Introducing ATC Document 118

Lubricant Additives: Use and Benefits

Lubricant Additives: Use and Benefits

Purpose

- Introduction to ATC; organisation and objectives
- Explains the contribution lubricant additives make to industry, consumers and the environment

Scope

- Automotive engine oil additives
- Europe (EU-28)

Target audience

- Regulators, Educators, Employers
- Anyone interested in our industry

Availability

- Online https://www.atc-europe.org/
- Hardcopies

Sister document (Document 113) also Available covering Fuel Additives

ATC Member Companies

AkzoNobel

Afton CHEMICAL Passion for Solutions

BASF We create chemistry

Chevron

Oronite

CRODA

EVONIK INDUSTRIES

Infineum

innospec

LANXESS Energizing Chemistry

Lubrizol

TOTAL

VeryOne Leading the way in Cetane Improver A Division of EURENCO

Lubricant Additive Industry Profile in 2016

- World-wide the industry spends about €600 million/annum on research and development, of which €240 million is spent in Europe (EU-28).
- World-wide the industry has a turnover of about €11,700 million of which the European market is about €3,600 million.
- The industry employs directly about 3,800 people in Europe and about 12,000 globally.
- The industry operates more than 35 research and development establishments and manufacturing sites in Europe, and more than 100 globally.
- The petroleum additive industry in Europe is a major exporter.

Document 118 issued in 2016

Document 49
First published **1993**


ATC

A SECTOR GROUP OF cefic

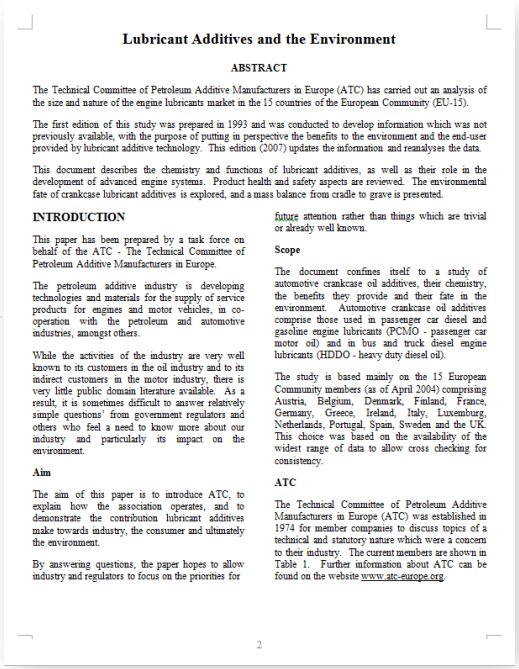
LUBRICANT ADDITIVES

and

THE ENVIRONMENT

ATC Document 49

Updated **2007**


Lubricant Additives and the Environment

ABSTRACT

The Technical Committee of Petroleum Additive Manufacturers in Europe (ATC) has carried out an analysis of the size and nature of the engine lubricants market in the 15 countries of the European Community (EU-15).

The first edition of this study was prepared in 1993 and was conducted to develop information which was not previously available, with the purpose of putting in perspective the benefits to the environment and the end-user provided by lubricant additive technology. This edition (2007) updates the information and reanalyses the data.

This document describes the chemistry and functions of lubricant additives, as well as their role in the development of advanced engine systems. Product health and safety aspects are reviewed. The environmental fate of crankcase lubricant additives is explored, and a mass balance from cradle to grave is presented.

INTRODUCTION

This paper has been prepared by a task force on behalf of the ATC - The Technical Committee of Petroleum Additive Manufacturers in Europe.

The petroleum additive industry is developing technologies and materials for the supply of service products for engines and motor vehicles, in co-operation with the petroleum and automotive industries, amongst others.

While the activities of the industry are very well known to its customers in the oil industry and to its indirect customers in the motor industry, there is very little public domain literature available. As a result, it is sometimes difficult to answer relatively simple questions' from government regulators and others who feel a need to know more about our industry and particularly its impact on the environment.

Aim

The aim of this paper is to introduce ATC, to explain how the association operates, and to demonstrate the contribution lubricant additives make towards industry, the consumer and ultimately the environment.

By answering questions, the paper hopes to allow industry and regulators to focus on the priorities for future attention rather than things which are trivial or already well known.

Scope

The document confines itself to a study of automotive crankcase oil additives, their chemistry, the benefits they provide and their fate in the environment. Automotive crankcase oil additives comprise those used in passenger car diesel and gasoline engine lubricants (PCMO - passenger car motor oil) and in bus and truck diesel engine lubricants (HDDO - heavy duty diesel oil).

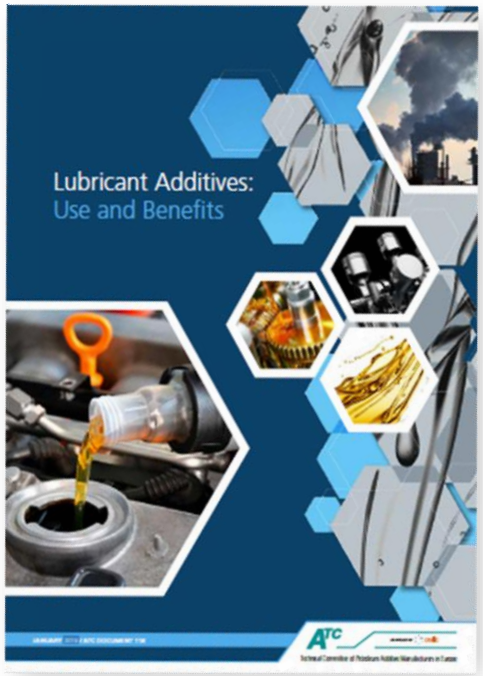
The study is based mainly on the 15 European Community members (as of April 2004) comprising Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Spain, Sweden and the UK. This choice was based on the availability of the widest range of data to allow cross checking for consistency.

ATC

The Technical Committee of Petroleum Additive Manufacturers in Europe (ATC) was established in 1974 for member companies to discuss topics of a technical and statutory nature which were a concern to their industry. The current members are shown in Table 1. Further information about ATC can be found on the website www.atc-europe.org.

2

Document 118 **2016**



Update team

Joerg Wilmink
Afton Chemical

OEM Relationship Manager for heavy duty engine oil solutions . Mechanical engineer and business economist with 20 years of automotive experience.

Ray Calder
Lubrizol

Global business manager and former chairman of ATC. Chemist with over twenty years of experience in the additive industry.

Joanne Jones
Lubrizol

Formulator for passenger car engine oils. Chemist with 10 years of experience in the additive industry.

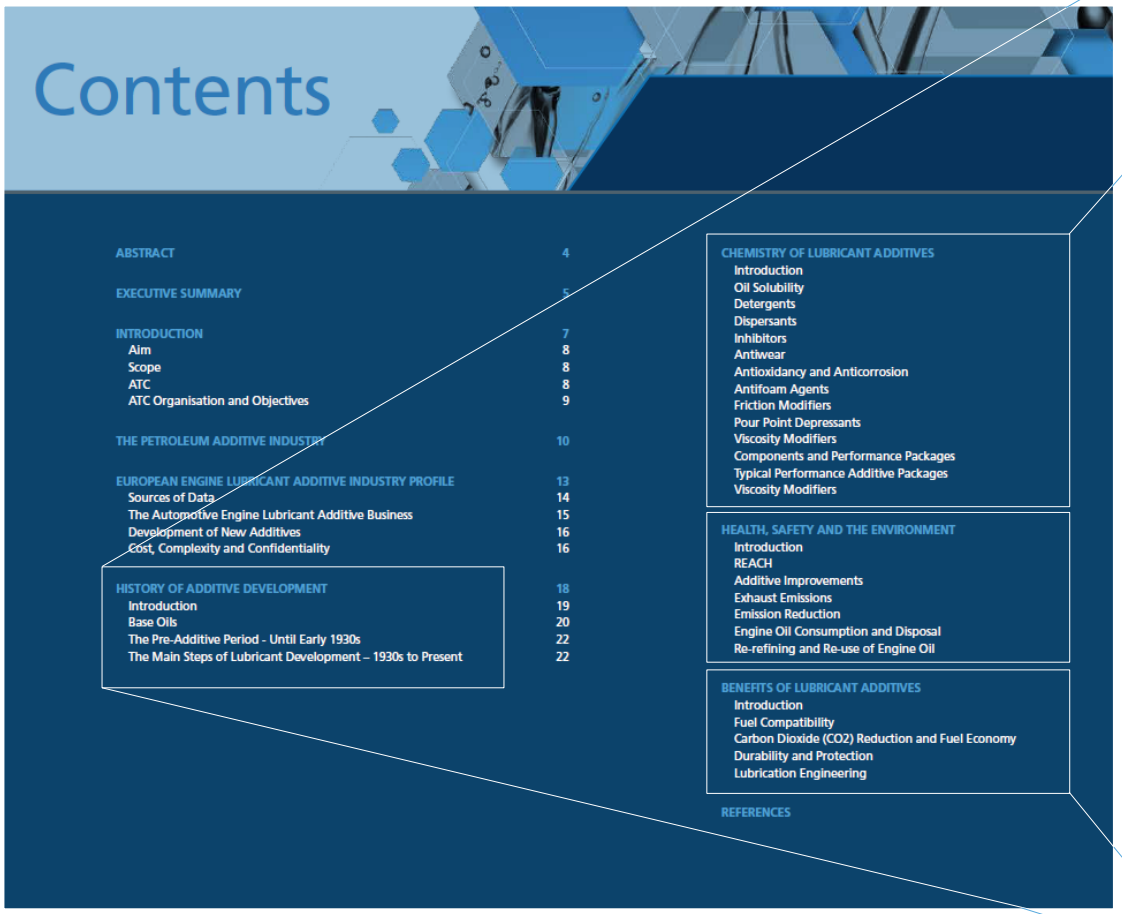
Walter Hartgers
Chevron Oronite

Formulator for passenger car engine oils. Polymer chemist with 10 years of automotive experience.

Jacquie Berryman
Infineum

Industry Liaison Advisor. Chemist with 30 years of experience in the lubricant additive industry.

Main topics



Contents

History of Additive Development

Early 1930s to current developments

Chemistry of Lubricant Additives

Chemical description of main additive classes; e.g. dispersants, detergents, anti-oxidants, anti-wear components and friction modifiers

Health, Safety and the Environment

Chemical Regulations (REACH) and additive contribution to exhaust emission reduction; Disposal and re-refining of used oil

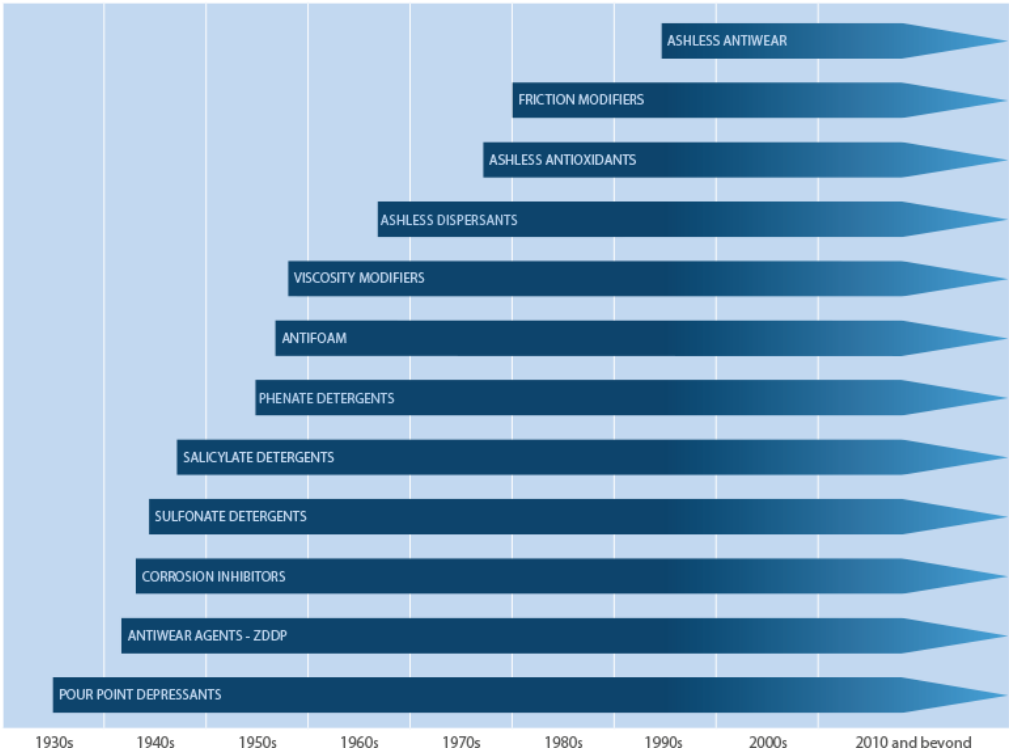
Benefits of Lubricant Additives

Additive contribution to fuel economy and CO_2 reduction; Lubrication engineering for durability and engine protection

History of Additive Development

Early 1930s to Current

- Additive development is a key activity of ATC members and is driven by new lubricant specifications, to meet higher engine oil performance for new engine designs and increasing fuel economy demands.
- Recent innovations do focus on ashless additives and friction modifiers.



Chemistry of Lubricant Additives

- Document 118 describes each of the major classes of additive chemistry.

Additive Class	Function & Mode of Operation
Detergents	Detergents are surface active. Deposit precursors are trapped within the detergent micelle keeping them in solution.
Dispersants	Prevent larger particle agglomeration and hence oil thickening. Effective at stabilising soot produced by diesel engines.
Antiwear	Prevent wear of metal surfaces by reduction of friction during boundary lubrication by forming low shear films on metal surfaces. ZDDPs are by far the most effective antiwear agents.
Anti oxidants / Anti corrosion	Prevent oil thickening and build up of corrosive acids by disrupting the chain propagation steps of the oxidative reaction, acting as either peroxide decomposers or free radical traps.
Antifoam	Prevent foaming by reducing surface tension of air bubbles causing them to rupture.
Friction Modifiers	Reduce power loss by forming films between metal surfaces during boundary lubrication.
Pour Point Depressants	Reduces the lowest temperature at which an oil will pour or flow when cooled. Inhibit the formation of interlocking wax crystal networks.
Viscosity Modifiers	High molecular weight polymers which increase oil viscosity at higher temperature, allowing acceptable engine operation over a much wider temperature range

Figure 8. Overbased Detergent

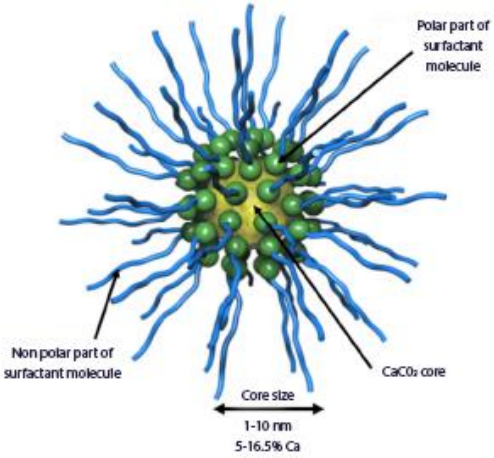
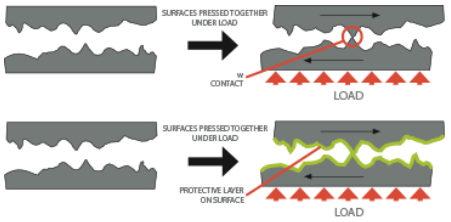
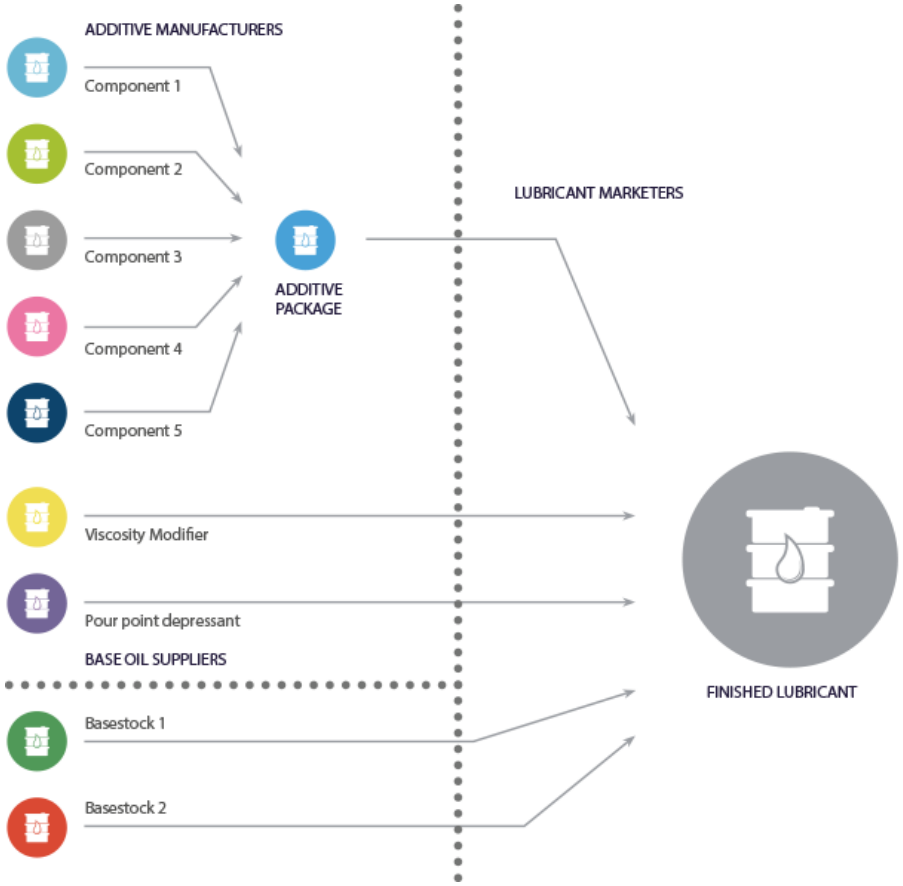


Figure 17. Illustration of Boundary Lubrication



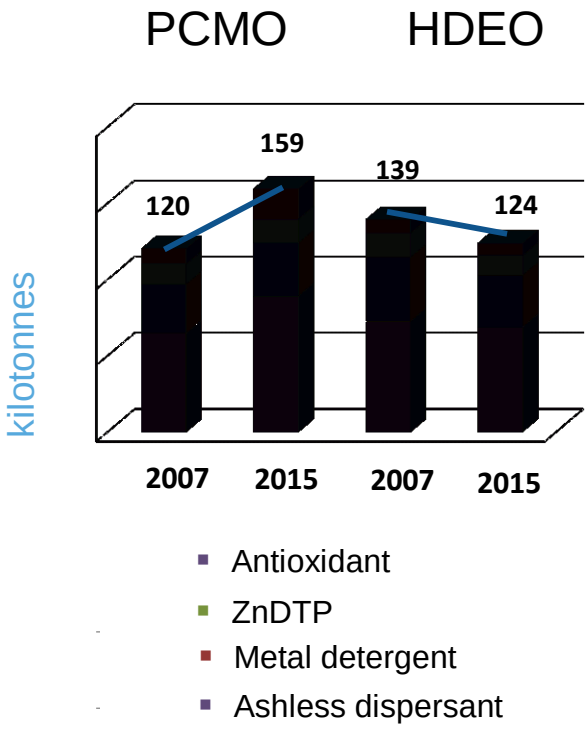
Formulation of Lubricating Oils

- Performance additive packages are complex mixtures of individual components.
- Formulation expertise is required to ensure synergistic and adversarial effects are balanced.
- Document 118 presents an update of typical formulations for both PCMO and HDEO lubricants.
  - Update member survey
  - Weighted averages
  - Major component categories
  - Constituent additive components



Formulation and Market Trends

- A study was conducted providing insights to current formulation and market trends. The document presents rationale for those trends including
  - Market size; i.e. EU-15 expansion to EU-28
  - Changes in formulation strategies due to emission legislation
  - Growth in lower viscosity lubricants
  - Extended oil drain intervals
  - Use of alternative fuels
- EU-28 sales of major additive classes show growth in PCMO, in particular for dispersants and antioxidants.



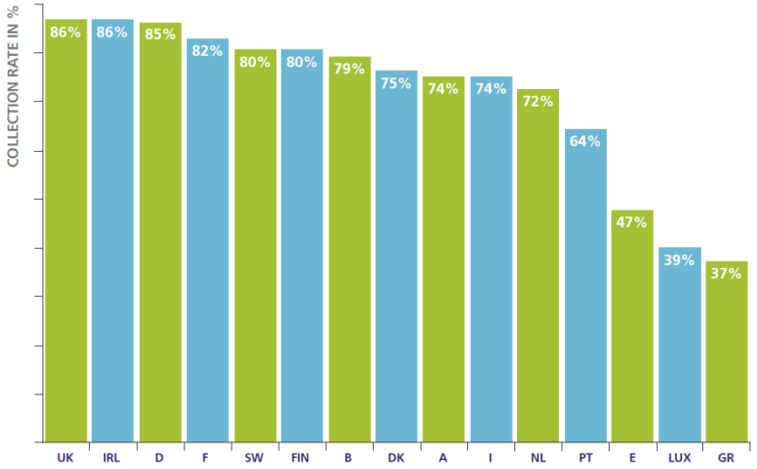
Health, Safety and Environment

- This update of Document 118 includes a brief summary of the work done by the ATC / ATIEL REACH Working Group in the HSE section covering
  - Generic Exposure Scenarios
  - Specific Environmental Release Categories

- Impact of environmental legislation on lubricant formulation.
  - Formulating without hazardous chemistries, e.g. Chlorine, Barium
  - Reduction of Sulphur, Phosphorus and Ash

- Engine oil consumption and disposal.
  - Collection rate varies by country

- Re-refining and re-use of engine oils
  - Re-refined base oils can be classified as API Group I, II or III.



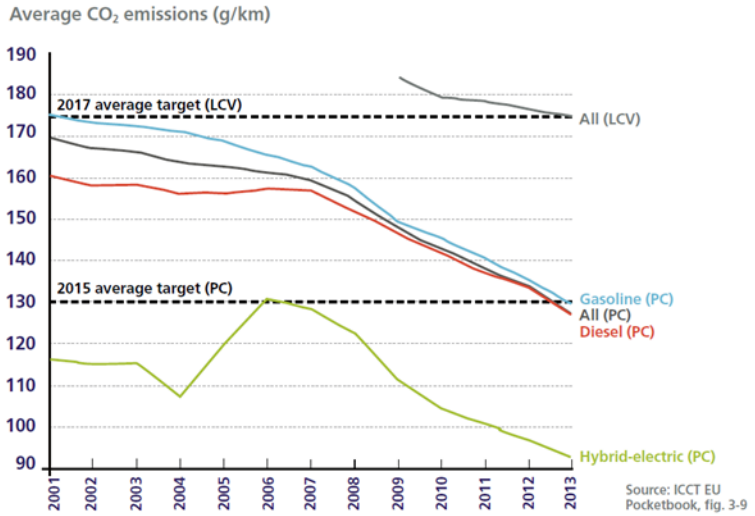
Collection rate (%) by country

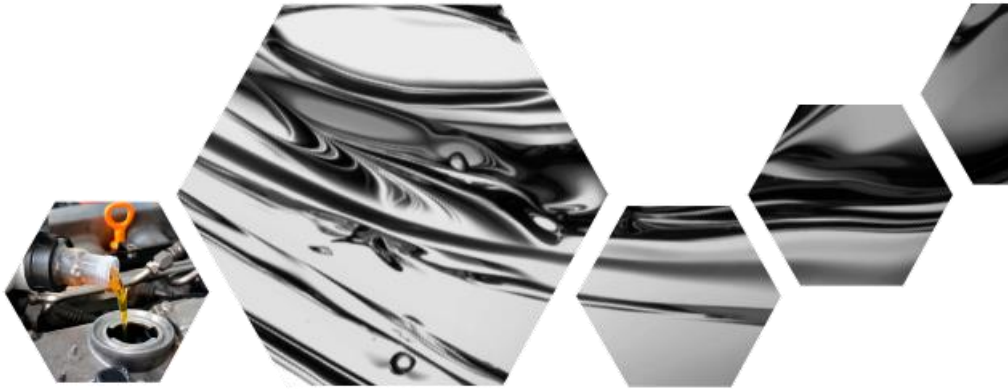
REACH

Benefits of Lubricant Additives

- Significantly enhanced section on the benefits of lubricant additives included in this update of the document covering
  - CO_2 reduction and fuel economy
  - Durability and protection
  - Compatibility with alternative fuels
  - Additives as engine design components

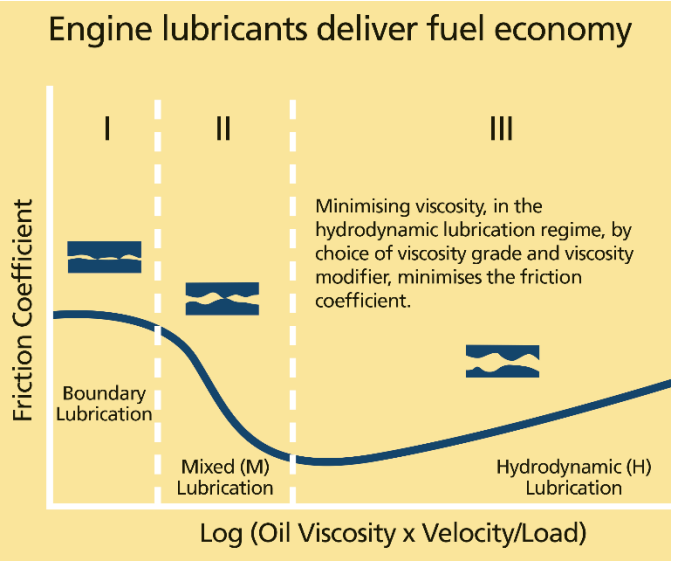
- **CO2 Reduction** – EU Exhaust Emission Regulations including penalties for non-compliance are in place. Lubricants with innovative additive technology can reduce engine friction to improve fuel economy performance.



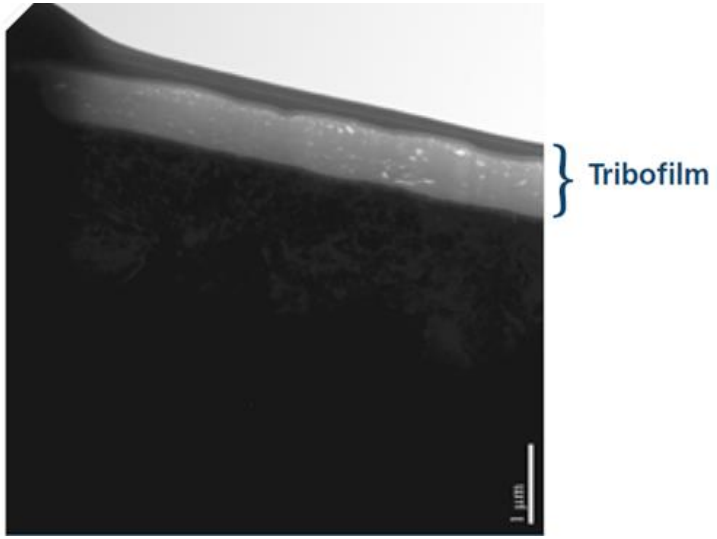


Benefits of Lubricant Additives

- **Fuel Economy** – Reducing energy loss due to friction in the engine is key to improving the fuel economy performance of vehicles; this has driven the trend towards lower viscosity oils.



- **Durability and Protection** – Increasing power output at higher-load engines combined with longer drain intervals requires additive technology to protect and form anti-wear layers on surfaces.



ZDDP tribofilm on metal test piece

Benefits of Lubricant Additives

- **Bio-Fuel compatibility** – Biofuel dilution in engine oils requires additive technology which prevent viscosity increase and sludge formation.
- **Lubrication Engineering** – Lubricant additives are now considered as lubrication engineering design components enabling significant advances in engine design.

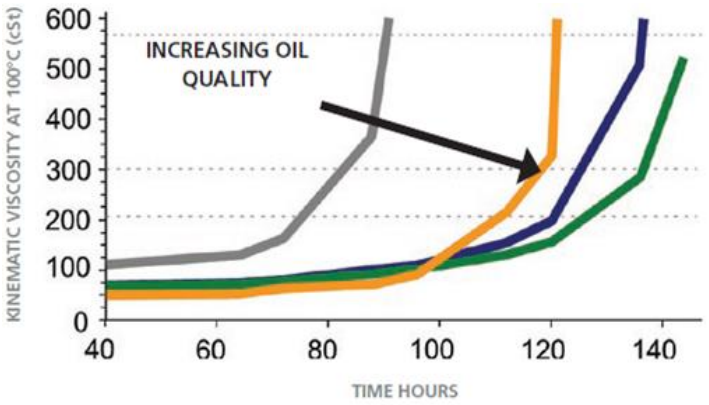


Figure 31 – Impact of Different Oil Formulations on Oxidation Performance in the Presence of Biodiesel

Factors	1996	2014	Change and Impact
Engine	2.3L Gasoline	2.0L Gasoline	-15% smaller
Power	148 HP	220 HP	+48% more power
Power Density	64 HP/litre	110 HP/litre	+72% power density
Emissions	Euro II	Euro VI	Reduced Emissions
Weight	1147 kg	1407 kg	+23% heavier
0-100 km/hr	8.2 s	6.5 s	More performance

Table 12. Example of Changes in Passenger Car OEM Hardware

Lubricant Additives: Use and Benefits

- First edition produced in 1993 and revised in 2007.
- Aims to show the contribution lubricant additives make towards the automotive industry, the consumer and the impact on the environment.

- This edition (2016) provides an update on recent additive developments and contains recent data on the lubricant market.
- Describes the chemistry and functions of lubricant additives, as well as their role in the development of advanced engine systems.

- Product health and safety aspects are reviewed.

- The significant benefits of additive technology towards engine operation and end-users are explored.

- Useful overview document for anyone with an interest in the lubricant additive business.

Lubricant Additives: Use and Benefits

Acknowledgments

- The Update team would like to acknowledge the expertise and support of the following people without whom the update would not have been possible:

  - Ian Field, ATC Secretary General. For his guidance and providing original documentation.
  - Jeff Clark, Staff Engineer ASTM Test Monitoring Center. For his support with statistical services.
  - Catherine Tuerlinckx, CEFIC Statistics Manager. For her support with statistical services.
  - ATC member companies, for providing relevant data.
  - ATC Representative Steering Group (RSG) for endorsing the update.

Thank you

Lubricant Additives: Use and Benefits

Permissions

Permission is given for storage of one copy in electronic means for reference purposes. Further reproduction of any material is prohibited without prior written consent of ATC, Additive Technical Committee.

The information contained in this document is based upon data believed to be reliable at the time of going to press and relates only to the matters specifically mentioned in this document. Although ATC has used reasonable skill and care in the preparation of this information, in the absence of any overriding obligations arising under a specific contract, no representation, warranty (express or implied), or guarantee is made as to the suitability, accuracy, reliability or completeness of the information; nothing in this document shall reduce the user's responsibility to satisfy itself as to the suitability, accuracy, reliability, and completeness of such information for its particular use; there is no warranty against intellectual property infringement; and ATC shall not be liable for any loss, damage or injury that may occur from the use of this information other than death or personal injury caused by its negligence.

Links to third party websites from this document are provided solely for your convenience. ATC does not control and is not responsible for the content of those third party websites. If you decide to access any of those websites, you do so entirely at your own risk.