

# The use of Group III in Heavy Duty Diesel Engine oils in Europe

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When EURO VI emissions legislation was introduced in 2013 (and then mandatory in 2014) it saw an 80% reduction in NOx emissions from 2.0 g/kWh to 0.4g/kWh and a halving of the particulate matter from 0.02 g/kWh to 0.01g/kWh (figures 1 and 2) compared to EURO V. Overall since the introduction of EURO 0 in 1990 this is a reduction of over 99% in particulate matter and a 97% reduction in NOx.

As a result of these new emissions regulations all new heavy duty diesel trucks and buses are now fitted with advanced exhaust aftertreatment systems which include a DPF (diesel particulate filter), EGR (exhaust gas recirculation) and SCR (selective catalytic reduction) as well as other devices for treatment of exhaust gasses.

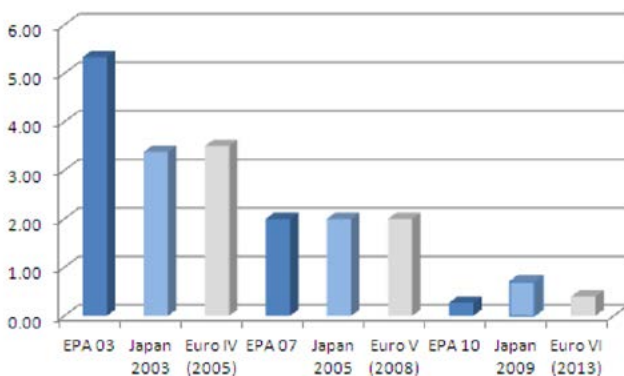


Figure 1. NOx emissions requirements (g/kWh)

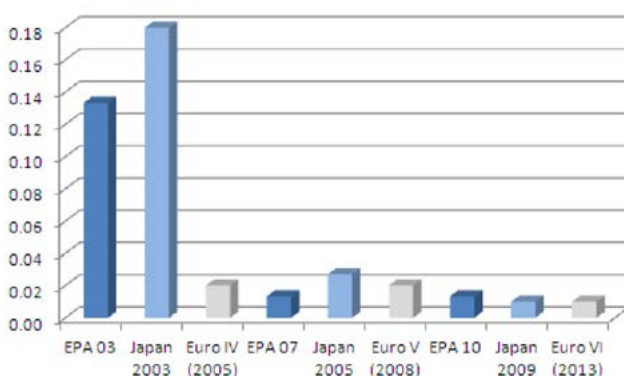


Figure 2. Particulate Matter emissions requirements (g/kWh)

The inclusion of these exhaust aftertreatment devices has led to significant changes in the requirements for engine oils for lubricating these engines. Cleaning and servicing of a DPF is costly and time consuming therefore low SAPS lubricants with sulphated ash below 1%, phosphorus at <0.08% or 0.12% and sulphur at <0.3% or 0.4% (ACEA E6 or E9 respectively) are now recommended for OEM factory fill and service fill in Europe. With these lower ash lubricants less ash can get into the exhaust and this reduces the amount of ash that could block the DPF and hence increases the service life of the DPF.

The restriction in sulphur in these specifications has driven the market to move to use Group II and Group III base oils for formulating these heavy duty diesel engine lubricants. Group I base oils are not limited to their sulphur content and in some instances can have sulphur levels much higher than the limits in the industry and OEM specifications.

As well as EURO VI emissions there is also a drive towards fuel economy with the introduction of fuel economy targets in May 2018 by the European commission. These targets set an average 15% decrease in CO<sub>2</sub> emissions by 2025 compared to 2019 and a proposal for a 30% reduction in CO<sub>2</sub> emissions in 2030 compared to 2019. However with up to 50% of the cost of the operation from the truck coming from the fuel there has been a focus on fuel economy within the industry for quite some time.

As a result heavy duty diesel OEMs are using or moving to 5W-30 (or lower). This further increases demand for Group III in the HD market. Early 5W-30 formulations also contained PAO but as the market has developed and newer formulations have come to the market there has been a trend to reduce or remove the PAO from these new formulations.

Group III base oils have lower CCS and Noack volatility properties compared to Group II which makes them the ideal base oils for formulating 5W-30 HD oils (figure 3).

Although 5W-30 heavy duty diesel engine oils have been available for many years (even before EURO VI emissions legislation) the market is still small with a market share around 1% in 2013 but growing rapidly. Some projections show over 20% market share in Europe for 5W-30 heavy duty diesel engine oils by 2020. The introduction of fuel economy targets from the European commission will also accelerate this transition to 5W-30 (and possibly even lighter viscosity grades). More traditional viscosity grades for heavy duty diesel engine oils have been 15W-40, 10W-40 and 10W-30 and there will still be significant market share for all these grades looking to the future. Some Group III is also used in some 10W-30 and 10W-40 formulations to help meet the low temperature viscometric requirements and more demanding performance requirements.

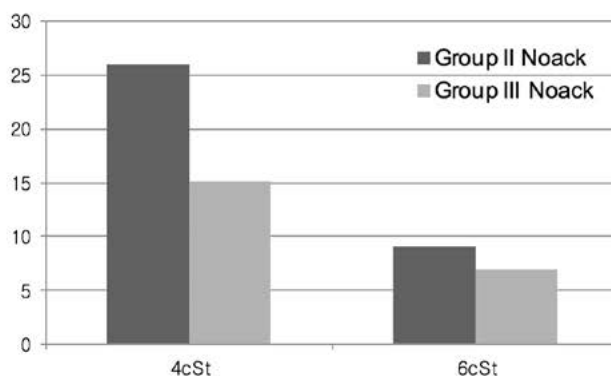
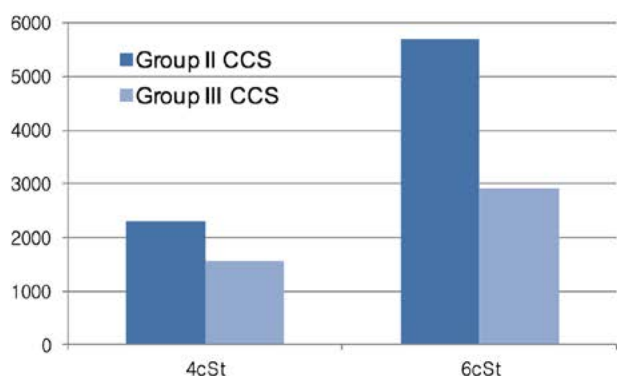
Industry and OEM approvals for heavy duty diesel engine oils are also important as the additive supplier and sometimes the base oil supplier have made significant investments in developing formulations and testing them in specific lab and bench tests, rig tests, engine tests and for some specifications even field trails which can take several years to complete. These specifications contain engine testing requirements which have to be passed in order to get approval. These engine tests cover engine and piston cleanliness, wear, sludge, oxidation and soot handling and there can be up to 10 engine tests in a specification. As well as the cost of the field trials developing engine oil for a heavy duty diesel engine is an investment of several million dollars.

If the formulation is not blended to the recipe defined in the approval from the OEM or on the

documentation supporting the industry (ACEA) claim how can it be certain that using unapproved or different base oils or lower additive and viscosity modifier treat rates will meet the requirements of the lubricant for the engine? This is very important especially for heavy duty diesel engines and vehicles as they are used for business and if they have to be taken out of service it can cost a lot of money, not just for repairs but also in lost trade. The industry and OEM specifications for heavy duty diesel engine oils define the performance requirement for the lubricant and if oil marketers blend the formulation differently to what has been defined there is no guarantee it will meet the performance needs of the engine oil specification. Here at SK Lubricants we work with all the major additive suppliers to develop approved heavy duty diesel engine oils so our customers can meet the needs of the industry and the OEMs and have confidence that SK Lubricants is at the forefront of heavy duty diesel engine oil technology.

Future European heavy duty diesel engine oils specifications will be focussed on even greater performance with enhanced oxidation protection and further fuel economy with the inclusion of the Volvo T13 engine test into the ACEA sequences. There will also be the introduction of 'F' categories with lower HTHS at 150°C allowing a thinner oil to reduce pumping losses in the engine. This will be on top of all of the current EURO VI requirements and new fuel economy targets and will further enhance the position of Group III base oils as the base oils of choice for the HD formulations. We may even see viscosity grades lower than 5W-30 as the focus for even more efficiency gathers pace.

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**Figure 3.** CCS and volatility comparison between Group II and Group III