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REDUCED SAPS LUBRICANTS

A new generation of lubricants, designed to work with the latest advanced aftertreatment technologies, can help reduce particulate matter emissions in diesel and gasoline engines

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Barely a week goes by when quality of air and airborne pollutants are not in the news, and very often vehicle emissions are the primary focus of the headline. Emissions standards introduced around the world have undoubtedly had a major impact on reducing vehicular pollutants. However, it is widely acknowledged that there is more to be done in the drive to further reduce harmful gases and particulates: further ICE vehicle hardware changes, the expansion of current technologies and the introduction of new hardware are among the options that are currently being explored.

Diesel particulate filters (DPFs) are now commonplace in markets such as Europe, where diesel-powered passenger cars constitute a notable percentage of the vehicles on the road. DPFs have been shown to be effective in reducing particulates, exhibiting over 90% efficiency in some vehicles.

With gasoline engines, which are by far the most common powertrain in dominant markets such as China and North America, the global drive to lower emissions is increasing demand for gasoline direct injection (GDi) technology. When coupled with a turbocharger (TGDi), this can increase power, notably improve efficiency, and thereby reduce the level of greenhouse gas emissions.

One of the challenges for GDi and TGDi engines is the increase in fine exhaust particles (PM2.5). The World Health Organization has stated that there is a strengthened link between cardiovascular and respiratory ill health and PM2.5. The response from legislators worldwide has been a tightening of tailpipe emissions limits, with a real focus on both particulate matter (PM) and particulate number (PN) for gasoline engine systems. It is this global emissions legislation that is driving the use of gasoline particulate filters.

When looking at the operation of a gasoline particulate filter, it is important to consider the exhaust gas itself, which contains oxides of nitrogen, polynuclear aromatic hydrocarbons and various other gaseous products of combustion.

It is also important to consider particulate matter such as soot. It is the primary function of the GPF to filter out these carbonaceous products of incomplete combustion. However, over time, soot builds up in the filter, which can eventually result in increased backpressure. The soot is usually removed via a process known as regeneration, burning it off in the presence of oxygen at temperatures in excess of 700°C. Unlike diesel engines, GPFs rarely need active regeneration. The exhaust is much hotter than a diesel exhaust and therefore soot is being continuously burned off. Coupled with the fact that GDi particulates are up to 30 times smaller than diesel particulates, it is therefore of little consequence that the GPF substrate capacity is only around 1g/l, compared to a diesel filter which is able to accommodate up to 10g/l.

The third product to consider during GPF operation is ash. The effect of ash on diesel particulate filters, often formed as a result of lubricant combustion, is very well understood. In 2004, an entire category of engine lubricants was introduced by ACEA, specified for use in vehicles with exhaust aftertreatment devices, including particulate filters. These lubricants are sometimes referred to as lower SAPS (sulfated ash, phosphorus and sulfur) oils.

In formulating this generation of lubricants, attention was given to the detergent components, which are generally calcium and magnesium compounds, as well as the anti-wear package, which commonly uses zinc, phosphorus and sulfur in various molecular forms. Formulating lower SAPS lubricants is a significant challenge. Engine component protection and durability have to be maintained throughout the life of the oil drain. However, using more traditional, well-established components is restricted, given the components' propensity to form ash and other compounds harmful to exhaust aftertreatment devices. This forces

September 2017

Europe
Euro 6d Emissions Level

New Drive Cycle - WLTP
PM / PN limits for Gasoline engines

On Road Testing - RDE
PM / PN limits for Gasoline engines

July 2020

China
China 6 Emissions Level

New Drive Cycle - WLTP
PM / PN limits for Gasoline engines

On Road Testing - RDE
PM / PN limits for Gasoline engines

Beyond 2020

North America
California may drive PM/PN limits

India
Bharat Stage VI Emissions Level
India's own Drive Cycle
European PM/PN limits
On Road Testing - RDE

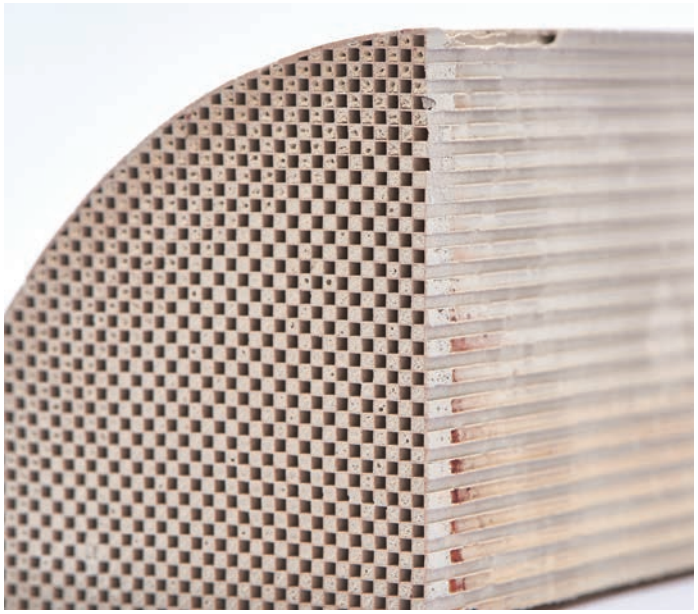
Europe
Euro 7 Emissions Level

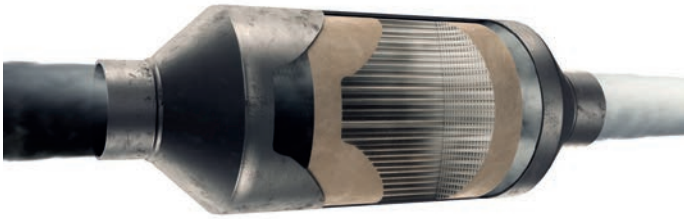
WLTP – World Harmonised Light Vehicle Test Procedure
RDE – Real Driving Emissions

The tightening of legislative regulations worldwide suggests that the use of gasoline particulate filters is likely to continue to increase

the formulator to use alternative chemistries that are quite often expensive and more challenging to produce. However, despite all the challenges, laboratory testing and many years of field experience have demonstrated the importance and benefits of lower SAPS lubricants in protecting vehicles fitted with exhaust aftertreatment devices. The reduction in metallic elements in the lubricant formulation means a lower potential for ash build-up in the particulate filter, thus avoiding an increase in backpressure from the filter to the engine. The resulting benefit to the vehicle operator is no loss in efficiency and any associated fuel economy penalty.

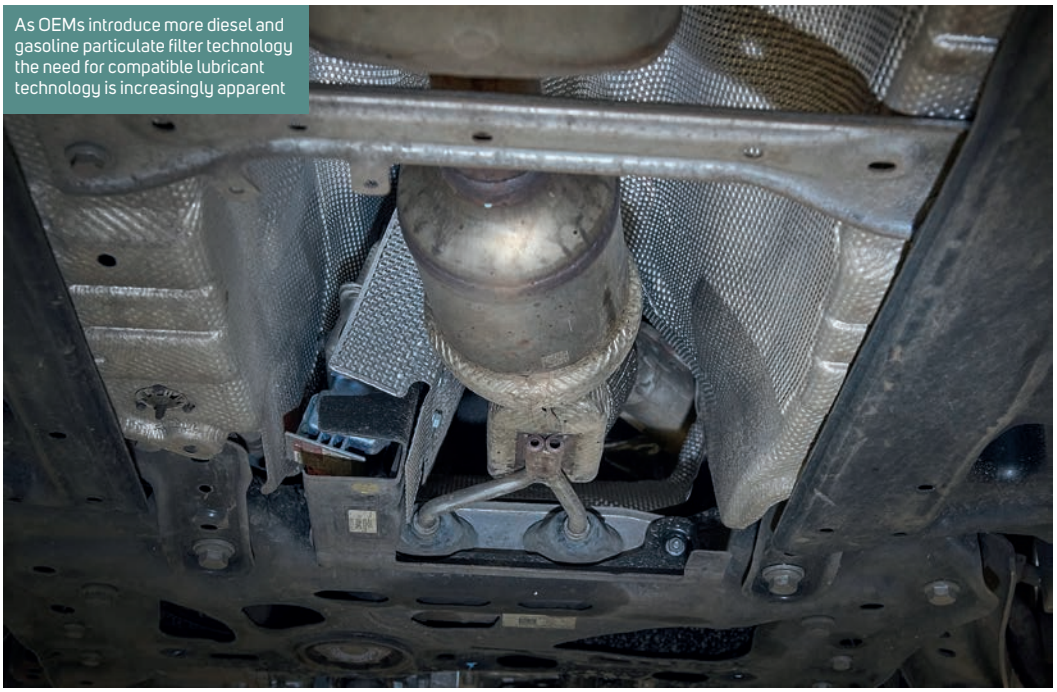
GPF technology is a more recent introduction, and studies in terms of ash accumulation are ongoing. However, as GDi emissions include less soot than diesel emissions, ash accumulation can be relatively more important in the operation of a GPF. Studies have shown that ash does penetrate the GPF wall over the life of the filter and by definition, ash is an incombustible material and therefore has the potential to stay in the GPF for life, giving rise to associated backpressure and efficiency concerns.





Left: Gasoline particulate filters rarely need active regeneration as soot is continuously burned off in the exhaust system

Below left: As gasoline particulate filters are a more recent introduction, studies on the effects of ash build-up are ongoing



As OEMs introduce more diesel and gasoline particulate filter technology the need for compatible lubricant technology is increasingly apparent

In addition, when choosing a lubricant, consideration should be given to protection of the filter-coated TWC catalyst. Components such as anti-wear systems, which often contain zinc and phosphorus, can have negative effects on TWC performance and durability. This again emphasizes the importance of selecting a lower SAPS oil that is specifically formulated to avoid damage to the catalyst.

The extensive use of particulate filters on diesel cars has shown that a lower SAPS lubricant is the key enabler in maintaining operation of these critical components.

CONTACT

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