



Technical Article:

“How do I know if/when I need fuel injectors for my 7.3L Power Stroke?”

We always try to do as MUCH troubleshooting & vehicle diagnostics prior to recommending that customers (or one of our dealers) invest in a set of fuel injectors for a vehicle that may or may not have more severe, underlying engine issues, or issues not isolated solely to the fuel injectors (fuel pressure, fuel quality, electrical part or harness failure, etc).

This article is applicable to 1994.5-2003 7.3L Power Stroke vehicles.

Over nearly ten years of troubleshooting, rebuilding, and successfully diagnosing thousands of customer concerns, we want to provide some testing & troubleshooting information that may benefit you in the future.

Each 7.3L fuel injector can be thought of as having an “oil side” and a “fuel side”.

The **oil side** of the injector has one main component, called the poppet valve. The poppet valve operates JUST like a valve in a cylinder head. However, instead of being opened and closed by a ‘rocker arm’ or camshaft...this poppet valve is opened by the magnetic force of the (energized) solenoid on top of the injector.

As a very broad average, we typically see normal wear on the oil side of the injector begin to cause drivability, performance, and poor running (particularly on a cold engine) at approximately 200,000 miles. Some trucks have hard cold start, or very low power when cold as early as 165-180k miles...and very few make it past 220,000 miles without some of these symptoms.

\*\*\*This normal wear on the poppet valve will USUALLY cause the truck to run rough UNTIL THE ENGINE OIL WARMS UP\*\*\* as the thinner/hotter (high pressure) engine oil is much less viscous, and can sufficiently pass through the worn poppet valve..while the colder/thick oil can not sufficiently flow through the worn valve.

Many customers & shops misdiagnose this as *not* being associated with the fuel injectors...since the truck may drive perfectly fine once the oil temp comes up.

Other “oil side” symptoms can be excessive (white/grey) smoke on a cold start. As the poppet valve is wearing, it moves further and further away from the injector solenoid. This increased ‘gap’ between these components is similar to retarding the injection timing...injector fires “late”, so there is less time for the injected fuel to be fully combusted, creating excess smoke out the tailpipe.

The **fuel side** of the 7.3L fuel injector contains many more components, which are not normally considered ‘wear’ items. With proper fuel filtration, good, clean diesel fuel, and adequate fuel pressure, the fuel side of the injector can go well in excess of 400,000 miles without issue. **However**, ONE bad tank of diesel fuel (water, gasoline, poor filtration, etc) can immediately and permanently damage the fuel side. Particularly, the ‘plunger & barrel’ assembly, which relies on the diesel fuel to lubricate these very tight tolerance components. (Think of a piston in a cylinder bore..without piston rings...with a “gap” of only 0.0001”) Since the injector is “fired” by high pressure engine oil...any lack of lubrication inside the plunger and barrel will almost instantly cause metal transfer between these two components (galling).

Once/if the fuel side of the injector is damaged, the symptoms are usually much more consistent. As in..IF “a” plunger and barrel assembly is damaged...it may be so severely galled, that any fuel that is trying to be pushed out of the nozzle, simply escapes up/past the plunger...and is not injected at all. Any time a truck has a “dead miss”...hot or cold, part throttle, or full throttle this is almost certainly a problem with the fuel side of the injector. A slightly damaged P&B assembly can, occasionally cause a rough running when HOT...since the thinner/hotter diesel fuel is thin enough to escape up past the scored/galled plunger & barrel assembly.

Other considerations should be made when inspecting the vehicle as a whole...The Ford OEM airbox/filter lid design is less than reliable (look for broken clips, missing plastic tabs, holes in the rubber tubing between the turbo & air filter)...if any of these components are missing or broken, the customer should have SERIOUS concern regarding the air filter/air box, and the effects of dirty air entering the turbo and engine cylinders. (A ‘new’ turbo on a rough running engine should make everyone question if the turbo was damaged by poorly filtered air< which may also have severely damaged the piston rings/cylinder walls)

If the truck has a history of oil consumption, has any excessive crankcase pressure, &/or a new turbo, then it is our recommendation to perform a COMPRESSION TEST on the engine prior to purchasing, or recommending fuel injectors as the solution.

If a compression test isn’t feasible, then all you can do is inspect the rest of the vehicle (worn turbo compressor wheel, white smoke out the tailpipe AT full operating temperature during an extended period of idle, lots of oil inside the air inlet tube<from air filter to turbocharger, check the blowby out of the oil fill cap<while blocking off the breather on the passenger side valve cover) for signs other signs that the engine (cylinders/rings/compression) may be too poor to significantly improve performance (or alleviate the customers rough running concerns) by installing a fresh set of injectors.

The above 'tests' and inspections are often going to give you much more information than ANY professional grade scan tool on the market can give.

Common Diagnostic tests, related to the fuel injectors/engine, that can be performed with a good scan tool are cylinder contribution test (CCT), and an injector buzz test. Some tools can also monitor rotational velocity percentages.

**Cylinder contribution tests (CCT)** & rotational velocity tests are not "injector" specific tests. A **buzz test** is as close to an injector specific test...but...an injector buzz test, merely checks the electrical continuity to/from each inj to the IDM.

basically...if all 8 injs 'buzz'...then that *merely means* that they are **plugged in**. No determination can be made about whether the injectors are good or bad..or somewhere in-between.

The consistency (in tone) of the buzz test (audibly) should be considered and paid attention to when a buzz test is performed ...since any difference in *sound* can indicate problems (or just normal wear issues) related to the movement of the poppet valve, when it is pulled up by the (energized) solenoid.

While any injector can immediately and permanently be damaged by lack of fuel pressure, fuel contamination, gas, water, etc.... the poppet valve in the injs is really the only part of the injector that 'wears'...

this valve operates just like a valve in a cyl head...and this valve & seat wear allows the poppet to move further and further from the injector solenoid. This causes a couple of typical symptoms/issues.

The larger the 'gap' between the solenoid and poppet...the larger the delay in injector firing becomes...ie..the SIGNAL from the IDM is still getting to the solenoid at the 'speed of light'....but the mechanical wear (at the poppet valve) can cause the injector to open later than the electrical/commanded 'timing' might indicate..(think of this as turning the distributor on a gas engine the wrong way, LOL)...retarding the timing can cause lack of fuel efficiency, lack of power, and increased smoke at the tailpipe.< injector fires 'late'...the injected fuel isn't completely combusted...so some % of that fuel makes its' way out the exhaust valve and into the tailpipe, etc...

Another function of normal poppet valve wear is poor valve sealing at the poppet...and with cold (thick) engine oil...these damaged (poor sealing) valves can't allow the normal or proper amount of HPOil to enter the injector..<<this cold oil/hot oil usually manifests itself as low power when cold, runs good warm....or very hard/no starts when cold...and usually plugging the block heater in (overnight) can warm the oil up enough to minimize these types of symptoms...

once the oil warms up (block heater or 10-15min of driving) can thin the oil out enough for a larger volume of oil to get through the (worn) poppet valves...

FWIW- the poppet valve is probably the area of the injector least understood by 99% of injector rebuilders out there...not saying we know it all...but we are confident enough to warranty ALL of our 7.3L injs for 5yr/200k miles...

CCT test:

this test compares the RELATIVE BALANCE between the output of (not just the injs!) but **everything** that contributes to the power output of that *cylinder*...which includes quite a lot.. from that cylinders compression (piston ring sealing), the intake & exhaust valve sealing, valve lift, injector output, etc..we've even seen bad torque converters and flywheels cause enough engine vibration to cause various cylinder balance faults..so, while a scan tool can aid in the detection/direction of a problem... *experience* can & will outweigh a scan tool 9 out of 10 times..."no codes" doesn't mean everything is "OK"...and conversely...just because you HAVE a code...doesn't mean that there is a problem...or it has anything at all to do with a specific problem or issue.

so...a truck could have 8 weak injectors...that show up FINE on these tests...or 8 GOOD injectors that could fail CCT in a worn out engine...balance is balance...so even if you DID have something show up on a CCTest...it doesn't mean it's BAD...hell we've seen guys replace the same inj, multiple times...leaving the other 7 w/ 200k+ miles...and call back saying that they still have the same code(s)...in these types of cases...a STRONG injector will show out of balance against the 7 old/weak injs...

More rare issues, such as aerated engine oil...or aerated fuel can also cause goofy/poor/inconsistent running issues..that new injectors can't fix...or may only fix for a short time...

the last thing we like to do is have someone purchase injs for a truck/engine that needed injectors...but later finds out that the injectors weren't the only problem.

Compression is king...meaning....that if the compression is good...then the engine can be fixed, and is worth investing time/money in getting it to run properly...but if compression is poor or mediocre...no amount of injectors, sensors, fuel system/HPOil system improvements are going to make it 100% right...it may only make the situation/engine run "better"...

Some quick tips:

If a truck has a misfire...and NO check engine or Service Engine Soon light (constantly) illuminated, then you can be 99.9% sure that there is NOT a problem with the IDM, the injector WIRING or valve cover gaskets or any other engine harness. The PCM does not monitor injector balance...but the PCM does actively monitor ELECTRICAL CONTINUITY to all the injs.

If a truck **DOES have** a (constant) SES light/CELlight...annnd has a dead miss...then the repair may be as simple as replacing the under valve cover wiring & or gaskets. Though there are rare cases where an injector solenoid (or clearance issue b/w the solenoid and poppet valve can cause an illuminated CEL/SES light that is a legitimate injector issue, and not merely a wiring or harness issue.

During a BUZZ test...LISTEN carefully to the difference in sound that each injector makes during the buzz test...weak or muted buzzes can indicate excessive wear at the poppet valve.

Cylinder Contribution Tests can often flag cylinders #1 & #8, or #3 & #8 as both failing the CCT. Anytime #1 & #8 are paired as having balance faults...especially on 99-03 trucks, this may indicate a fuel delivery problem (pressure, contamination, etc).

The pairing of #3&#8 are "companion" cylinders...so an internal or external engine balance problem will often show up as 3&8 cyls failing balance tests. We have also seen a CPS (camshaft position sensor) show false codes related to cyls 3&8...however if the engine runs normally, then it is our recommendation to simply ignore these phantom codes.

We also have seen numerous problems (poorly shielded wires, wires not ROUTED properly<ie firing cylinders out of proper firing order!) with aftermarket valve cover gaskets and valve cover wiring (especially DORMAN brands)...so we highly recommend replacing the UVC harnesses and gaskets with **OEM Ford gaskets and wiring only**. We have actually lost an engine due to the Dorman gaskets/wiring, and have spoken with at least one other customer that lost 2 engines (rods through the block) that was traced back to a faulty Dorman UVC gasket & harness.

Engines with higher mileage fuel injectors with severe poppet valve wear may start when cold, but may die when the oil heats up and thins out. Since the HPOil pressure (ICP on a scantool) is common to all 8 injectors equally...ONE severely leaking injector poppet valve can create a no-start issue, since the one valve is leaking more oil than the HPOPump can overcome to create sufficient pressure to the other injectors. A truck will not start with less than ~450-500psi of ICP pressure...which can be caused by a faulty IPR valve, leaking injector o-rings, or worn injector poppet valves...and rarely...the HPOPump itself.

If you have any questions related to this write up, please don't hesitate to contact us.

Sincerely,

Dave Armstrong  
Swamp's Diesel Performance

dave@swampsdiesel.com