Fuel Economy Low Viscosity Engine Oil Compatible with Low Speed Pre-ignition Performance

Sinopec Lubricant Co., Ltd

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Outline

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1. Previous Research on EOs Effect Factors of LSPI & FE
2. Research Results Introduction
3. Summary & Discussion

Previous Research on EOs Effect Factors of LSPI & FE

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Effect Factors of LSPI

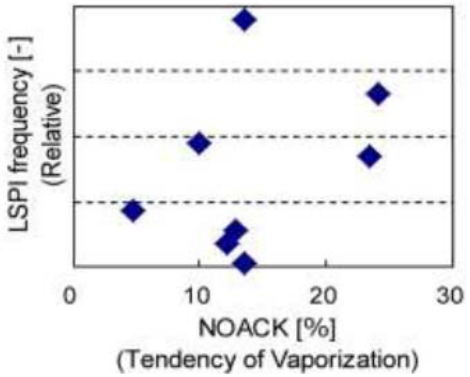

Fig.1 Correlation between Engine Oil Volatility and LSPI Frequency

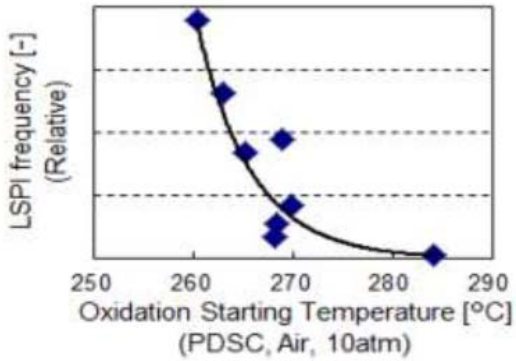

Fig.2 Correlation between PDSC Oxidation Starting Temperature and LSPI Frequency

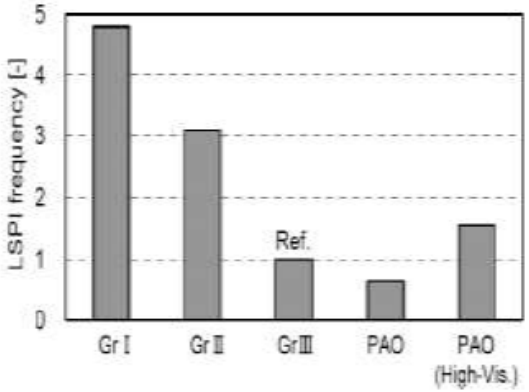

Fig.3 Correlation between Base Oil type and LSPI Frequency

- Non-effective volatility of oil
- Engine oil oxidation resistance has a good correlation with LSPI
- The higher the quality of the base oil, the lower the incidence of LSPI

Source: Kosuke Fujimoto, Engine Oil Development for Preventing Pre-Ignition in Turbocharged Gasoline Engine
Kazuo Takeuchi, Investigation of Engine Oil Effect on Abnormal Combustion in Turbocharged Direct Injection - Spark Ignition Engines

Previous Research on EOs Effect Factors of LSPI & FE

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Effect Factors of LSPI

Reduce Ca content (including Ca detergent)

• High temperature cleaning performance is damaged, need to replace the detergent

• 1400ppm is generally considered a cut-off point

Increase the content of P (ZDDP)

• Consider the protection of tail gas post-treatment devices

Increase Mo content (Mo FM containing)

• Overall balance of formula

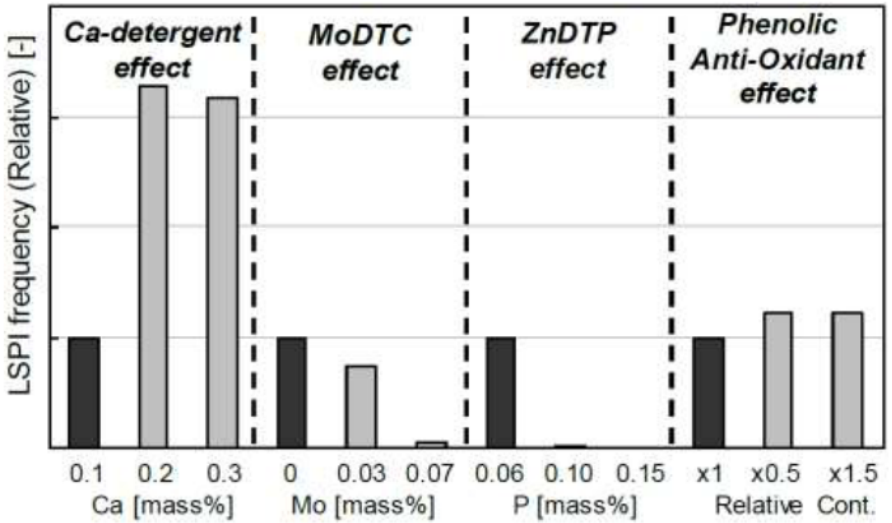

Fig.4 Effects of Engine Oil Additives on LSPI Frequency

Source: Kosuke Fujimoto, Engine Oil Development for Preventing Pre-Ignition in Turbocharged Gasoline Engine

Previous Research on EOs Effect Factors of LSPI & FE

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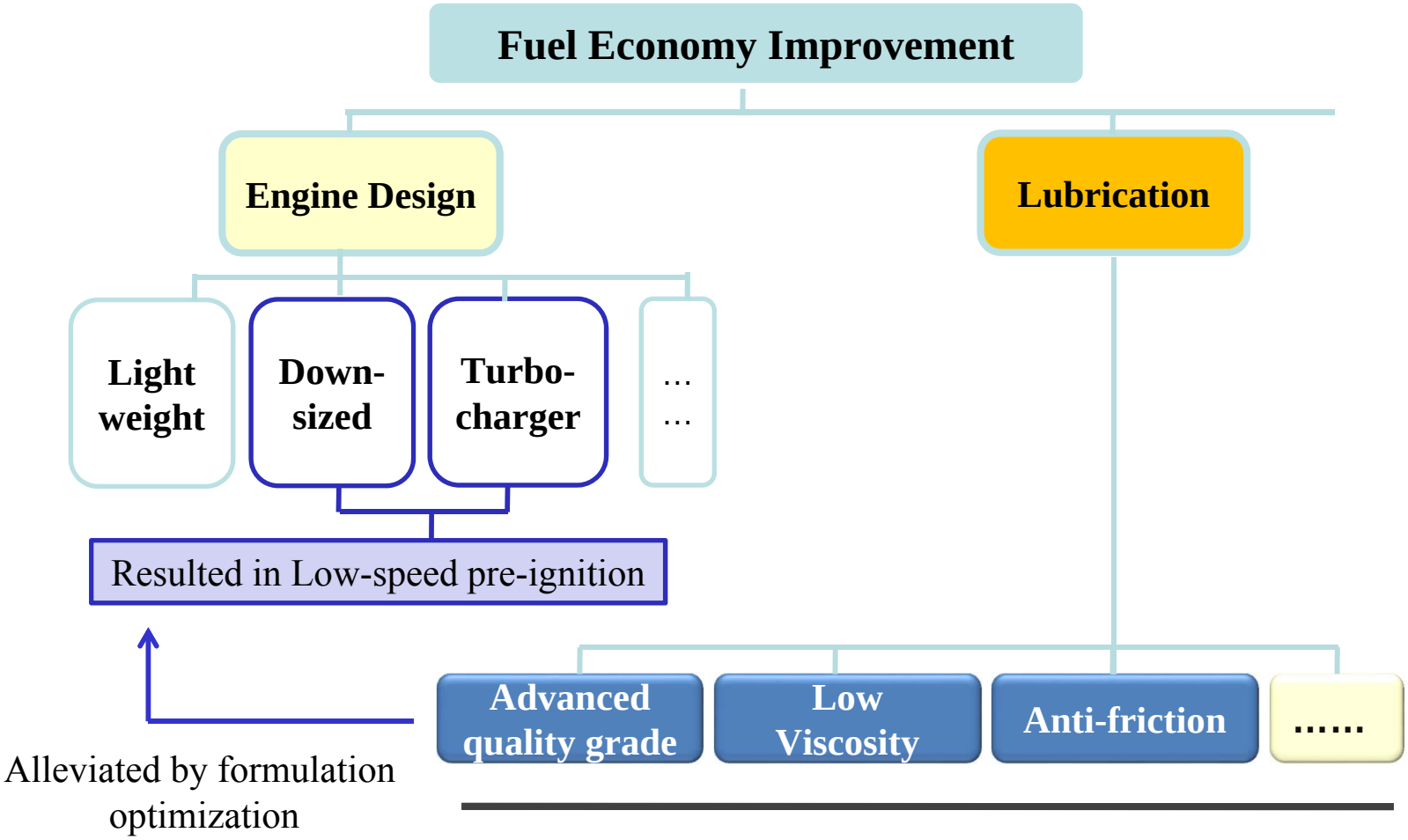

Fig. 5 Fuel Economy Improvement

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Tab. 1 Evaluated engine oil samples

Items	Formula system1		Formula system2	
	0W-16	0W-20	0W-16	0W-20
Ca / Wt.%	0.19			
Mo/ ppm	＜10			
VM	VM1		VM2	
Additive package and PPD	Same			
Base Oil	Same (Group III)			
Additional additive component / Wt.%	Without		Component with good oxidation stability: 0.3%	

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LSPI Engine Test Results

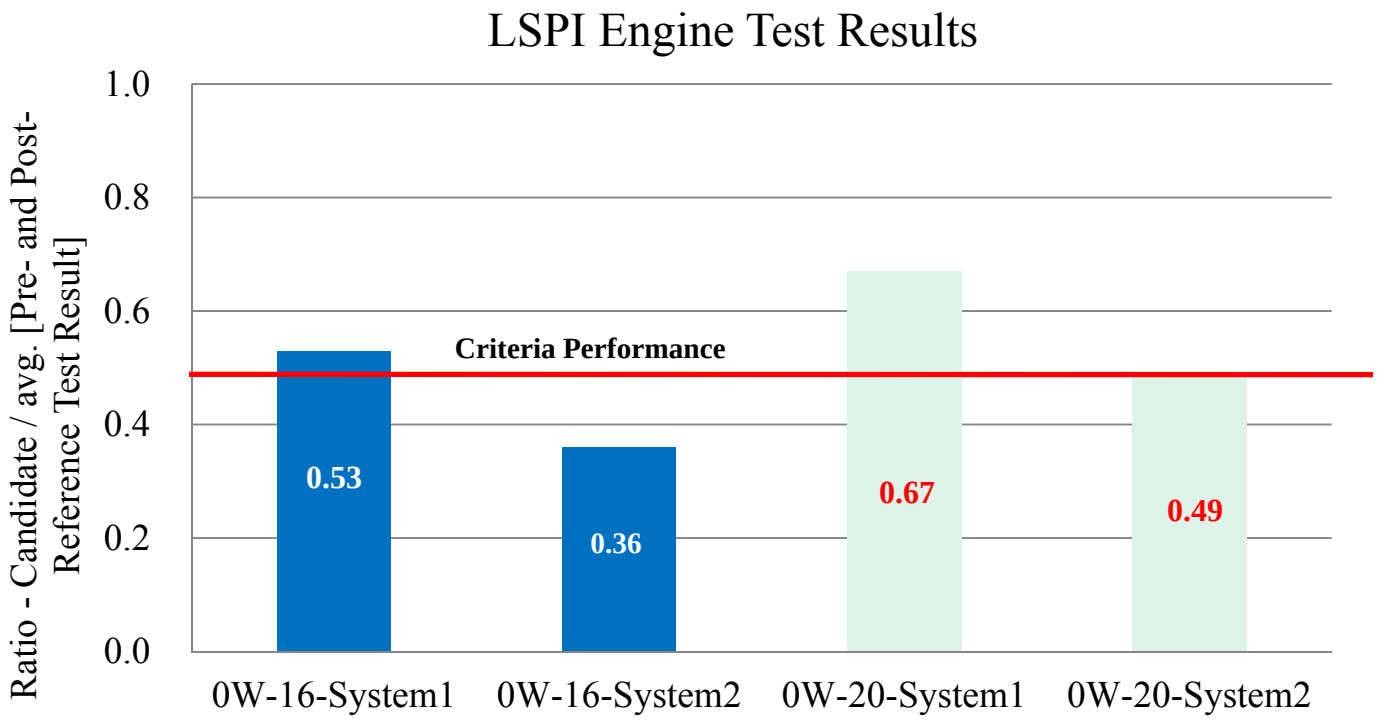

Fig. 6 LSPI Engine Test Results

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WLTP Cycle

- Use the same set-up, test procedure and reference oil as those for OEM certified FE test.

E220

-2.0T Diesel Engine

Engine Model: OM 654 DE 20 LA

-Car Model: E220d W213

-Reference oil: RL007

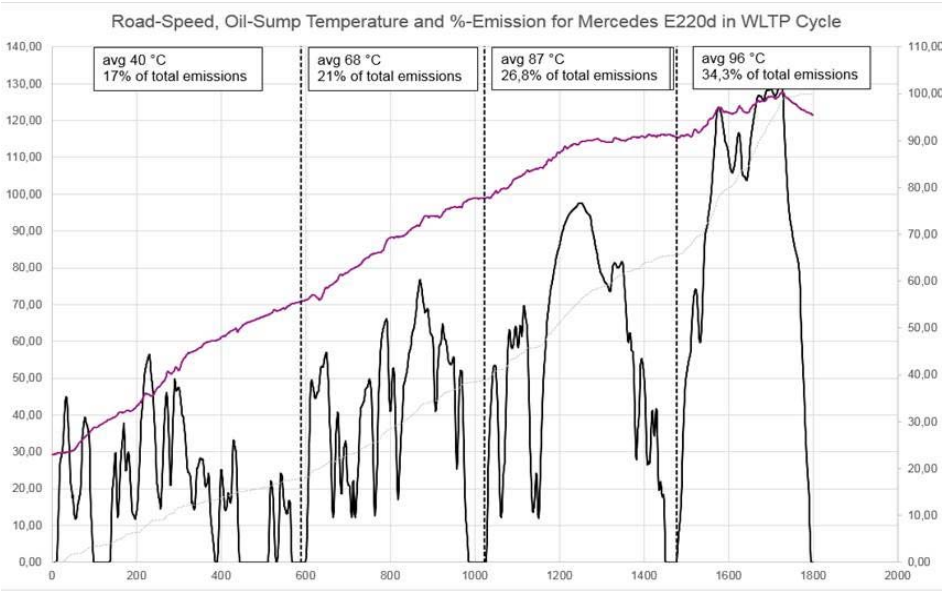

Fig. 7 The typical test profile

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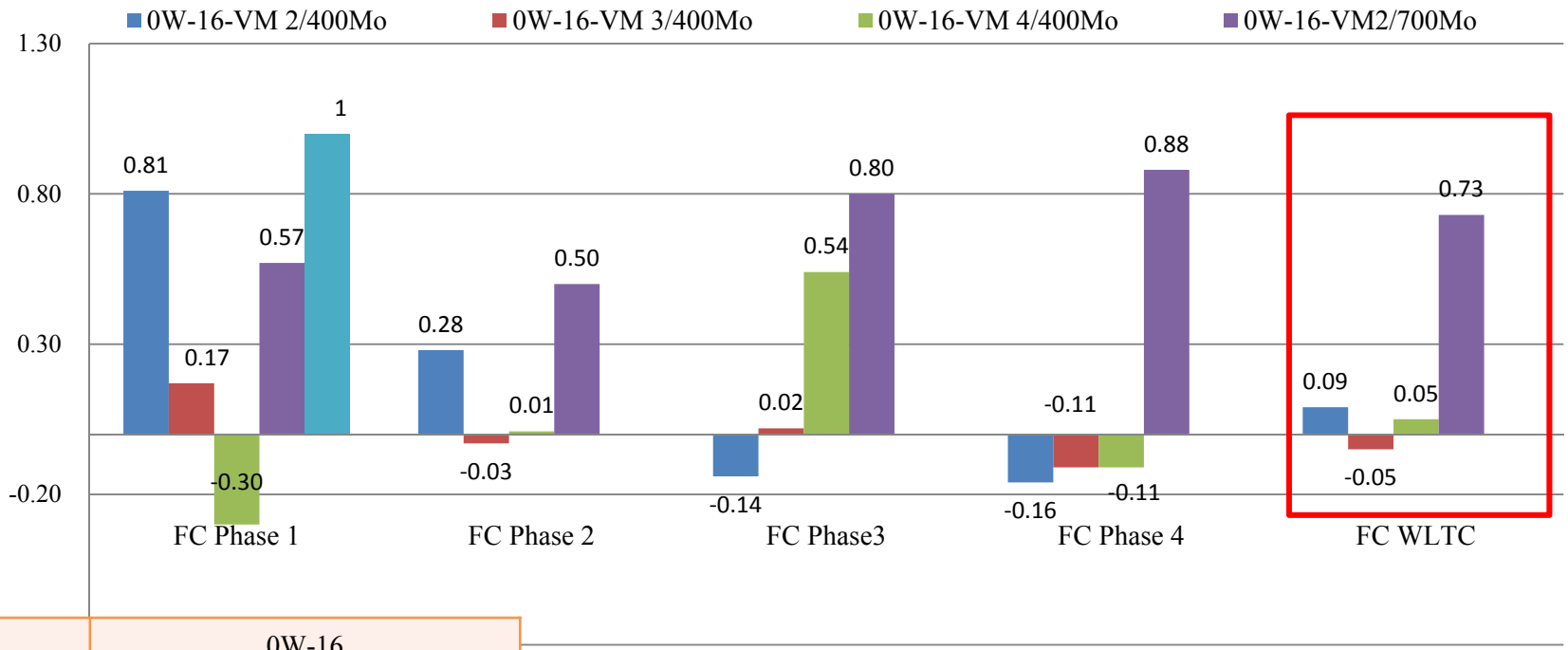
FE measurements



Items	0W-16			
Ca / Wt.%	0.19			
Mo/ ppm	400			700
VM	VM2	VM3	VM4	VM2
Additive package and PPD	Same with table 1			
Base Oil	Same (Group III)			

Fig. 8 Fuel Economy

The test result of Sinopec & EVONIK joint development

Research Results Introduction

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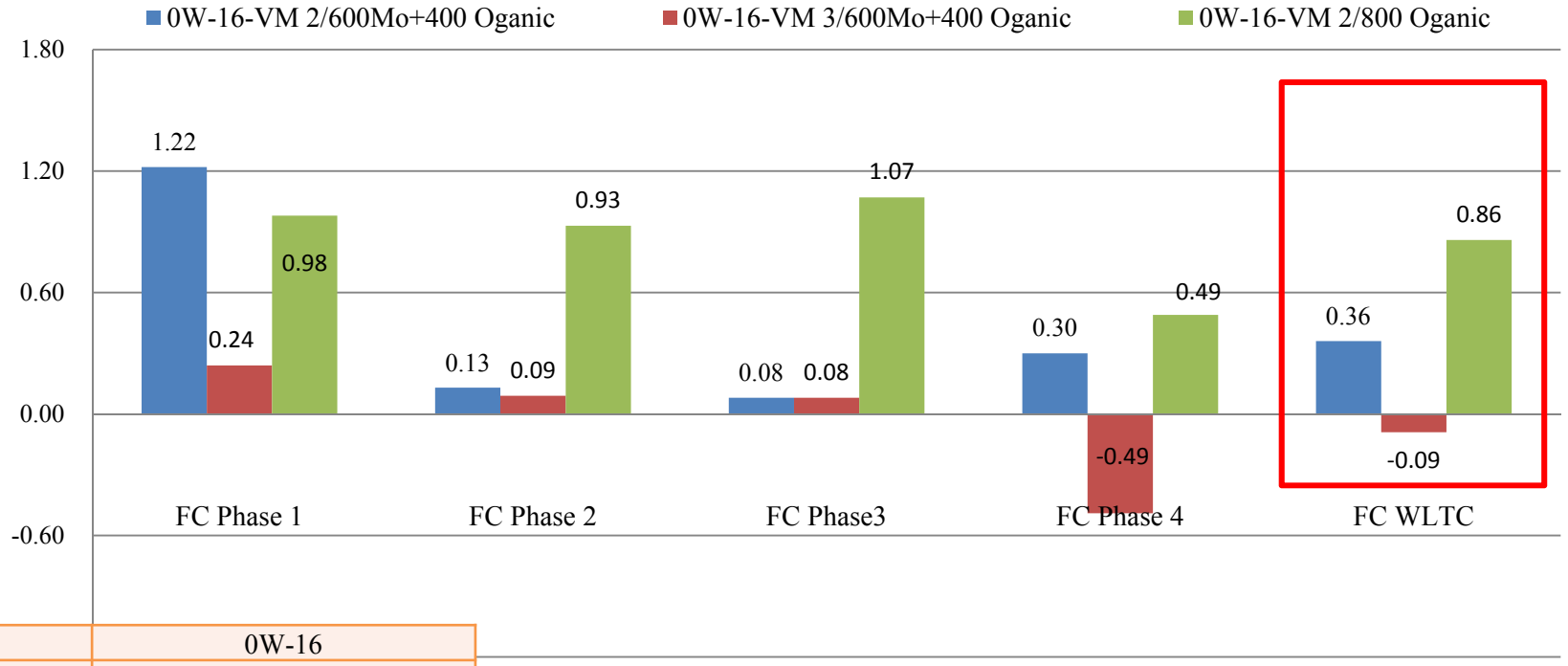
FE measurements



Items	0W-16		
Ca / Wt.%	0.19		
Mo / ppm	600	600	0
Organic FM/ ppm	400	400	800
VM	VM2	VM3	VM2
Additive package and PPD	Same with table 1		
Base Oil	Same (Group III)		

Fig. 9 Fuel Economy

The test result of Sinopec & EVONIK joint development

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WLTP Cycle

E220

-2.0T Diesel Engine

Engine Model: OM 654 DE 20 LA

-Car Model: E220d W213

-Reference oil: RL007

C400

-2.0T Gasoline Engine

Engine Model: M276

-Car Model: C400 4MATIC

-Reference oil: RL007

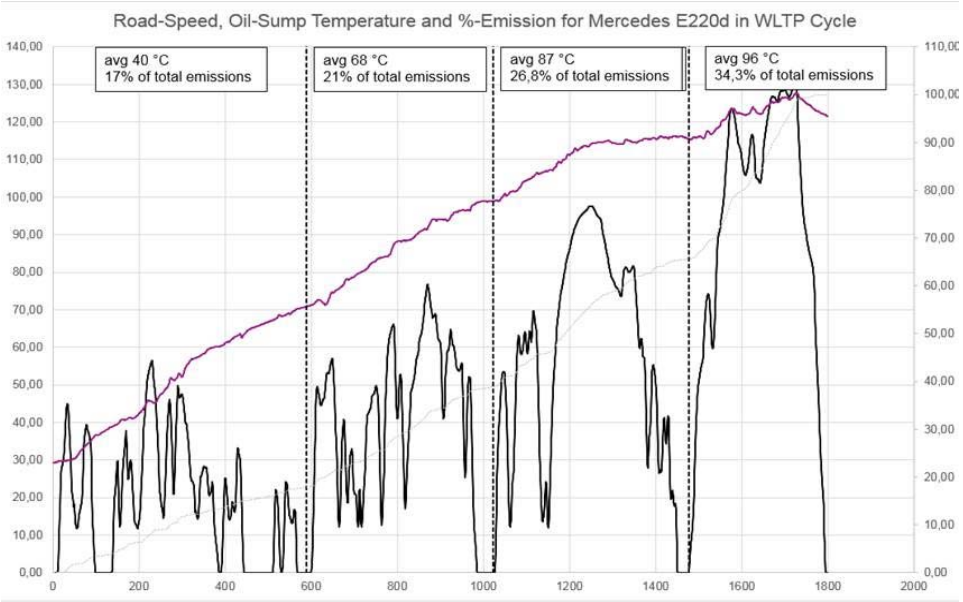

Fig. 10 The typical test profile

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Tab. 4 Evaluated engine oil samples

Items	0W-16		
Ca / Wt.%	0.19		
Mo / ppm	700	600	0
Organic FM/ ppm	0	400	800
VM	VM1	VM1	VM2
Additive package and PPD	Same with table 1		
Base Oil	Same (Group III)		

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FE measurements

Tab. 5 Test Results

Fuel Economy, /%	0W-16		
	Mo:700ppm	Mo 600ppm+ Organic FM: 400ppm	Organic FM: 800ppm
E220d FE(OM654)FEI VS. RL007	0.55	0.64	0.68
C400 FE(M276)FEI VS. RL007	/	0.67	0.89

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Mo Effects on Corrosion

Tab. 6 Corrosion Test Results

	Limit	0W-16	0W-16		0W-16	Test Method
		Mo	Mo	Organic	Organic	ASTM D6594
		0.7%	0.6%	0.4%	0.8%	
HTCBT Cu increase / ppm	≤20	39	21		7	

Summary & Discussion

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LSPI

- In our research , formulation with high content of Ca, no Mo and suitable oxidation could effectively restrain LSPI.
- Higher viscosity more likely to cause LSPI.

FE

- It seems that high content Mo has negative effect on corrosion but active effect on FE improvement.
- In the particular formulation , organic anti-friction performance excellent on FE.

The development of low viscosity engine oil compatible with low speed pre-ignition performance and Fuel Economy. And meet the requirement of OEM.

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Thanks for your attention

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