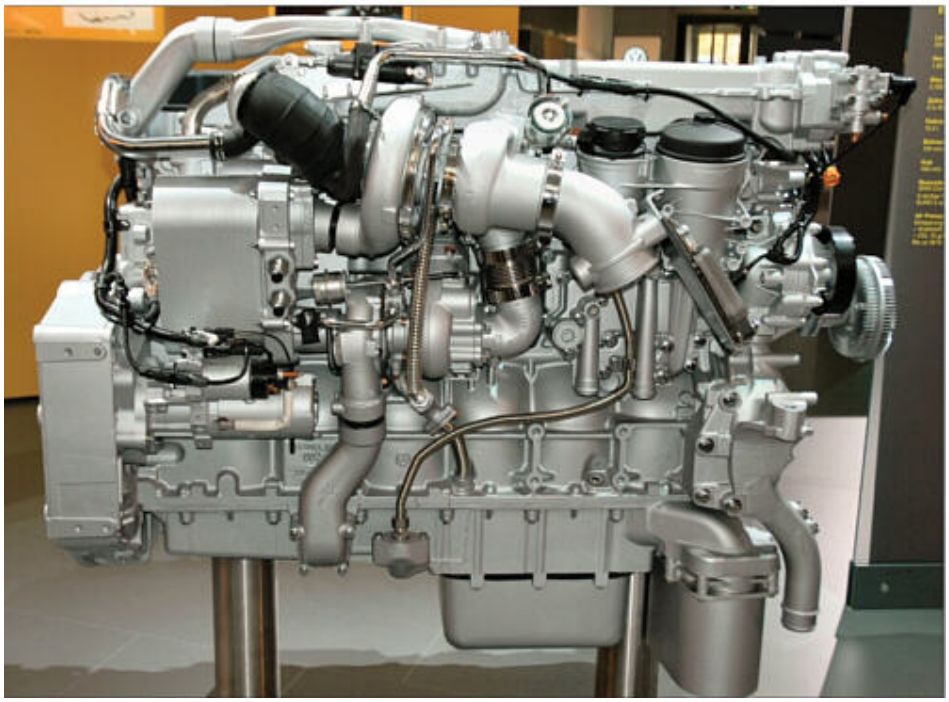
TechnicalWatch

A few microns can punch massive holes



▲ **MAN engine –** This latest 3rd generation common rail diesel engine from MAN uses two turbochargers and two water-cooled intercoolers combined with exhaust gas recirculation to achieve a Euro 5 emission standard without involving complex exhaust gas cleaning systems. This is typical of future standards that will need serious protection from contaminants, both inservice

daily operations and during major maintenance.

It's the one message every transport operator fears – 'There's a hole in the block'! And when uncontrolled seizuredebris punches a gap in an engine block, very few think that this could possibly start with wearing particles measuring only a few microns. Mix in wear rates with lack of fuel lubrication – or the new technical term 'lubricity' – and the early onset of fuel injector failure is guaranteed. Technical correspondent *Dave Scott reports...*

Fuel injector malfunction is a leading factor in the cascade of events leading to engines seizure and throwing components through a crankcase. As we employ an increasing number of new diesel engines equipped with common rail or unit injector fuel delivery systems, truck workshop culture has to adapt to being micron-clean to prevent a 'hole in the block'.

A recent 'Healthy Truck Clinic', sponsored by Nissan Diesel and hosted by well-known trucking expert, Hans Theunissen, reviewed the current issues attacking 'truck health'. There's no rocket science in attending to the basics that cause breakdowns. According to Theunissen's experience and records the top three items, in order of priority that will stop wheels rolling are –

- ✔ **Overheating** – who bothers to clean radiators, intercoolers and bug screens?

- ✔ **Fuel starvation** – often the simple breathers are overlooked.

- ✔ **No start** – batteries are a big problem. Workshops are not using distilled water, there are no hydrometers to check battery health, charge-rates are not checked and 'wildcat jumpstarting' are among many factors diminishing truck battery life.

Guest speaker for truck health, At von Wieligh is widely-known for his consulting role in failure analysis including issues surrounding tribology – the science of the mechanisms of friction, lubrication, and wear of interacting surfaces that are in relative motion. And when it comes to diesel fuel, Von Wielligh is quite clear on the fact that dirty diesel is a misnomer. "I am satisfied," he says, "that there's nothing wrong with the standard of fuel leaving South Africa's refineries. The problems with our fuel occur in the supply chain."

Diesel engine fuel pumps and injectors are fuel-lubricated. Von Wielligh is outspoken on the subject of diesel fuel lubricity, the measure of diesel fuel's ability to reduce wear on contacting metal surfaces found in fuel pumps and injectors. He concludes that all branded diesel fuel suppliers are now adding lubricity additives in sufficient ratios to avoid injector failure. In the days of high sulphur diesel fuels, compounds with the sulphur acted as an inherent lubricating agent - the use of lubricity additives has become necessary now that sulphur is removed, while detergents are also included in the additive pack.

So why is diesel fuel lubricity so important? It's very evident that modern diesel engines are providing far more efficiency from a smaller displacement. At the same time the modern diesel must deliver lower exhaust emissions, a longer in-service life with extended service intervals. Just compare the volumetric efficiency improvement of Mercedes-Benz engines from the ADE era to current times. See chart below.

Manufacturer	ADE	Mercedes
Engine type	442N	OM 904 LA
Aspiration	Normal	Turbo-intercool
No. of cylinders/capacity	8/15080cc	6/6370cc
Power kW @ r/min at sea level	213 @ 2100	205 @2300
Torque Nm @ r/min at sea level	1100 @ 1000 - 1500	1100 @ 1250 - 1500
Power to displacement ratio	14,12kW/litre	32,18kW/litre

Note 1: The Mercedes 904 is turbo intercooled - no altitude losses occur
Note 2: The ADE engine is nominally de-rated for altitude but will lose more kW/Nm

Von Wielligh points out that this means turbocharged and intercooled diesel engines will be designed with smaller coolant volumes, plus

- Electronically controlled fuel delivery systems under extremely high pressure that include adjustable valve and fuel injection timing. This in turn requires injection equipment with 1,5 micron tolerance on the injector tip to handle more than 1800 bar constant pressure and not dribble;
- A high positioned top ring – this has lubrication implications.

Spiking wipes out fuel lubricity

Various tests are conducted for fuel lubricity. There is a SANS Standard 342 which uses an officially recognised 'HFRR' test procedure. Together with this Von Wielligh has also used an SRV machine to test fuel lubricity and measure the result in Newtons (N) – the pressure applied before a lubricity film breaks. He lists the following comparative results for fuels

- Good quality diesel above 700N
- Petrol at 350N
- IK or Illuminating kerosene (paraffin) at 150N. This is a startling result. "When spiking diesel with IK, it's not about any change to the cetane value that affects engine life, it's simply poor lubricity that destroys a diesel engine", says Von Wielligh.

Another lubricity enemy is excessive fuel heat as lubricity decreases with increasing temperature. Devices that are supposed to save fuel by heating it are thus playing with engine life – beware! If fuel temperature is an operating problem a fuel cooler can be installed on the return line to a fuel tank.

Extreme cleanliness is not negotiable

With 1,5 micron clearance at an injector tip and 200MPa pressure behind it, contaminants are the unseen enemy. A 2 micron filter is required. What is a micron? It's a metric unit of measure equal to one one-thousandth (1/1000) of a millimetre and written as 0.001mm or 1µ or 1 µm. Really invisible to the naked eye and miniscule.

South Africa is famous for its silicaladen dust. On the 'Mohr Scale' of hardness, if a diamond has a value of 10, then silica rates at 7 – it's harder than steel. A 5 micron silica particle entering a 1,5 micron fuel injector tip will cause abnormal wear and the cascade of events starts.

- The injector provides poor spray patterns with resulting combustion disturbance.
- The injector nozzle starts to drip and washes away the cylinder wall oil film.
- Lubricant fuel dilution means a drop in lube viscosity and wiping of bearing white metal – that's when the connecting rod is pushed through the block.

A significant requirement for modern truck workshops is the creation of a 'Clean Room' where it must be possible to totally close the area, using traditional doors, roller shutters or curtains. The walls and floors of a 'Clean Room' should either be sealed with industrial paint or tiled. It's essential that dust ingress is minimised. All windows must be kept closed while exhaust extraction is provided for vehicles under test. Ventilation is also required to prevent fume build-up from cleaning solvents.

And then there's water. That problem will never go away – free water is a corrosive, anti-lubricant in diesel fuel. See *FleetWatch* article dated May 2000 *'Water in diesel – a hole in the cash bucket'* -

http://www.fleetwatch.co.za/magazines/may00/007.htm

So the things that you cannot see can destroy an engine, cash flow, and business survival. There's no alternative to changing the culture of truck workshops and daily start up procedures to one of hospital cleanliness. A few outsize micron particles can cause a hole that leads to many arguments about who was responsible – the driver, the technician, the fuel pump attendant, who? Cleanliness – in addition to being green – means survival