Diesel engine emissions have been an ongoing environmental concern for the past few decades. Particulates and nitrogen oxides (NOx) associated with health problems and damaging smog and acid rain have been targeted by governments globally, and the United States, Europe and Japan have responded to demands to reduce these harmful emissions.

NOx forms when atmospheric nitrogen in the power-cylinder oxidizes. Because peak cylinder temperature plays a key role in NOx formation, methods of reducing the temperature, including cooled exhaust gas recirculation (EGR) technology, have been employed in modern diesel engines as solutions to reducing NOx emissions.

Diesel particulates are composed of solid carbon (soot), sulfate, bound water and unburned fuel and oil. Because sulfur is key to particulate formation, the sulfur level in diesel fuel has been gradually decreased over the years.

In the U.S., particulate and NOx levels were first regulated in 1988, with regulations becoming increasingly stringent through the years. In fact, 1988 standards set NOx and particulate levels at 14.4 g/kW-hr (grams/kilowatts-hour) and 0.8 g/kW-hr respectively, while 2010 standards have been set at 0.27 g/kW-hr and 0.013 g/kW-hr respectively.

Between the years 1988 and 1991, emission standards were met by improving in-cylinder combustion through the use of unit injectors, electronic controls, controlled air swirl, improved combustion bowl design, reduced piston crevice volume, turbo-charging, air inter-cooling and reductions in oil consumption. The year 1991 also saw the use of high top rings to lower particulate emissions.

Fuel sulfur was successfully reduced by 90 percent in order to meet 1994 particulate targets, dropping from 5,000 ppm to 500 ppm in October 1993. The sulfur reduction had no harmful effects on diesel engines, and the API CG-4 oil category was established in 1994 using low-sulfur diesel fuel in all engine tests.

By 1998, retarded fuel injection timing was introduced to meet increasingly stringent NOx emission standards. By displacing combustion until later in the expansion stroke, retarded fuel injection timing lowers the peak flame temperature and effectively reduces NOx formation. High top rings and retarded fuel injection timing increased soot-loading on the oil, leading to the introduction of API diesel oil category CH-4 in order to prevent viscosity increases and increased wear due to soot.

In order to meet 2002 emission standards, most engine manufacturers introduced low levels (10-15%) of cooled EGR technology. EGR engines reduce NOx emissions by recirculating a portion of the exhaust to the engine's combustion chamber, lowering peak combustion temperature and NOx formation. Although EGR engines effectively reduce emissions, they also run hotter and introduce higher levels of soot and acid into the oil, leading to increased wear, increased oil viscosity and shorter oil drain intervals.

The API CI-4 diesel oil specification was introduced in December 2001 to protect against the higher temperatures and increased levels of acids, soot and oxidation associated with EGR engines. API CI-4 oils were formulated with increased detergent levels to protect rings and liners and increased oxidation inhibitors to prevent bearing corrosion. API issued an upgrade to its CI-4 specification, CI-4 PLUS, in September 2004 in order to provide improved oxidation resistance, shear stability, acid neutralization and soot dispersancy for EGR engines.

Some manufacturers released their own diesel oil performance specifications in order to assure optimum protection for their equipment. For example, Mack released its stringent EO-N Premium Plus High Performance Diesel Engine Oil specification in the spring of 2002 and upgraded it in April 2003 to EO-N Premium Plus 03 and again in June 2006 to EO-O Premium Plus.

The latest round of emission standards went into effect in 2007, requiring even more stringent NOx and particulate emissions reductions. While low levels of EGR technology (10-15%) were successfully applied in diesel engines to meet 2002 NOx emissions standards, most manufacturers incorporated increased EGR rates of 25-35% in order to meet 2007 standards. Increased EGR rates mean 2007 and newer diesel engines run hotter than their predecessors, requiring diesel oils meeting the latest API CJ-4 specification to be formulated with improved oxidation resistance properties to prevent thermal runaway and maintain engine protection.

Decreasing the level of sulfur in diesel fuel has been determined to be the most cost-effective way to decrease particulate emissions. The introduction of ultra low sulfur diesel (ULSD) fuel in June 2006 dropped

diesel fuel sulfur levels from 500 ppm to 15 ppm in order to meet 2007 particulate limits, provide compatibility with NOx after-treatment systems and enable high EGR rates.

In addition, in order to further reduce particulate emissions, diesel particulate filters (DPF's) were incorporated into all 2007 and newer American diesel engines, and CJ-4 diesel oils are faced with the challenge of balancing engine protection with DPF life. Increased EGR, although effectively decreasing NOx emissions, results in less efficient combustion and increased levels of soot, and some of it finds its way into the engine oil. Detergents within the oil are responsible for preventing soot from accumulating on internal engine components and increasing friction and wear, as well as preventing soot particles from agglomerating into larger particles that increase oil viscosity and clog oil filters.

Premium API CJ-4 Synthetic 5W-40 and 15W-40 Diesel Oils

AMSOIL Premium API CJ-4 Synthetic 5W-40 (DEO) and 15W-40 (DME) Diesel Oils are the premium choice for model year 2007 and newer diesel engines requiring API CJ-4 oil standards. Premium API CJ-4 Synthetic Diesel Oils withstand the stress of heat, soot and acids to help prevent deposits, corrosion and wear, while their broad viscosity ranges offer superior protection over a wide temperature range. Premium API CJ-4 Synthetic Diesel Oils effectively reduce oil consumption and emissions, while improving fuel efficiency.

Synthetic Diesel Oils for Off-Road and Pre-2007 On-Road Diesel Engines

AMSOIL offers four premium-quality synthetic diesel oils for all model year off-road diesel vehicles and pre-2007 EGR-equipped and non-EGR-equipped on-road diesel vehicles. They surpass the most stringent diesel oil specifications for pre-2007 on-road diesel engines, including CI-4 PLUS and EO-O Premium Plus.

AMSOIL Synthetic 15W-40 Heavy Duty Diesel and Marine Motor Oil (AME) is a premium synthetic diesel oil providing excellent protection and performance where highly effective control of wear and deposits is vital.

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AMSOIL Series 3000 Synthetic 5W-30 Heavy Duty Diesel Oil (HDD) combines extraordinary lubrication with improved fuel efficiency in commercial, fleet and personal diesel vehicles.

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