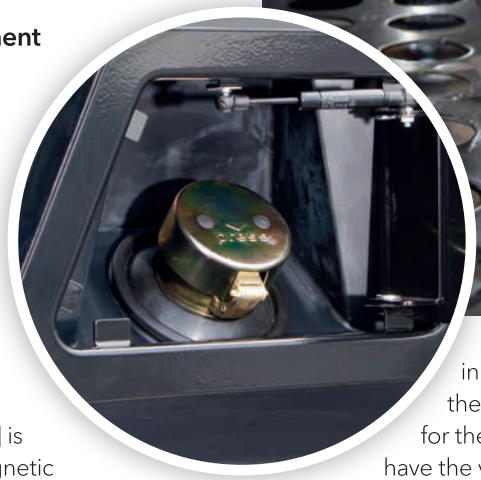
Cleaning up, breaking down

Preventing and repairing damage to exhaust aftertreatment systems has become an essential mission for fleet engineers, reports Richard Simpson

The great clean-up of heavy-duty exhaust emissions ranks as an engineering achievement of our time. As a reminder, tailpipe emissions of NOx, unburned hydrocarbons, and particles are a tiny fraction of what they were when the first European emissions regulations appeared. For example, the Euro I limit of 1992 specified a maximum output of 8.0g/kWh of NOx and 612mg/kWh of particulate matter. By 2013, when Euro VI had come into force, NOx limits were down to 0.4g/kWh and PM to 10mg/kWh, and there was also a limit on the total number of particles emitted. It takes a fleet of today's Euro VI trucks to produce the same quantity of toxic exhaust as a single Euro I truck would have done in 1992.

But that has come at a cost. While today's engines are incredibly reliable and durable, fleet engineers report that emissions control systems are now a major source of glitches in themselves. Diesel oxidisation catalysts, NOx selective reduction catalysts and particulate filters are all prone to contamination and damage by misuse.

The former was particularly problematic when SCR technology was first introduced. DAF marketing manager Phil Moon says: "Mis-filling of the AdBlue reservoir, or contamination by decanting into dirty containers to transfer fluid to the truck, was a big issue on introduction. But fleets have educated themselves on this and are filling direct from AdBlue IBCs or original bottles. The tank filler itself [pictured] is protected by a magnetic latch now," he adds.



"Some operators running in urban conditions are still reporting problems with the particulate filter not getting hot enough to burn off accumulated soot. Where possible, we recommend mixing the duty cycles of trucks, so the same vehicle isn't always on the slow city run.

"On our LF trucks, we've revised the NOx control to SCR only. Deleting the EGR gets the system to a higher temperature earlier in the duty cycle, so build-up on the PM filter is reduced."

Where contamination does occur, the situation must be acted on, says Volvo Trucks product quality manager Iain Chapman: "The ideal, of course, is for these kinds of issues to be avoided in the first place. Operators should continually educate all of their drivers on the costly outcome of getting it wrong and what dos and don'ts should be observed if such mistakes are made. They will also be advised during Volvo's vehicle handover process.

"If the incorrect fluid has been filled in the incorrect tank, then the safest thing for the operator is to have the vehicle recovered into a Volvo workshop. Once in the workshop, the fluid can be drained out and the system tested."

FUEL CHOICE

Chapman warns that non-standard fuels can damage emissions control systems: "Non-approved fuels also affect the emissions, and the emission system will detect higher NOx levels due to the reduced effectiveness of the combustion process, which then leads to increased AdBlue usage."

Non-standard fuel has been blamed for abnormally high emissions from a 2015 Optare Solo bus powered by a Daimler OM394 Euro VI Step A engine, which was tested for in-service emissions conformity by the UK's Department for Transport. It was producing abnormally high levels of NOx (although not high enough for the engine to de-rate).

Investigations suggested the vehicle had run on fuel with a FAME (biodiesel) content exceeding the 7% (B7) limit specified by Daimler. While untreated

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NOx levels in the exhaust upstream of the catalysts were found to be normal, emissions from the tailpipe exceeded legislative limits. The matter was investigated by Daimler, focusing on the condition of the aftertreatment system. It found significant areas of concern with the material integrity, oxygen storage capacity and NOx conversion efficiency of the SCR system.

Further testing confirmed the hypothesis that use of high-percentage FAME biodiesel had degraded the aftertreatment system. Long-chain molecules found in FAME are thought to obstruct the catalyst.

Analysis of fuel taken from the bus operator's depot with engine and aftertreatment test and analysis confirmed that use of high-percentage FAME biodiesel degraded the aftertreatment system to such an extent the NOx emissions exceeded the allowable conformity factor. The FAME content of the fuel was 22%.

ALTERNATIVE SUPPLIER

Where replacement aftertreatment parts are required, original equipment can be very costly. For out-of-warranty vehicles, aftermarket parts can be considered. Eminox and Dinex are OE suppliers to leading manufacturers, but also offer a range of replacement parts, systems and catalysts that can be used to restore compliance.

DPF PURGE BENEFITS

While DPF elements that have been physically damaged must be repaired, Norwich company DPF Recovery suggests that some damage can be prevented by removing the filter unit and having it cleaned as a proactive measure. Attempting a forced regen on a DPF that is obstructed with ash is likely to destroy the filter.

DAMAGE

Aftertreatment systems can also be subject to physical damage: the DfT investigation also revealed unexpectedly high temperatures recorded by a sensor at the exit of the diesel oxidation catalyst (DOC). Physical examination revealed the DOC element had become displaced and bent the heat sensor. This meant that when the particulate filter regenerated, the DOC was subject to abnormally high temperatures, and its ability to convert nitric oxide (NO) into nitrogen dioxide (NO_2) was reduced. The low concentration of NO_2 reaching the SCR unit compromised its ability to convert NOx into CO_2 and H_2O.

A further cause of damage is using the wrong engine oil. Sulphur and phosphorous are traditional and effective anti-wear additives in engine oils, but the small amount of oil burned in engines can lead to metallic ash deposits accumulating on particulate filters (pictured). Unlike carbon, they can't be removed by regeneration.

Steve Oakley, technical manager, Scania UK, warns that manufacturers' recommendations on fuel and oil should be followed. "To get the optimum life from the DPF, use low-ash LDF4 oil or a Scania-recommended and -approved alternative."

He also points out that switching from standard EN590 diesel to fuel with a high FAME content should only be done after advice from a Scania dealer. "If the fuel system, exhaust silencer and software file hasn't been converted in accordance with the conversion programme, it will lead to catastrophic failure of components in the engine, fuel and aftertreatment systems. The DOC in a Scania exhaust aftertreatment system is not a maintenance item when using EN590 and would only need to be replaced if there is a malfunction. However, it becomes a maintenance item when using FAME EN14214.

"Fuel with a high sulphur content can also be extremely harmful and can lead to permanent engine damage. Sulphur is fed back into the system via the exhaust gases and then cools and forms sulphuric acid. Even a single tank of diesel with high sulphur content can cause permanent engine damage.

"If the vehicle has a diesel particulate filter aftertreatment management system with SCR/EGR system, the sulphur content of the fuel must not exceed 10ppm." TE