

# Overview of EU Oil Quality and Emissions Legislation Developments

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## ABSTRACT

The European engine lubricant market is undergoing a period of dramatic change. The introduction of new emissions legislation is resulting in the development of new engine designs and aftertreatment systems that will require a new generation of advanced engine lubricants to be developed to meet the performance demands of the future.

This paper provides an overview of the changes occurring in the European passenger car engine lubricants market and highlights some of the challenges faced by engine lubricant formulators when designing lubricants at lower levels of Sulphated Ash, Phosphorus and Sulphur.

**Key-words:** Euro 4, Engine Lubricant, Engine Oil, Emissions

## INTRODUCTION

Since the introduction of Euro 3 emissions standards in 2000 there has been a growing requirement for engine lubricants to function over extended oil drain intervals and to provide a measure of fuel economy improvement which has resulted in the development of new engine lubricant technology.

As European Union (EU) emissions legislation changes from Euro 3 to Euro 4 it brings further reductions in the levels of carbon monoxide, hydrocarbons, oxides of nitrogen and particulates of between 20% and 50% depending on the vehicle type. The levels set are intended to force widespread introduction of new aftertreatment systems such as diesel particulate filters (DPF). The introduction of these new aftertreatment systems is also creating a demand for new engine lubricant technology.

The move to Euro 4 is fundamentally changing engine lubricant formulations demanding the development of new components that are optimised to deliver the required engine performance but with less impact on the efficiency of the aftertreatment system.

New specifications are beginning to be introduced that restrict the level of Sulphated Ash, Phosphorus and Sulphur as a way of minimising the impact on the efficiency of the aftertreatment system. Extensive research and development is underway to create these new components that provide the required engine performance as well as meeting the challenge of formulating at lower Sulphated Ash, Phosphorus and Sulphur.

## DEVELOPMENT OF THE EUROPEAN UNION EMISSION STANDARDS FOR PASSENGER CARS AND LIGHT COMMERCIAL VEHICLES

The European Economic Community (EEC), now the European Union (EU), issued its first directive (70/220/EEC) detailing the measures to be taken against air pollution by gases from passenger cars and light commercial vehicles in 1970. All member states of the EEC adopted this directive from 1971, either in replacement or addition to any existing national regulation of vehicle emissions. Although amended considerably since its introduction, Directive 70/220/EEC remains the basis for the current EU passenger car and light commercial vehicle emissions laws, known as Euro 3, which are currently detailed in directive 98/69/EC.

The legislation for passenger cars and heavy duty diesel vehicles has been aligned since 1992 into a series of standards known as Euro 1, 2, 3, 4 and 5. Although the date for compliance with each standard differs for each vehicle class they may be considered as following the timeline shown in figure 1.

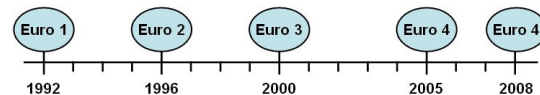


Figure 1 – EU Emission Standards Timeline

The directives also include provisions for each member state to introduce tax incentives to encourage the early adoption of vehicles meeting the new emissions standard. This can result in vehicles meeting the next

emissions standard entering the market at least two years before compliance becomes mandatory. Whilst the provision for tax incentives to encourage the move to Euro 4 compliant vehicles has been available to member states since January 2000, it is only expected that widespread use of tax incentives will begin in 2004.

## STRUCTURE OF THE EUROPEAN PASSENGER CAR ENGINE OIL MARKET

The western European passenger car engine oil market may be segmented into two distinct areas:

- Initial fill
- Service fill

The Initial Fill market represents the engine oils filled into vehicles during the production process. This factory fill market represents approximately 7% of the demand for passenger car engine oils in Europe.

The market is segmented by the performance required by each vehicle manufacturer. Over the last 10 years the oils used for initial fill have increased in performance and now represents some of the highest performance levels in Europe. The majority of engine oils used for initial fill applications are SAE 0W-30, 5W-30 or 5W-40 based formulations.

The Service Fill market represents the engine oils supplied to workshops, dealerships and all retail locations. This market represents approximately 93% of the demand for passenger car engine oils in Europe.

This market is segmented by both performance and viscosity grade. Over the last 10 years this market has also seen an increase on engine oil performance as a result of new vehicles requiring higher performance oils for top-up and servicing.

Whilst a broad range of viscosity grades are seen in the market, demand for lower viscosity grades (0W-30 and 5W-30) has increased whilst demand for higher graders (20W-50 and 15W-40) has declined. Figure 2 illustrates the change in demand for viscosity grades since 1995 with a forecast of demand changes to 2010.

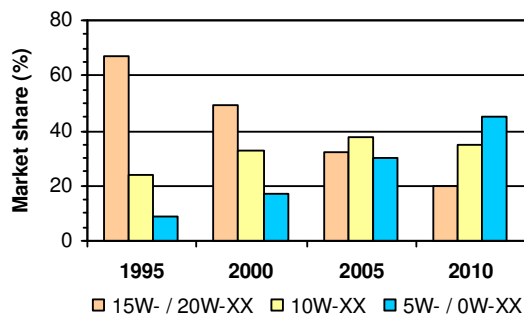


Figure 2 – Change in European viscosity grade demand

The main changes in engine oil quality arise as a result of the higher performance initial fill engine lubricants being required in the service fill market. As the European car park evolves and the proportion of pre-Euro 3 vehicles declines the demand for engine lubricants for Euro 3 and Euro 4 vehicles will increase. This will result in an upgrade in the average quality of engine oils and an increase in the demand for lower viscosity grades as shown in figure 2.

## FACTORS AFFECTING ENGINE OIL QUALITY

Environmental concerns, in most cases supported by legislation, are the largest single factor impacting the performance requirements of passenger car engine lubricants.

To meet the requirements of European Union legislation vehicle manufacturers have developed new engine designs. This creates a demand for new lubricant performance, resulting in the development of new engine lubricant formulations. Changes in lubricant technology over the past decade can be considered to be the result of three distinct factors, each of which address an environmental concern.

- Extended drain
- Fuel economy
- Emissions

### Extended drain

Since 1995 the average oil drain interval for a new passenger car has been increased from an average 10,000km to 15 - 30,000km for gasoline fueled vehicles and 15 - 50,000km for diesel fueled vehicles. This move to increase oil drain intervals has been primarily to reduce the amount of used oil requiring disposal and to reduce the cost of ownership.

To enable this extension in drain interval the engine lubricant must provide increased resistance to thermal and oxidative degradation, lower oil consumption rates and greater Total Base Number (TBN) retention. To achieve these performance increases, engine lubricant formulations have evolved to use unconventional base oils (API Group III and API Group IV) rather than mineral base oils (API Group I) and new additive technology that is formulated for use in conjunction with these unconventional base oils. The use of unconventional base oils has also led to a move away from higher viscosity grades (20W-50 and 15W-40) to lower viscosity grades (0W-30, 5W-30 and 5W-40).

### Fuel economy

There are increasing demands for vehicles to use less fuel in order meet a combination of environmental and cost requirements. Vehicle manufacturers are working to increase fuel efficiency in order to lower carbon

dioxide (CO<sub>2</sub>) emissions from vehicles, reduce the rate at which fossil fuels are being consumed and to reduce the cost of using a vehicle. In order to achieve this reduction in CO<sub>2</sub>, many ACEA members have increased the fuel efficiency of their vehicles through introduction of new engine designs and technology, for example direct injection diesel engines.

These changes in engine design have resulted in both an increase in the performance demanded from the engine lubricant in conjunction with an increasing requirement for the engine lubricant to deliver a measure of fuel economy itself. To meet these requirements there has been an increase in the use of lower viscosity grades (0W-30 and 5W-30) and an increase in the use of friction modifier technology in conjunction with new additive technology.

#### Emissions

The third factor influencing changes in engine lubricant requirements is the continuing move to reduce the potentially harmful exhaust emissions generated by vehicles.

European Union legislation defines the maximum permissible emissions of a range of substances. The dramatic reduction in permissible emissions that Euro 4 introduces is resulting in vehicle manufacturers developing new engine and aftertreatment systems that are, in turn, bringing new performance demands for engine lubricants.

Some vehicle manufacturers are beginning to set limits on the levels of Sulphated Ash, Phosphorus and Sulphur which are significantly lower than the levels seen in existing engine lubricants. As Sulphated Ash, Phosphorus and Sulphur relate to some of the most fundamental building blocks of engine lubricant formulations, reductions in these are resulting in the development of new technology for additives and may restrict the types of base oils used to formulate engine lubricants.

#### Convergence of trends

The convergence of these trends is resulting in a demand for engine lubricants that deliver an extension of oil drain and a measure of fuel economy at a lower level of Sulphated Ash, Phosphorus and Sulphur. This is presenting a challenge for oil formulators as developing engine oils to satisfy these demands requires juggling many conflicting factors.

Emission trends are driving down the levels of sulphated ash phosphorous and sulphur for aftertreatment system compatibility.

Fuel economy trends generally increase the levels of phosphorus- and sulphur-containing compounds to help reduce friction in the engine and increase wear protection.

Extended drain intervals are requiring the additive system to function for increasingly longer durations. This has been traditionally achieved through increasing the levels of many of the formulation components leading to engine lubricants with higher levels of sulphated ash, phosphorous and sulphur.

## **CONCLUSIONS – THE IMPACT OF TRENDS ON ENGINE LUBRICANT FORMULATION**

#### Impact of lower sulphated ash

Lowering the sulphated ash of a lubricant impacts the level of metal-containing detergents that can be used. Therefore, the detergency needs to be compensated with alternative detergent and dispersant technology.

#### Impact of lower phosphorus

The key lubricant component that contains phosphorus is zinc dialkyl dithio phosphate (ZDDP). ZDDP has been used since the 1950s as a very effective antiwear and antioxidation additive. As the levels of phosphorus are reduced to avoid poisoning effects on catalysts, ZDDP will need to be reduced and replaced with alternative phosphorous-free antiwear and antioxidant technology.

#### Impact of lower sulphur

ZDDP also contains sulphur and whilst level of sulphur in the engine lubricant will be reduced as the level of ZDDP is reduced main contributor to sulphur is the lubricant basestock. API Group I basestocks can contain between 0.2%wt and 1.0%wt sulphur. Consequently, in lower sulphur lubricants the mineral basestocks will need to be replaced by sulphur-free basestocks, as API Group III and Group IV. The majority viscosity modifiers contain mineral basestocks which will also be replaced sulphur-free basestocks. Some detergents also contain sulphur these will need to be kept to a minimum replaced with sulphur-free detergent chemistries.

#### Impact of trends on engine oil formulations

The move to aftertreatment system compatible engine lubricant technology represents a significant change in additive and lubricant formulating. New lubricant specifications are beginning to be introduced that restrict the level of sulphated ash, phosphorus and sulphur level and extensive research and investment is underway to develop and bring new chemistries to production. The challenge for the lubricants industry is to provide the fuel economy and extended drain benefits while formulating aftertreatment compatible engine lubricants with lower levels of sulphated ash, phosphorus and sulphur.