http://www.fleetwatch.co.za/magazines/May2009/45-FuelW-lubrication.htm

Modern Diesel Engine Technology

Diesel fuel and why engines fail

DIESEL AND TRUCKING is synonymous and diesel is any trucker's biggest expense. It is also the energy source that makes his trucks move. Without it, his trucks simply go nowhere. Modern trucks are significantly more efficient in every way than previous truck generations. They are more powerful, faster, quieter, more fuel efficient, generally last longer and exhaust emissions are greatly reduced in line with international legislation.

At the same time, very little in the basic engine has changed. What has changed is the combustion chamber. This is where the fuel burns and transfers its energy through the piston to the crankshaft. To make an engine more efficient, combustion must be more efficient. This also reduces some exhaust emissions.

Advances in Fuel Injection

Exhaust emissions and fuel economy are the major design goals of modern engine manufacturers. In a diesel engine, raw fuel is injected into the combustion chamber where it must mix thoroughly with the waiting air, vaporise, auto ignite and burn. To start this process, the fuel is atomised so the overall air and fuel mixture is reasonably uniform throughout the combustion chamber. To improve combustion efficiency, there must be only one combustion chamber thus eliminating pre-combustion chambers, and the fuel must be injected at significantly higher pressures and through more holes in the injector tip to achieve a more uniform air fuel mixture.

Injection pressures have increased at least 10 fold in the past 10 to 15 years - from about 200 bar to a minimum of 2 000 bar, and the number of holes in the injector tip have increased to nine in some instances. These holes now have a much smaller diameter - less than 200 micron - and are laser drilled. Between 10 and 30% of the fuel entering an injector passes through into the combustion chamber. The remaining 70 to 90% is used to cool the injector tip and passes back to the tank which doubles as a radiator to cool the fuel.

Modern injectors therefore see higher transient temperatures and greatly higher internal pressures. To control fuel flow within the injector, the internal tolerances have been reduced from around 10 micron to about 1 micron.

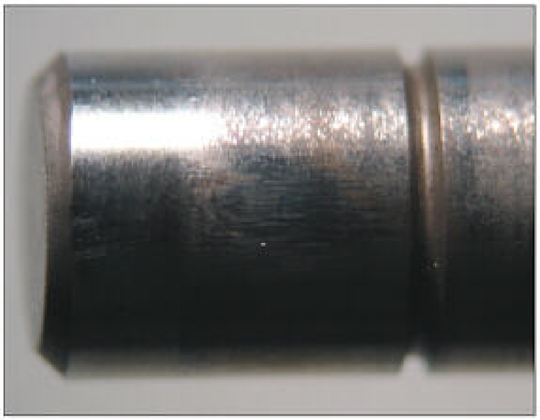
Advances in Diesel Fuel

In line with international requirements, diesel fuel sulphur in South Africa has been reduced in steps to the current maximum of 0.05%, or 500 parts per million. Some fuel suppliers also offer a boutique diesel with a sulphur content of less than 50 parts per million. This boutique diesel is required for engines fitted with diesel particulate filters (DPF) and may also benefit some engines with exhaust gas recirculation (EGR).

Reducing the fuel sulphur content immediately reduces exhaust particulate emissions but sulphur in diesel is an excellent lubricant. Because the fuel passing through the fuel pumps and injectors also lubricates those parts, a change in the fuel's lubricating properties can be disastrous. Low sulphur diesel is therefore boosted with lubricity enhancers.

Engine Failures

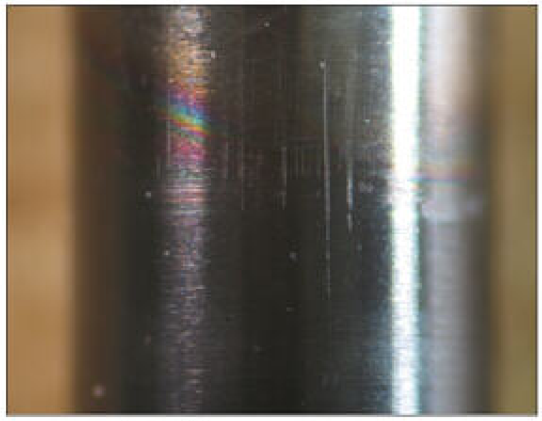
Modern engines are perceived to be more prone to failure than older engines. Given the fuel system changes in modern engines, the question is: What comes first, maintaining new technology engines or failure of new technology engines?



■ Figure 1

■ Figure 2

■ Figure 3



■ Figure 4

Dirty Fuel

The quality of diesel fuel in South Africa is controlled by SANS 342:2006. This specification loosely conforms to the European EN 590 specification and for South African conditions, gives equal performance. The major differences between these specifications are fuel sulphur and boiling range, both to assist the European industry to more easily reach their significantly more severe emissions targets than those applicable in South Africa. Because sulphur is such a good lubricant and also acts to control fuel oxidation at higher temperatures, it can be argued that South African diesel fuel is superior to European fuel - but is not as environmentally friendly.

It's not the fuel therefore, but the solid contaminants in the fuel that matter. Solid particles in the fuel should be removed by the engine's fuel filters. When this doesn't happen, the injector nozzle needle sticks, resulting in uncontrolled fuel flow into the combustion chamber. Past engine technologies could operate with solid particles in the fuel that had a diameter of up to 5 or even 8 micron, and those particles would pass through the injector nozzle. With a clearance of close to 1 micron, modern injectors will stick if 1 micron particles are in the fuel. Airborne dust is a major problem in South Africa due to our dry atmosphere and typical soil types and it is easy for these minute dust particles to enter any bulk fuel storage system unless breathers are also filtered to about 1 micron. The results of a sticking injector needle are disastrous. *Figure 1* shows typical abrasive wear of solid particles on an injector needle and *Figures 2 and 3* show typical resultant piston crown damage to a steel crown and an aluminium piston as the excess fuel burns on the crown.

Correct fuel filtration is critical. OEMs supply appropriate filters but often these filters are more expensive than aftermarket filter elements - so after market filter elements are used. That's all well and good but do ensure that the filter performance is equal or the results will be disastrous.

Fuel Lubricity

Failure due to poor fuel lubricity is generally not caused by diesel fuel but is caused by blending some other fuel - such as paraffin - which has poor lubricity, with the diesel. This then causes the needle to stick due to adhesive wear, with typically the same results seen in *Figures 2 and 3*. Typical adhesive wear on an injector needle is shown in *Figure 4*.

Poor fuel lubricity can also cause the injection pressure to drop. Instead of atomising the fuel to small droplets during injection, bigger droplets with higher momentum are formed. These droplets travel across the combustion chamber and condense on the liner wall, running down the wall in line with the injector nozzle holes where they wash away the oil and cause piston seizure such as shown in *Figure 5*. *(below)*.

Figure 5

Figure 6

Water

Water at high pressures and temperatures is not a lubricant or a fuel. It will therefore cause similar damage to the injector as particles in the fuel or poor fuel lubricity, resulting in piston crown erosion and piston seizure.

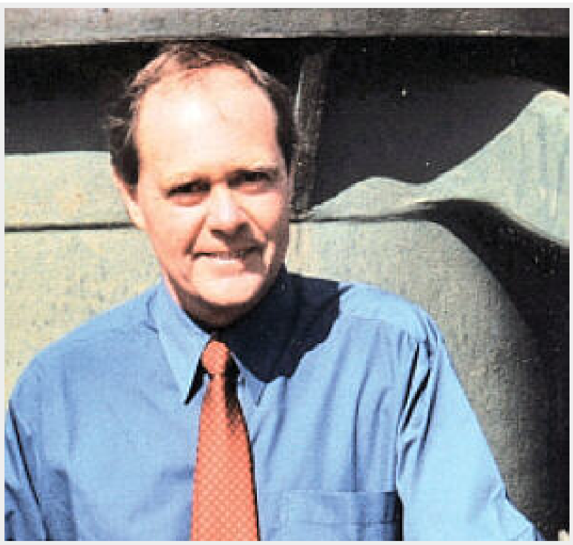
Most vehicles are fitted with water traps but unfortunately many operators bypass them because they block and cause fuel starvation resulting in a breakdown. Check water traps daily so that they do not block and if no water trap is fitted to a vehicle, the expense of fitting one is negligible compared to an engine failure.

Poor Installation

From the outside, injectors appear to be tough but under pressure, they can distort and interrupt needle movement if they have been incorrectly installed in an engine. Unfortunately, common causes of engine failure are fitting the injectors over deposits - such as old carbon deposits on the injector seat - or over torquing the injector. Both these installation faults will distort an injector cause needle sticking and result in piston failure due to over fuelling. Typical injector needle wear due to distortion is shown in *Figure 6*.

Maintenance

Correct maintenance has always been critical to minimise operating costs and for optimum vehicle performance. With modern higher performance engines, this is more critical than ever. Modern engines are made to give higher returns on investment but require greater care because their limits of abuse are lower than older technology engines. Use the correct fuel, filters and water traps and ensure that your injectors are always operating correctly and you will be able to sit back and enjoy a well run fleet.



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