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Fuel Additives Special Supplement

Challenges & Solutions with Petroleum Fuel Additives

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Diesel Deposit Control Additives You're Never Too Clean

By Keith C. Corkwell and Thomas R. Weyenberg

How do you know when your injectors are dirty and functioning poorly? Listen to your engine, it's trying to tell you something. Diesel injector deposits can lead to poor combustion, costing you fuel economy and power. In the past, these problems developed gradually and could be controlled with available diesel fuel additives. In today's modern fuel injection systems, the equipment is more sensitive, the deposits are more tenacious and the problems are getting worse. Newer generation diesel injector deposit control additives provide the answer to maintaining the fuel economy, power and emissions of these newer engines.

A New Twist on an Old Problem

Additives to prevent or remove diesel injector deposits have been in the market for decades. Even in older diesel engines, the injection system is one of the most important components that determine combustion efficiency in an engine. Without proper combustion, fuel economy decreases, emissions go up and power is reduced.

Deposits are prone to build up in the tiny injector nozzle holes, slowly choking off the flow of diesel fuel in a process called nozzle coking. These deposits impact the amount of fuel delivered, the spray size and pattern of the fuel droplets and how the fuel and air mix as the fuel spray enters the combustion chamber. All of these impact how combustion occurs and the fuel economy, emissions and power that you get out of the engine.

Since it takes time for deposits to form, the impact on engine operation changes gradually. Many drivers don't even realize how much power or fuel economy they've lost or that there is a cause – nozzle coking. Older generation diesel detergents were specifically used to address these issues and maintain or restore optimal engine performance.

Unfortunately, this problem of nozzle coking has increased with new injector designs. As engineers work feverishly to meet new emissions standards for engines and the fuel economy expectations of customers, the fuel injection systems have continuously evolved. Nozzle spray holes in many modern injectors are now only slightly bigger than the diameter of a human hair. Not only are the holes smaller, but they have complex shapes that can involve a rounded inlet and a smaller outlet hole. All of this makes the injector more likely to suffer from nozzle coking and the impacts on combustion – fuel economy, emissions and power. That makes the job of a diesel fuel additive even greater.

As if nozzle coking wasn't creating enough problems, modern injectors are now suffering from deposit problems in areas other than the nozzle holes. Older injector systems used unit injectors that were driven from a cam shaft or hydraulically-actuated electronic unit injectors (HEUI) that used oil pressure to create the forces needed to inject fuel. These systems are giving way to high pressure common rail injection systems where fuel is supplied already at high pressure to the fuel injector. The injector is then electronically controlled to open and close, injecting fuel at precisely the right time and, in many cases, in several small injections instead of one big one.

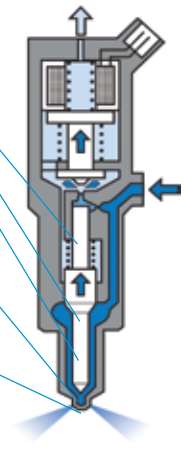
Deposit Concerns For Diesel Fuel Injectors

Internal Diesel Injector Deposits (IDID)

- Control valve plunger
- Needle guide
- Above the needle seat

'Conventional' Deposits

- Deposits inside spray channel reduce the hydraulic flow leading to a loss of power
- Injector tip deposits adversely affect the fuel spray leading to loss of power, increased emissions, and higher fuel consumption



The new standard for diesel fuel performance requires technologies that inhibit both conventional and IDID deposits without compromising any of the other performance-enhancing attributes of a premium diesel fuel.

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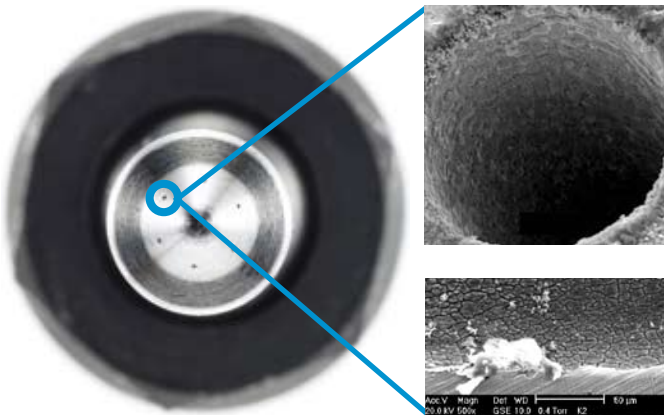


This scanning electron microscopy (SEM) image shows a remarkable level of injector dispersion hole cleanliness from fuel injectors that were sectioned during a DW10 nozzle fouling test.

In order to make that happen, the moving parts inside the injector, like the needle and command piston, have become very small and lightweight. Additionally, the tolerances between the moving parts and the stationary parts are now extremely tight – down to just a few microns. The result is that any deposits that build up on these internal injector parts can cause a binding or sticking of the moving parts. This type of deposit is known as IDID, short for internal diesel injector deposits, and is just as bad, if not worse, than the traditional nozzle coking deposits.

IDID results in poor fuel control. Fuel can be injected in the wrong amount or at the wrong time because of sticking parts. That results in poor combustion, which for the operator can mean a drastic loss of power and fuel economy as well as increased emissions and lots of black smoke. Unlike the nozzle coking deposits that continuously choke off the nozzle spray holes, the problems caused by IDID can appear quite suddenly. In many cases, an engine that ran fine one afternoon will start poorly and idle rough the very next morning.

With the new diesel engine emissions standards, the use of these high pressure common rail systems is growing with every model year in both on-road and off-road applications. As more of these systems enter the market and accumulate hours, the problem of IDID grows. The very injectors that are designed to help improve emissions and efficiency can actually make matters worse if IDID deposits are allowed to grow unchecked.

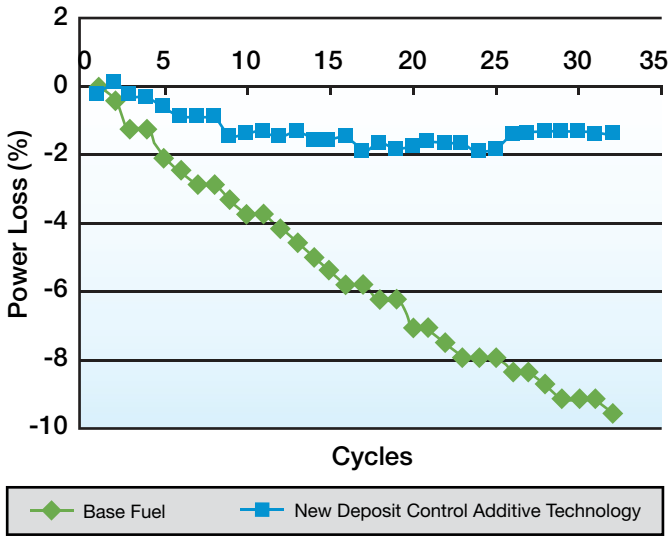
A new deposit control solution is needed. However, many previous generation additives that address basic nozzle coking aren't capable of controlling IDID. But some solutions do exist. Newer diesel deposit control additives are available that can both prevent the IDID problem from starting as well as correct existing problems. Removing these IDID deposits with an advanced deposit control additive means that the equipment is not only up and running, but running well and delivering the fuel economy and power it was designed to produce.

New deposit control technology can be found in some premium diesel fuels on the market today. In situations where the deposit problems are severe, concentrated bottled additives can be applied to reduce deposits in a single tank of fuel. But in either case, it is important to ensure that a deposit control additive package addresses all the trouble spots in engines. That means working on both nozzle coking problems as well as IDID problems. It also means being equally effective in the newest engines with the latest technology coming off the production line as well as in the oldest engines on the road. And finally, it means working to eliminate problems regardless of the source of deposits or the type of fuel used. With today's mix of ultra low sulfur diesel fuels and biodiesel blends, it is crucial to have an additive solution that works in all of these circumstances.

The new standard for diesel fuel performance requires technologies that inhibit both conventional and IDID deposits without compromising any of the other performance-enhancing attributes of a premium diesel fuel.

This scanning electron microscopy (SEM) image shows a remarkable level of injector dispersion hole cleanliness from fuel injectors that were sectioned during a DW10 nozzle fouling test.

Comparative power loss capability as demonstrated through CEC DW10 testing.



Comparative power loss capability as demonstrated through CEC DW10 testing.

Conclusion

Clean fuel injectors have always been an important means of insuring quality combustion. With changes in fuel injector design, this has never been more true. Not only are nozzle coking problems growing with more complicated nozzle geometry, but now newer engines face IDID problems as well. Newer generation diesel deposit control additives are already available in some premium diesel fuels and in concentrated bottle formulations that are capable of dealing with the most difficult IDID problems. And they are just as effective at handling the traditional nozzle coking problems. With fuel economy, power and emissions at stake, keeping these injectors clean is more important than ever, so when it comes to fuel injectors, you can't be too clean.

Keith C. Corkwell, Regional Business Manager, The Lubrizol Corp.

Mr. Corkwell is currently a Regional Business Manager with The Lubrizol Corporation for the Fuels, Refinery and Oilfield Products Group. He holds numerous degrees in Physics, Mechanical Engineering and Business. His 20 year career has focused on fuel and fuel additive performance and has included work at Texaco and British Petroleum. For the past 12 years he has worked for Lubrizol supporting fuel additive customers in markets in Asia, Latin America, and North America.

Thomas R. Weyenberg, Global Business Manager, The Lubrizol Corp.

Mr. Weyenberg is currently the Global Business Manager – Consumer Products, leading Lubrizol's efforts in the automotive aftermarket. He has been with the Lubrizol Corporation for 25 years in a variety of functions, including Research and Development, Business Development and Product Management. During his career he has worked in a number of areas of fuels and lubricants businesses. Tom has degrees in Chemistry and Liberal Studies from The University of Notre Dame, and an MBA from Case Western Reserve University.

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