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ISSN 0350-350X
GOMABN 43, 2, 109-119
Stručni rad / Professional Paper
UDK 665.765.035 : 631.3 : 061.5 : 621.892.097.2 : 620.168.2 : 631.512 "323/324"

TESTIRANJE SVOJSTAVA MOTORNOG ULJA SHPD U MOTORU TRAKTORA PRI OSNOVNOJ OBRADI TLA

Sažetak

Testiranje motornog ulja SHPD kvalitete, gradacije viskoznosti SAE 15W-40 obavljeno je u jesensko-zimskom oranju, s ciljem prikupljanja podataka o dinamici promjena osnovnih karakteristika motornog ulja i temeljem toga mogućnostima produljenja intervala zamjene ulja. Oranje je obavljano na tlu teksturne oznake praškasto-glinasta ilovača, sadržaja vode 15-19 % na dubinu od 30-32 cm u vremenu od 13. studenoga do 11. prosinca 2002. godine. Posao je obavljen za 24 radna dana sa četverobrazdnim okretnim plugom Regent Megastar 600 CX i traktorom John Deere 8200 od 155 kW (210 KS), a uzorci ulja u količini od 1 litre uzimani su crpkom izravno u polju. Vrijednosti fizikalno kemijskih svojstava ulja kretale su se unutar očekivanih granica. Trend promjene viskoznosti navodi na zaključak da se tijekom ispitivanja viskoznost vrlo malo mijenjala i u cijelom razdoblju ostala je unutar početne gradacije, što znači da ulje pri teškim uvjetima rada traktora uspješno održava svojstva podmazivosti bez opasnosti za ispravan rad i stanje motora. Ulje je i nakon završetka ispitivanja imalo visoku alkalnu rezervu (TBN), što znači da je dobro štitilo motor i da je moglo biti još u uporabi. Trošenje metalnih djelova, vidljivo u vrijednostima količine metala u ulju, bilo je nisko. Tijekom ispitivanja ukupno je nadoliveno 3,7 l ulja, što daje prosječnu potrošnju od 1,22 l ulja na 100 sati rada traktora. Ukupno vrijeme testiranja ulja je bilo 304 sata rada traktora. Iako su gotovo svi pokazatelji ukazivali na mogućnost produženja rada, odnosno produljenja intervala zamjene ulja, krajnji interval zamjene ulja nije utvrđen zbog prijevremenog prekida ispitivanja što su učinili korisnici, vjerojatno potaknuti prethodno uobičajenim mijenjanjem ulja na 200 sati rada.

Uvod

Opseg proizvodnje i potrošnje maziva značajno je uvjetovan i trendovima razvoja motora i strojeva budući da su maziva njihov bitan konstrukcijski element. Već niz godina maziva hrvatskih proizvođača slijede svjetske standarde kvalitete. U četiri istočno slavonske županije: Osječko-baranjskoj, Vukovarsko-srijemskoj, Brodsko-posavskoj i Požeškoj, traktori i kombajni troše približno 3000 t godišnje motornih ulja. Na istom području hranu za ljude i domaće životinje proizvode četiri najveća kombinata – IPK Osijek, «Belje» PIK, «Vupik» Vukovar i «Hana» Našice, a i brojna obiteljska gospodarstva, koja za pogon brojne poljodjelske mehanizacije koriste maziva domaćih i stranih proizvođača. Uz mazivo korisnici dobiju i podatke o razni kvalitete, odnosno tehničku informaciju u kojoj je naveden i interval zamjene ulja. Tako npr. najveći domaći proizvođač goriva i maziva u Hrvatskoj za svoje motorno ulje kvalitete SHPD navodi da je «*interval zamjene ulja do 40.000 prijeđenih kilometara ili jednom godišnje, odnosno prema preporuci proizvođača vozila*». Naš drugi proizvođač ulja preporuča zamjenu svoga ulja između 30-40.000 km. Na našim velikim poljoprivrednim kombinatima interval zamjene ulja takve kvalitete je cca 200 sati rada traktora, bez obzira na stupanj opterećenja motora traktora. Preporuka proizvođača motora, a temeljem njihovih iskustava, testiranja i faktora sigurnosti (Mack T-10, Cummins M-11, Caterpillar 1Q) jest da interval zamjene motornog ulja bude 200 sati. Naime, u tom vremenu korištenja ulje ne bi smjelo ni pod najtežim režimom rada motora izgubiti osnovna svojstva zaštite motora.

Na Poljoprivrednom fakultetu Sveučilišta u Osijeku na dvodnevnom edukacijskom okupljanju voditelja mehanizacije na velikim kombinatima i slavonsko-baranjskih farmera raspravljalo se o odnosima najvećeg domaćeg proizvođača maziva i korisnika sa ciljem ostvarenja TQM (Total Quality Management) u području maziva što podrazumijeva pružanja pune usluge korisnicima i to ne samo prodajom proizvoda već i kompletnom skrbi tijekom primjene maziva. Svrha ovog rada je ukazati korisnicima na mogućnost produljenja intervala zamjene domaćeg motornog ulja SHPD kvalitete u motoru traktora pri osnovnoj obradi tla (oranju).

Metode rada i uvjeti istraživanja

Istraživanje je obavljeno na proizvodnim površinama VUPIK Vukovar RJ Ovčara u razdoblju od 13. studenoga do 11. prosinca 2002. godine (24 dana). Obavljana je osnovna obrada tla-oranje traktorom John Deere 8200, godina proizvodnje 1997., tip motora RG 6081 H029110 i četverobrazdnim plugom premetnjakom Regent Megastar. Korišteno je motorno ulje SHPD, SAE 15W–40, razine kvalitete ACEA E3-96 issue 2, API CE/CF/SF, MB 228.3 uz novi pročistač ulja oznake RE 57394 Donalson. Uzorci tla za određivanje sastava tla uzimani su sondom za uzorkovanje s dubine od 0 do 30 cm, a analizirani su u Zavodu za agrokemiju Poljoprivrednog fakulteta Osijek. Vlaga tla utvrđivana je u trenutku uzimanja uzorka tla sondom za trenutačno određivanje vlage tla tipa BWK Lanze Stelzner GmbH (Njemačka). Uzorci ulja u količini od cca 1 litre uzimani su mehaničkom crpkom iz kartera motora

traktora u polju i isti dan otpremani u laboratorij INA Maziva Rijeka. Komentar analiza uzoraka ulja obavila je INA-industrija nafte d.d. Služba veleprodaje maziva, Komercijalno tehnički servis Rijeka. Analize svojstava korištenog ulja obavljane su metodama ASTM D 445, 93, 664, 2896, 95, 893 i ICP-OES. Orano tlo po teksturi, odnosno mehaničkom sastavu pripada grupi tzv. srednje teških tala, a u vrijeme obrade je bilo dosta suho (tablica 1).

Tablica 1: Mehanički sastav i trenutačna vlaga tla

Broj uzorka	Vlaga (%)	Pijesak	Prah	Glina	Teksturna oznaka
		0,05 – 2 %	0,002 – 0,05%	<0,002 %	
1	15-16	1,9	72,0	26,1	Praškasto glinasta ilovača
2	17-18	1,9	71,5	26,6	Praškasto glinasta ilovača
3	19	2,5	71,4	26,1	Praškasto glinasta ilovača

U navedenom razdoblju traktor je ostvario ukupno 304 radna sata, odnosno u prosjeku 12,6 h dnevno. Učinak agregata u ovom vremenu bio je oko 260 ha, odnosno oko 0,86 ha na sat.

Rezultati istraživanja

Rezultati ispitivanja uzoraka ulja uzetih nakon 56, 169, 286 i 304 sati rada traktora prikazuje tablica 2.Vrijednosti fizikalno kemijskih svojstava kretala su se unutar očekivanih granica, a o pojedinačnim svojstvima komentar je slijedeći:

Kinematička viskoznost – Očekivano, kinematička viskoznost nakon 50-ak sati rada pada i postiže vrijednost od oko 10 % niže od početne. U daljnjem radu ulje održava kinematičku viskoznost na postignutoj vrijednost, no može, ovisno o utjecaju netopljivih tvari lagano rasti ili radi prodora goriva padati. Tijekom ovog ispitivanja, u odnosu na početnu vrijednost svježeg ulja (14,5 mm^2/s) ukupan pad viskoznosti je iznosio 11,1 %. Kinematička viskoznost se vrlo malo mijenjala i u cijelom razdoblju ispitivanja ostala je unutar početne gradacije viskoznosti. To znači da je ulje uspješno održavalo svojstva podmazivanja bez opasnosti za ispravan rad i stanje motora.

Plamište – Vrijednosti plamišta pokazuju da je tijekom primjenskog ispitivanja malo goriva dospijevalo u ulje i snižavalo mu plamište. Nakon prvih 56 sati rada plamište je prilično palo (25%), no nakon upozorenja na pojavu i, pretpostavljamo, podešavanje tehničkog stanja motora (sustav goriva) stanje se popravilo tako da se u narednim uzorcima plamište nije pojavljivalo kao problem. Stanje kontinuiranog minimalnog prodora goriva posljedica je i potvrda stanja motora uzrokovanog starošću motora i trošenja koja su dovela do tog stanja.

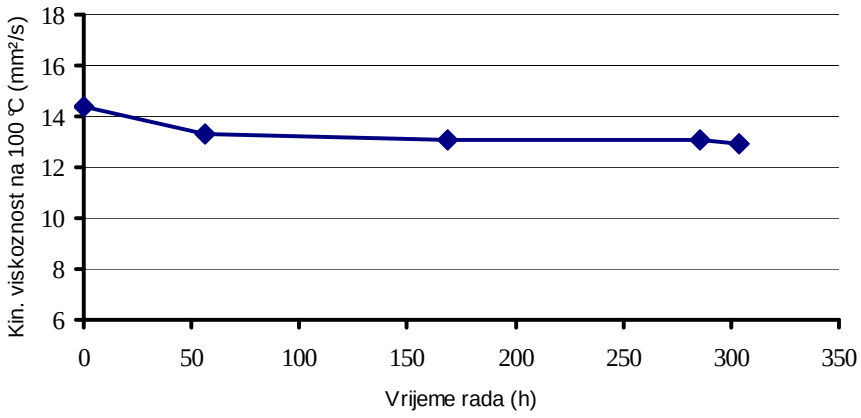
Ukupni bazni broj (TBN) – To je važan pokazatelj izdržljivosti ulja, gdje veliki utjecaj ima kvaliteta goriva i količina ulja u sustavu. Konačne vrijednosti u trenutku ispuštanja ulja bile su 68% početne vrijednosti. Dakle, motorno ulje je na kraju

korištenja još imalo vrlo visoke vrijednosti TBN-a, tj. visoku alkalnu rezervu, što znači da je dobro štitilo motor i da je moglo biti još u uporabi.

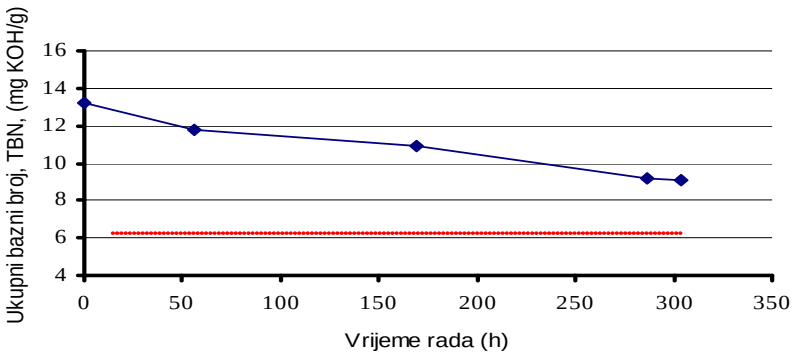
Tablica 2: Promjena kvalitativnih i kvantitativnih svojstava korištenog ulja

Svojstvo	Jedinica	Uzorci: sati rada ulja (h)			
		56	169	286	304
Viskoznost kod 100°C	mm^2/s	13,34	13,04	13,10	12,89
Plamište, PM	°C	135	198	180	196
Ukupni bazni broj,TBN	mg KOH/g	11,8	10,9	9,2	9,1
Količina vode	% v/v	<0,1	<0,1	<0,1	<0,1
Netopljivo u n-pentanu	% m/m	0,10	0,30	0,04	0,02
Metali: Ca	mg/kg	4260	4340	4540	4450
P	mg/kg	1140	1120	1170	1140
Zn	mg/kg	1280	1270	1340	1320
Fe	mg/kg	9	18	27	27
Cr	mg/kg	3	3	4	4
Mo	mg/kg	2	4	6	6
Sn	mg/kg	20	25	0	10
Pb	mg/kg	5	5	9	9
Cu	mg/kg	1	1	1	1
Na	mg/kg	23	24	26	27
Mg	mg/kg	94	99	104	98
B	mg/kg	57	43	33	21
Al	mg/kg	2	1	2	2
V	mg/kg	0	0	0	1
Si	mg/kg	4	4	4	5

Dijagram 1: Promjena kinematičke viskoznosti motornog ulja u toku ispitivanja



Dijagram 2: Promjena ukupnog baznog broja motornog ulja u toku ispitivanja



Netopljivo u n-pentanu – Vrijednosti netopljivih tvari tijekom ispitivanja bile su vrlo male (0,10; 0,30; 0,04; 0,02 % m/m) u odnosu na početnu vrijednost (0 % m/m) svježeg ulja. Ovi rezultati pokazuju da motor ima vrlo dobro izgaranje, da je bilo malo trošenje motora, odnosno da je i sustav održavanja čistoće motora (pročistački sklop) uspješno obavio svoju ulogu, tako da nije bilo utjecaja na promjenu viskoznosti motornog ulja.

Količina vode – Uglavnom nije utvrđena ili se pojavljivala u tragovima tijekom ispitivanja.

Sadržaj metala

Metali iz trošenja motora – Vrijednosti količine metala koje potječu od trošenja pojedinih dijelova motora bile su male i ukazuju na minimalno trošenje motora. Brojčano su najveće količine željeza, što je uobičajena pojava, iskazuje se mali sadržaj kositra (Sn) iz ležaja, ali je sve to daleko ispod dopuštenih granica iz trošenja za količine metala u motornom ulju.

Metali iz aditiva – Količine pojedinih metala kretale su se oko početnih količina u motornom ulju i nije bilo jačeg istrošenja aditivnog sklopa ulja.

Ostali metali – Pojavljivali su se tijekom ispitivanja u vrlo malim količinama. Pokazuju da nije bilo propuštanja rashladnog sredstva u motorno ulje, a također su i vrijednosti količine silicija bile male, što potvrđuje ispravnost rada pročistača zraka.

Potrošnja ulja

Potrošnja ulja je značajan podatak, čija veličina ovisi o kvaliteti motornog ulja, konstruktivnim karakteristikama motora, tehničkom stanju motora te uvjetima

eksploatacije. Da bi se relevantno moglo komentirati stvarnu potrošnju ulja i trend potrošnje glede odrađenih sati potrebno je u stalnim intervalima provjeravati razinu ulja i nadolijevanjem manjak ulja dovesti unutar potrebne razine. Za usporedbu valjalo bi poznavati prethodnu potrošnju i, jasno, u nekoliko ciklusa (tijekom godine i u različitim uvjetima eksploatacije) pratiti ulje i nadolijev.

Prema podacima koje smo dobili od korisnika ukupno je nadoliveno (do ispuštanja ulja) 3,7 litara ulja, ne računajući dio koji se nadolio zbog manjka kod uzimanja uzorka ulja za ispitivanje, što daje prosječnu potrošnju od 1,2 litre ulja na 100 radnih sati.

Zaključak

Iako kratkotrajno, ovo ispitivanje (praćenje) promjena osnovnih svojstava ulja za radno vrlo opterećene turbo dizelove motore traktora omogućuje sljedeće konstatacije:

- Ispitivano motorno ulje SHPD kvalitete za vrijeme upotrebe u motoru traktora nije izgubilo osnovna maziva svojstva. Fizikalno kemijska svojstva ulja, posebno TBN vrijednost, ostala su unutar normalnih, očekivanih primjenskih granica te se ulje moglo i dalje koristiti iznad postignutih 304 sata rada.
- SHPD ulje je tijekom provedenog ispitivanja pokazalo izrazito dobru sposobnost održanja čistoće motora.
- Potrošnja ulja od 1,2 l/ 100 radnih sati iznosi 5% ukupne količine ulja u koritu motora - karteru, no ona je primarno zavisna o stanju motora i režimu rada pa je treba uzeti samo kao orijentacijsku vrijednost,
- Konačna konstatacija jest da bi trebalo nastaviti, a i proširiti ovakva istraživanja i to tijekom dužeg razdoblja eksploatacije.

TESTING THE PROPERTIES OF SHPD ENGINE OIL IN TRACTOR ENGINES DURING PRIMARY SOIL TILLAGE

Abstract

The testing of the engine oil of SHPD quality, viscosity grade SAE 15W-40, was performed during the autumn/winter ploughing, with the purpose of gathering data on the change dynamics of basic engine oil properties and the resulting possibilities of oil change interval extension. Ploughing was performed on soil with the texture of silty-clay loam, water content 15-19 %, to the depth of a = 30-32 cm during 13 November to 11 December, 2002. The work was done in 24 workdays with a four-furrow reversible plough Regent, type Megastar 600 CX and tractor John Deere 8200, engine power of 155 kW (210 HP).The oil samples in the amount of 1 litre were taken by pump directly in the field.

The values of the physical-chemical properties of oil were within the expected limits. The viscosity change trend suggests the conclusion that viscosity changed very little during testing and remained throughout the entire period within the initial SAE viscosity grade, which means that the oil was able to maintain its lubrication properties under heavy-duty tractor operating conditions, without threat to the normal functioning and overall condition of the engine. Even when the test was finished, the oil still had a high alkaline reserve (TBN), which means that it was protecting the engine well and could have remained in use. The wear of metal parts, indicated by the value of the oil metal content, was low. During testing, the total of 3.7 l of oil was topped up, indicating an average consumption of 1.22 l of oil per 100 op. hrs of the tractor. The total oil testing time was 304 op. hrs of the tractor. Although nearly all indicators were pointing to the possibility of continued operation i.e. oil change interval extension, the final oil change interval was not determined because the user discontinued the test beforehand, probably due to the usual oil changeinterval of 200 hrs of operation.

Introduction

The amount of lubricant production and consumption is to a large extent conditioned by the trends of engine and machinery development, since lubricants constitute their

important structural element. For a number of years now, the lubricants by Croatian manufacturers have been following world quality standards. In the four eastern Slavonian counties: Osječko-baranjska, Vukovarsko-srijemska, Brodsko-posavska and Požeška, tractors and combine harvesters are consuming nearly 3,000 t (three thousand tons) of motor oils annually. In the same region, both human and cattle food is manufactured by the four largest cooperatives – IPK Osijek, «Belje» PIK, «Vupik» Vukovar and «Hana» Našice, as well as by many husbandries, using both domestic and foreign lubricants for the drive of their extensive agricultural machinery. The lubricant always comes with the information on the quality level i.e. oil specification indicating the oil fill interval. Thus, for instance, the largest local manufacturer of fuels and lubricants states for its motor oil of SHPD quality that the «*oil fill interval is up to 40,000 kilometers covered or once a year, i.e. according to the vehicle manufacturer recommendation*». Another domestic oil manufacturer recommends the oil fill interval between 30-40,000 km. At our large agricultural cooperatives, the oil fill interval for such a level of oil quality is ca. 200 hours of tractor operation, regardless of the tractor engine load degree. Recommendation of the engine manufacturer, based on his experience, testing, and safety factor (Mack T-10, Cummins M-11, Caterpillar 1Q) is for the oil fill interval to be 200 hrs. Namely, during that period, the oil should not loose its basic engine protection properties, not even under the heaviest operating regime.

At the Osijek University Faculty of Agriculture, during a two-day educational gathering of those in charge of machinery at large cooperatives and local farmers, there was talk about the relationship between the largest domestic lubricant producer and his users, for the purpose of achieving TQM (Total Quality Management) in the area of lubricants. This implies a full service rendered to the users, not only through product sale, but also post-sales services during lubricant application. The purpose of the present paper is to alert the users about the possibility of extending the oil fill interval of domestic SHPD quality level motor oil in tractor engines during basic soil cultivation (ploughing).

Operation Methods and Test Conditions

The test was performed on fields of VUPIK Vukovar RJ Ovčara between 13 November and 11 December, 2002 (24 days). Primary soil tillage was performed by ploughing, using the tractor John Deere 8200, manufactured in 1997, engine type RG 6081H029110, and a four-furrow reversible plough Regent Megastar. The engine oil used was SHPD, SAE 15W – 40, ACEA E3-96 issue 2, API CE/CF/SF, MB 228.3, with a new oil filter labelled RE 57394 Donalson. Soil samples for determining its composition were taken by a sampling probe from the depth of 0 to 30 cm, and analyzed at the Institute for Agrochemistry of the Faculty of Agriculture in Osijek. Soil water content was determined when the soil was sampled using a probe for momentaneous soil water content determination, type BWK Lanze Stelzner GmbH (Germany). Oil samples in the amount of ca. 1 litre were taken, using a mechanical pump, from the tractor oil-sump in the field and shipped the same day to

the laboratory of INA Maziva Rijeka. The oil sample analysis was performed and commented by INA-industrija nafte d.d. Lubricants Wholesale Dept., Commercial-Technical Service Rijeka. The analyses of the used oil properties were performed using methods ASTM D 445, 93, 664, 2896, 95, 893 and ICP-OES. The ploughed soil by its texture i.e. mechanical composition pertains to the group of the so called medium heavy soils, quite dry during tillage (Table 1.)

Table 1: Mechanical composition and momentaneous soil water content

Sample n°	Water content (%)	Sand 0,0 5- 2 %	Silt 0,002 - 0,05 %	Clay <0,002 %	Texture Mark
1	15-16	1,9	72,0	26,1	Silty-clay loam
2	17-18	1,9	71,5	26,6	Silty-clay loam
3	19	2,5	71,4	26,1	Silty-clay loam

In that period, the tractor went through the total of 304 working hours, i.e. 12.6 h/day in average. The effect of the aggregate within this period was around 260 ha, i.e. cca. 0.86 ha/h.

Testing Results

The analysis of oil samples taken after 56, 169, 286 and 304 tractor operating hrs is shown in Table 2.

Table 2: Change of qualitative and quantitative properties of used oil

Property	Unit of Measure	After 56 hrs	After 169 hrs	After 286 hrs	After 304 hrs
Viscosity at 100°C	mm^2/s	13,34	13,04	13,10	12,89
Flash Point, PM	°C	135	198	180	196
Total base number,TBN	mg KOH/g	11,8	10,9	9,2	9,1
Water content	% v/v	<0,1	<0,1	<0,1	<0,1
n-pentane insoluble	% m/m	0,10	0,30	0,04	0,02
Metals: Ca	mg/kg	4260	4340	4540	4450
P	mg/kg	1140	1120	1170	1140
Zn	mg/kg	1280	1270	1340	1320
Fe	mg/kg	9	18	27	27
Cr	mg/kg	3	3	4	4
Mo	mg/kg	2	4	6	6
Sn	mg/kg	20	25	0	10
Pb	mg/kg	5	5	9	9
Cu	mg/kg	1	1	1	1
Na	mg/kg	23	24	26	27
Mg	mg/kg	94	99	104	98
B	mg/kg	57	43	33	21
Al	mg/kg	2	1	2	2
V	mg/kg	0	0	0	1
Si	mg/kg	4	4	4	5

The values of physical-chemical properties were within the expected limits, while the

comment on individual properties is as follows:

Kinematic viscosity – As expected, kinematic viscosity dropped after some 50 hrs of operation, going down to the value about 10 % lower than the initial one, after which it maintained its value, slightly dropped or increased, depending on the impact of insoluble substances (increase) or fuel penetration (drop). With regard to the initial value (14.5 mm^2/s) of fresh oil, the total viscosity drop was 11.1%. During the testing, kinematic viscosity was changing very little and remained within the initial grade throughout, which means that the oil maintained its lubricating properties well, without threat to the correct engine operation and condition.

Flash Point – Flash point values show that during the tests some fuel ended up in oil, reducing its flash point. After the first 56 hrs of operation, the flash point dropped considerably (25%), but after the warning and probable adjustment of the vehicle's technical condition the condition was improved, so that the flash point was not an issue in subsequent samples. A continuous minimal fuel penetration is the result of engine condition caused by its age, as well as of wear, leading to such a condition.

Total base number (TBN) – It is an important indicator of oil durability, considerably dependent on fuel quality and amount of oil in the system. Final values when the oil was released amounted to 68% of the initial value. In other words, the motor oil still had quite high TBN values i.e. high alkaline reserve at the end of its use, which means that it was protecting the engine well and could have remained in use.

N-pentane insoluble – Values of insoluble substances during tests were very low (0.10; 0.30; 0.04; 0.02 % m/m) with regard to the initial value (0 % m/m) of fresh oil. These results show that the engine has a very good combustion, that there was little engine wear i.e. that the engine cleanliness maintenance system (the filtering system) performed its role well, so that there was no impact on motor oil viscosity.

Water Content – Mostly not established or appeared only in traces during the tests.

Metal Content – Metals resulting from engine wear – Values of the content of metals resulting from the wear of individual engine parts were low and indicate minimal engine wear. Numerically the highest was the iron content, which is usual, and there was also some low tin (Sn) content from the bearings, but it was all far below the permissible limits of metal content by wear in motor oil.

Metals from additives – The volumes of individual metals were around those initial in motor oil and there was no pronounced wear of the additive oil complex.

Other metals – were appearing in very low volumes during tests. They indicate that there was no coolant leakage into motor oil, and also the silicon values were low, confirming the correct operation of the air filter.

Oil Consumption - Oil consumption constituted an important item, whose value is dependent on the quality of motor oil, structural engine properties, technical engine condition and exploitation terms. In order to be able to authoritatively comment on the real oil consumption and consumption trend in terms of operating hours, the oil level must be checked in regular intervals and make up for the missing oil by topping up. For comparison's sake, one should be familiar with the previous consumption,

and, of course, monitor both oil and its topping up in several cycles (throughout the year, under different exploitation conditions).

According to the data obtained from the user, the total of 3.7 liters of oil was topped up (before oil discharge), not including the part topped up because of the lack when taking samples, indicating an average consumption of 1.2 litres of oil per 100 operating hrs.

Conclusion

Although short-term, the present testing of the change of basic oil properties for heavy duty turbo diesel tractor engines enables the following conclusions:

- The tested engine oil of SHPD quality did not loose its basic lubricating properties. Physico chemical properties of the oil particularly TBN value remained within normal and expected limits in application, so that the oil could be safely used longer than achieved 304 engine operating hours.
- SHPD oil has during the tests performed shown also an extremely good engine cleansing ability.
- Oil consumption of 1.2 l/ 100 operating hrs amounts to 5% of total oil volume in the oil-sump, but it is dependent primarily on engine condition and operating regime, which is why it should be taken as an orientation value only.
- The final conclusion is that such tests should be continued, and even expanded, over a longer exploitation period.

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ključne riječi:	key words:
665.765.035 motorno ulje, svojstva u primjeni	engine oil application properties
631.3 : 061.5 traktor JOHN DEERE 8200	tractor JOHN DEERE 8200
621.892.097.2 motorno ulje SHPD za dizelove motore	SHPD super high performance motor oil for diesel engines
620.168.2 ispitivanje, primjensko eksploatacijsko (field conditions)	field application testing
631.512 "323/324" jesensko-zimsko oranje	autmn-winter ploughing

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Primljeno / Received:
26.11.2003.