

Marijan Podobnik, Josip Bambić, Višnja Mihaljuš-Sklepić

ISSN 0350-350X

GOMABN 44, 5, 317-336

Stručni rad / Professional Paper

UDK 389.6 : 621.892.097 : 629.113 : 061.2(4) : 621.43.068 : 621.434/.436 : "2004"

ACEA 2004 SPECIFIKACIJE

Sažetak

Krajem 2004. godine usvojene su nove ACEA 2004 specifikacije motornih ulja za cestovna vozila (ACEA-Association des Constructeurs Européens d'Automobiles). Najznačajniji razlozi uvođenja novih specifikacija bili su Euro 4 zahtjevi emisije ispušnih plinova koji su uzrokovali uvođenje novih sustava obrade ispušnih plinova motora.

U odnosu na prethodne ACEA 2002, nove ACEA 2004 specifikacije uvele su sljedeće bitne promjene:

- dosadašnje grupe A i B za osobna vozila objedinjene su u zajedničku grupu A/B,*
- uvedena je nova grupa C za motore osobnih vozila sa sustavima za obradu ispušnih plinova,*
- u grupi E povučene su dvije i uvedene dvije nove specifikacije.*

U novo formiranoj grupi A/B definirane su četiri specifikacije motornih ulja za benzinske i dizelove motore osobnih vozila A1/B1-04, A3/B3-04, A3/B4-04 i A5/B5-04. U odnosu na ACEA 2002 nije došlo do promjena zahtjeva kvalitete ulja već samo spajanja dviju grupa.

Nova grupa C uvedena je za benzinske i dizelove motore osobnih vozila sa sustavima za obradu ispušnih plinova. Unutar navedene grupe definirane su tri specifikacije motornih ulja C1-04, C2-04 i C3-04 čija kvaliteta odgovara specifikacijama A5/B5 odnosno A3/B4. Najbitnije kod ovih specifikacija je ograničenje količine sulfatnog pepela, fosfora (P) i sumpora (S) motornog ulja radi štetnog djelovanja na sustave obrade ispušnih plinova.

U grupi E povučene su iz uporabe specifikacije E3 i E5, a uvedene su nove E6-04 i E7-04. Specifikacija E6-04 definira kvalitetu ulja za motore gospodarskih vozila sa sustavom za obradu ispušnih plinova te također ima ograničenje količine sulfatnog pepela, fosfora (P) i sumpora (S) motornog ulja, dok je specifikacija E7-04 zapravo poboljšana dosadašnja E5 specifikacija.

1. Uvod

Specifikacije motornih ulja služe proizvođačima motora i vozila, proizvođačima maziva, proizvođačima aditiva te korisnicima motornih ulja. Definiraju se s ciljem osiguranja neophodne kvalitete motornog ulja za podmazivanje modernih konstrukcija motora.

Temelje se na propisanim motornim testovima, razvijenim na reprezentativnim motorima, referentnim gorivima i uljima, kao i laboratorijskim ispitivanjima. Preciznost testova te pouzdanost i vjerodostojnost ispitnih rezultata osigurava se strogo propisanim postupcima provođenja ispitivanja.

U ovom radu govori se o europskim specifikacijama motornih ulja, tj. ACEA specifikacijama.

ACEA (Association des Constructeurs Européens d'Automobiles) udruženje europskih konstruktora vozila, koje je osnovano 1991. godine, nasljednik je CCMC (Comité des Constructeurs d'Automobiles du Marché Commun) i preuzelo je njegove specifikacije.

Današnji članovi ACEA-e su: BMW, DAF, DaimlerChrysler, Fiat, Ford-Europa, GM-Europa, MAN, Porsche, Peugeot Citroen, Renault, Scania, Volkswagen i Volvo.

Prve ACEA specifikacije za motorna ulja izdane su krajem 1995. g. pod oznakom ACEA European Oil Sequences 1996. Slijedila su nova izdanja specifikacija motornih ulja ACEA 1998, ACEA 1999 i ACEA 2002. U studenom 2004. g. objavljeno je najnovije izdanje specifikacija motornih ulja ACEA 2004.

2. ACEA 2004 specifikacije

Glavni razlozi uvođenja novih ACEA 2004 specifikacija bili su:

- potreba podmazivanja novih Euro 4 motora,
- kompatibilnost sa sustavima obrade ispušnih plinova vozila.

Da bi zadovoljili zahtjeve Euro 4 emisije ispušnih plinova, konstruktori motora razvili su nekoliko različitih sustava obrade ispušnih plinova kao npr:

- široka primjena filtra čestica za dizelove motore osobnih vozila,
- uporaba recirkulacije ispušnih plinova (EGR) sa ili bez filtra čestica ili selektivne katalitičke redukcije (SCR) za dizelove motore gospodarskih vozila.

Kod benzinskih motora osobnih vozila nije došlo do većih promjena u konstrukciji, već je naglasak na održavanju kvalitete ispušnih plinova tijekom vijeka trajanja motora.

ACEA 2004 specifikacije definiraju minimalnu razinu kvalitete motornih ulja za servisno punjenje benzinskih i dizelovih motora osobnih i lakih dostavnih vozila, zatim benzinskih i dizelovih motora osobnih vozila sa sustavima obrade ispušnih plinova te dizelovih motora gospodarskih vozila.

2.1 Specifikacije motornih ulja za osobna vozila – A/B grupa

Kod motornih ulja za osobna vozila došlo je do spajanja postojećih A i B grupa specifikacija u zajedničku A/B grupu specifikacija ali treba naglasiti da nije došlo do povećanja zahtjeva kvalitete ulja. Dosadašnje specifikacije A2 i B2 nisu uključene u ACEA 2004 jer su motorna ulja tih razina kvalitete neprikladna za uporabu u modernim motorima.

Kvaliteta motornih ulja definirana je zahtjevima laboratorijskih i motornih testova koje ulje mora zadovoljiti.

Laboratorijski testovi propisani su za sve specifikacije unutar grupe i obuhvaćaju uobičajene zahtjeve za motorna ulja bez posebnih ograničenja sumpora i fosfora (tablica 1):

- smična stabilnost
- HTHS viskoznost (kod 150 °C i 10⁶ s⁻¹ brzine smicanja)
- isparivost (Noack)
- sulfatni pepeo
- pjenjenje (sequences I, II, III i IV kod 150 °C)
- kompatibilnost s brtvama

Tablica 1: Fizikalno-kemijska svojstva motornih ulja A/B grupe

	A1/B1-04	A3/B3-04	A3/B4-04	A5/B5-04
Sulfatni pepeo, % m/m	≤ 1,3	≤ 1,5	≤ 1,6	≤ 1,6
Sumpor, % m/m	–	–	–	–
Fosfor, % m/m	–	–	–	–
HTHS viskoznost, mPa·s	2,6 – 3,5	> 3,5	> 3,5	2,9 – 3,5

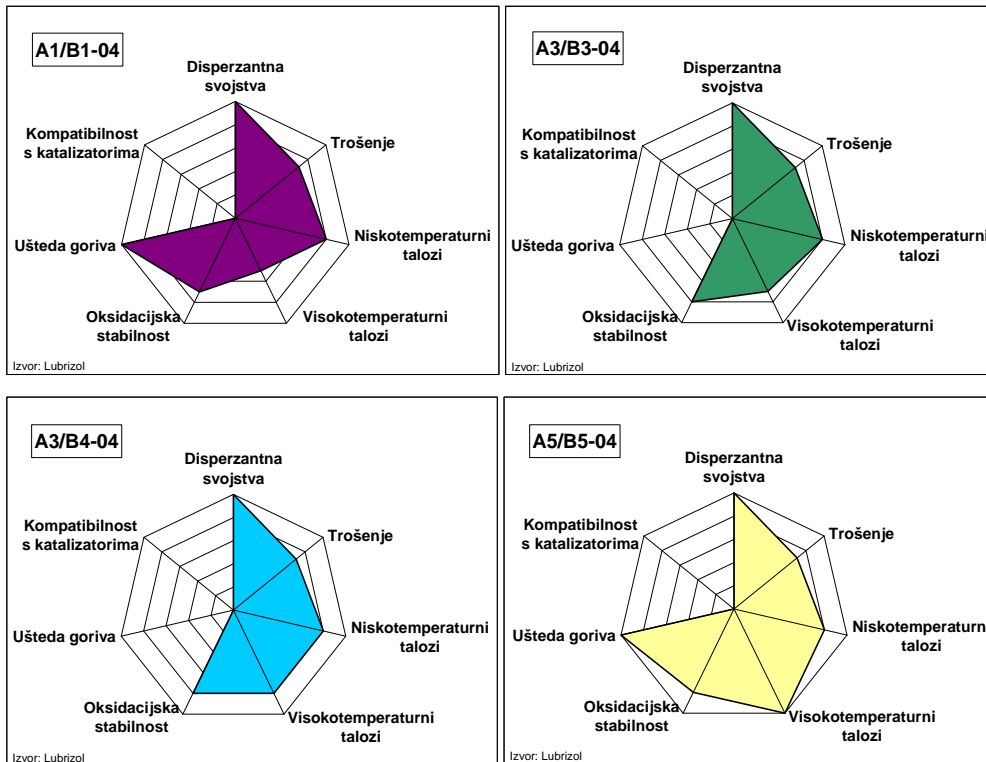
Primjenska svojstva motornih ulja definirana su motornim testovima kojima se ocjenjuju različita svojstva motornog ulja i to na sljedećim motorima:

- Peugeot TU 5JP-L4 – visokotemperaturni talozi
- Sequence VG (Ford) – niskotemperaturni talozi
- Peugeot TU 3M – trošenje pogona ventila
- Mercedes-Benz M111 – crni talozi (black sludge)
- Mercedes-Benz M111 – ušteda goriva (samo za za A1/B1 i A5/B5)
- Volkswagen 1.6 IC TD – čistoća klipa i klipnih prstena (samo za A1/B1 i A3/B3)
- Peugeot XUD 11BTE – disperzantna svojstva
- Mercedes-Benz OM 602A – različita svojstva ulja
- Volkswagen TDI – čistoća klipa i klipnih prstena (samo za A3/B4 i A5/B5)

Motorni testovi ostali su isti kao i kod ACEA 2002 specifikacija.

Usporedba najvažnijih primjenskih svojstva motornih ulja A/B grupe prikazana je na slici 1.

Slika 1: Primjenska svojstva motornih ulja A/B grupe



A/B grupa specifikacija obuhvaća 4 specifikacije motornih ulja za benzinske i dizelove motore osobnih vozila.

A1/B1-04

Ulje za uporabu u benzinskim i dizelovim motorima, koji su posebno konstruirani za uporabu ulja niske viskoznosti koja štede gorivo i čija HTHS viskoznost iznosi 2,6 - 3,5 mPa·s. Ovo ulje može biti neprikladno za uporabu u nekim motorima.

A3/B3-04

Ulje visoke smične stabilnosti za uporabu u visokoučinskim benzinskim i dizelovim motorima (prvenstveno s indirektnim ubrizgavanjem goriva) te za produžene intervale zamjene ulja odnosno teže uvjete eksploatacije prema preporukama proizvođača motora.

A3/B4-04

Ulje visoke smične stabilnosti za uporabu u visokoučinskim benzinskim i dizelovim motorima s direktnim ubrizgavanjem goriva, kao i za produžene intervale zamjene ulja odnosno za teže uvjete eksploatacije prema preporukama proizvođača motora. Ulje zadovoljava i zahtjeve B3-04 specifikacije.

A5/B5-04

Ulje visoke smične stabilnosti za uporabu u visokoučinskim benzinskim i dizelovim motorima, koji su posebno konstruirani za uporabu ulja niske viskoznosti koja štede gorivo i čija HTHS viskoznost iznosi 2,9 - 3,5 mPa·s te za produžene intervale zamjene ulja odnosno teže uvjete eksploatacije prema preporukama proizvođača motora. Ovo ulje može biti neprikladno za uporabu u nekim motorima.

2.2 Specifikacije motornih ulja za osobna vozila sa sustavima obrade ispušnih plinova – C grupa

Najznačajnija promjena u novim ACEA 2004 specifikacijama je uvođenje nove C grupe specifikacija motornih ulja za osobna vozila s modernim sustavima obrade ispušnih plinova, prvenstveno kod dizelovih motora. Kvaliteta motornih ulja definirana je istim motornim testovima kao i za A/B grupu uz dodatna ograničenja sulfatnog pepela, fosfora i sumpora (tablica 2).

Laboratorijski testovi:

- smična stabilnost
- HTHS viskoznost (kod 150 °C i 10⁶ s⁻¹ brzine smicanja)
- isparljivost (Noack)
- sulfatni pepeo
- fosfor
- sumpor
- TBN (samo za C3)
- pjenjenje (sequences I, II, III i IV kod 150 °C)
- kompatibilnost s brtvama

Tablica 2: Fizikalno-kemijska svojstva motornih ulja C grupe

	C1-04	C2-04	C3-04
Sulfatni pepeo, % m/m	≤ 0,5	≤ 0,8	≤ 0,8
Sumpor, % m/m	≤ 0,2	≤ 0,3	≤ 0,3
Fosfor, % m/m	≤ 0,05	0,07 – 0,09	0,07 – 0,09
HTHS viskoznost, mPa·s	≥ 2,9	≥ 2,9	≥ 3,5

Primjenska svojstva motornih ulja C grupe odgovaraju:

- C1-04 ⇒ A5/B5-04
- C2-04 ⇒ A5/B5-04
- C3-04 ⇒ A3/B4-04

i provode se na sljedećim motorima:

- Peugeot TU 5JP-L4 – visokotemperaturni talozi
- Sequence VG (Ford) – niskotemperaturni talozi
- Peugeot TU 3M – trošenje pogona ventila
- Mercedes-Benz M111 – crni talozi (black sludge)
- Mercedes-Benz M111 – ušteda goriva
- Peugeot XUD 11BTE – disperzantna svojstva
- Mercedes-Benz OM 602A – različita svojstva ulja
- Volkswagen TDI – čistoća klipa i klipnih prstena

C grupa specifikacija obuhvaća 3 specifikacije motornih ulja za benzinske i dizelove motore osobnih vozila sa sustavima obrade ispušnih plinova.

C1-04

Ulje visoke smične stabilnosti za uporabu u visokoučinskim benzinskim i dizelovim motorima s katalizatorom odnosno filtrom čestica, koji su posebno konstruirani za uporabu ulja niske viskoznosti koja štede gorivo i čija HTHS viskoznost iznosi više od 2,9 mPa·s. Ulje će produžiti vijek trajanja katalizatora odnosno filtra čestica te zadržati uštedu goriva tijekom primjene. Ovo ulje ima najniže količine sulfatnog pepela, fosfora i sumpora te može biti neprikladno za uporabu u nekim motorima.

C2-04

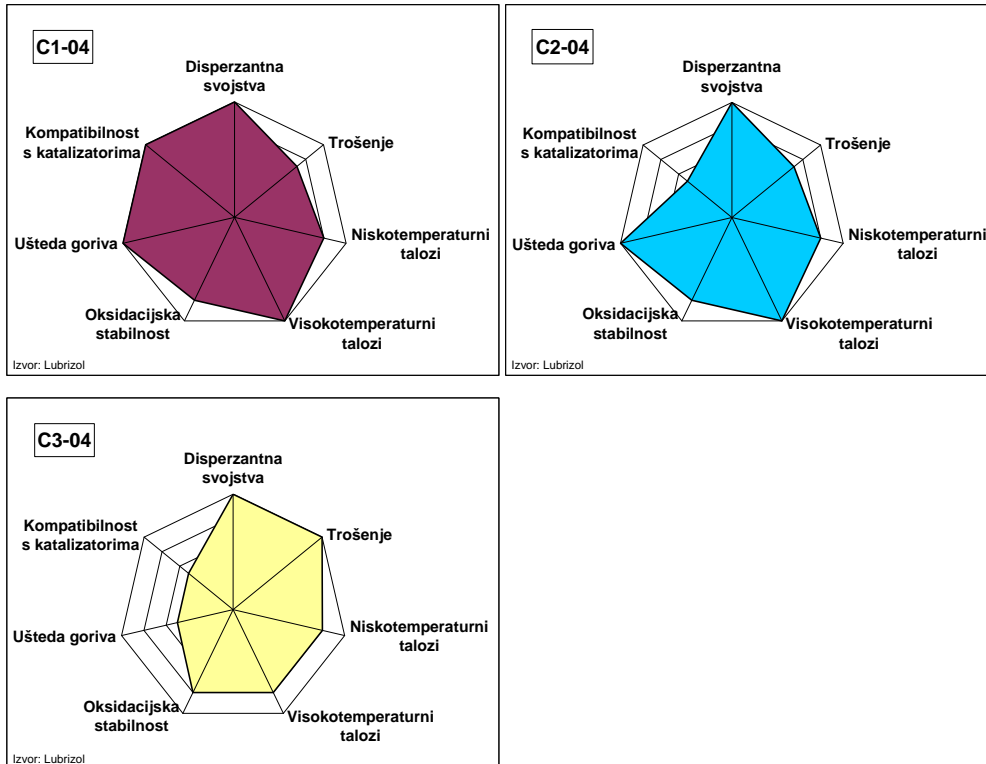
Ulje visoke smične stabilnosti, sa smanjenom količinom sulfatnog pepela, fosfora i sumpora za uporabu u visokoučinskim benzinskim i dizelovim motorima s katalizatorom odnosno filtrom čestica, koji su posebno konstruirani za uporabu ulja niske viskoznosti koja štede gorivo i čija HTHS viskoznost iznosi više od 2,9 mPa·s. Ulje će produžiti vijek trajanja katalizatora odnosno filtra čestica te zadržati uštedu goriva tijekom primjene. Ovo ulje može biti neprikladno za uporabu u nekim motorima.

C3-04

Ulje visoke smične stabilnosti, sa smanjenom količinom sulfatnog pepela, fosfora i sumpora za uporabu u visokoučinskim benzinskim i dizelovim motorima s katalizatorom odnosno filtrom čestica. Ulje će produžiti vijek trajanja katalizatora odnosno filtra čestica.

Usporedba najvažnijih primjenskih svojstva motornih ulja C grupe prikazana je na slici 2.

Slika 2: Primjenska svojstva motornih ulja C grupe



2.3 Specifikacije motornih ulja za gospodarska vozila – E grupa

Kod motornih ulja za gospodarska vozila specifikacije E3 i E5 povučene su iz uporabe a uvedene su nove specifikacije E6 i E7. Specifikacije E2 i E4 ostale su praktično nepromijenjene.

Nova specifikacija E6 temelji se na E4 zahtjevima uz dodatni motorni test Mack T-10, strože zahtjeve smične stabilnosti (ista metoda ali 90 umjesto dosadašnjih 30 ciklusa ispitivanja) i dodatna ograničenja sulfatnog pepela, fosfora i sumpora (tablica 3).

Nova specifikacija E7 temelji se na E5 zahtjevima uz dodatni motorni test Mack T-10 i strože zahtjeve smične stabilnosti (ista metoda ali 90 umjesto dosadašnjih 30 ciklusa ispitivanja).

Osim uobičajenih laboratorijskih testova uvedena su dva posebna testa za E7 specifikaciju te zbog većih opterećenja motora stroži zahtjevi za smičnu stabilnost ulja:

- smična stabilnost (30 ciklusa za E2 i E4 te 90 ciklusa za E6 i E7)
- HTHS viskoznost (kod 150 °C i 10⁶ s⁻¹ brzine smicanja)
- isparljivost (Noack)
- sulfatni pepeo
- fosfor (samo za E6)
- sumpor (samo za E6)
- pjenjenje (sequences I, II, III i IV kod 150 °C)
- oksidacijska stabilnost (samo za E7)
- antikorozivna svojstva (samo za E7)
- kompatibilnost s brtvama

Tablica 3: Fizikalno-kemijska svojstva motornih ulja E grupe

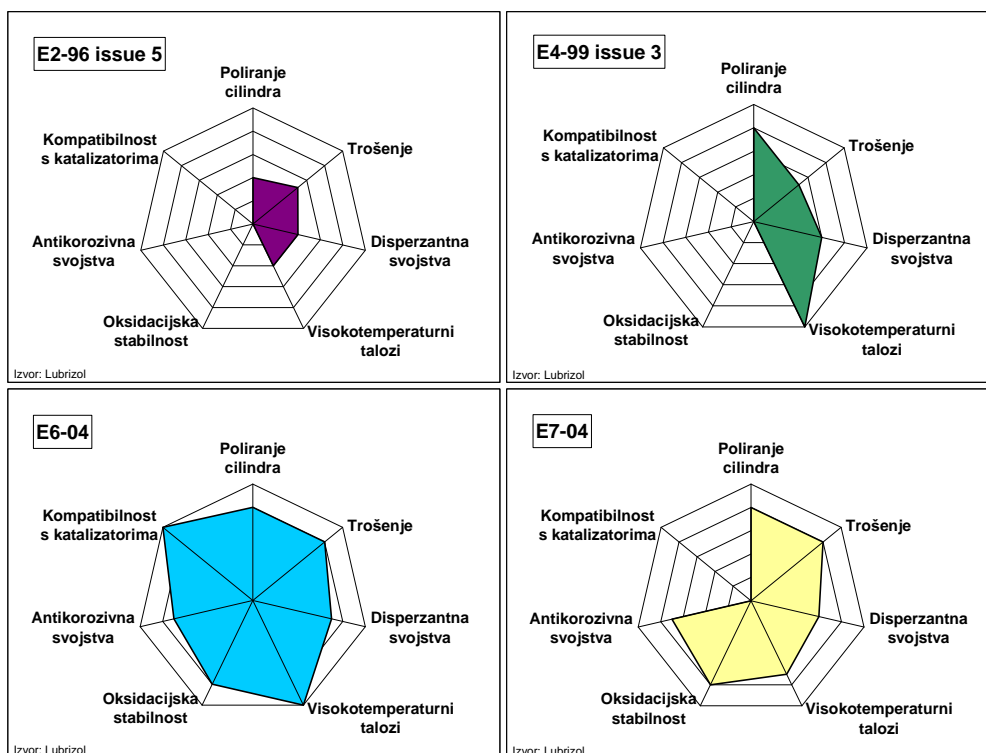
	E2-96 issue 5	E4-99 issue 3	E6-04	E7-04
Sulfatni pepeo, % m/m	≤ 2,0	≤ 2,0	≤ 1,0	≤ 2,0
Sumpor, % m/m	–	–	≤ 0,3	–
Fosfor, % m/m	–	–	≤ 0,08	–
HTHS viskoznost, mPa·s	≥ 3,5	≥ 3,5	≥ 3,5	≥ 3,5

Kod motornih testova zamijenjen je dosadašnji motor Mack T-9 novim motorom s prednabijanjem Mack T-10

- Mercedes-Benz OM 364LA – poliranje cilindra, čistoća klipa (samo za E2)
- Mercedes-Benz OM 602A – antitrošeća svojstva
- Mack T-8E – disperzantna svojstva (sve specifikacije osim E2)
- Mercedes-Benz OM 441LA – različita svojstva ulja (sve specifikacije osim E2)
- Cummins M11 – disperzantna i antitrošeća svojstva (samo za E7)
- Mack T-10 – antitrošeća svojstva (samo za E6 i E7)

Usporedba najvažnijih primjenskih svojstva motornih ulja E grupe prikazana je na slici 3.

Slika 3: Primjenska svojstva motornih ulja E grupe



E grupa specifikacija obuhvaća 4 specifikacije motornih ulja za dizelove motore gospodarskih vozila.

E2–96 issue 5

Ulje za uporabu u većini teško opterećenih dizelovih motora s normalnim punjenjem odnosno pretpunjenjem te s normalnim intervalom zamjene ulja.

E4–99 issue 3

Ulje visoke smične stabilnosti za uporabu u visokoučinskim dizelovim motorima, koji zadovoljavaju Euro 1, Euro 2, Euro 3 i Euro 4 zahtjeve emisije ispušnih plinova i rade pod vrlo teškim uvjetima eksploatacije te za značajno produžene intervale zamjene ulja prema preporukama proizvođača motora. Prikladno je za motore bez filtra čestica i za neke motore s recirkulacijom ispušnih plinova (EGR) ili selektivnom kataličkom redukcijom (SCR) – prema preporuci proizvođača.

E6-04

Ulje visoke smične stabilnosti, sa smanjenom količinom sulfatnog pepela, fosfora i sumpora za uporabu u visokoučinskim dizelovim motorima, koji zadovoljavaju Euro 1, Euro 2, Euro 3 i Euro 4 zahtjeve emisije ispušnih plinova i rade pod vrlo teškim uvjetima eksploatacije, te za značajno produžene intervale zamjene ulja prema preporukama proizvođača motora. Prikladno je za motore s recirkulacijom ispušnih plinova (EGR) sa ili bez filtra čestica i za motore sa selektivnom kataličkom redukcijom (SCR) – prema preporuci proizvođača.

E7-04

Ulje visoke smične stabilnosti za uporabu u visokoučinskim dizelovim motorima, koji zadovoljavaju Euro 1, Euro 2, Euro 3 i Euro 4 zahtjeve emisije ispušnih plinova i rade pod vrlo teškim uvjetima eksploatacije, te za značajno produžene intervale zamjene ulja prema preporukama proizvođača motora. Prikladno je za motore bez filtra čestica i za većinu motora s recirkulacijom ispušnih plinova (EGR) ili selektivnom kataličkom redukcijom (SCR) – prema preporuci proizvođača.

3. Primjena ACEA specifikacija

Budući da su objavljene u studenom 2004. godine, nove ACEA 2004 specifikacije formalno se primjenjuju od 01.11.2004. Predviđeno vrijeme važenja novih specifikacija jest 3 godine, tj. do 01.11.2007. Dosadašnje ACEA 2002 specifikacije proizvođači motornih ulja mogu još koristiti do 01.11.2006.

4. Zaključak

- ACEA 2004 specifikacije donijele su bitne promjene u specifikacijama motornih ulja.
- Zbog kompatibilnosti sa sustavima obrade ispušnih plinova ograničena je količina sulfatnog pepela, fosfora i sumpora u ulju.
- Dosadašnje A i B grupe specifikacija spojene su u zajedničku A/B grupu.
- Uvedena je potpuno nova C grupa specifikacija.
- U E grupi povučene su iz uporabe E3 i E5 specifikacije, a uvedene dvije nove E6-04 i E7-04.

THE ACEA 2004 SPECIFICATIONS

Abstract

Towards the end of 2004, the new ACEA 2004 engine oil specifications for passenger cars have been adopted (ACEA - Association des Constructeurs Européens d'Automobiles). The most significant reasons for introducing new specifications were the Euro 4 exhaust gas emission requirements, causing the introduction of new after treatment devices.

With regard to the previous ACEA 2002 specifications, the new ACEA 2004 specifications have introduced the following major changes:

- the so far classes A and B for passenger cars were jointed together into a single A/B class*
- a new class C has been introduced for passenger car engines with after treatment devices*
- within class E, two categories were cancelled and two new ones introduced*

The newly established class A/B defines four engine oil categories for passenger car gasoline and diesel engines: A1/B1-04, A3/B3-04, A3/B4-04 and A5/B5-04. With regard to ACEA 2002, there have been no changes regarding oil quality requirements, only the merging of the two classes.

The new class C has been introduced for passenger car gasoline and diesel engines with after treatment devices. Within the said class, three engine oil categories have been defined: C1-04, C2-04 and C3-04, with quality matching that of A5/B5 and A3/B4 categories. The most significant element of these categories is the limitation of the engine oil sulphated ash, phosphorus (P) and sulphur (S) content due to its noxious effect on the after treatment devices.

In class E, categories E3 and E5 were cancelled, with new ones: E6-04 and E7-04 introduced. Category E6-04 defines oil quality for heavy duty diesel engines with after treatment devices, while it also limits the engine oil sulphated ash, phosphorus (P) and sulphur (S) content, while category E7-04 is in fact an improved former E5 category.

1. Introduction

Engine oil specifications are there for engine and vehicle manufacturers, lubricant and additive producers, and engine oil users. They are defined with the purpose of ensuring the necessary engine oil quality for the lubrication of modern engine designs.

They are based on stipulated engine tests, developed on representative engines, reference fuels and oils, as well as laboratory tests. The precision of tests and the reliability and accuracy of test results is ensured by strictly prescribed test procedures.

The present paper refers to European engine oil specifications i.e. the ACEA specifications. ACEA (Association des Constructeurs Européens d'Automobiles) – an association of European vehicle designers, established in 1991, is the successor of CCMC (Comité des Constructeurs d'Automobiles du Marché Commun), having taken over its specifications.

The present members of ACEA are as follows: BMW, DAF, DaimlerChrysler, Fiat, Ford-Europe, GM-Europe, MAN, Porsche, Peugeot Citroen, Renault, Scania, Volkswagen and Volvo.

The first ACEA engine oil specifications were issued towards the end of 1995, labelled as the ACEA European Oil Sequences 1996. They were followed by new engine oil specifications editions: ACEA 1998, ACEA 1999 and ACEA 2002. In November 2004, the latest engine oil specifications edition ACEA 2004 has been published.

2. ACEA 2004 specifications

The main reasons for the introduction of new ACEA 2004 specifications were as follows:

- the need for the lubrication of new Euro 4 engines
- compatibility with after treatment devices

In order to meet the requirements of the Euro 4 exhaust gas emission, engine designers have developed several different after treatment devices, such as:

- wide application of particulate filters for passenger car diesel engines
- using exhaust gas recirculation (EGR) with or without particulate filters and selective catalytic reduction (SCR) for heavy duty diesel engines.

As regards passenger car gasoline engines, there have been no major design changes, but rather the stress has been put on maintaining exhaust gas quality during the engine's service life.

The ACEA 2004 specifications define the minimum quality level of engine oils for the service fill of gasoline and diesel engines of passenger car and light van diesel engines, as well as for gasoline and diesel engines of passenger cars with after treatment devices and heavy duty diesel engines.

2.1 Passenger car engine oil specifications – class A/B

As regards passenger car engine oils, the existing A and B classes have been merged into a single A/B class. However, it should be stressed that there has been no oil quality increase requirement. The so far A2 and B2 categories have not been included into ACEA 2004 because engine oils of these quality levels are not suitable for use in modern engines.

Engine oil quality has been defined through the requirements of laboratory and engine tests it has to meet.

Laboratory tests are set for all specifications within the class and encompass the usual requirements for engine oils without special sulphur or phosphorus limitations (Table 1):

- Shear stability
- HTHS viscosity (at 150 °C and 10^6 s^{-1} of shear rate)
- Volatility (Noack)
- Sulphated ash
- Foaming (sequences I, II, III and IV at 150 °C)
- Seal compatibility

Table 1: Physical and chemical properties of engine oils in A/B class

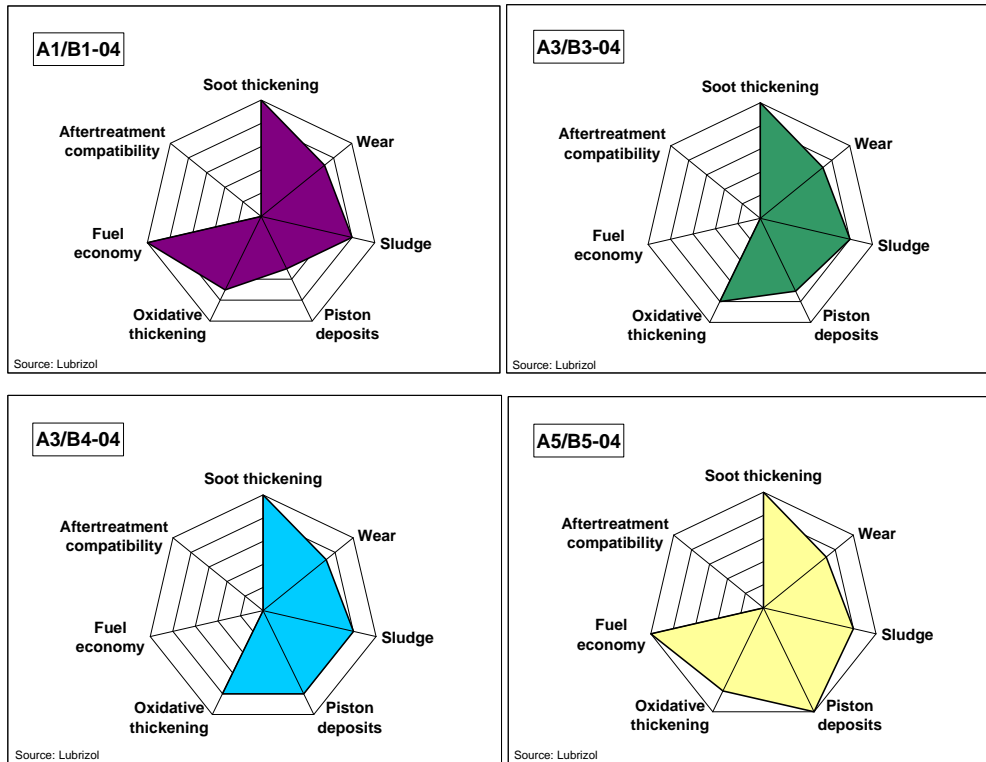
	A1/B1-04	A3/B3-04	A3/B4-04	A5/B5-04
Sulphated ash, % m/m	≤ 1,3	≤ 1,5	≤ 1,6	≤ 1,6
Sulphur, % m/m	–	–	–	–
Phosphorus, % m/m	–	–	–	–
HTHS, mPa·s	2,6 – 3,5	> 3,5	> 3,5	2,9 – 3,5

The applicative properties of engine oils are defined by engine tests evaluating different engine oil properties, on the following engines:

- Peugeot TU 5JP-L4 – high temperature deposits
- Sequence VG (Ford) – low temperature sludge
- Peugeot TU 3M – valve train scuffing wear
- Mercedes-Benz M111 – black sludge
- Mercedes-Benz M111 – fuel economy (only for A1/B1 and A5/B5)
- Volkswagen 1.6 IC TD – ring sticking and piston cleanliness (only for A1/B1 and A3/B3)
- Peugeot XUD 11BTE – dispersant properties
- Mercedes-Benz OM 602A – various oil properties
- Volkswagen TDI – piston cleanliness and ring sticking (only for A3/B4 and A5/B5)

Engine tests have remained the same as in the case of ACEA 2002 specifications. Engine test performance comparison of the A/B class engine oils is shown in Figure 1.

Figure 1: A/B class engine oils performance



The A/B class encompasses 4 engine oil categories for passenger car gasoline and diesel engines.

A1/B1-04

Oil for gasoline and diesel engines, designed especially for the use of fuel economy low viscosity oils, whose HTHS viscosity amounts to 2,6 - 3,5 mPa·s. The oil may be unsuitable for use in some engines.

A3/B3-04

High shear stable oil for high performance gasoline and diesel engines (primarily with indirect fuel injection) for extended oil drain intervals and/or severe operating conditions, according to manufacturer recommendations.

A3/B4-04

High shear stable oil for high performance gasoline and diesel engines with direct fuel injection, for extended oil drain intervals and/or severe operating conditions, according to engine manufacturer recommendations. The oil also meets the B3-04 category requirements.

A5/B5-04

High shear stable oil for high performance gasoline and diesel engines, designed especially for using low viscosity fuel economy oils, whose HTHS viscosity amounts to 2.9 - 3,5 mPa·s, for extended oil drain intervals and/or severe operating conditions, according to engine manufacturer recommendations. The oil may be unsuitable for use in some engines.

2.2 Specifications of passenger car engine oils with after treatment devices – class C

The most significant change in the new ACEA 2004 specifications is the introduction of the new C passenger car engine oil class for vehicles with modern after treatment devices, primarily in diesel engines. The quality of engine oils has been defined by the same engine tests as for class A/B, with additional limitations of sulphated ash, phosphorus and sulphur (Table 2).

Laboratory tests:

- Shear stability
- HTHS viscosity (at 150 °C and 10^6 s^{-1} of shear rate)
- Volatility (Noack)
- Sulphated ash
- Phosphorus
- Sulphur
- TBN (only for C3)
- Foaming (sequences I, II, III and IV at 150 °C)
- Seal compatibility

Table 2: Physical and chemical properties of engine oils in C class

	C1-04	C2-04	C3-04
Sulphated ash, % m/m	≤ 0,5	≤ 0,8	≤ 0,8
Sulphur, % m/m	≤ 0,2	≤ 0,3	≤ 0,3
Phosphorus, % m/m	≤ 0,05	0,07 – 0,09	0,07 – 0,09
HTHS, mPa·s	≥ 2,9	≥ 2,9	≥ 3,5

Performance of the C class engine oils correspond to:

- C1-04 ⇒ A5/B5-04
- C2-04 ⇒ A5/B5-04
- C3-04 ⇒ A3/B4-04

and tests are performed on the following engines:

- Peugeot TU 5JP-L4 – high temperature deposits
- Sequence VG (Ford) – low temperature sludge
- Peugeot TU 3M – valve train scuffing wear
- Mercedes-Benz M111 – black sludge
- Mercedes-Benz M111 – fuel economy
- Peugeot XUD 11BTE – dispersant properties
- Mercedes-Benz OM 602A – various oil properties
- Volkswagen TDI – piston cleanliness and ring sticking

The C class encompasses 3 engine oil categories for passenger car gasoline and diesel engines with after treatment devices.

C1-04

High shear stable oil for high performance gasoline and diesel engines with catalytic converters and particulate filters, designed especially for using fuel economy low viscosity oils which HTHS viscosity amounts to over 2.9 mPa·s. The oil will extend the catalytic converter and particulate filters service life and also maintain fuel economy throughout its application. The oil has the lowest sulphated ash, phosphorus and sulphur levels, and may be unsuitable for use in some engines.

C2-04

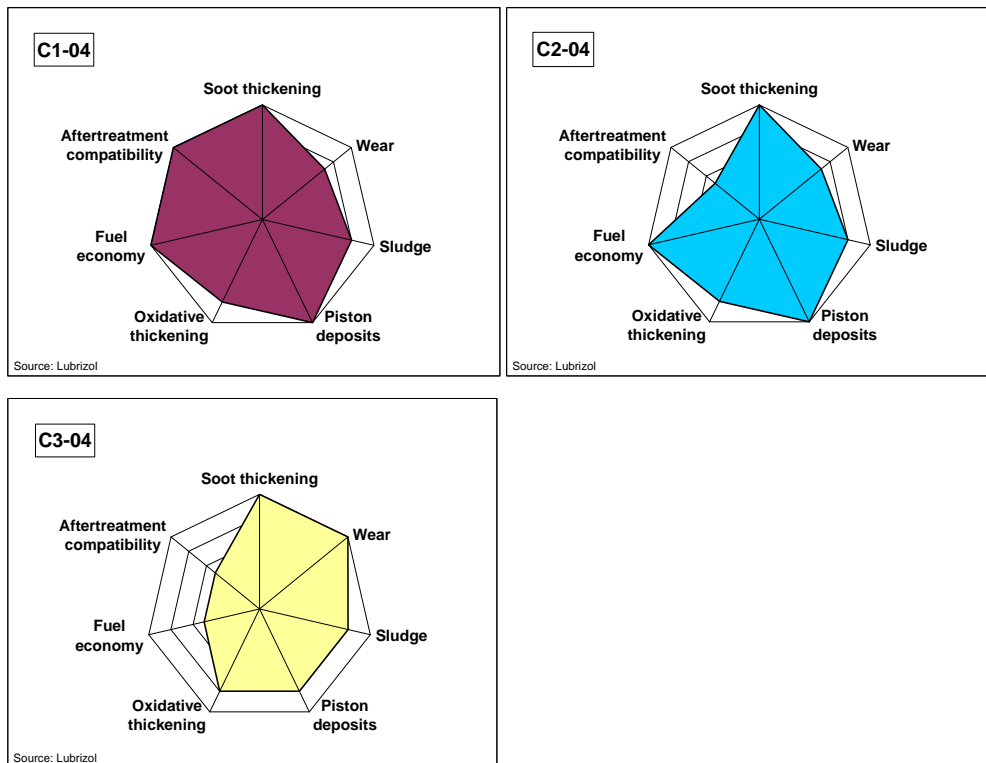
High shear stable oil, with reduced sulphated ash, phosphorus and sulphur level, for use in high performance gasoline and diesel engines with catalytic converters and particulate filters, designed especially for using fuel economy low viscosity oils, which HTHS viscosity amounts to over 2.9 mPa·s. The oil will extend the catalytic converter and particulate filters service life and also maintain fuel economy throughout its application. The oil may be unsuitable for use in some engines.

C3-04

High shear stable oil, with reduced sulphated ash, phosphorus and sulphur level, intended for use in high performance gasoline and diesel engines with catalytic converters and particulate filters. The oil will extend the catalytic converter and particulate filters service life.

Engine test performance comparison of the C class engine oils is shown in Figure 2.

Figure 2: C class engine oils performance



2.3 Engine oil specifications for heavy duty diesel engines – class E

As regards engine oils for heavy duty diesel engines, categories E3 and E5 are no longer in use, while new categories E6 and E7 have been introduced. Categories E2 and E4 have remained more or less the same.

The new category E6 is based on the E4 requirements plus the additional Mack T-10 engine test, more stringent shear stability requirements (the same method, only with 90 testing cycles instead of the so far 30) and additional limitations of sulphated ash, phosphorus and sulphur content (Table 3).

The new category E7 is based on the E5 requirements plus the additional Mack T-10 engine test and more stringent shear stability requirements (the same method, only with 90 testing cycles instead of the so far 30).

Apart from the usual laboratory tests, two special tests have been introduced for the E7 category, and, due to greater engine loads, more stringent shear stability requirements:

- Shear stability (30 cycles for E2 and E4 and 90 cycles for E6 and E7)
- HTHS viscosity (at 150 °C and 10^6 s^{-1} of shear rate)
- Volatility (Noack)
- Sulphated ash
- Phosphorus (only for E6)
- Sulphur (only for E6)
- Foaming (sequences I, II, III and IV at 150 °C)
- Oxidation stability (only for E7)
- Anticorrosive properties (only for E7)
- Seal compatibility

Table 3: Physical and chemical properties of engine oils in E class

	E2-96 issue 5	E4-99 issue 3	E6-04	E7-04
Sulphated ash, % m/m	≤ 2,0	≤ 2,0	≤ 1,0	≤ 2,0
Sulphur, % m/m	–	–	≤ 0,3	–
Phosphorus, % m/m	–	–	≤ 0,08	–
HTHS, mPa·s	≥ 3,5	≥ 3,5	≥ 3,5	≥ 3,5

As regards engine tests, the so far Mack T-9 engine has been replaced by the new turbocharged Mack T-10 engine

- Mercedes-Benz OM 364LA - bore polishing, piston cleanliness (only for E2)
- Mercedes-Benz OM 602A - antiwear properties
- Mack T-8E - dispersant properties (all categories except for E2)
- Mercedes-Benz OM 441LA - different oil properties (all categories except for E2)
- Cummins M11 – dispersant and antiwear properties (only for E7)
- Mack T-10 – antiwear properties (only for E6 i E7)

Engine test performance comparison of the E class engine oils is shown in Figure 3. The E class encompasses 4 engine oil categories for heavy duty diesel engines.

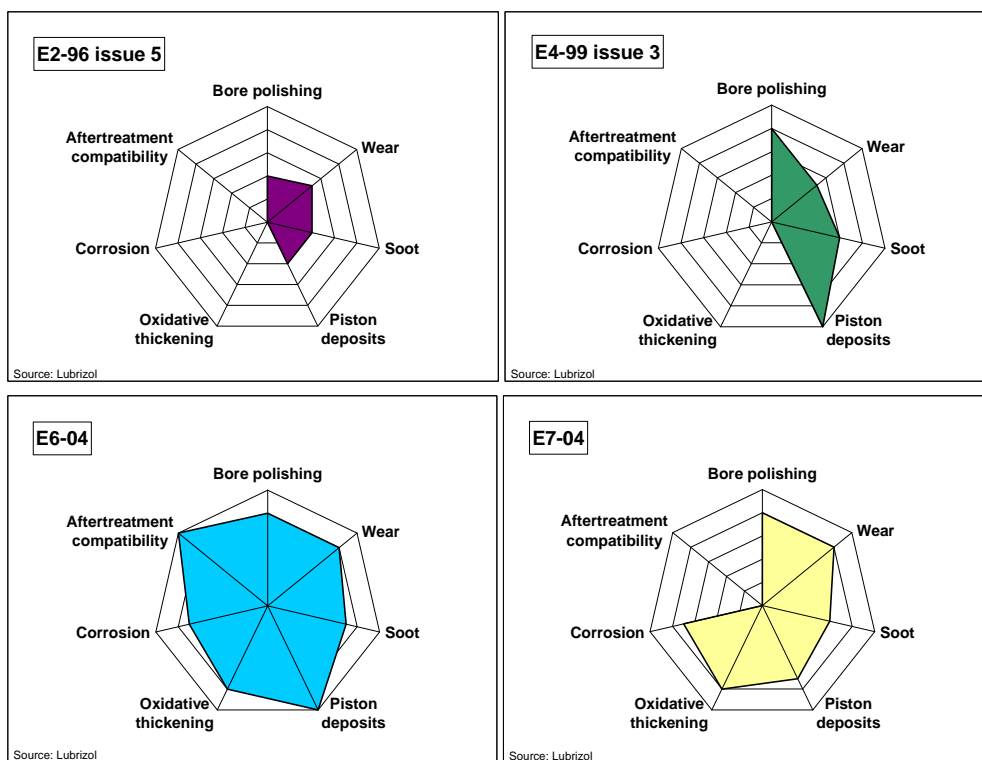
E2–96 issue 5

Oil for most heavy duty diesel engines with naturally aspirated and turbocharged and with normal oil drain intervals.

E4–99 issue 3

High shear stable oil for high performance diesel engines meeting Euro 1, Euro 2, Euro 3 and Euro 4 exhaust gas emission requirements, operating under very severe conditions, for considerably extended oil drain intervals according to engine manufacturer recommendations. Suitable for engines without particulate filters and for some engines with exhaust gas recirculation (EGR) or selective catalytic reduction (SCR) – according to manufacturer recommendations.

Figure 3: E class engine oils performance

**E6-04**

High shear stable oil, with reduced sulphated ash, phosphorus and sulphur level, for use in high performance diesel engines meeting Euro 1, Euro 2, Euro 3 and Euro 4 exhaust gas emission requirements, operating under very severe conditions, for considerably extended oil drain intervals according to engine manufacturer recommendations. It is suitable for engines with exhaust gas recirculation (EGR) with or without particulate filters and for engines with selective catalytic reduction (SCR) – according to manufacturer recommendations.

E7-04

High shear stable oil for high performance diesel engines meeting Euro 1, Euro 2, Euro 3 and Euro 4 exhaust gas emission requirements, operating under severe conditions, for considerably extended oil drain intervals according to engine manufacturer recommendations. It is suitable for engines without particulate filters and for most engines with exhaust gas recirculation (EGR) or selective catalytic reduction (SCR) – according to manufacturer recommendations.

3. Application of ACEA specifications

Since they were published in November 2004, the new ACEA 2004 specifications have been officially applied as of 1st November 2004.

The estimated duration of the new specifications' validity is 3 years i.e. until 1st November 2007.

The engine oil manufacturers may continue to use the so far ACEA 2002 specifications until 1st November 2006.

4. Conclusion

- ACEA 2004 specifications have brought major changes to the engine oil specifications.
- Due to the compatibility with the after treatment devices, the engine oil content of sulphated ash, phosphorus and sulphur has been limited.
- The so far A and B classes have been joined together into a single A/B class.
- An entirely new C class has been introduced.
- As regards class E, E3 and E5 categories have been put out of use, with 2 new ones introduced: E6-04 and E7-04.

Literatura / References:

1. Podobnik M., Bambić J., Oršić M., "ACEA specifikacije motornih ulja", *Goriva i Maziva*, 41, 1, 23.-43., Zagreb, Hrvatska, 2002.
2. "ACEA European Oil Sequences 2002", Brussels, Belgium, 2002
3. "ACEA European Oil Sequences 2004", Brussels, Belgium, 2004
4. "Passenger Car Engine Oils - ACEA Sequences", Lubrizol Corporation, Hazelwood, United Kingdom, 2005

UDK	ključne riječi	key words
389.6 : 621.892.097	specifikacije motornog ulja	engine oil specification
621.892.097	maziva za automobile	automotive lubricants
629.113 : 061.2(4)	Udruženje europskih proizvođača automobila	ACEA Association des Constructeurs Europeens d'Automobiles
621.43.068	uređaji za naknadnu obradu ispušnih plinova motora	engine exhaust gases after treatment devices
621.434	benzinski motor	gasoline engine
621.436	dizelov motor	diesel engine
"2004"	2004. godina	2004 year

Autori / Authors:

Marijan Podobnik, dipl.ing., INA Maziva Rijeka, M. Barača 26, Rijeka

Josip Bambić, dipl.ing., INA Maziva Rijeka, M. Barača 26, Rijeka

Višnja Mihaljuš-Sklepić, dipl.ing., INA Maziva Rijeka, M. Barača 26, Rijeka

Primljeno / Received:

15.11.2005.