

GREEN POWER
Feeds Your Engine



2nd VegOil

Demonstration of 2nd Generation Vegetable Oil Fuels in Advanced Engines

**Workpackage WP4
Engine Oil Development**

**Deliverable N° 4.4:
Conclusions from Engine Oil
Tier 3+DPF Evaluation
Publishable**

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1 Results from Engine Oil Tier 3 + DPF Evaluation

An ACEA E9 engine lubricant (ref: Deliverable 4.11a, Section 2) has been supplied to the relevant test facilities to enable them to conduct their field trial activities (ref: Deliverable 4.11a, Section 1). ACEA E9 engine lubricants are suitable for use in heavy duty vehicles fitted with DPF's according to the ACEA 2008 Engine Oil Sequences (ref: Deliverable 4.1, Appendix A).

Used engine lubricant samples have been supplied to Lubrizol by these test facilities.

Lubrizol has analysed these used engine lubricant samples using various industry standard used lubricant analysis techniques:

- Total Base Number (TBN by ASTM method D2896)
- Total Base Number (TBN by ASTM method D4739)
- Kinematic Viscosity (tested at 40°C and 100°C by ASTM method D7279)
- Total Acid Number (TAN by ASTM method D664)
- Wear metals and engine lubricant additive depletion, measured by Inductive Coupled Plasma (ICP)
- High Temperature High Shear viscosity (as measured by CEC Test method L-36-A-90)
- Percentage soot measured by Thermogravimetric Analysis (TGA)

The analytical data (ref: Table 1) from the used engine lubricant samples is detailed in Table 1.

Table 1 Summary of Analytical Data from used Lubricant Samples

	Fresh Lubricant Code	OS240946	OS240946	OS240946	OS240946	OS240946	
	Lubricant	ACEA E9	ACEA E9	ACEA E9	ACEA E9	ACEA E9	
	Date Lubricant Sample Received	Fresh Oil Sample	Aug-09	Oct-09	Mar-10	Mar-10	
	Tractor ID		613519	613519	613532	586574	
	Tractor Owner		JDWM	JDWM	JD Serial Washers	JDWM	
	Tractor Operating Hours			355	397	1814	
	Lubricant Operating Hours		246.3	259	250		
Test	Test Method						
TBN mg KOH/g	ASTM D2896		8.4	8.91	9.18	8.28	8.48
TBN-INFLECTION mg KOH/g	ASTM D4739	6.99	6.6	6.38	6.5	7	
VISCOSITY @40 cSt	ASTM D7279	114.4	103	106	109.4	106.6	
VISCOSITY @100 cSt	ASTM D7279	15.82	14.1	14.4	14.3	13.8	
TAN BUFFER mg KOH/g	ASTM D664	2.47	2.55	2.45	3.51	2.29	
Ca ppm	Inductive Coupled Plasma	2337	2449	2411	2292	2402	
Cu ppm		0	4	5	2	7	
Fe ppm		0	29	27	23	35	
Mg ppm		0	7	6	6	7	
Na ppm		0	0	4	0	13	
P ppm		1098	1024	1040	1168	1055	
Pb ppm		0	2	0	0	0	
S ppm		3693	3701	3501	3352	3876	
Si ppm		0	3	4	2	18	
Zn ppm		1198	1186	1194	1167	1169	
HTHSR cP		CEC L-36-A-90	4.43	4.2	4.25	4.2	
CARBON %wt		Thermogravimetric Analysis	0	0.511	0.476	0.21	0.174

Review of the used lubricant samples shows

- Total Base Number (TBN by ASTM method D2896) and Total Base Number (TBN by ASTM method D4739)
 - Very little reduction in TBN is noted (<10%). This is considered to be a very small reduction in TBN. This highlights that the engine lubricant is effectively neutralising the acidic components caused by the combustion process.
- Kinematic Viscosity (tested at 40°C and 100°C by ASTM method D7279)
 - All used lubricant samples fall within the stay in grade specification for the ACEA E9 2008 specification (note: the stay in grade specifications for SAE 40 viscosity grade lubricants is between 12.5 to <16.3 mm²/s according to SAE J300). The slight reduction in kinematic viscosity measured at 100°C for all the used engine lubricant samples is considered to be normal as has been caused by the shearing of the viscosity modifier used in the engine lubricant.
- Total Acid Number (TAN by ASTM method D664)
 - Very little increase in TAN has been noted. This is combination with the small reduction in TBN confirms that the engine lubricant is effectively neutralising the acidic components caused by the combustion process.

- Wear metals and engine lubricant additive depletion, measured by Inductive Coupled Plasma (ICP)
 - The measured wear metals, copper (Cu), iron (Fe) and lead (Pb) are considered very low. This highlights that the engine lubricant is providing effective protection from wear.
 - The measured additive metals, calcium (Ca), phosphorus (P), sulphur (S) and zinc (Zn) highlight no change compared to the fresh oil.
- High Temperature High Shear viscosity (as measured by CEC Test method L-36-A-90)
 - Very little change in dynamic viscosity is noted between the fresh and used lubricant samples.
- Percentage soot measured by Thermogravimetric Analysis (TGA)
 - The soot levels in all the used lubricant samples are very low. This highlights that the combustion process is not producing a high level of soot species. The level of soot present in the engine lubricant are not expected to cause any problems in terms of soot handling capability of the engine lubricant.

2 Conclusions from Engine Oil Tier 3 + DPF Evaluation

The analysis of the used lubricant samples highlighted in Section 1 confirms that the engine lubricant has not significantly changed compared to the fresh engine lubricant.

The ACEA E9 lubricant (OS240946) used in the evaluation of the Tier 3 + DPF fitted tractors is therefore considered suitable for this application (up to a drain oil interval of 250 hours). An assessment of engine lubricant performance beyond 250 hours in DPF fitted tractors is recommended.

Appendix A

List of Acronyms

ACEA – European Automobile Manufacturers Association

E9 – An engine lubricant which meets the ACEA E9 engine lubricant specification

DPF – Diesel Particulate Filter