

Simple steps for the perfect spray

A correct-functioning mechanical injector should atomise fuel with the correct spray pattern, open at the correct pressure, and not dribble fuel. With the purchase of a simple pop tester, injectors can be serviced in the farm workshop.
 By Josh Giumelli with photos by Ben White

On farms across Australia, there are thousands of older diesel engines still hard at work earning their keep.

Whether it be a tractor on a field bin, old truck carrying a fire unit, or a diesel engine-powered generator, pump or welder, these engines provide reliable service provided they receive basic maintenance.

Having said that, the fuel injection equipment in these engines can suffer through wear, poor quality fuel, or simply sitting idle for long periods of times. Irregular running, poor starting, low power and white exhaust smoke are all symptoms of injection equipment which is not at the top of its game.

As opposed to modern diesels with their electronically-controlled common-rail injection systems, most diesel engines built before 2000 have mechanical injectors. These can be readily serviced or replaced, but the cost does add up, as well as the inconvenience. But you can test and perform a basic service on these older style injectors at home in the farm workshop, provided care is taken to keep things clean.

In many cases, a fuel injection specialist will replace the nozzle and needle valve as a matter of course during an overhaul, so there is no harm attempting to get things working yourself, before resorting to specialist help if needed.

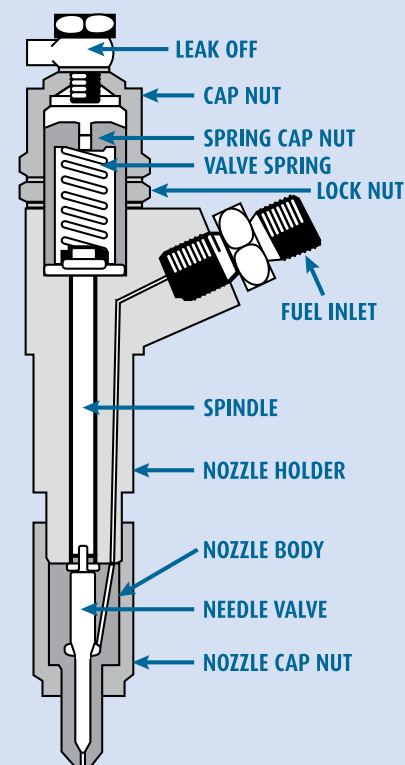
A fuel injection specialist will always have better quality test equipment, cleaner workshop, and more experience, but this shouldn't deter anyone willing to have a go at home. This is especially true when working on older diesel engines, when the typical service charge can easily be \$130 per injector.

SAFETY WARNING

On no account should you ever place a hand or finger over the nozzle, or anywhere near it when connected to a fuel injection pump or test apparatus. The high-pressure spray can easily penetrate skin, leading to horrific injuries, necrosis, and sometimes death. Only observe injector spray by eye from a safe distance.

All tools sourced from Toolmart where possible. Pop tester purchased from ebay.com.au.

Figure 1. Typical injector cross-section



The operation of typical injector is probably simpler than you imagine. High pressure fuel from the injection pump enters the inlet, and travels down a drilling in the body of the injector to the needle valve, which is held in the closed position by the valve spring. As the pressure rises in the void around the needle valve, force is exerted on the tapered shoulder of the needle. When sufficient pressure has developed to counteract the spring, the needle lifts upwards, opening the nozzle orifice and ejecting an atomised spray of fuel into the combustion chamber. When the injection pump ceases pumping, the pressure falls and the needle valve shuts against its seat in the nozzle. A small amount of fuel leaks up past the needle valve, lubricating the needle and cooling the injector. This 'leak-off' fuel leaves the injector through a low-pressure leak-off line, where it is either returned to the fuel tank or the injection pump.



1

Injectors come in all shapes and sizes to suit the different design requirements of diesel engines. Whether you are handling a newly overhauled injector, or a used unit removed from an engine, it pays to place caps over the nozzle and the fuel inlet to prevent accidental damage and dirt ingress.



2

There are two main styles of nozzles fitted to the business end of a diesel injector - hole and pintle. Hole-style nozzles can either have a single hole, or multiple holes as with the one pictured.



3

Hole-type injectors are mostly fitted to direct injection engines, where the fuel spray is injected over the top of the piston. They operate at higher injection pressures, which are needed to counteract the high combustion-chamber pressure, while also dispersing the fuel evenly across the chamber.



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Pintle-style injector nozzles feature a pin or pintle which protrudes through a hole in the nozzle body. They are usually fitted to indirect-injection diesel engines.



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Pintle injectors generally open at lower pressures, and have tighter, jet-style spray, as there is less need to disperse the fuel in the tighter confines of a pre-combustion chamber.



6

This injector test unit, otherwise known as a 'pop tester', is simply a hand-operated fuel pump and pressure gauge. While there are units of higher quality and price, this was purchased for \$140 on-line, and is ideal for infrequent use. Note the two adaptor pipes which are used to connect the unit to the injectors.



7

Without a pop tester, it is still possible to check the spray pattern by simply reconnecting an injector to the fuel line with it removed from the engine. But this doesn't allow the opening pressure to be measured and reset. We have attached this unit to a block of wood which is secured in the bench vice. Alternatively, bolt it to the bench top. The unit cannot be used free-standing, as some force needs to be exerted on the handle.



8

Before starting work on an injector, give it a good clean. Depending how filthy it is, this could be as simple as a quick degrease, to a soak in degreaser or even brake cleaner. Heavy rust can be cleaned off carefully on a motorised wire brush. The cleaner the external surfaces of the injector, the less chance there is of contaminants finding their way into the inside.



9

Perform an initial test on the injector, especially if you are trying to track down a faulty unit from an engine which runs irregularly. Select the appropriate adapter pipe and connect the injector to the pop tester. Fittings will need to be nipped up tight as any leakage will affect the test. Face the nozzle downwards or away from you.



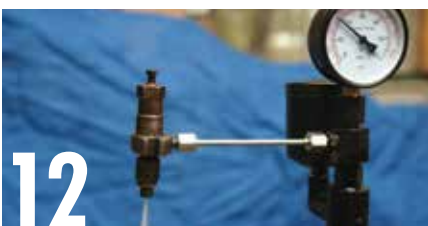
10

Fill the canister on the tester with clean diesel fuel. Make sure your tester has a fine mesh filter fitted inside the canister. If this is the first time the unit has been filled with fuel, you may need to bleed air out of the line by pumping with the delivery line fittings loosened.



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Pump the handle and watch the pressure build up slowly. It pays to do a little research beforehand to determine the opening or cracking pressure of the injector, so this value can be compared with the injector in question.



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As the pressure builds, the injector should open, expelling a high-pressure spray, and making a creaking or chirping sound. Note the pressure on the gauge - about 18 megapascals or 18 bar, which is about correct in this case. Note the spray pattern; this is also fine for a pintle nozzle, but can be checked against manufacturer's specifications if in doubt.



13

The spray pattern can also be further checked by spraying onto a piece of cardboard held at a distance from the nozzle. It should be relatively even and circular.

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Now check for dripping from the nozzle by slowly building up pressure on the pop tester and holding it just below the opening pressure. No drips should form on the nozzle, as opposed to the unit tested here. It also pays to check the integrity of the test adapter pipes, as sometimes a slight leak between the pipe and the injector inlet may dribble down and appear to be a leaking nozzle.

14



The needle valve in the nozzle can sometimes seize in the open position, or sit slightly open due to contamination. This will be obvious during testing as there will be little pressure on the gauge, and the fuel ejected from the nozzle will be a solid squirt rather than an atomised spray. In this case the nozzle will need overhaul or replacement.

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To service the nozzle, mount it upside down in the bench vice using aluminium soft jaws to avoid damage. Unscrew the nozzle cap nut.



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Place the cap nut to one side then carefully remove the nozzle assembly from the injector body.



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Moisture has obviously found its way into this injector, and sitting idle for some time, it is little wonder the needle has seized into the nozzle body. Needle valves are supplied complete with nozzle bodies, and usually cost around \$30 for common engines, but can be very expensive for obsolete or rarer units.



19

It should be possible to slip the needle valve out of the nozzle by grasping the protruding shaft. If not, the needle is seized. Note the nozzle body part number - this is used when ordering a replacement.



20

If you are desperate to reuse a nozzle with a seized needle, carefully grip the pin with the soft jaws and work it free by gently pulling and rotating the nozzle body. It helps if you can soak the unit in a penetrating fluid for some time beforehand.



21

With the needle free, inspect the components. A professional would not consider reusing these parts, but they can sometimes be salvaged. The corrosion on the needle tip is little more than staining, and can be polished off with a diesel-soaked cloth. Clean the nozzle, but don't use any items to probe blocked nozzle holes. Wash items in clean diesel and place in a clean location.



22

Now turn your attention back to the injector body. Clamp it right-side up in the vice and remove the cap nut. Free-up the adjusting screw and locknut, as they will need to be adjusted later when re-installing the nozzle.



23

Wash the body and clean all threads. It can be re-attached to the tester to pump some clean fuel through the body to purge fuel passages.



24

Reassemble the nozzle, needle valve and nozzle cap nut, and tighten the nut by placing the injector in the bench vice.



25

Now re-test the injector, taking note of the opening pressure, spray pattern, and any dripping. Note the spray pattern shown above for this multi-hole injector is meant to be asymmetrical. There are locating pins between the nozzle body and the injector body to ensure it is assembled with the correct orientation.



26

Whether replacing the original nozzle and needle, or installing a new one, the opening pressure will most likely need to be reset. In addition, the opening pressure of an injector will decrease over time due to wear and tear, and the spring losing tension. The pressure is raised by increasing the spring pressure on the needle valve.



27

On this style of injector, the centre screw is used to adjust spring pressure. It usually takes less than a turn to adjust most units. Repeat the test until the opening pressure is within specification, and tighten the locknut and replace the cover. With care, the spring pressure can be adjusted with the injector still connected to the pop tester.



28

This pintle injector does not have an adjusting screw for the spring. Instead, it uses a shim (second from right) placed in between the upper injector body and the top of the spring. To adjust the pressure on these injectors, shims of different thickness are added to increase or decrease pressure as needed. These can be purchased in kits, or injector overhaul packages, or obtained from a fuel injection specialist.