Impact of emissions legislation on engine lubricants

Increased use of exhaust after-treatment technologies to meet tougher European emissions legislation has proved a major challenge in the development of heavy-duty diesel engine lubricants that maintain oil drain intervals and wear protection.

Heavy-duty (HD) diesel engine emissions have been getting significantly cleaner as a result of legislation introduced by the European Commission. The process started in 1992 with the Euro 1 emissions limits and subsequent regulations have become progressively tougher.

The regulations are designed to reduce levels of particulates and NOx emissions from vehicle exhausts, due to their detrimental effect on air quality.

In the past, OEMs have used a range of engine design measures to accommodate the emissions legislation, including modified combustion chambers and the use of EGR (exhaust gas recirculation). The introduction of the Euro IV regulations in 2005, however, required significant reductions in both particulates and NOx (see Figure1) beyond those already achieved under Euro III.

Having ‘exhausted’ the design tweaks under their control, the engine manufacturers have turned to exhaust after-treatment technology in order to comply with Euro IV. Since these after-treatment technologies are considered sensitive to the chemical composition of engine lubricants, this had major implications for the way lubricants are formulated and manufactured.

A typical engine lubricant incorporates a base oil and a package of additives that may include viscosity improvers, anti-wear compounds, friction modifiers, corrosion inhibitors, dispersants, anti-foaming agents, anti-oxidants and detergents. Together, through their chemical compositions, they contribute to the so-called SAPS (Sulphated Ash, Phosphorus and Sulphur) profile of the lubricant.

While SAPS have no direct effect on emissions, they have been associated with a negative impact on the performance and longevity of the new after-treatment hardware.

The severity of the emissions standards requires the performance of after-treatment systems to be sustained over the life of the vehicle. As a result, lubricants for use with Euro IV after-treatment systems have had to be reformulated to lower the SAPS content.

In Europe, the SAPS content is specified by ACEA, the European Automobile Manufacturers Association, in its latest E6 specifications.

Oil companies have invested significant time and resources in developing and testing new low SAPS lubricant formulations. By using their extensive formulation expertise, and careful selection of the base oil and additive components, they have managed to meet the stringent new SAPS limits without compromising engine integrity.

The reduction in sulphur (see Figure 2) has been achieved largely through the use of more sophisticated base oils. Traditional mineral base oils have been replaced with more highly refined varieties and synthetics.

These base oils require different manufacturing methods and are inevitably more expensive, and so impact the price of finished lubricants. A major challenge for the industry is developing sufficient capacity to produce the volume of these base oils that is required both now and in the future.

Euro V emissions regulations are already on the horizon. Due for implementation in 2008, Euro V leaves particulate levels roughly the same but requires another significant reduction in NOx.

Discussions between the oil industry, represented by ATIEL, and ACEA have already begun, due to the long industry lead times required to develop new lubricants. ATIEL's role in this process is to ensure that the industry has the products that they need in the future, while at the same time ensuring that any changes to specifications are based on sound technical arguments.

These discussions will be critical to the development of future lubricants that continue to provide the performance and protection that heavy-duty diesel engines have enjoyed in the past.

Figure1

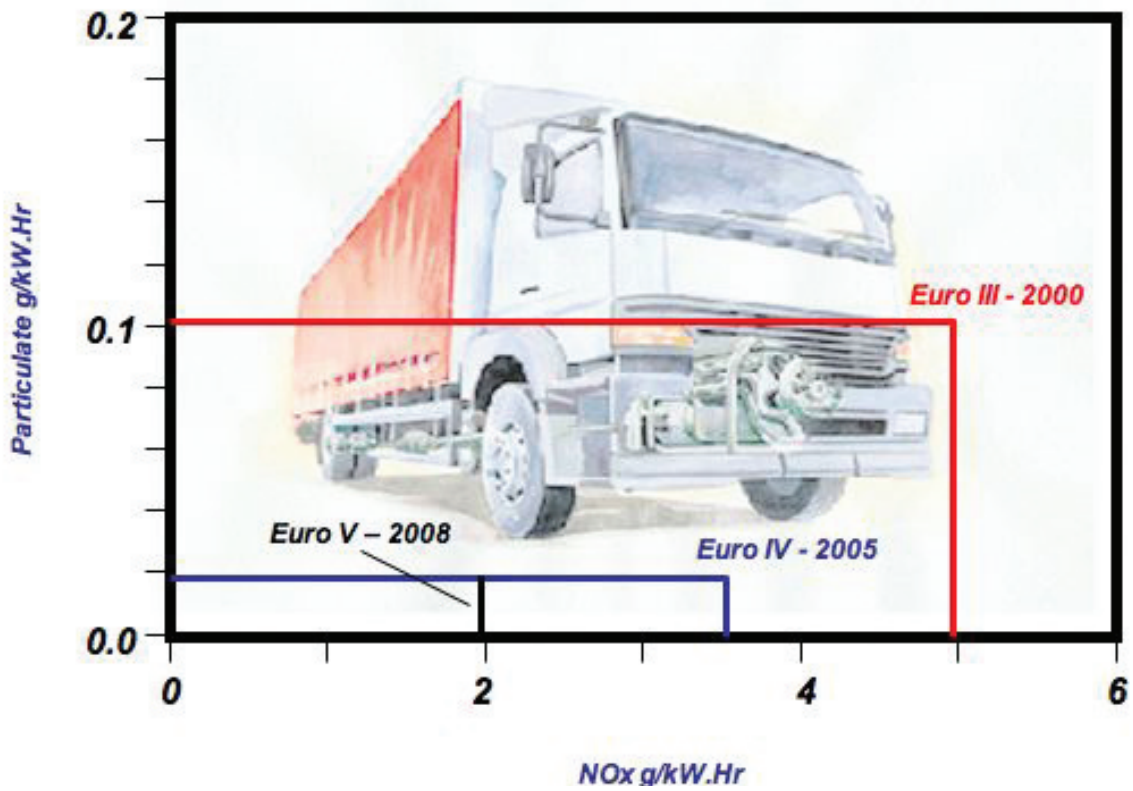

Figure2