STROKE Dealing with Air in the Fuel System

Aerated fuel can create some major performance problems for a diesel application and some difficult challenges for the technician. While some fuel injector problems may be inherent in the system by design, many of the issues are the result of improper fuel filter installation procedures, or poor lube and filter service intervals. There is more to making a proper installation than replacing the fuel filter and starting the engine. In fact, that is how the problem usually starts. And almost always, the filter gets blamed for the condition.

It is not uncommon to receive a call from a shop that just completed a fuel filter installation on a diesel application, and they are now faced with a no-start or poor engine performance condition. When assisting with the diagnosis, it is often determined that the installer made a dry start following the filter installation. A dry start involves starting the engine with a filter housing empty of fuel. When this occurs, you have some major challenges to overcome in purging the air from the system and restoring engine performance. This can be frustrating and time consuming.

Ford's turbo diesel engines (referred to as a Power Stroke) can offer some challenges to the misinformed technician. Listed in order of production, the 7.3L, 6.0L, 6.4L and the 6.7L engines share one thing in common; they do not perform well on aerated fuel. In fact, no diesel engine runs well on aerated fuel.

FORD'S POWER STROKE

Ford's 6.0L engine generates the majority of the customer complaints that we receive on the Ford diesel applications. There are some good reasons for this, and it has nothing to do with the quality of the fuel filter. The number of 6.0L units in service, some inherent fuel injector design issues, and lack of maintenance all contribute to the high failure rate. Extended lube service intervals spell disaster for this system, as it utilizes oil pressure to pulse the injectors. Oil is the hydraulic fluid required for fuel injector activation. While much of this article will focus on problems related to the 6.0L engine, the same concerns and service procedures apply to the other mentioned Power Stroke engines, especially priming the system following a fuel filter installation.

FUEL INJECTOR OPERATION

On the 6.0L injection system, the engine is fitted with two oil pumps. A low pressure pump provides engine lubrication

for the bearings and internal engine components. A high pressure pump provides increased hydraulic pressure required for the electro-hydraulic actuated fuel injectors. A supply of oil from the low pressure oil pump is fed into an oil reservoir, which provides oil for the high pressure oil pump mounted on top of the engine. The high pressure pump provides oil in a pressure range that can exceed 3,000 psi to oil rails in the cylinder heads. From there, the oil is fed into the fuel injectors. Fuel is supplied to the injectors at approximately 50 psi through fuel rails in the cylinder heads. This system is electro-hydraulic actuated. When the Powertrain Control Module and the Injector Driver Module electrically energize a fuel injector, a valve in the injector is opened by a solenoid mounted on top of each injector. The high oil pressure exerted from the high-pressure oil pump flows from the oil rail into the injector intensifier/amplifier piston, where a pressure multiplication occurs at a ratio of 7:1. Fuel is then injected into the combustion chamber through the injector nozzle tip at a pressure ranging up to 28,000 psi. A coil operated spool valve in the injector controls the oil entry and exit to and from the intensifier/amplifier piston.

COMMON COMPLAINTS

Often, we receive a call from a technician that has encountered a recurring fuel aeration complaint. They may have installed the third set of fuel filters, only to encounter the same aeration concerns. Installing the second or third set of fuel filters is not the solution. Sometimes, out of frustration, the vehicle will be taken to the dealership in an effort to get the issue resolved. Many times they are told that the fuel injectors are damaged due to the use of non-original equipment fuel filters. They are quoted an injector replacement cost in the range of \$2,400, plus five hours labor. The customer will be looking for someone to cover the cost of the repair. You must understand and be prepared to explain the reason for the injector failures, as the fuel filter is not the culprit.

CAUSE OF INJECTOR FAILURE

Low fuel pressure may be the reason for the repeated aeration symptoms. The recurring aeration condition may be due to low line pressure at the bottom of the injectors. On this design system, fuel enters the fuel injector at line pressure. A minimum of 45 psi is required to prevent the intensifier/amplifier piston in the injector from bottoming

out during its cycle. Once it bottoms out, the piston becomes damaged and will no longer seal, allowing compression gases to enter the fuel system, aerating the fuel. Once damaged, the injectors will require replacement. Fuel provides a cushion for the internal injector components. The pressure should be between 45-55 psi and never fall below this range, even while under load.

The solution is an updated pressure regulator from Ford, which raises the fuel line pressure an additional 10-15 psi to prevent the intensifier/amplifier pistons in the injectors from bottoming out.

Symptoms of Injector Failure

- 1) Long crank times/hard starting
- 2) Rough running
- 3) Excessive smoke
- 4) Loss of power
- 5) Misfiring
- 6) Stalling

Causes of Fuel Aeration

- 1) When changing a fuel filter, make certain you use the proper tool to loosen or tighten the fuel filter cap. It is not uncommon to encounter a crack in the filter cap, due to improper removal and tightening procedures. A damaged cap will allow air to enter the fuel system.
- 2) Make certain the O-rings are positioned in the proper groove in the cap and they are properly lubricated prior to tightening.
- 3) Running the vehicle out of fuel can result in damage to the fuel injectors, promoting aeration from the compression gases.
- 4) Fuel lines or fittings not properly tightened.
- 5) Loosening a filter water drain valve with the engine running.
- 6) Following the filter replacement, make certain you prime/bleed the system prior to starting the engine. Dry starting the engine will require some major bleeding to purge the air from the system.

PRIMING THE SYSTEM

When we receive a complaint of poor engine performance or a no-start condition following a fuel filter replacement on a diesel application, we ask a simple question. *Did you prime the fuel system to fill the empty filter reservoirs prior to cranking the engine?* Many times the response is, "How do you do that?" And sometimes we don't get a straight answer, but the one we do get makes it obvious they failed to perform that procedure. The system must be primed prior to starting the engine.

The following priming procedure is recommended following the installation of a new fuel filter/filters on any

Power Stroke application. It is a quick and simple procedure that can save you and the customer a lot of frustration.

- 1) Ignition switch on for 30 seconds.
- 2) Turn ignition switch off.
- 3) Repeat the procedure a minimum of 6 times.

This will ensure that the fuel filter reservoirs are filled with fuel prior to starting the engine. Failure to perform this priming procedure can aerate the entire system, creating some difficult engine performance conditions.

AIR IN THE OIL SYSTEM

The removal of any high pressure oil system component may result in air being trapped in the system, causing long crank times. To purge the air from the system, the vehicle must be driven through 12 short, high-demand drive cycles or until the crank time has improved. For example: Make 12 aggressive accelerations from 25 mph to 50 mph. Shut the engine down for 5 minutes following the drive cycle, then restart the engine. The goal is a 2.5 second start time. In cold temperatures, a crank time of 3-5 seconds should be considered normal. Failure to perform this drive cycle may require 100 miles of normal driving to remove all the trapped air.

SCHEDULED MAINTENANCE

Good maintenance is imperative in order to maintain good diesel engine performance. Keeping the air, oil, and fuel filters changed is the life of the engine. Contaminated oil and fuel will promote premature injector failure. Contaminated oil may create a condition in the injectors referred to as "stiction." This is a condition whereby the internal injector control valve sticks intermittently, creating rough running engine performance conditions.

Periodically, the water separators should be drained, to ensure the fuel system is free from water contamination.

For some reason the fuel filters get neglected until a performance condition occurs, and then it may be too late for a new fuel filter to make an improvement in engine performance.

Often, late in the diagnostics, it is determined that the vehicle had poor performance symptoms all along and that was the reason they initially came in for a fuel filter replacement. That would be good information to know, early on. If the customer comes in requesting a fuel filter replacement, question them prior to performing the service. Does the vehicle have any performance issues? It could save you a lot of diagnostic time, unnecessary expense and bad publicity for the shop.

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