Optimizing Friction Torque Reduction with ultra-low viscosity oils

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Introduction

- Research and development activities on passenger car vehicles have been increasingly driven by ever-tougher emissions legislation and fuel economy targets
- Japanese OEMs have shown leadership in developing the engine hardware to take advantage of Ultra-Low Viscosity Oils at 0W-16 grade and lower
- A friction torque test (FTT) engine cell has been developed to identify and investigate the key lubricant formulation properties which achieve the greatest reductions in friction
- This study explores the influence of base oil type, base oil viscosity, different polymer technologies and alternative additive chemistries on friction reduction within ultra-low viscosity lubricant

Program Overview

Matrices 1-3

Candidate optimisation for FTT tests

Matrix 4

Further candidate optimisation for FTT tests

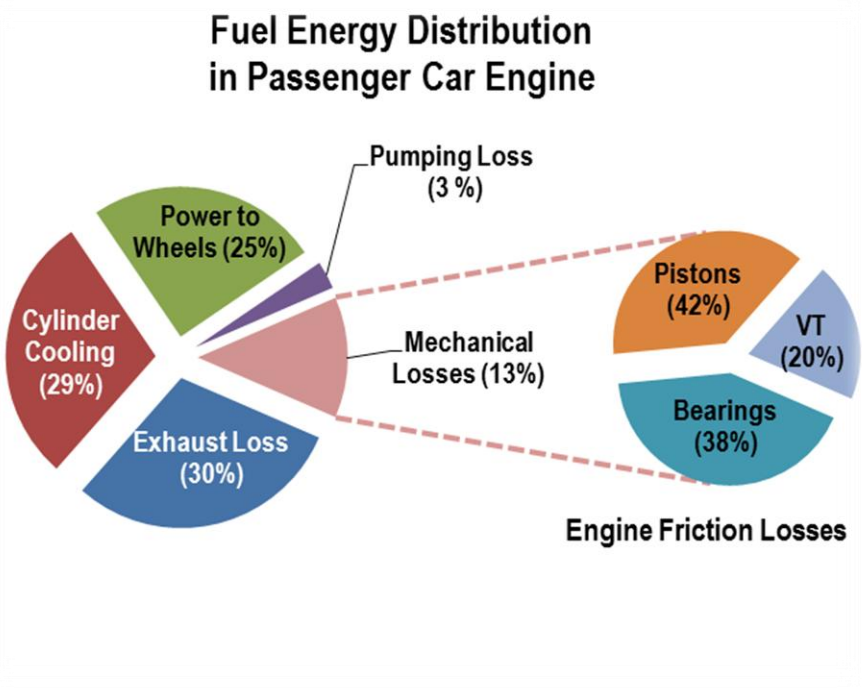
Inclusion of commercial (genuine) oils

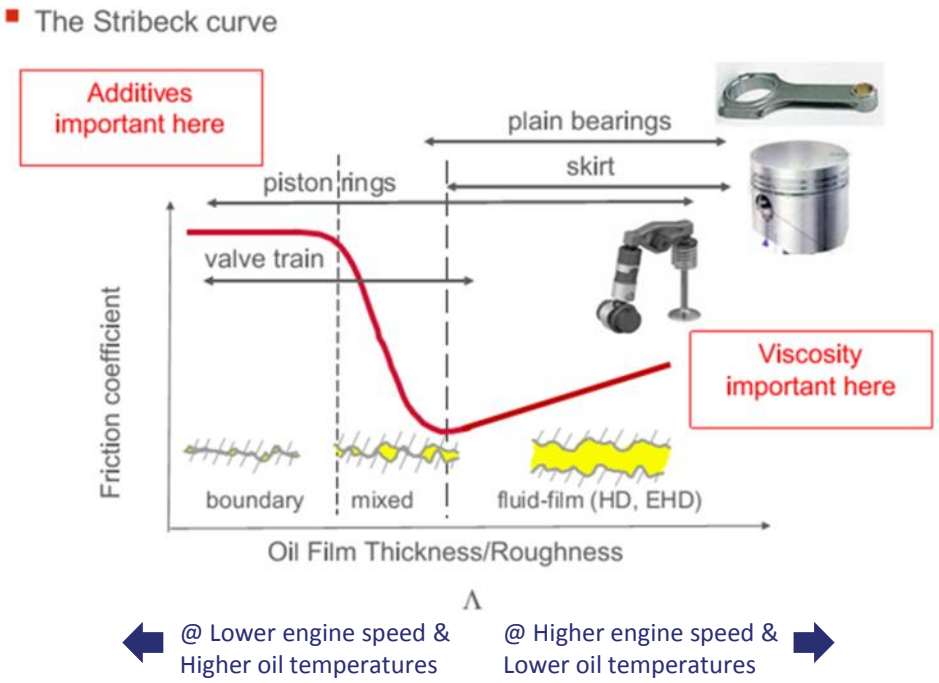
Matrix 5

Extension to JC-08 chassis dynamometer testing

- Today's presentation focuses on Matrix 4

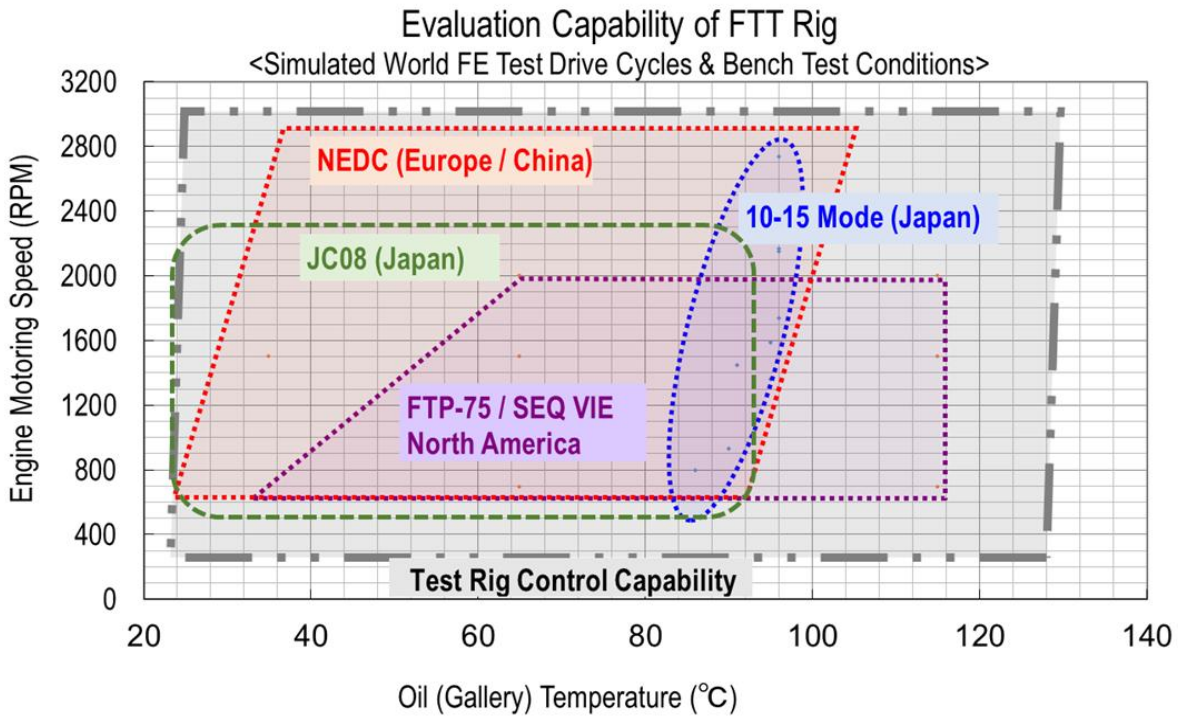
Friction and Lubrication Theory





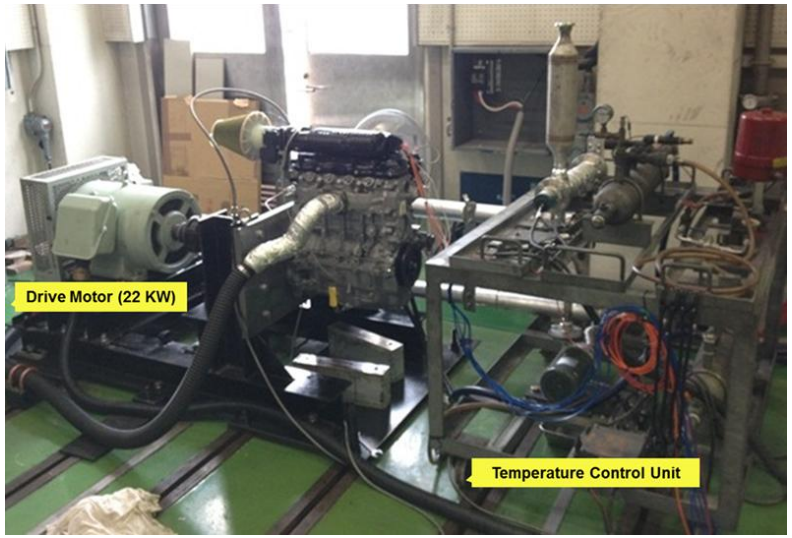
- 15% of energy derived from fuel is wasted as friction losses in the engine
- Piston rings, bearings and the valve train contribute to friction losses
- Discrete mechanical centres operate under different lubrication regimes

FTT Mapping



- Regional fuel economy drive cycles have different profiles
- Fired engine conditions - engine speed and temperature - can be mapped at different engine speeds and temperatures
- Friction torque can be measured according to the mapping

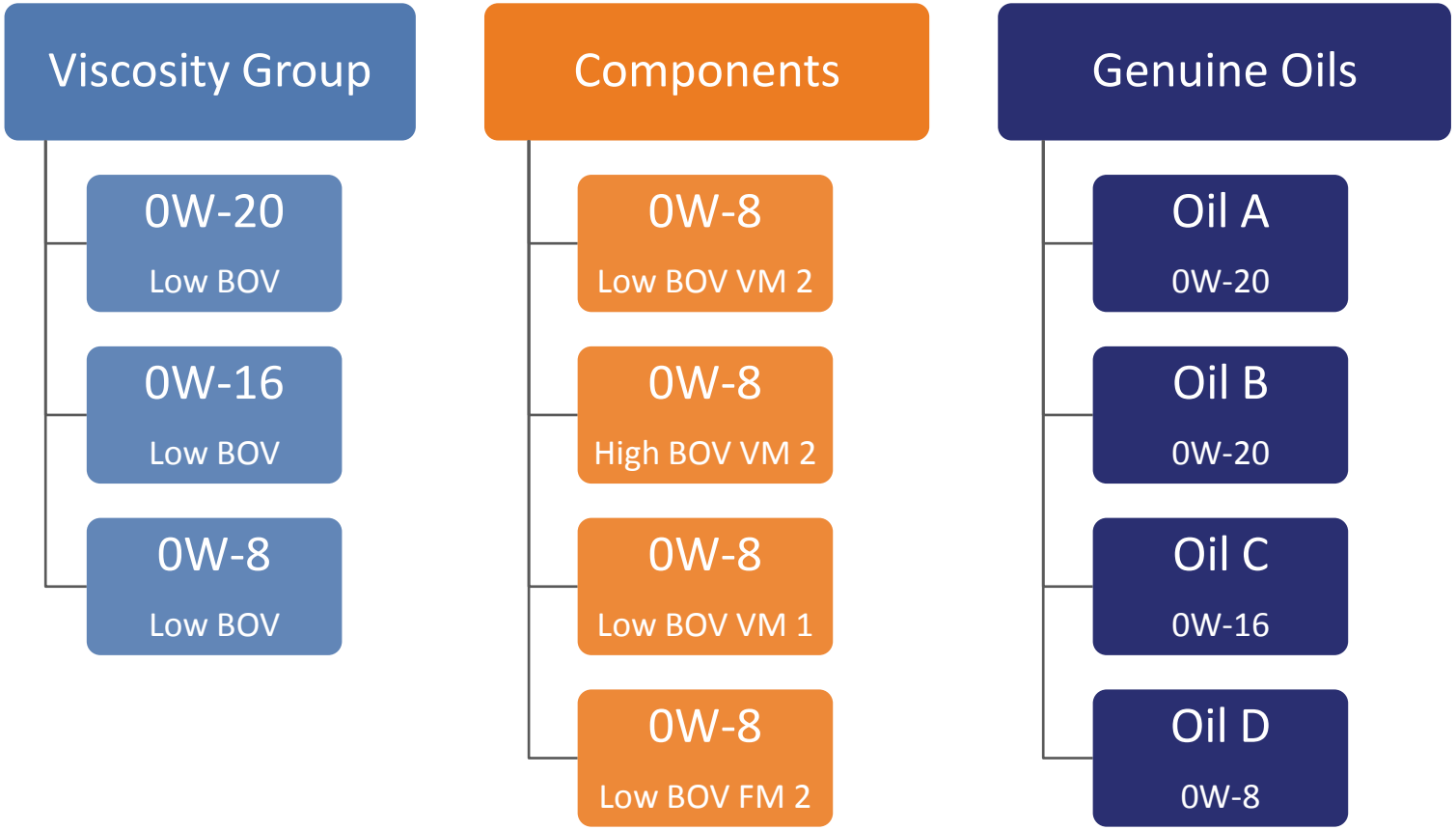
Motorized Friction Torque Test Bench



Oil (gallery) temperature	Steady-mode Friction Torque	
	650 rpm (idling)	1500 rpm (normal cruising)
30°C	•	•
80°C	•	•
90°C	•	•

- Baseline reference - a Japanese general market 5W-30 SN/GF-5 oil
- Test sequence - baseline oil followed by candidate oil

FTT Matrix Structure

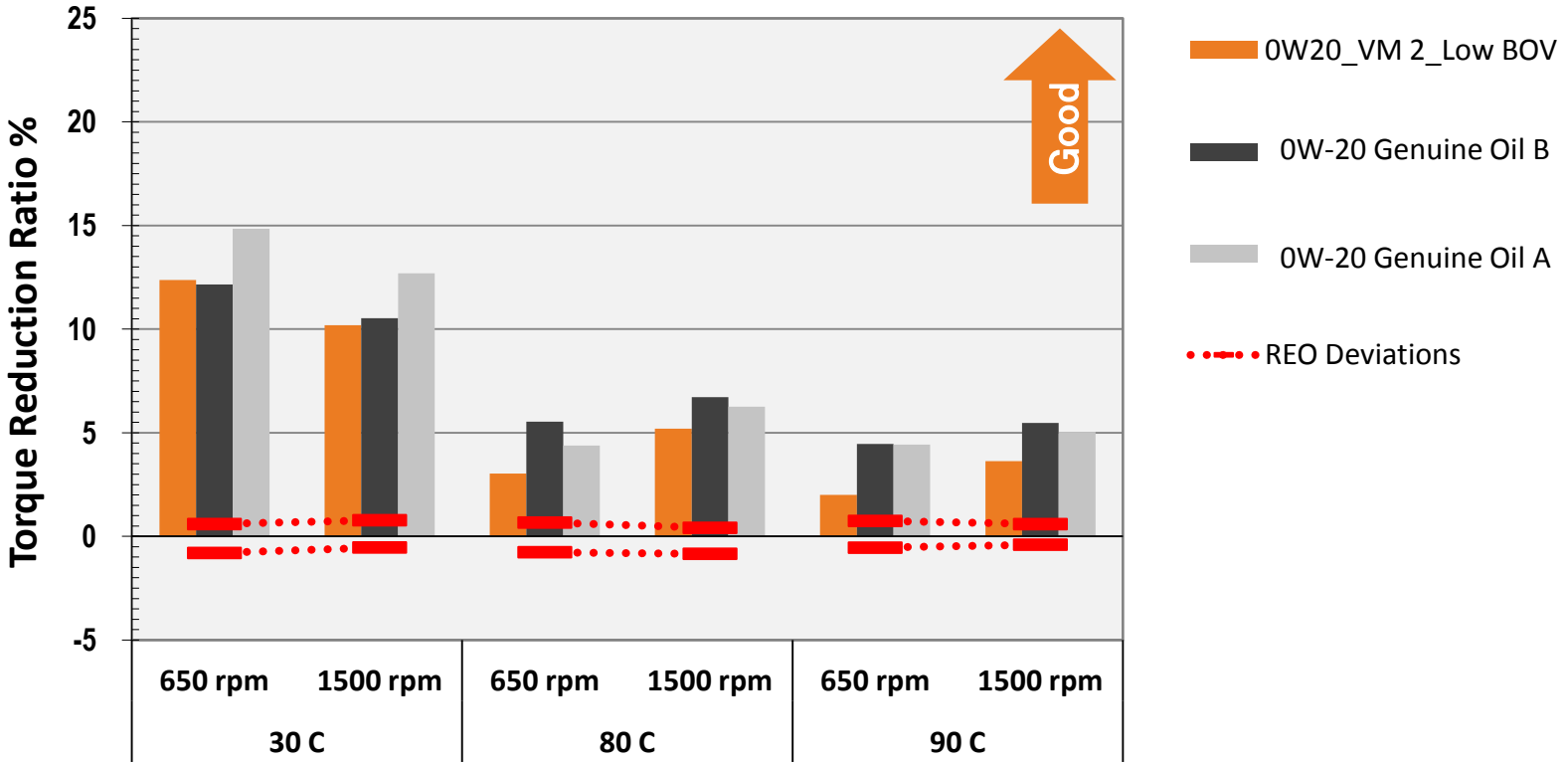


FM = Friction Modifier, VM = Viscosity Modifier, BOV = Base Oil Viscosity

FTT Test Oils

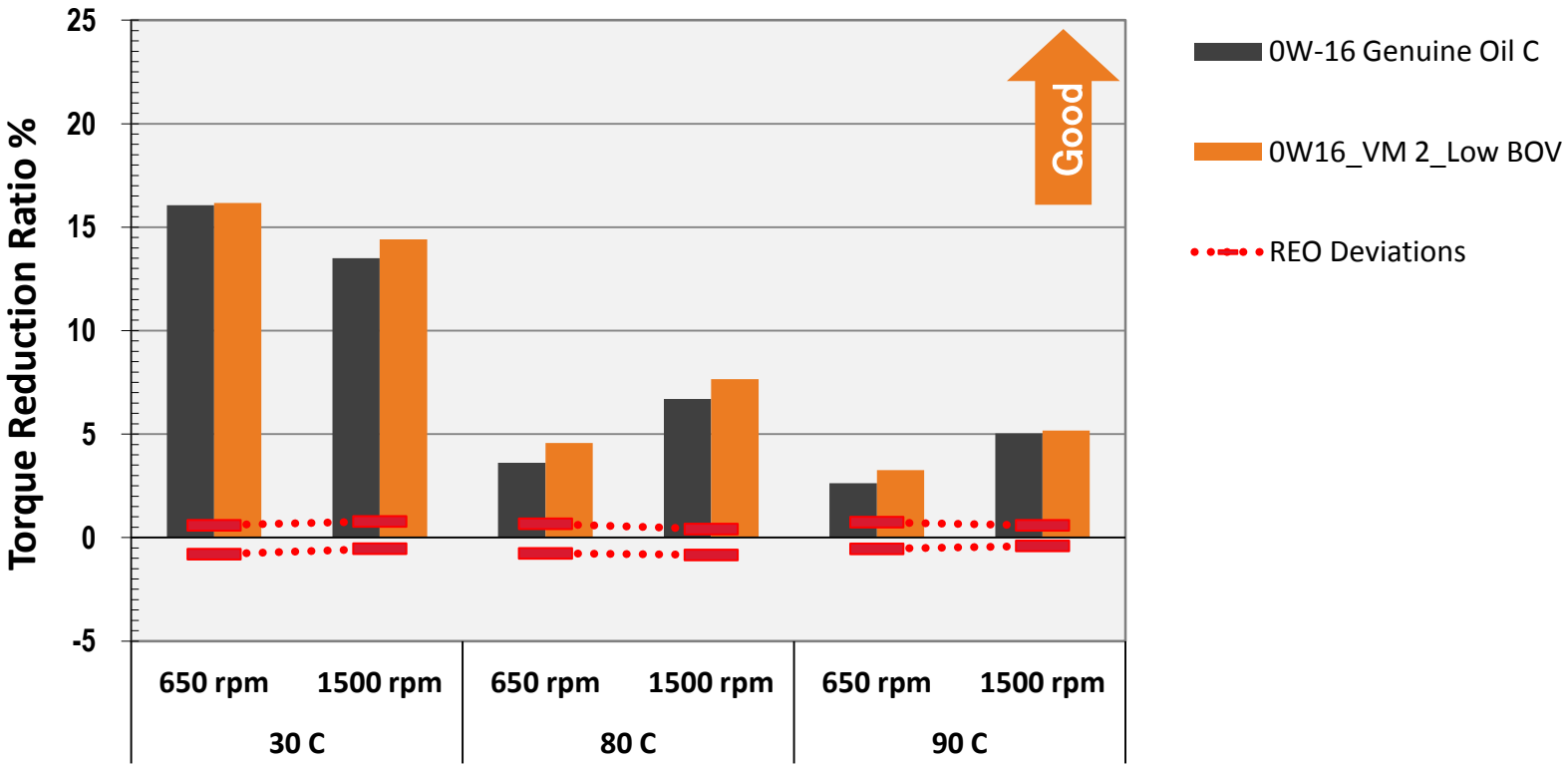
Viscosity Grade / Description	0W-20_VM 2_Low BOV	0W-16_VM 2_Low BOV	0W-8_VM 1_Low BOV	0W-8_VM 2_High BOV	0W-8_VM 2_Low BOV
KV @ 40° C,cSt	40.7	32.4	23.0	24.2	21.7
KV @ 100° C,cSt	9.0	7.7	5.3	5.4	5.6
VI	211	221	178	165	218
HTHS @ 150° C, cP	2.8	2.4	1.8	1.8	1.9
HTHS @ 100° C, cP	6.5	6.0	5.4	5.3	5.1
CCS @ -35° C, cP	3030	1970	1150	1870	1070
Viscosity Grade / Description	**0W-8_VM 2_Low BOV_FM2**	**0W-20 Genuine Oil A**	**0W-20 Genuine Oil B**	**0W-16 Genuine Oil C**	**0W-8 Genuine Oil D**
KV @ 40° C,cSt	21.5	30.9	33.8	30.5	17.0
KV @ 100° C,cSt	5.6	7.8	7.4	8.0	5.3
VI	221	239	195	251	290
HTHS @ 150° C, cP	1.7	2.6	2.5	2.7	1.9
HTHS @ 100° C, cP	5.1	5.9	6.0	5.8	5.0
CCS @ -35° C, cP	1059	3320	5890	3330	1180

FTT Matrix : 0W-20 Group (Steady State)



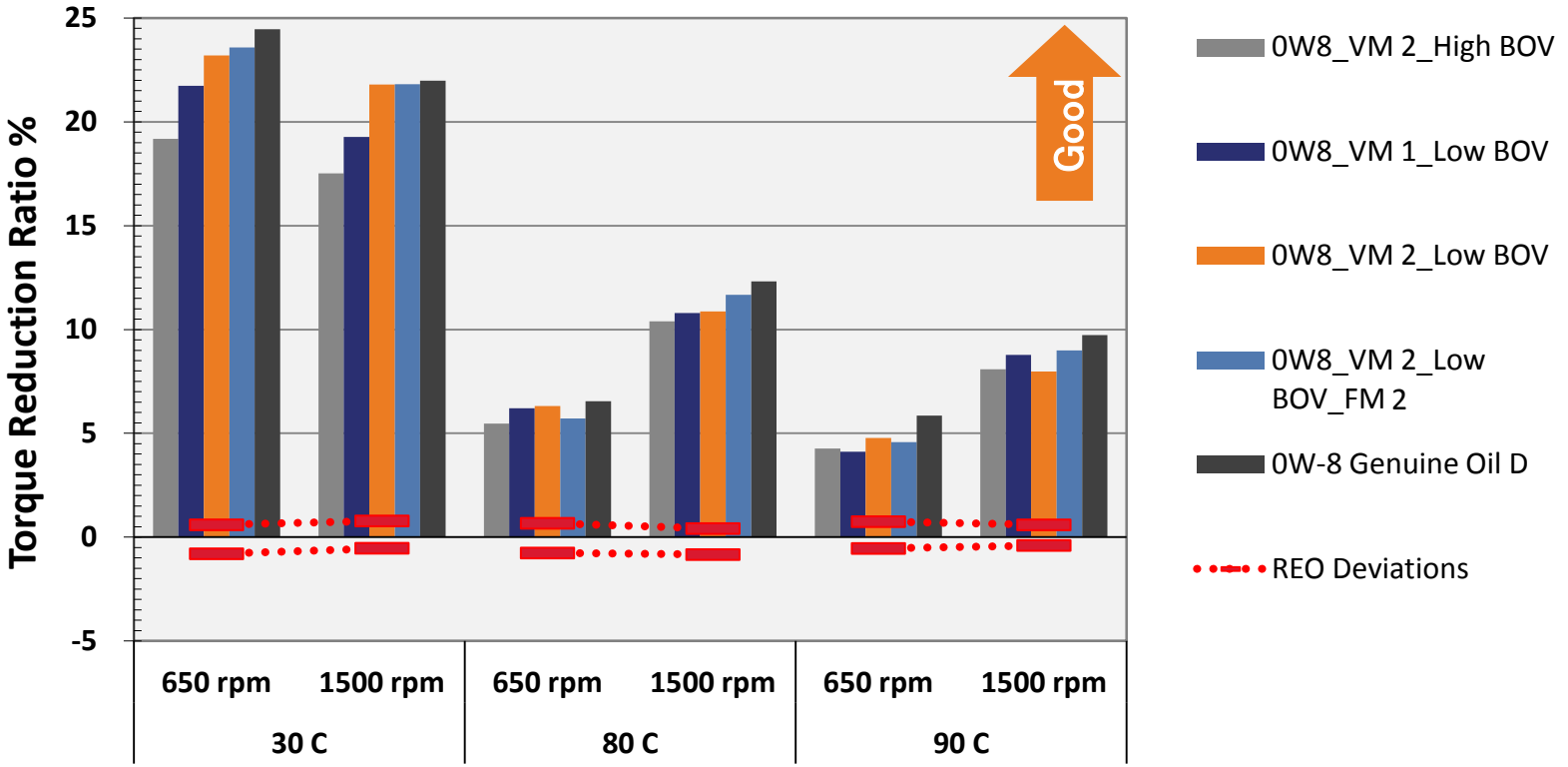
0W-20 Torque reduction baseline comparison

FTT Matrix : 0W-16 Group (Steady State)



0W-16 optimisation providing enhanced FTT performance

FTT Matrix : 0W-8 Group (Steady State)



Formulation optimisation, the key to delivering superior fuel economy.

Conclusions

- FTT technology, methodology and expertise are available for the differentiation of base oil and additive technology from a friction and fuel economy perspective
- Additive chemistry (FM and VM selection) have been shown to impact FTT results
- Base oil properties specifically viscometrics through base oil viscosity should be optimised to meet optimal friction torque test performance

Thank you for your attention.

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