

Internal Diesel Injector Deposits: A New Twist on an Old Problem

Advancements in diesel fuel delivery systems have resulted in more power, improved fuel economy and fewer emissions. But one challenge remains: performance-robbing deposits. In part two of this diesel-fuel series, *AMSOIL Magazine* takes a closer look at injector technologies, deposit types and how AMSOIL diesel fuel additives address the problem.

The HEUI System

In the early 1990s, diesel engine manufacturers began seeking ways to increase fuel efficiency and reduce emissions without sacrificing power or torque. One answer was to redesign the fuel-delivery system. In 1993, Caterpillar introduced hydraulically actuated electronic unit injection (HEUI), which uses high-pressure oil to mechanically pressurize fuel inside the injector prior to it being injected into the combustion chamber. The resulting fuel injection pressures of up to 21,000-25,000 psi improved fuel economy and reduced emissions without affecting performance compared to mechanical injectors of the time.

The HPCR System

High-pressure common-rail (HPCR) direct-fuel injection is the latest design development. Over the past 10 years, HPCR systems have slowly eroded use of HEUI systems, and now most major manufacturers use HPCR systems. The name "common rail" indicates all the injectors receive fuel from the same fuel rail, as opposed to individual lines for each injector. HPCR systems generate fuel pressures of 30,000 psi and above, atomizing the fuel into a fine mist prior to combustion. They allow manufacturers to build more powerful diesel engines while still satisfying tightening emissions regulations. A recent common-rail engine features piezoelectric injectors for multiple injections per cycle. This all means higher performance potential, increased low-end performance, improved fuel economy, reduced engine noise and significantly lower emissions.

Direct-Injection Drawbacks

In direct-injection diesel engines, the fuel and air are mixed in the combustion chamber and ignited using high-temperature compressed air. This arrangement improves combustion efficiency, but also increases the possibility of deposits forming on the injectors since they are exposed to the intense heat found in the combustion chamber. Deposits inherently form in the presence of increased temperatures and can negatively affect horsepower and fuel economy.

New Technology, New Deposits

Deposits on the injector tips, known as nozzle coking, have been an issue for years. These "conventional" deposits form in and around nozzle holes through which the fuel passes, disrupting the spray pattern and reducing efficiency. In recent years, a new type of deposit has surfaced in HPCR fuel injectors. Known as internal diesel injector deposits, they do not form on the external tips of the injectors, but on the internal parts. HPCR injectors feature highly engineered components with tolerances as low as 1-3 microns (a human hair is 70-100 microns thick). Given the microscopic clearances, even minimal deposits can cause sticking in HPCR injectors, leading to poor engine performance, high maintenance costs and vehicle downtime.



OEMs Recognize Problem

Almost all U.S. original equipment manufacturers (OEMs) have encountered internal diesel injector deposits in testing or field trials. These results point to what the future holds for the diesel market and are a growing concern with many OEMs. Some OEMs are beginning to supply their own bottled fuel additives. Engine and injector manufacturers indicate injectors may be even more sensitive to internal diesel injector deposits in the future. One of the main problems for diesel owners is that many of the "all-in-one" additives available today aren't formulated to address internal diesel injector deposits, which have proved more resilient than traditional coking deposits and require advanced, potent technology for adequate removal.

AMSOIL Diesel Injector Clean (ADF) and Diesel Injector Clean + Cold Flow (DFC) offer advanced chemistry that guards against internal diesel injector deposits. As performance concentrates, they deliver performance all-in-one additives can't match.

Next month, part three of this series looks at seasonality issues and cost of ownership for diesel owners. ■

Fuel injectors in high-pressure common-rail diesel engines use smaller, highly engineered components to produce the higher fuel pressures needed for improved combustion. The tighter clearances invite internal diesel injector deposits that interfere with injector needle actuation, reducing performance.