Testing piezoelectric injectors

When you squeeze quartz an odd thing happens, it will produce a current. When you apply current to quartz, it will rapidly change shape and stay in that new shape. Piezoelectric injectors uses this characteristic to provide fast, precise control of injection timing, while eliminating all other moving parts. Joe Clarke, from DIT, makes it simple to sort out problems with these injectors.

Joe Clarke, D.I.T.

Fundementals

The electromagnetic type injector is controlled when its solenoid is energised, enabling a controlled leak-off resulting in a pressure difference within the injector leading to its opening. The closing of this type of injector occurs when the electric current is cut, the solenoid becomes de-energised, resulting in the closing of the control chamber valve via a spring. Because of the design, there is an unavoidable delay in the time taken for this spring to close the control chamber valve. The Piezo-electric controlled injector can operate up to four times faster than the electromagnetic type, as the control valve is driven closed instead of relying on a spring. This extremely rapid open/close time has enabled up to 5 injections per cylinder per cycle (2 pilot injections, split main injection & post injection) according to running conditions. As a result, use of this technology has increased since the introduction of ever increasing emission control standards.

Operation

The mechanical principle of operation is similar to the electromagnetic solenoid injector. The controlled leak off, used to assist in the opening of this type of injector, utilises the "inverse Piezo-electric effect". The injector contains a control actuator, consisting of several hundred thin layers of Piezo crystal material, (normally quartz). When a voltage is applied to the quartz it will either expand or contract, according to the polarity of this voltage applied. The Electronic Control Unit (ECU) will continually alternate the polarity of the voltage, enabling precision opening/closing of the injector as required.

Note: When an electromagnetic type injector is disconnected from an electrical signal, it closes immediately due to the solenoid valve spring action. If a Piezo-electric type injector is disconnected from an electrical signal when the engine is running, the injector may remain in its open state for a period of time, which could lead to over fueling and possible engine damage.

Identification

The majority of piezoelectric injectors may be recognised by the location of the leak off pipe, located at the side of the injector and not on the top as seen on the electromagnetic type.

Safety Precautions & System Protection

• The operating fuel pressure within modern common rail systems may exceed 1,800 bar, or 26,100 psi. Therefore, before any work is carried out on the high pressure circuit, it is imperative that the system is depressurised after the ignition has been switched off. This depressurisation may involve a procedure using the diagnostic tool, or waiting a specified time for the pressure to drop naturally.

Note: Recently developed injection systems as used on hybrid vehicles may retain their pressure for longer periods of time, to enable immediate restart of the engine.

• If a high pressure pipe is loosened, disconnected or removed, it should not be reused as its integrity cannot be guaranteed. These pipes should always be replaced and tightened to the manufacturer's recommended torque.

• The working clearances within the injector are in the region of 3µm, many times smaller than that of a human hair. For this reason cleanliness must be ensured and all openings must be sealed following component disconnection.

• If a Piezo-electric injector is dropped or receives an impact, its internal crystals may be damaged resulting in faulty operation.

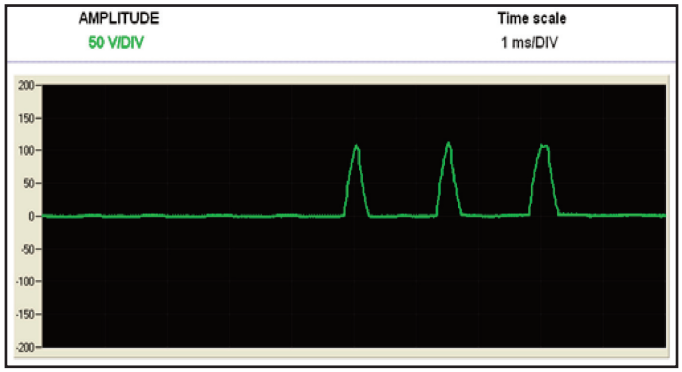

Figure 1 - A scope trace from a Euro 5 compliant diesel engine

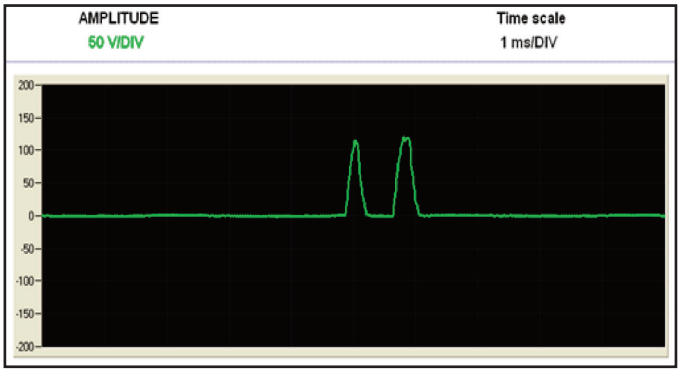

Figure 2 - This injector was triggered twice in about 1 millisecond