



Using Lubricant Technology to Drive Down Particulate and CO₂ Emissions in Diesel Engines

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Summary

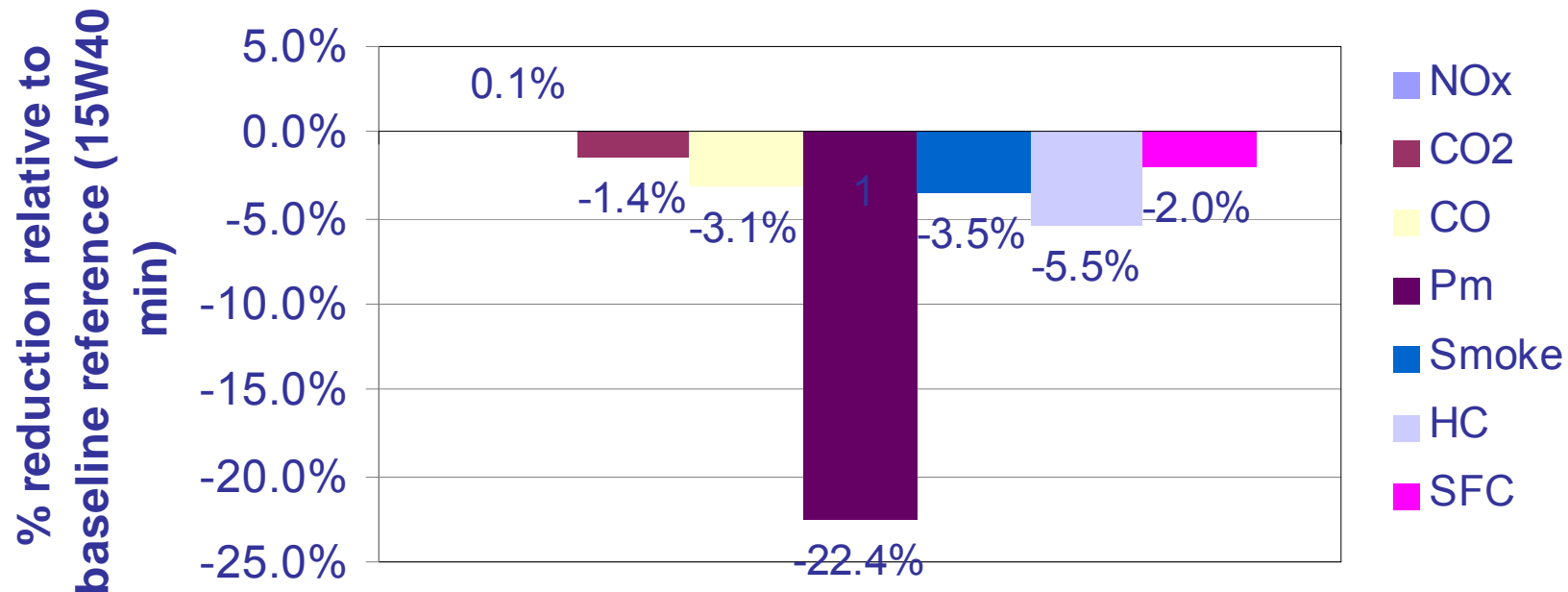


- Lubricant Effects on Engine Out Emissions
- Lubricant Effects on Post-trap Emissions
- Lubricant Effects on Fuel Economy in Modern HD Diesel Engines
- Lubricant Effects on Fuel Economy in Older Diesel Engines
- Conclusions

Impact of Synthetic Lubricant On HD Engine Emissions



Synthetic SAE 5W-30 HD Lubricant (programs 1 - 9)



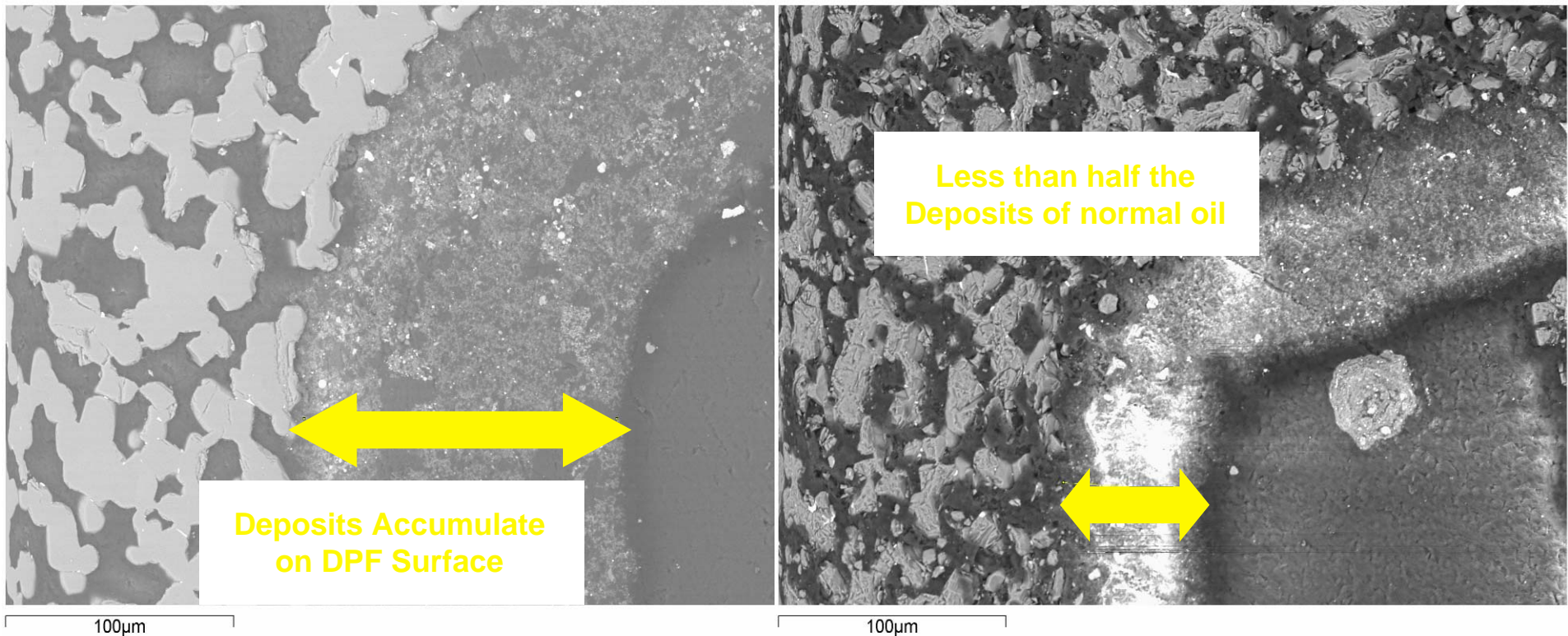
- Optimised synthetic lubricant showing real benefit in emissions reduction (7 different engine types)
- Results from HDD engines without exhaust after treatment

Accumulated deposits on DPF



Test with normal oil

Test with low ash oil

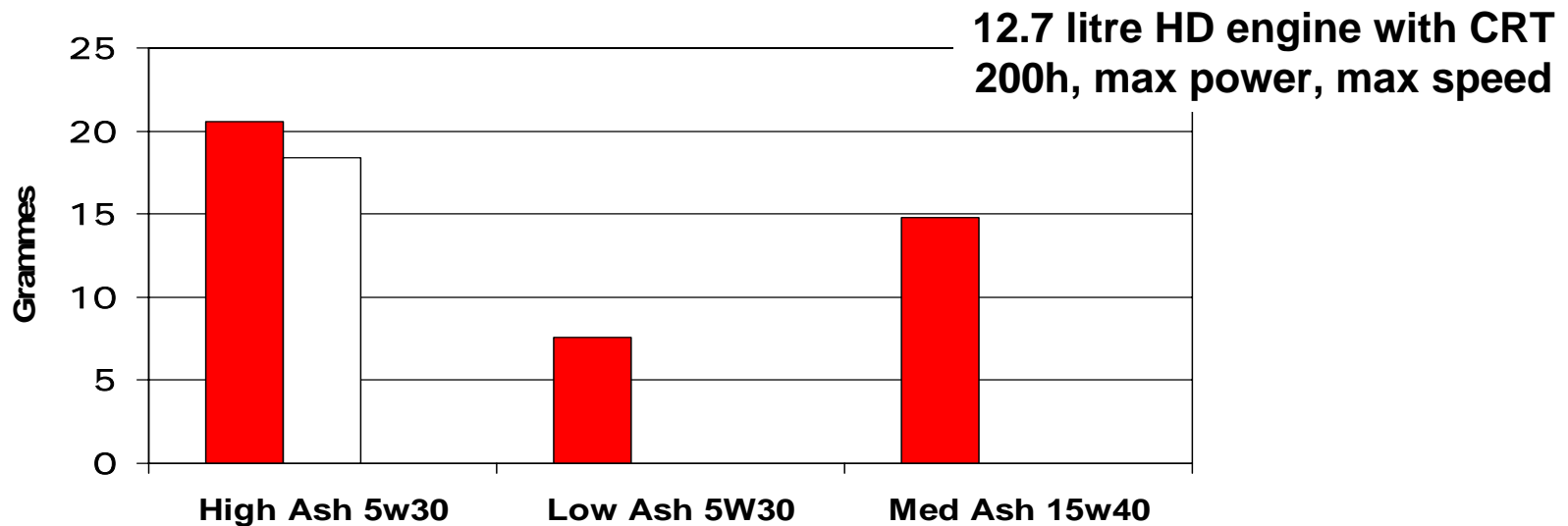


Deposits Photographed using Scanning Electron Microscopy

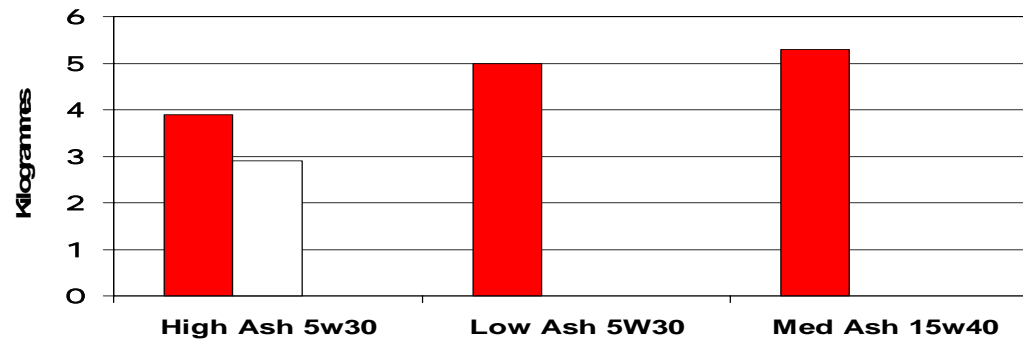
Ash accumulation in DPF



Ash Accum in 200 hours



Oil Consumed in 200 hours

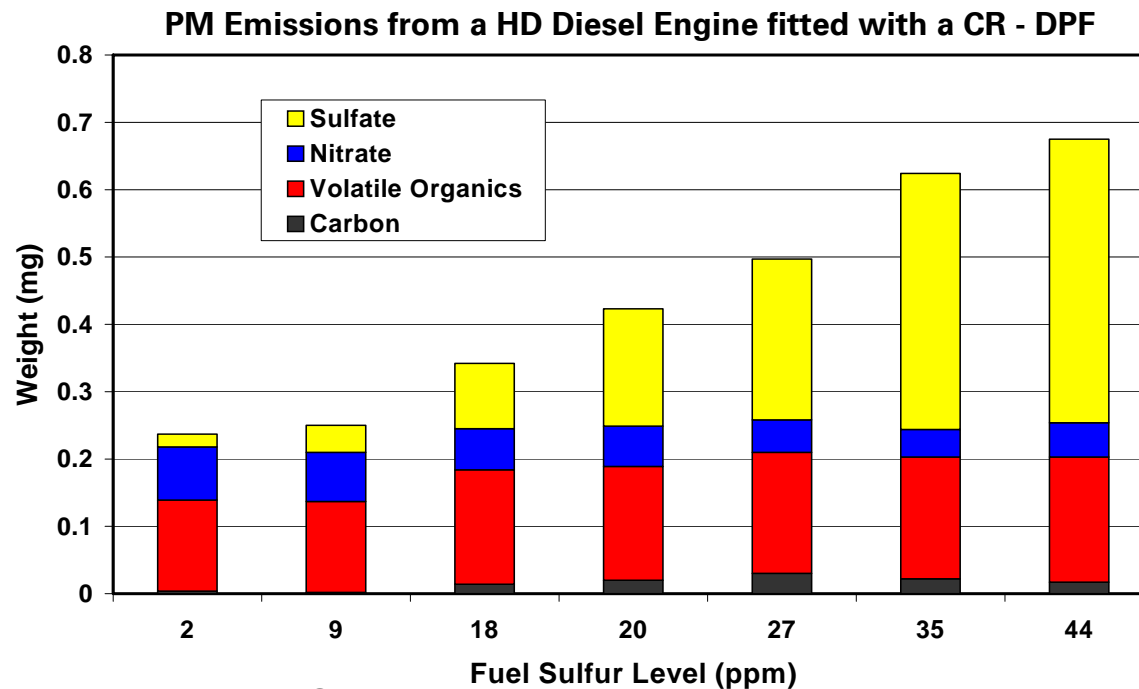


- Weight of trap deposits corresponds to sulphated ash level of the oil

Truck Chasing – Mobile Emissions Laboratory



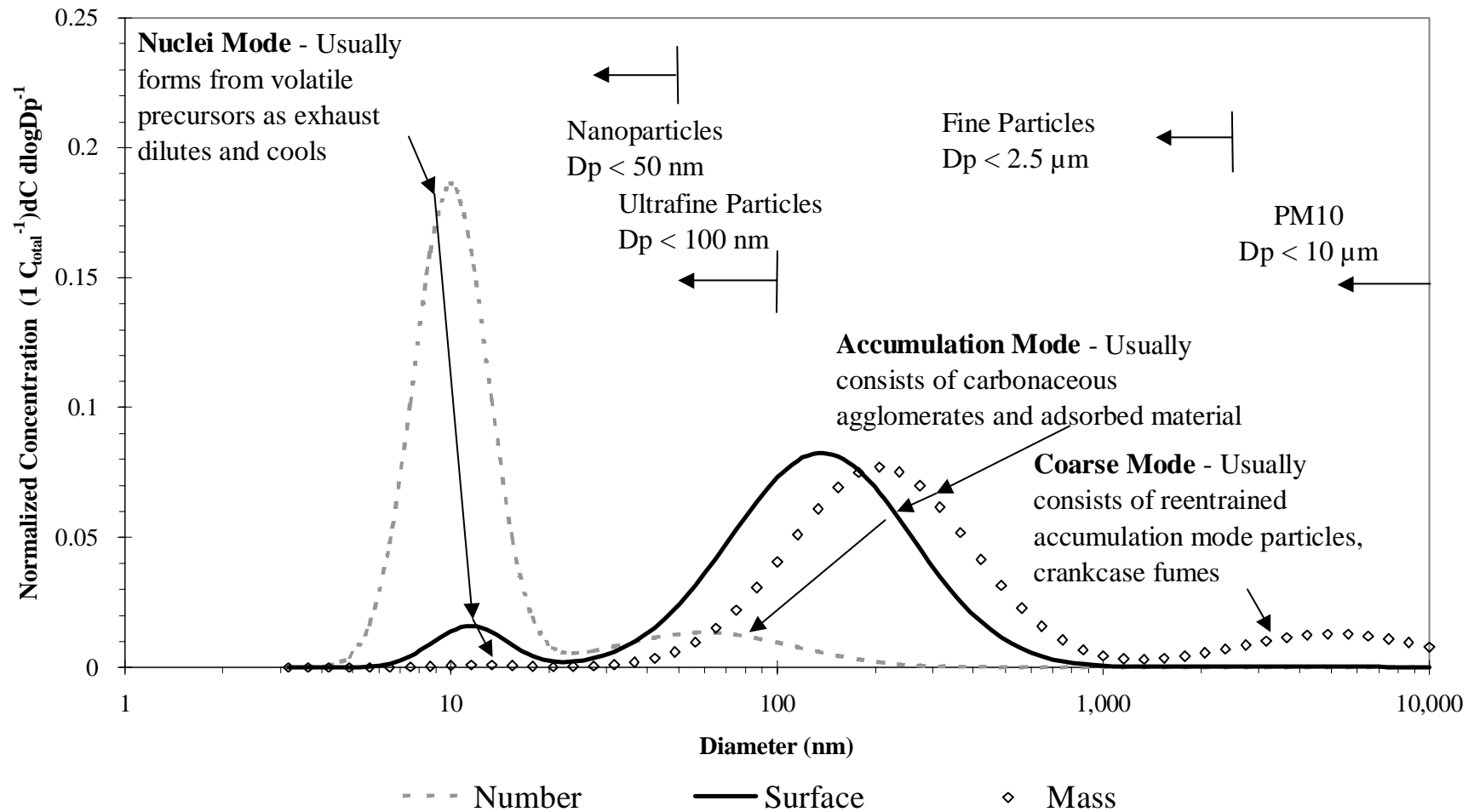
Truck Chasing



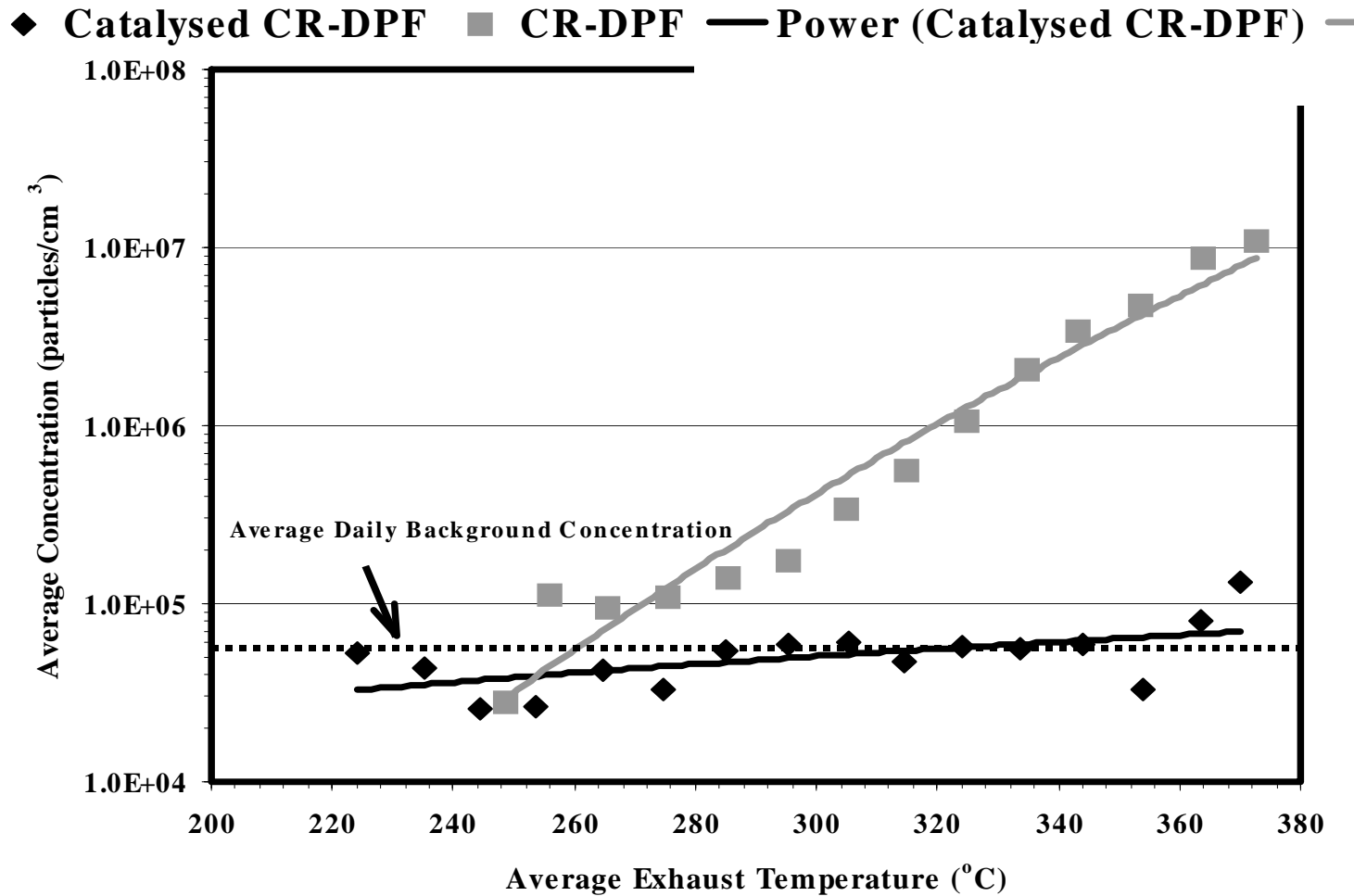
- Combined Programme
- Fuel
- Lubricant
- After-treatment system

CR-DPF = Continuously Regenerating Diesel Particulate Filter

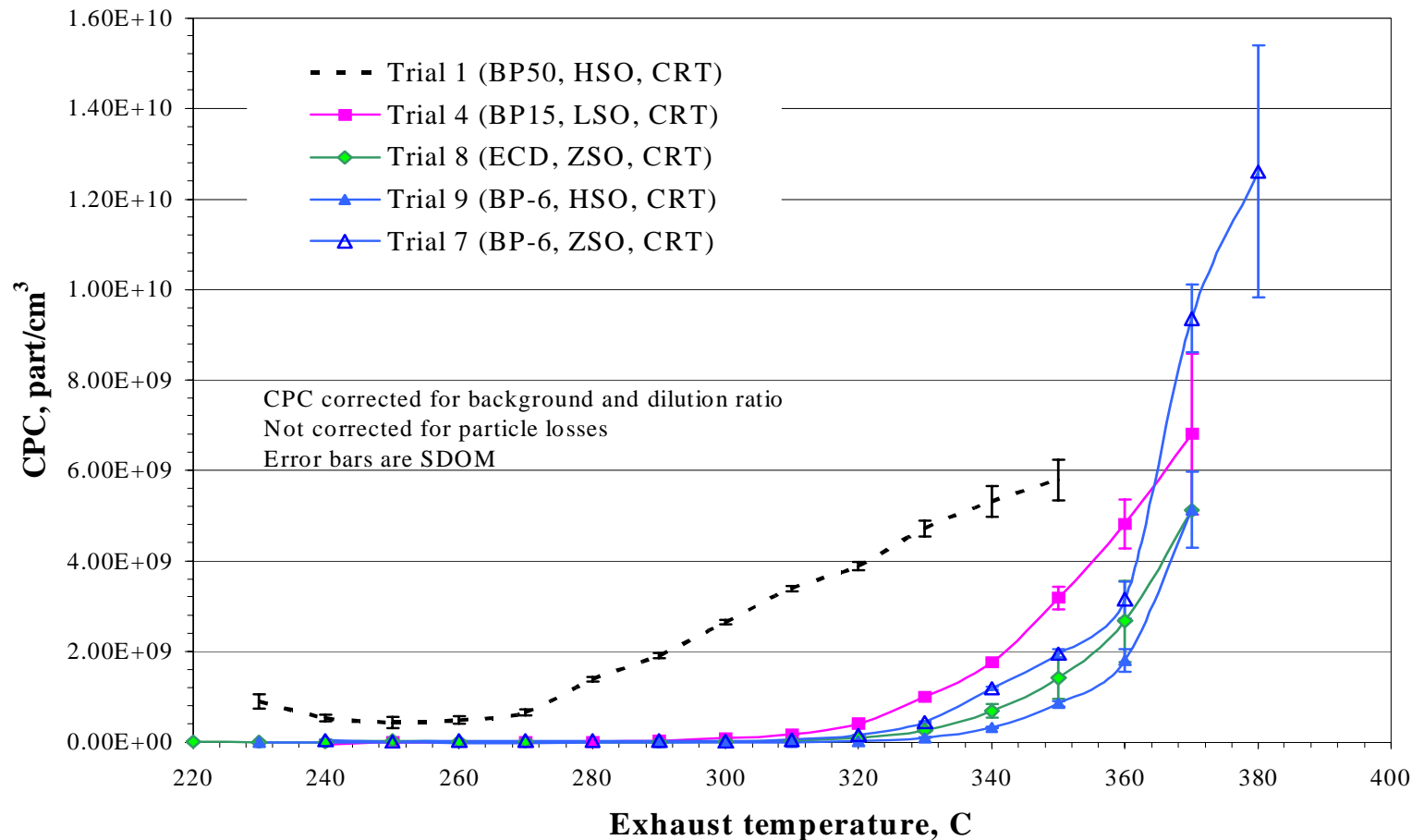
Schematic of Particulate Emissions



Relationship Between Particle Concentration And Exhaust Temperature – CR-DPF & Catalysed CR-DPF



Relationship Between Particle Concentration And Exhaust Temperature

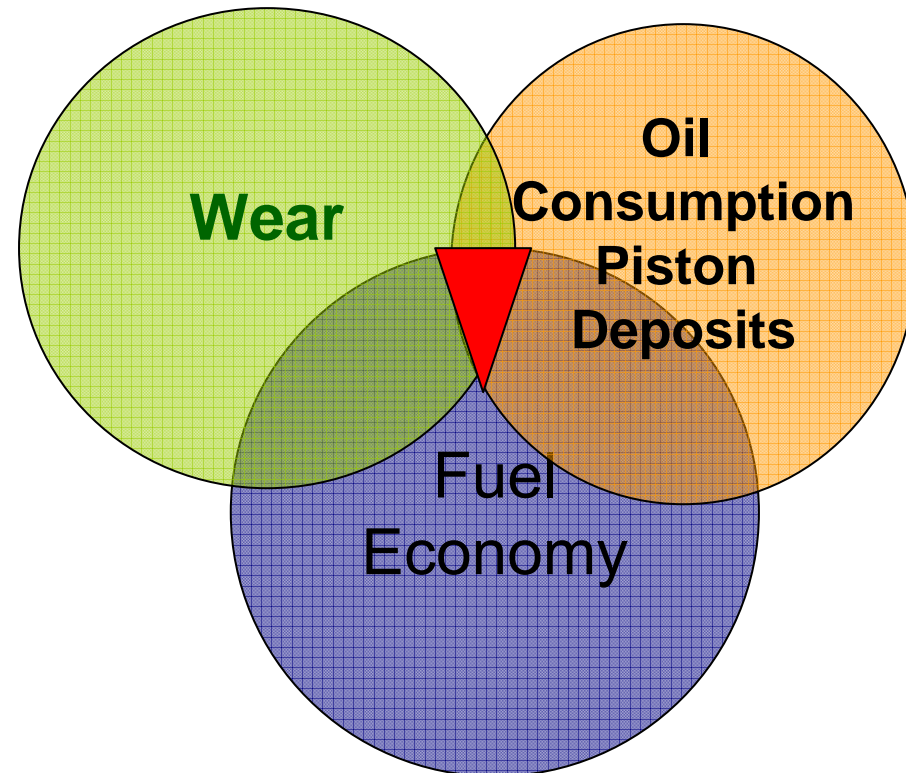


- The higher the exhaust temperature the greater the particle production.
- There is a relationship between fuel and lube oil S content.

Lubrication & Fuel Efficiency



- Reduced viscosity engine and transmission lubricants give better fuel efficiency
- They reduce frictional losses
- Reduced viscosity lubricants must be formulated to control engine wear, oil consumption and piston deposits
- Formulating window for low viscosity lubricant is small



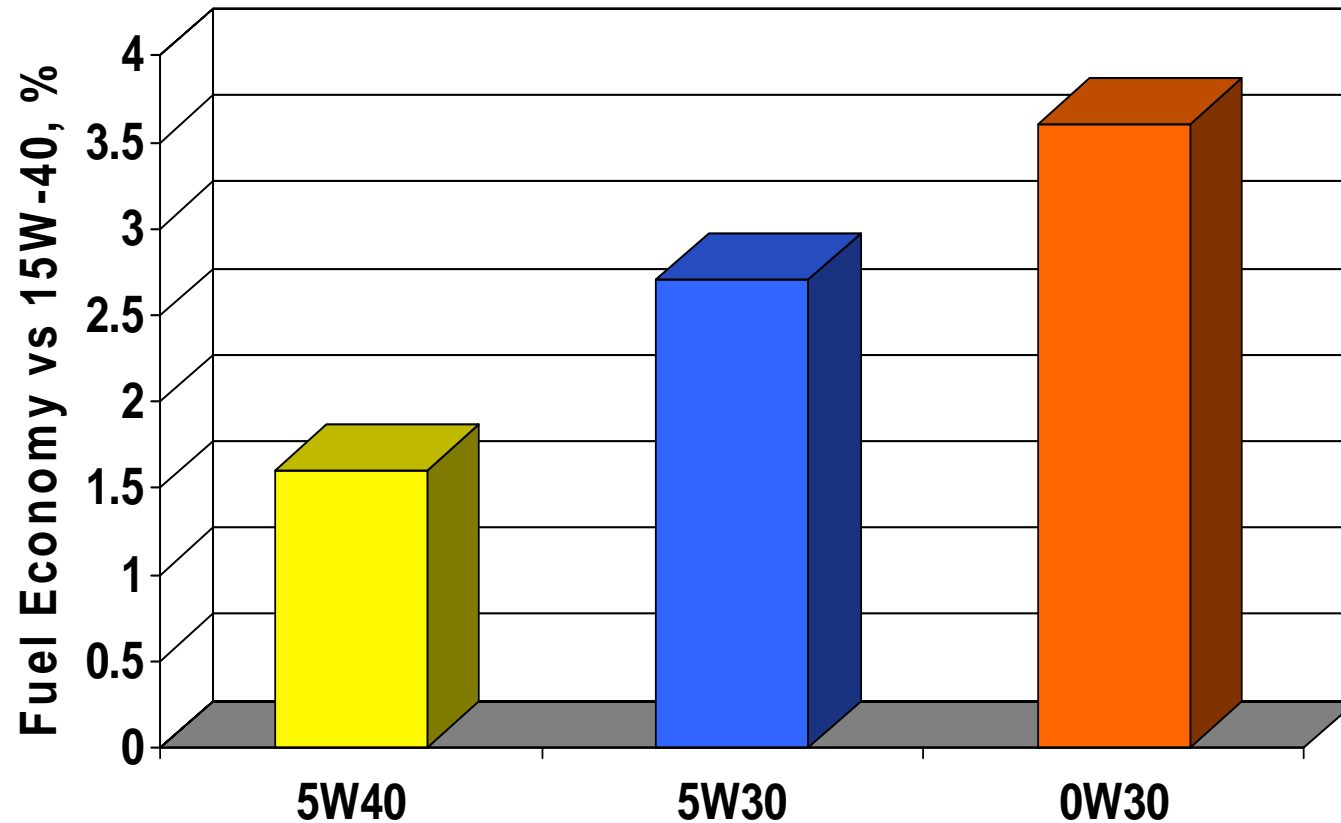
Typical Lubricant Factors Affecting Fuel Efficiency



- Kinematic Viscosity @ 100°C and 40°C
- High temperature high shear viscosity @ 150°C and 100°C
- The kinematic viscosity of the base oils used in the formulation
- Additive; type and level
- Base oil type
- Polymer; type and level

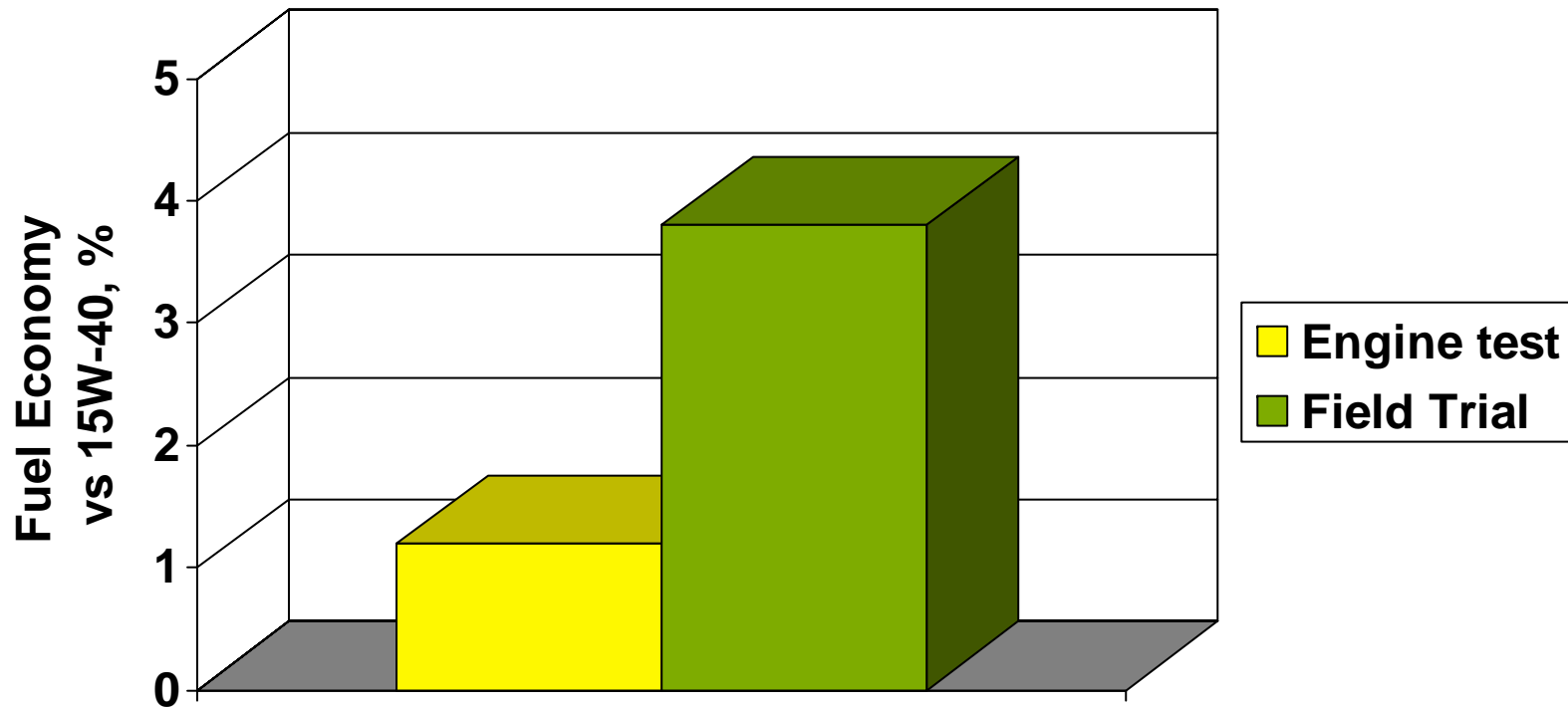
Effect of Viscosity Grade

Cummins M11 – Steady state (Tested at SwRI)



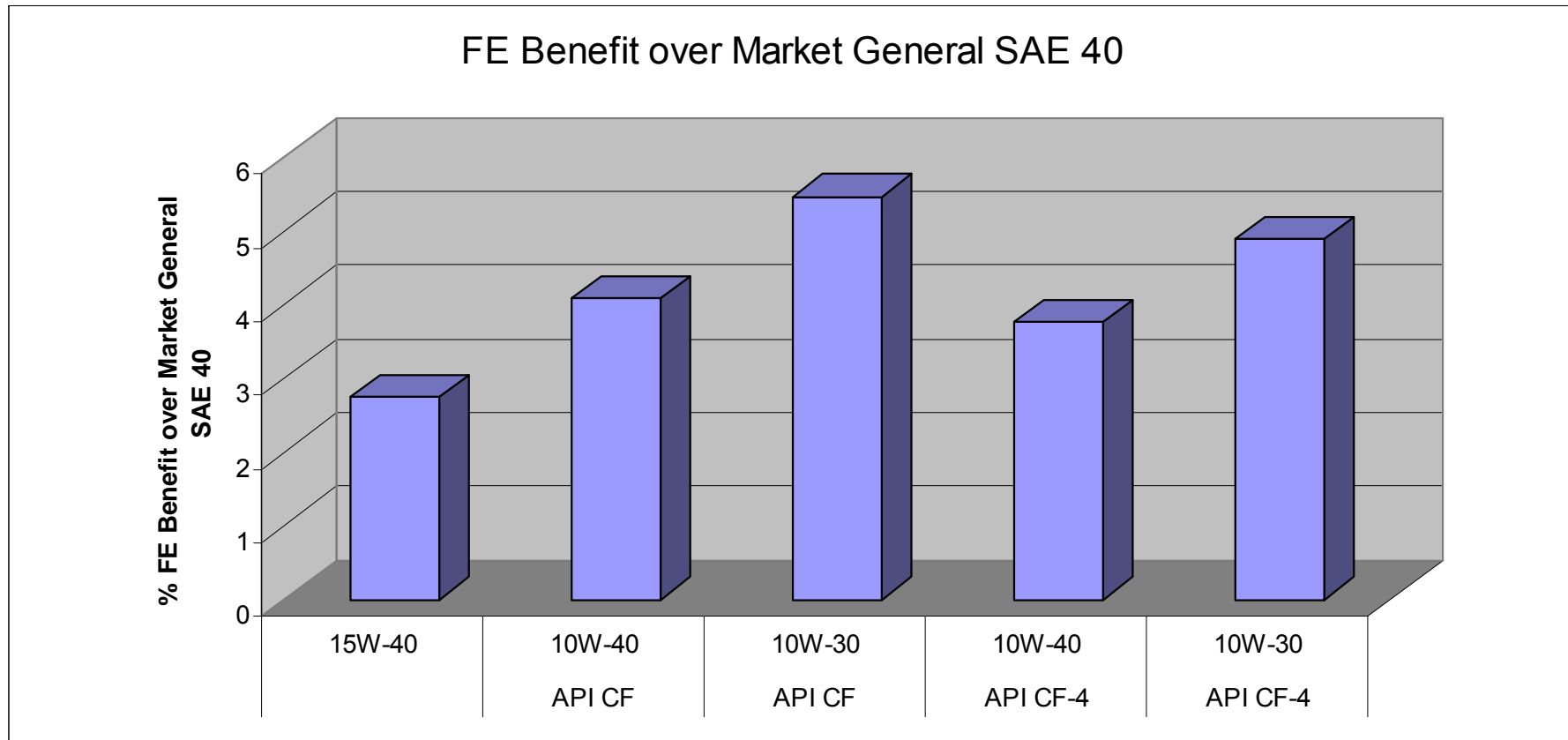
Fuel economy results derived from steady state testing give a smaller benefit compared to results derived from dynamic testing

Fuel Economy in Engine Test vs Field Trial

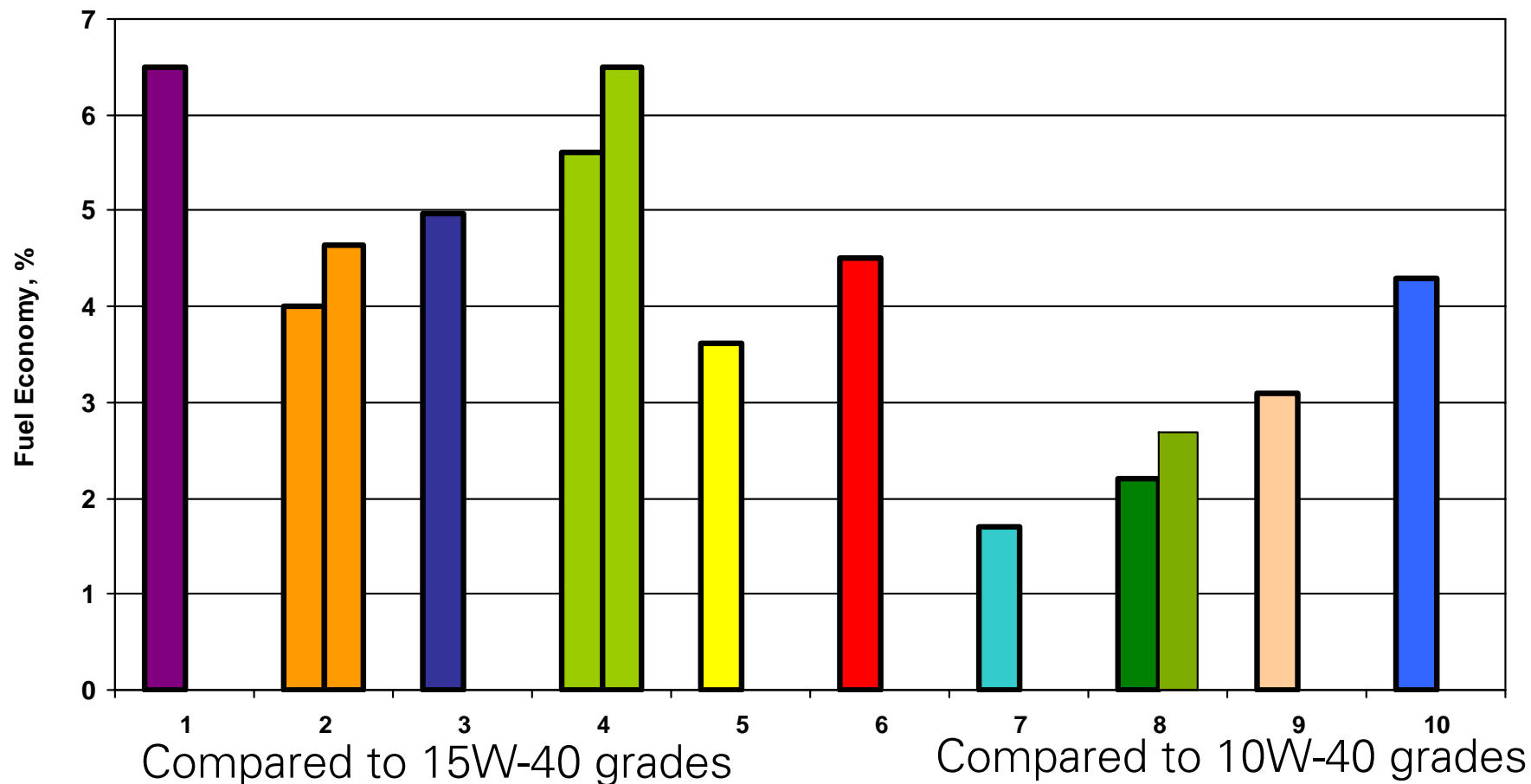


Data from the field are greater than from steady state engine test. Therefore we need a transient engine test to move closer to real world conditions

Fuel Economy – Emerging Markets

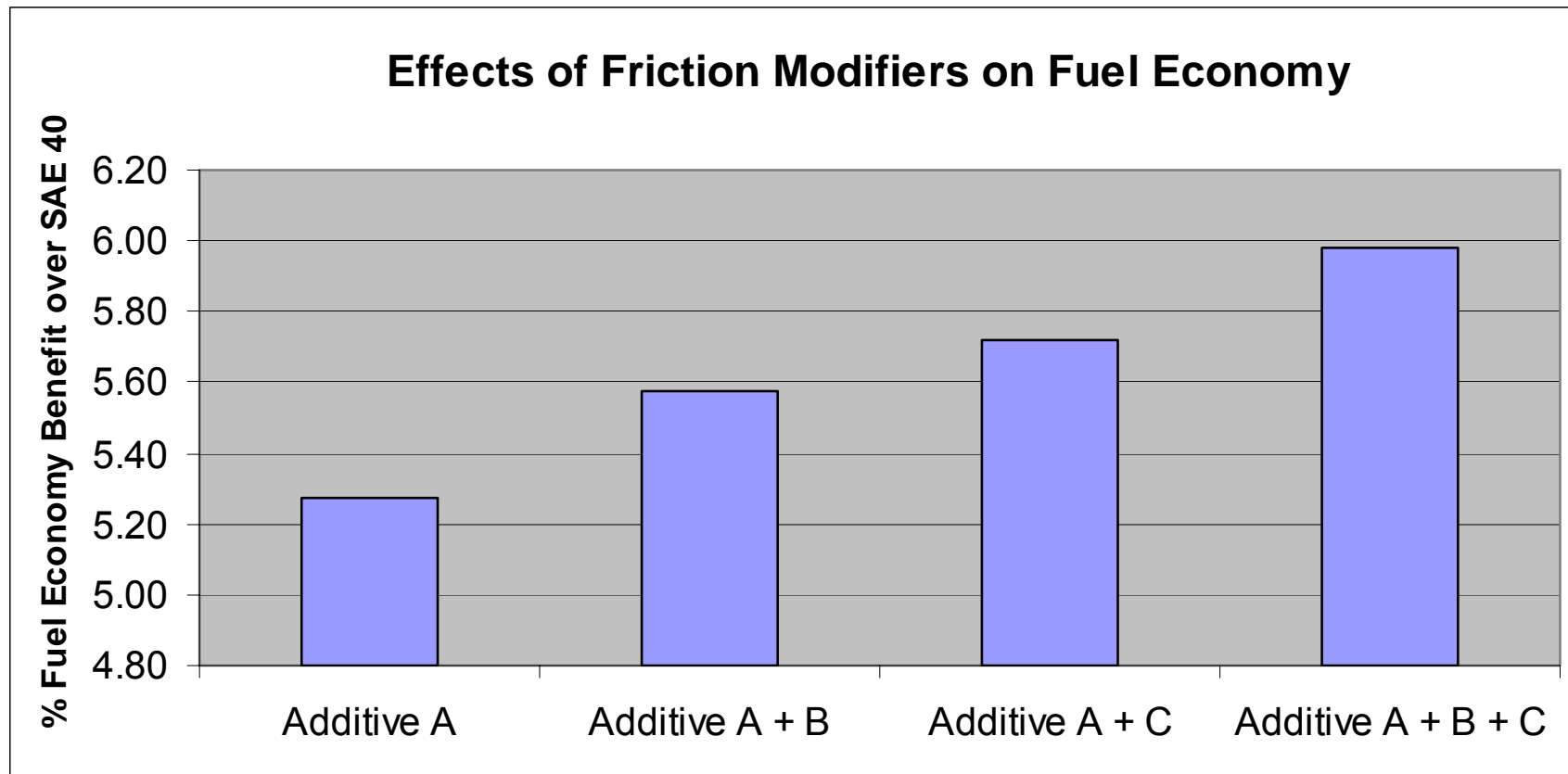


Fleet Data: Fuel Economy of an SAE 0W-30 HD Diesel Lubricant



Rigorous statistical analysis of fuel records show benefit of SAE 0W30 heavy duty diesel oil

Friction Modifiers



Fuel Economy for Emerging Markets



- Fuel economy benefits determined through a specially developed engine test at the Global Lubricants Technology Centre in Pangbourne
 - Backed up by field trial data
- FE benefit determined versus market general formulations or competitor oils
- We offer the truck driver
 - ~5% benefit versus a SAE 40 formulation
 - ~2% benefit versus a 15W-40 formulation
- **Environmental benefits through reduced CO₂ emissions**
- **Financial benefits for the driver through reduced fuel consumption**

Conclusions – So Far



- Engine Out Emissions
 - Optimised synthetic lubricant formulations have a clear benefit on engines running without after-treatment
 - When after-treatment is added, carefully formulated lubricants with lower ash can extend the life of the filter systems
- Post Trap Emissions
 - The catalysed CR-DPF produce no measurable particles above background levels
 - There appears to be a relationship between increasing fuel S concentration and increasing particle concentration on a vehicle fitted with a CR-DPF
- Fuel Economy
 - Low viscosity multi-grade lubricants give greater fuel economy benefit
 - In Europe this means moving to synthetics (0W-30, 5W-30, 5W-20, etc)
 - In emerging markets this means moving away from mono-grade formulations