Why Injectors Wear

If proper maintenance is performed and problematic practices can be avoided, most diesel owners will go trouble-free.

If you're a diesel owner with an older engine (pre-common-rail) besides the general maintenance advice, like changing your fuel filter regularly doesn't apply to you. This is because older diesel injection systems only use much less fuel pressure modern engines, and older injectors send the fuel through much larger passages.

Why is there such a difference with common-rail injectors? Modern common-rail diesel injectors can fire up eight times per engine cycle depending on the maker. This increases the wear on the injector compared to the older diesels vehicles. Diesel injector's fail mainly because it has to do with the quality of the fuel running through the injector and we know from our reports of failures there's always room for improvement in our fuel quality.

Common cause of failures and why and how to prevent

Failure: High Internal Leakage or Return Flow

Indicators:

- Engine is hard to start
- Low common-rail pressure codes

Causes:

- Worn injector ball seat
- Blown internal high-pressure seal
- Incorrect nozzle needle clearance
- Cracked nozzle body
- Cracked injector body

Prevention:

- Keep fuel system clean, change fuel filters, purchase fuel from reliable sources, and avoid filling from portable fuel tanks.
- Avoid aggressive tuning that increases rail-pressure and injector pulse widths and do not remove pressure-limiting devices from the system (they are there for a reason).
- Do not use aftermarket counterfeit injection components that are not properly designed or manufactured.

Failure: No Injection

Indicators:

- Cylinder Balance rates are high (positive), indicating fuel is being added to the cylinder because the computer thinks the fuel injector is not flowing enough.
- ECU fault codes

Causes:

- Debris or rust in the injector plugging the nozzle
- Armature and/or nozzle needle stuck
- Loss of cylinder compression or other mechanical problem

Prevention:

- Keep fuel system clean, change filters, purchase fuel from reliable sources, and avoid filling from portable fuel tanks or Unknown sources.
- Do not use aftermarket counterfeit injection components that are not properly designed or manufactured.
- Reject all fuel system replacement parts that have metallic burrs
- If a long storage time of the vehicle is expected, arrange to have it started on occasion to prevent internal varnishing and corrosion of internal components; aftermarket fuel additives specifically designed for stabilizing diesel fuel could also be added

Failure: Excessive Injection

Indicators:

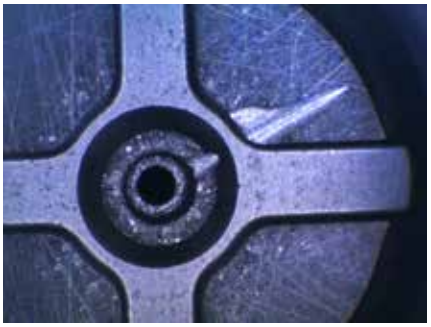
- Excessive smoke at idle, poor running, and banging
- Cylinder Balance rates are low (negative), indicating fuel is being reduced to the cylinder because the computer thinks the fuel injector is flowing too much, normally this is the side effect of another much larger issue.
- Excessive exhaust gas temperature
- Engine damage from excessive heat or hydraulic lock from excessive fuel in the cylinder

Causes:

- Worn ball seat in injector or poor end of injection cut off
- Nozzle needle seat worn or damaged
- Debris in control system of injector, which holds it open
- Debris in nozzle needle seat holding it open
- Cracked nozzle from overpressure, or overheated nozzle from improper installation of injector

Prevention:

- Replace worn and high-mileage injectors; do not use these injectors as a foundation

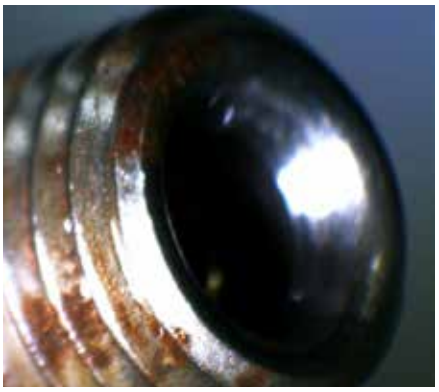


- Keep fuel system clean, change filters, purchase fuel from reliable sources, and avoid filling from portable fuel tanks or questionable sources
- Do not use aftermarket counterfeit injection components that are not properly designed or manufactured

Failure: Incorrect Injection Rate

Indicators:

- Rough running and poor cylinder balance



- Large cylinder-to-cylinder exhausts temperature variation

Causes:

- Poor nozzle flow balance
- Nozzle needle lift incorrect (mixed or missing parts)
- Partially plugged nozzle
- Wire-brushed nozzles

Prevention:

- Keep fuel system clean, change filters, purchase fuel from reliable sources, and avoid filling from portable construction fuel tanks or questionable sources
- Reject all fuel system replacement parts that have metallic burrs
- Do not use aftermarket counterfeit injection components that are not properly designed or manufactured
- Ensure injectors are serviced or purchased from a reliable source
- Do not clean nozzles with a wire brush?

Failure: Incorrect Injection Timing and Duration

Indicators:

- Rough running, poor cylinder balance, and knocking
- Piston damage
- Large cylinder-to-cylinder exhausts temperature variation

Causes:

- Ball seat wear
- Incorrect injector assembly, parts mixed, or parts missing
- Injector needle lift increased to increase output

Prevention:

- Replace worn injectors
- Ensure injectors are serviced, tested, and purchased from a reliable source

Diesel Fuel Failures

Three major causes of injector failure associated with the properties of the fuel itself: excess wear, abrasion, and deposits.

Prior to January 2006, diesel fuels contained relatively large amounts of sulphur. This sulphur is found in the crude oil that gets refined into diesel fuel. The sulphur in the fuel was used as a natural lubricant for the fuel system. Low sulphur diesel is now mandated in all diesel fuel segments. Diesel has a maximum allowable sulphur content of 10 parts per million (ppm) since January 2009. As refiners removed this sulphur, the lubrication benefits went away. As a result, diesel fuel refineries now put additives in the fuel to restore lubricity. The standard for measuring this lubricity is ASTM D-6079, which measures the size of a wear scar between two metal surfaces lubricated with the fuel. The less lubrication the fuel provides, the larger the wear scar. Many fuel distributors add additional lubricity to the fuel to limit premature wear.

ABRASION

While fuel lubricity is an important factor in determining the wear characteristics of the fuel injection system, it's not the only fuel-related cause of excess wear. The other potential cause of premature injector failure (due to wear) is caused by abrasion. All fuels contain small amounts of impurities, even the highest-quality diesel fuels. Some of these impurities include very small particles that can pass through even the tightest on-board vehicle filters. If the fuel contains a large amount of these small, insoluble particles, over time they can abrade the injectors as they pass through during normal engine operation. In extreme cases, this abrasion can significantly alter the fuel spray pattern, causing reduced engine performance. In severe cases, it can even lead to injector failure. Good housekeeping practices by the fuel supplier, and good fuel filtration, can reduce the damage caused by this abrasion.

DEPOSITS

While excess wear is important to consider when discussing the cause of injector failure, one major reason for injector failure today is due to excessive build-up of deposits. There are two major types of these deposits - external injector deposits and internal injector deposits. External injector deposits are generally caused by incompletely burned fuel that builds up around the injector holes. These deposits are referred to as coking deposits. While in most cases these deposits may not lead to injector failure, they can build up enough to disrupt the fuel spray, which leads to less efficient fuel combustion. This is often observed by the vehicle operator as a noticeable loss in power or lost fuel economy.

INTERNAL DIESEL INJECTOR DEPOSITS

This deposit doesn't form on the external tips of the injectors, but rather on the internal parts, such as the injector needles and pilot valves. These deposits often look similar to the coking deposits (dark brown in colour). While they can form in virtually any type of diesel engine, they typically only cause operational issues in the newer engines with precision injection systems. Injection pressures near 30,000 psi create a very fine fuel mist spray in the combustion chamber, resulting in more complete burning of the fuel. This yields lower emissions and can also improve fuel economy. In order to maintain these high injection pressures, the injector assemblies have been highly engineered and have very tight clearance tolerances, sometimes as small as 1-3 microns (a human hair is typically 70-100 microns thick). So, you can imagine it wouldn't take much material depositing on these parts to cause poor injector needle actuation, leading to poor engine performance. In extreme cases, these deposits can lead to complete sticking or seizing of the injector needles, particularly after the vehicle has been shut down and the engine has been allowed to cool.

As these internal deposits build up, they can cause the same symptoms as the more traditional external coking deposits, namely lost power and reduced fuel economy. In extreme cases in which the injectors begin to completely stick, they can lead to excessive vehicle downtime and high maintenance costs.

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