Many significant changes have occurred in diesel engine designs over the years to improve performance, efficiency, emissions, and durability. But one thing that hasn’t changed is the need for proper maintenance. While we’re all familiar with general practices like oil and filter changes, less well known is how the choice of fuel selection also plays a critical role. Simple fact is, diesel engines are very susceptible to fuel injector deposits. They always have been. But with modern Tier 3 and Tier 4 engine designs, the problem is getting worse.

Essentially, there are two areas where deposits occur in fuel injectors - first, on the nozzle tips, which contain holes through which the fuel is sprayed into the combustion chamber, and second, deeper inside injectors where moving parts open and close to allow the flow of fuel.

Even under the best conditions, there are only tiny fractions of a second for each combustion event to take place. Nozzle coking deposits that impact the amount of fuel injected or the size of those fuel droplets will impact combustion. Less than complete combustion means fuel isn’t burnt at the right time in the cylinder. That leads to a loss of power and fuel economy as well as an increase in exhaust emissions.

In older diesel engines with unit injectors, the primary challenge was cleaning and preventing deposit build up in and around these small nozzle holes. Nozzle coking slowly blocks off the fuel flow and disrupts the process of creating very small fuel droplets. Internal diesel injector deposits (IDID) were not as much of an issue with older injectors as moving parts were bulky and heavy and not significantly impacted by internal deposits.

While the nozzle deposits themselves occur slowly, injector holes could be quickly cleaned up with just a few tanks of quality diesel fuel with deposit control additives. Fuel economy, power, and emissions could all be restored to normal levels. Since the clean-up process tends to happen much faster than deposit formation, the sudden performance improvements from a clean engine was often very noticeable to operators.

In contrast to older vehicles, today’s diesel engines use common-rail direct injection technology to provide much higher efficiencies. Fuel injection now occurs at pressures of tens of thousands of psi, through holes that are about the size of a human hair. Internal moving parts are also much smaller, lighter, and more intricate. But while bringing many efficiency improvements, the new injector designs bring increased deposit concerns.

This photo compares the size of a moving internal diesel injector part, a pintle, from a Cummins L10 injector to a newer John Deere injector in a Tier 3 compliant common-rail direct injection engine.
The problem of nozzle coking deposits is still a concern in these modern injectors, but because holes are now even smaller, they are sensitive to even smaller amounts of deposits. The operator may not even realize it is happening, but with each hour of operation the deposits slowly grow. Over the course of a season or two, engine can suffer very real performance losses.

But more importantly, newer diesel engines now often suffer from a whole new deposit affliction. These new, common-rail injection systems use very different fuel injectors that are supplied with fuel at a high pressure in the common rail. The injectors are then computer controlled to inject the fuel into the combustion chamber with greater accuracy and efficiency. Because the fuel is already pressurized, the injector just needs to open and close to deliver the fuel, which means moving parts are much smaller and lighter to allow split-second electronic actuation.

With computer controls, injectors can be actuated to inject multiple injections in a single combustion event - giving engineers the ability to tailor combustion in each cylinder for more complete combustion, lower emissions, easier starting, and less noise. In some cases, these modern common-rail injectors may inject fuel up to 7 times during a single combustion event.

As moving internal injector parts became significantly smaller to achieve these engine improvements, internal diesel injector deposits (IDID) challenges tremendously increased. Deposits now forming on moving pintles lead to sticking and slower operation. This impacts the amount of fuel injected and the timing of the fuel injection, which greatly impacts combustion and performance.

An engine suffering from IDID issues can show severe combustion problems including no start, poor idle, excessive smoke and inability to make power. Unlike nozzle coking that builds up over time, this IDID problem can appear quite suddenly. While operating fine on one day, the engine can make enough deposits to suddenly cause moving injector parts to stick the next day.

Concerns about both nozzle coking deposits and now IDID deposits are growing among engine manufacturers, fuel marketers, and fuel users. To maintain the performance of modern diesel engines, it is more important than ever to consider the choice of diesel fuel. Often, diesel fuel that was effective at cleaning nozzle tips of yesterday’s injectors is not capable of cleaning the more troublesome IDID issues of today. A premium quality diesel fuel should be treated with modern deposit control additives that are effective at preventing and eliminating troublesome deposits throughout the entire fuel injection system.