

PERFORMANCE ADDITIVES UPDATE

# OPTIMAL PERFORMANCE OF DIESEL INJECTORS



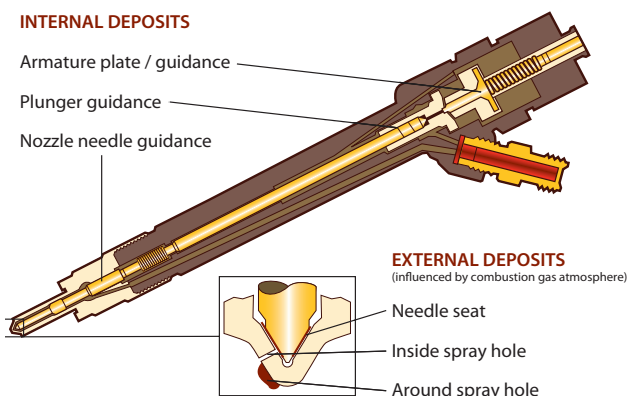
**Q. What is the role of the injector in the vehicle?**

**A.** The fuel injector is one of the most complex and critical components in the diesel engine. The fuel injector is responsible for ensuring that fuel is sprayed into the combustion chamber at the correct time during the engine's cycle and in the finely atomised form essential for efficient combustion. The fuel itself is delivered to the injector by a high pressure pump.

**Q. Why are injector technologies changing?**

**A.** Injector technologies are changing to meet the increased demand for reduced emissions. The most significant of these changes has accompanied the move away from indirect injection (IDI) to direct injection (DI) engines. In modern DI engines the injection systems operate at significantly increased injection pressures and temperatures and have multiple small injector nozzle holes, trends which will continue. These increased engine, injector and fuel system temperatures promote fuel degradation with deposits being formed.

**Locations of Internal and External Deposits**



**Q. How do deposits negatively impact the performance of injectors?**

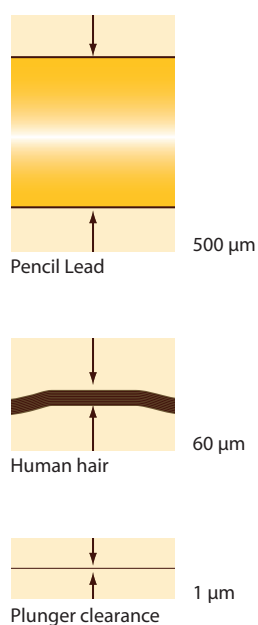
**A.** External deposits (coking or fouling) build-up in and around the injector nozzle and can occur as a result of exposure to the combustion environment. This will affect the fuel flow through the nozzle and resulting spray pattern, causing increased emissions and a loss of fuel economy and power. In areas marketing ULSD (Ultra Low Sulphur Diesel) a second type of deposit has been identified: internal deposits can develop on the injector needle shaft, plunger and armature plate in the form of a lacquer. As modern injectors are manufactured to extremely close tolerances, any such deposit can severely restrict movement, leading to poor engine starting, rough engine running, excessive engine noise and increased emissions.

## Q. How is the industry measuring the impact of deposits on the performance of injectors?

- A. There are currently two industry 'keep-clean' tests available globally: CEC-F-023 test (XUD-9) for IDI and CEC-F-098 test (DW-10) for DI, issued by the CEC and operated at its accredited test houses.

**The CEC-F-023 test (XUD-9):** Using the indirect injected Peugeot XUD-9 diesel engine fitted with a rotary pump injection system, this test assesses deposits formed between the injector needle, pintle, injector body and needle seat, as measured by flow loss through the injector. This engine is no longer representative of the current European passenger car market, but still has significance for developing markets. The older pintle type injectors used in this engine were designed and optimised for operation with a level of coking. Such injectors initially improve in operation as they develop the level of deposits expected when they were originally designed, although excessive coking is also undesirable. This is illustrated in contemporary papers such as SAE 912328, where an optimum flow loss of 15-50% is identified. Additive usage should target a level of deposits within that range to ensure optimal operation of vehicles with such older style engines.

### Relative Plunger Clearance



**The CEC-F-098 test (DW-10):** Using the direct injected Peugeot DW-10 engine with a high pressure, common fuel rail injection system, this test assesses flow reducing deposits in the injector nozzle holes by measuring engine power loss. To maintain optimum performance, the injection system should remain free from deposit formation, and it is generally accepted that the maximum recommended power loss in this test is 2%.

Currently the CEC test relies on the contamination of a non-coking base fuel with a zinc salt at 1ppm to initiate injector fouling. However, recent legislation mandating the use of bio-derived components in finished fuel has presented manufacturers with major concerns as they have been linked to high levels of injector deposits. The CEC are continuously working to ensure that appropriate, representative test fuels are identified and that the test is capable of discriminating between non-coking and pro-coking base fuels.

Afton has developed revolutionary deposit control additives that completely prevent the build up of coking in the DW-10 test with both zinc contaminated and bio-containing base fuels. Furthermore, this advanced additive technology can be utilised in emerging markets where the penetration of direct injected vehicle technology is not fully established. Adjustment of the treat-rate can provide total fleet protection covering indirect and direct injection passenger cars and trucks.

## Q. How does Afton's additive technology ensure the optimal performance of diesel injectors?

- A. As the market leader in diesel performance additives, Afton continuously works with OEMs, FIE manufacturers and oil companies to develop additive solutions which deliver optimal performance to diesel injectors. Our next generation detergent technology - Greenclean™ provides the optimal protection and performance in both industry tests. Moving beyond the DW10 test requires a more innovative approach to performance demonstration and Afton has developed the most comprehensive set of real-world data focusing on the benefits of injector deposit 'clean-up' in ways that will be meaningful to the consumer.

 **Greenclean™ 4**  
OUR GREENEST AND CLEANEST DIESEL TECHNOLOGY

### Summary

The injector system is the most complex component of the diesel engine and its technology is constantly evolving to meet performance demands (emissions reduction, fuel economy, sustained power delivery). Ensuring injector cleanliness is a key industry concern and there are two recognised industry 'keep-clean' tests to measure the impact of fuel on injector performance. Optimal 'keep-clean' can be defined as >50% remaining flow in the XUD-9 and <2% power loss in the DW-10.

Afton Chemical is the market leader in additive solutions for injector cleanliness and has best-in-class performance in both CEC tests. Afton Greenclean™ technology is also supported by the industry's most comprehensive real-world vehicle testing capabilities, allowing our customers to achieve their targeted brand ambitions.

For more information please contact your local Afton representative or visit [www.aftonchemical.com](http://www.aftonchemical.com)  
The CEC tests are owned by the CEC and the full test can be purchased via [www.cectests.org](http://www.cectests.org)