

TRUCKING'S DIRTY LITTLE SECRET, PART II

A few months ago, we told you about an overlooked problem that's wreaking havoc on engines. Here are more details on the problem and how to deal with it.

By Deborah Lockridge, Senior Editor Heavy Duty Trucking Magazine

George Morrison got an eye-opener a few years ago. The owner of AV Lubricants, an ExxonMobil distributor in Columbus, Ohio, he had a customer with a fuel filter problem. The customer's school buses kept getting stranded on the road, in the middle of busy intersections. Fuel filters were getting plugged, and the engines would do nothing more than idle. Morrison decided to take a look at the customer's fuel. When he had it analyzed, he found the fuel coming out of the tank was "horrendous," and it was plugging the finer filters on the fleet's new Caterpillar engines. He started looking at fuel tanks at other customer locations, including over-the-road truck fleets. What he found was fuel contaminated with dead microbes and tanks full of dirt and rust.

The lack of attention to fuel quality at many fleets is mind-boggling, Morrison says. Fuel, after all, is one of a fleet's top expenses -- and dirty fuel can wreak costly havoc in today's sophisticated diesel engines. The pressures in diesel fuel systems have gone from 3,000 psi to 20,000 to 30,000 psi, and tolerances are much tighter. Engine manufacturers have designed fuel injectors to be more robust to compensate, but at the same time, they have become a lot more expensive to replace. Southwest Research Institute found that the most damaging particle size for diesel fuel injection systems is 5 to 7 microns. Many standard engine fuel filters aren't fine enough to capture contaminants this small. To protect your equipment, you need to take a pro-active approach. Most fleets realize they have to monitor coolant quality as part of cooling system maintenance, and many fleets do oil analysis as part of their lube system maintenance, notes John Clevenger, director of global product management for Fleetguard. Yet, he says, "Most people don't think of doing much with their fuel. But it is the primary cause of the majority of on-vehicle problems." There are many strategies for improving the quality of the fuel going into your injectors, from improved quality of bulk storage to additional on-board filtration to the use of additives. Each fleet has to decide on what's right for them based on their operation and what will provide the most return on the investment.

THE JOB OF FUEL FILTERS

There are many contaminants commonly found in diesel fuel that can cause problems in your engine. Water is the most common form of contaminant, according to the Filter Manufacturers Council. It gets into the fuel when warm, moisture-laden air condenses on the cold metal walls of fuel storage tanks, or from poor housekeeping practices. Free water settles to the fuel tank bottom, where it can be drained. Emulsified water, however, stays in suspension where it can enter the fuel lines, fuel pump and injectors and cause corrosion and failure of key fuel system components.

“The problem with water is it’s not a very good lubricant,” says Fleetguard’s Clevenger. “It’s worse with today’s low-sulfur fuel, because sulfur is the best lubricant in fuel. So you’re taking away the lubricating ability of the fuel, at the same time the water in fuel is not lubricating.” The reduced lubricity can cause seizure of close-tolerance assemblies such as plungers, and water can even blow the tip off an injector. Water also is a problem because microbes, fungus and bacteria live in water and feed on the hydrocarbons found in fuel. They can quickly plug a fuel filter. If they pass through the filter, they can damage the fuel pump and injectors. Sediment and other solids often get into storage fuel tanks and cause problems. They can be introduced during the fuel transportation and transfer process, or through tank breathers without proper filtration. Corrosion of the fuel tank is another culprit. Asphaltenes are a contaminant that can be a special problem in newer engines. These black, tarry contaminants are naturally present in diesel fuel. But they separate out of the fuel as it is heated and cooled repeatedly, which happens on new engines that use the fuel to help cool the injectors. They are a common reason for filter plugging. It’s the fuel filter’s job to trap these contaminants before they get into your fuel system and do damage. As they trap more and more contaminants, fuel filters eventually will become restricted and eventually plugged. If they plug sooner than expected, don’t blame the filter. It’s just doing its job. Chances are, the problem is dirty fuel. The worst thing you can do to address problems with filter plugging is to switch to a more “open” filter. Sure, it doesn’t plug as fast, but you’re just pushing the problem down the road, when you face hundreds of dollars for injector replacement or thousands for a complete engine overhaul.

BULK STORAGE

If you store your own fuel on-site, that’s the first line of defense against dirty fuel. Even if the fuel you have delivered is incredibly clean (and often it’s not), it can become contaminated in your storage tanks with sediment, corrosion, rust, water and slime. Morrison is amazed by the number of companies that have never done any sort of testing on their fuel, either as it is delivered or the fuel in the storage tanks. “The biggest commodity they buy is diesel fuel, and no one is checking it for quality. They have no idea what the cetane number is, have no idea how much dirt and water are in the fuel they’re buying. Some trucking companies are getting as much as 1 to 2 percent of their fuel as water, and they’re paying \$1.50 a gallon for water!” Testing, however, can be confusing. There are literally dozens of things you can test fuel for, such as cetane, viscosity, sulfur content, water, sediment, density, cloud point, ash, distillation and lubricity. Testing runs the gamut from simple kits that allow you to test for water or biological contamination on-site to independent labs where you can pay several hundred dollars for an exhaustive test. Making matters worse, federal specifications for fuel quality were designed for the engines of 20 years ago, Morrison says. If you’re concerned about contamination, the main things you need to test for are water, sediment/particulates, and perhaps biological contamination. Cetane is also a good idea. “There’s a standard test for diesel fuel that is done to check that it meets ASTM standards,” says Barry Williams, owner of Predictive Maintenance Services in Uhrichsville, Ohio. “The fuel has to meet that spec, and you certainly should have that test done,” he says, which includes percent water/sediment, cetane index, API

gravity and distillation. Williams is referring to the American Society for Testing and Materials, which develops and publishes voluntary standard specifications, tests and practices for everything from paint to medical devices to toy safety to fuels. It has a standard, D975-03, which prescribes the required properties of diesel fuels at the time and place of delivery. Some in the industry, however, believe that ASTM's standard is not enough for evaluating fuel contamination today.

"The routine test that's currently available measures the percent of water and sediment," Williams says. "It doesn't really speak to the amount of particulates or their size." So in addition to a standard ASTM test, Predictive Maintenance Services will do a particle count -- test fuel for particulates in various size ranges according to ISO cleanliness standards. ISO, the International Organization for Standardization, is another voluntary standards group, having developed standards for everything from screw threads to freight container dimensions. It does not have a standard for diesel fuel; however, it does have standards for how to determine particle size in fluids such as hydraulic fluid.

"You'd be surprised at the number of fuel samples that come in that would pass the standard test with flying colors, but the particle counts were just through the roof," Williams says. The ISO cleanliness standard that Williams provides is expressed as three numbers separated by slashes, such as 20/19/15. The first number refers to the particles greater than 2 microns in a milliliter of fuel. The second number is those greater than 5 microns, and the third greater than 15 microns. Predictive Maintenance also translates that number to particles per gallon of fuel. "When you see you have 45 million particles in a gallon of fuel, that can be an eye opener," Williams says. Perfect Filtration Systems of Tampa, Fla., a small company that specializes in ultra-fine filtration, also advocates ISO particulate testing. "What we've found is what most fleets do is pretty primitive," says Keith Nye, vice president of sales. "It involves putting something like a piece of gum on the end of a stick and putting it in the tank to test for water and high algae/bacteria growth." However, there is no industry accepted ISO cleanliness standard for diesel fuel. Predictive Maintenance has set an alarm level of 20/19/15, based on work with George Morrison and engine manufacturer filter specs. "I've never seen a system fail because the fuel was too clean," Williams says. "It's good to set your sights high." In addition to testing, you need filtration. If you're concerned about the quality of the fuel going into your tank, you can set up a system to filter it as it goes in. More popular, however, are filters on the dispensing side, and it's an area of growing interest. "We're starting to see our sales of dispensing filters blip up as this issue becomes readily apparent to fleet owners," says Chris Greeson, senior technical service manager at Wix Filters. "There are people putting filters on tanks that have never done that before." Advice varies on exactly how fine that filtration should be. Right now, the most common filter used at dispensing pumps is a 30-micron. Many filter manufacturers offer bulk tank filters in the 10-micron range.

But Morrison says a 10-micron filter is not good enough. "They do not significantly filter the 7-micron component, which is the killer of high pressure injectors and pumps," he says. So he is working with a hydraulic filter manufacturer to develop a 1-micron diesel fuel dispenser. Perfect Filtration Systems offers a patented "Ultimate" filtration system that it claims filters out 99.9 percent of the water in the fuel and particles larger than 1 micron. The filter uses both centrifugal force and absorption to separate the water and solids from the fuel and lasts longer than conventional filters,

according to the company. It's not enough to install filters on your storage tanks. Make sure those filters are kept in place and changed. Some companies have discovered filter media pulled out by employees impatient with having to change filters frequently or by slower flow rates. This can be addressed through education, and also through specifying systems that can accommodate high flow in the first place. Racor and Wix are among the companies that offer high-flow dispenser filtration.

An often-overlooked source of fuel contamination, Morrison says, is the tank "breather." "Right now, the breather on top of every diesel fuel tank is an OSHA-approved screen that will keep out bricks and birds," he says. "Diesel fuel tanks 'breathe' from day to night, expanding and contracting as they heat and cool. So whatever is airborne in the evening hours will be sucked into the diesel fuel." When he couldn't find anything commercially available that he felt was good enough, Morrison developed a desiccant breather for his customers. But what if your trucks don't always fuel at your own facilities? Many truck owners are at the mercy of truckstops when it comes to fuel quality. At many truckstops, it's not unusual for someone to take the innards out of dispensing filters in order to achieve faster fueling and avoid the time and expense of changing them. "If you see a corroded, rusted filter at the fuel pump, it's probably been gutted and isn't filtering anything," Morrison says. John Hacker, director of liquid filtration development at Donaldson, recommends training drivers and fuel island workers to wipe off dirt, debris, mud and snow before opening up the fuel tank. "The average operator probably doesn't realize the amount of contaminant they're letting in just in fueling the truck," he says.

ON THE TRUCK

The single most important thing to do in on-board filtration may seem obvious, but it's something that some truck owners cut corners on in a shortsighted attempt to save money: Use high-quality filters as specified by the engine maker. As the pressures in the fuel system have increased, engine manufacturers are calling for finer filtration -- but they have taken various approaches in deciding how much filtration to require. Caterpillar is using a 2-micron secondary filter, while Cummins is using a 10- or 15-micron filter, depending on the engine, and other engine makers fall in between those two extremes. "Something that is unique to fuel filters is they have a very wide operating range depending on the application," says Chris Boesel, senior product manager for commercial vehicle filtration at Fram. "A primary fuel filter can be as wide open as 40 microns, while the secondary filters on Caterpillar engines are down to 2 microns. So it's very critical that you put on a filter that's designed for that application." If you don't, he says, the filter can plug faster or allow damaging particles to get past the filter and damage the injectors. Of course, those 2-micron filters can be expensive. After the warranty period is up, some truck owners are tempted to save money and fuel filter changes by going to an alternative, less expensive filter that doesn't trap the ultrafine particles. Or sometimes a fleet may want to consolidate two parts numbers for filters that appear very similar. "Make sure you're using a product that meets the performance requirements of your equipment manufacturer," says Travis Winberg, supervisor of the service engineering department at Baldwin Filters. "There are other filters that will screw on, but you need to make sure you're using the filter the

manufacturer lists. That way you make sure you're meeting the performance requirements. If you just use the filter you're supposed to be using, a lot of problems can be avoided." Many truck owners go beyond the standard filter, opting for additional filtration or fuel/water separation. "We've always said you can't have too much diesel filtration," says Wix's Greeson. "If you filter it at the [storage] tank and have two, three or even four filters on the engine, the better off you'll be." Fuel/water separators are optional on many engines today. "I don't know why any diesel engine wouldn't have a fuel/water separator on it," Greeson says. "Fuel/water separation is a big filtration issue. Just think about the condensation that can happen in your tanks going from Florida to New York." Add-on fuel filters/water separators on the suction side of the fuel system can add additional fuel filtration capacity, potentially longer fuel system maintenance intervals, easy access, and heating options for cold-weather operations. Different fleets use fuel/water separators in different ways, notes Kathy Edge, marketing manager for Racor. "A lot of fleets want to use it as their tightest filtration system," she says. "They may want a 2 micron or 10 micron element in it, and rarely change their final filter, letting the fuel/water separator do the work. Other fleets use the water separator as a primary filter, with say a 30-micron element in it, and the on-engine filter as the secondary filter." Keep in mind that in order to work properly, water separators must be drained regularly. "We have had fuel water separators sent to us that look like they had the Atlantic Ocean in them," Greeson says. "Once you saturate the media, you'll pump water-contaminated fuel right through it." Consider the ease of draining when spec'ing. Donaldson, for instance, has a "twist and drain" system that makes it easy to accomplish with a 180-degree turn forward and back.

Whether you decide to add fuel/water separators or other filters may depend on your duty cycle. If you're trading in your trucks every three years while they're still under warranty, sticking with the OEM's recommendations is probably fine, says Fleetguard's Clevenger. "But if you're keeping your trucks longer, the more you've done to minimize component wear, the better you're going to be from a fuel system maintenance cost standpoint after the warranty runs out."

Racor's Edge recommends looking at the investment in optional fuel filters/water separators from an operations standpoint and from an equipment life standpoint. "Step back and look at the big picture," she says. "Ask yourself, 'How long do I want my equipment to last?' Certainly a fuel filter/water separator can contribute to service life. From an operations standpoint, consider uptime and the fact that engines run more efficiently and put out less emissions when the fuel is clean. There is a myriad of benefits for a relatively small investment" No matter how many filters you have, OEM or add-on, make sure you change them regularly. It's probably best to err on the side of caution -- and make sure drivers have extras in the truck.

LOOKING AHEAD

New regulations that will even further reduce the amount of the lubricating sulfur in diesel fuel and mandate diesel engines that put out even less pollution will create more challenges for fuel filtration. "There's a lot of research going on, because we are anticipating some dramatic OE specification changes," says Wix's Greeson. "I think a component of reaching the 2007 EPA goals is going to be clean fuel"

“This is a big time of change in the industry of diesel fuel and diesel fuel filtration,” Greeson says, “and there are going to be some growing pains. I’m not sure if anyone has a real handle on how all the pieces of the puzzle are going to come together.”

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ANOTHER CLEAN-FUEL WEAPON: ADDITIVES

Additives can play an important part in the quest for quality fuel, if you choose and use them carefully.

For instance, Fleetguard offers an asphaltene conditioner to combat the problem of asphaltenes. There are various additives you can use to treat and prevent microbial growth. Other additives help minimize water problems, or improve cetane or lubricity. There are also additives designed to help prevent problems with wax and ice in fuel in cold weather.

Cummins notes that premium diesel fuels often contain several additives that can accomplish the same thing as buying additives and adding them to lower-quality diesel fuel. The company recommends using fuel additives that perform a single function so you can tailor the additives to the needs of your specific fuel.

“There are a lot of people out there who offer snake oil,” says Fleetguard’s Clevenger. “There are a lot of great things you can do with an additive, but they can’t do everything. Don’t go for hype. If they’re saying stuff that sounds too good to be true (like a 5 to 10 percent improvement in fuel economy), it probably is. Ask for data and make sure it’s from reputable labs, and work with companies that have a very good reputation. Some companies will offer customer testimonials instead of test data. If all you get is testimonials, run.”

Donaldson’s experts note a couple of things you might want to think twice about before adding to your fuel: used motor oil and biodiesel. “In the past, dumping used motor oil in the diesel fuel tank was probably a common practice and the engines were OK with it,” says John Hacker, director of liquid filtration development. “But with the higher tolerances, now it can cause a problem.” Hacker says biodiesel “is kind of a wild card.” Depending on what the biodiesel is made from (soybean oil, corn oil, animal fats, used French fry oil), it could cause problems with fuel filters not designed for these compounds.

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Microns 101

Here’s what you need to know about fuel filter micron ratings

By Jim Winsor and Deborah Lockridge

There's a lot more interest these days in fuel filtration because of the increasing complexity and high costs of diesel fuel injectors. The industry continues to increase injection pressures, and injector tip holes have become microscopic in size as diesel injection systems are even more sophisticated to meet ever-tightening EPA emissions regulations. The cleanliness of diesel fuel reaching injectors has become even more important.

Engine manufacturers and truck builders each have a filtration spec that should be adhered to. In talking about these specs, we talk about micron ratings. For instance, Caterpillar has the finest filtration spec, as low as 2 microns, on its engines. But just what, exactly, are micron ratings?

A micron rating is a measurement of the ability of a fluid filter (such as fuel or oil) to remove contaminants by size of particle.

How big is a micron? A micron is one-millionth of a meter or one-thousandth of a millimeter. It equals 39 millionths of an inch (0.000039). 25.4 microns equals one-thousandth of an inch (0.001). The diameter of a human hair is typically 40 to 90 microns. 40 microns is near the bottom of the range of what is visible to the naked eye. You can't even see the tiny particles that can do the most damage to injectors. Any way you look at it, a micron is tiny!

A filter marked "10 microns" has the capability to capture particles as small as 10 microns. It does not mean it will trap all particles down to 10 microns, nor does it indicate the total amount of particles the filter can hold. To understand what that 10-micron rating really means, you should understand the different rating methods.

Nominal Micron Rating means the filter will capture particles of the stated size. But in order for this rating to mean anything, you have to know at what efficiency it's rated. For example, a filter might have a nominal rating of 90 percent, 10-micron size, meaning it catches 90 percent of particles down to 10 microns. A 10-micron filter that catches 90 percent of the particles is more efficient than a 10-micron filter that catches 50 percent of these contaminants -- yet they can both be marketed as a "10-micron filter."

"A nominal rating [without knowing the efficiency] is basically meaningless," says John Clevenger, director of global product management with Fleetguard. "A screen door could be considered a 1-micron filter. It will catch a 1-micron particle -- once in a while."

Absolute Micron Rating is a single-pass test in which a fluid containing glass beads is passed through a flat sheet of filter material. Any beads passing through are measured. If you have a filter that is rated "10 microns absolute," that actually means it catches 98.7 percent of the particles 10 microns and above, Clevenger explains. It can't be 100 percent, he says; "that would be a brick wall." Multi-Pass Rating has traditionally been used internally by fluid filter and equipment manufacturers. However, Clevenger says, some engine manufacturers, such as Detroit Diesel, are now using these multi-pass specifications. During the test, contaminants graded by particle size are added regularly in measured quantities to the fluid, which is pumped continuously through the

filter. Contaminants are measured upstream and downstream of the filter for particle sizes and quantity of each size, with a ratio between the upstream and downstream particles, called a Beta ratio.

Chris Greeson, senior technical service manager at Wix, explains that if you have 150 particles upstream of the filter and 75 downstream, the Beta ratio would be 2. To convert a Beta ratio into an efficiency rating, subtract 1 from the Beta ratio, divide that result by the Beta ratio, then multiply it by 100. A Beta ratio of 2 is 50 percent efficient, a Beta ratio of 20 is 95 percent efficient, and a Beta ratio of 75 is the same efficiency as the “absolute” rating above.

Beta ratios are often reported in multiple ratios reporting the filter’s efficiency at removing different size particles. The first set of numbers represents the particle sizes, the second set the Beta ratio of the filter at removing those particles, such as 5/10/20=2/20/75.

Making matters more confusing, SAE has a newer testing standard that can’t test accurately down to 2 microns, so the previous 2-micron rating is now a 4.6-micron rating, according to Travis Winberg, supervisor of the service engineering department at Baldwin Filters. However, at this point most of the industry seems to be referring to the older standard.

To stay on the safe side, the Filter Manufacturers Council recommends buying filters by catalog listing as recommended by your engine maker, not just by “micro rating.”

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