
2007 Lubricant Impacts on Emissions



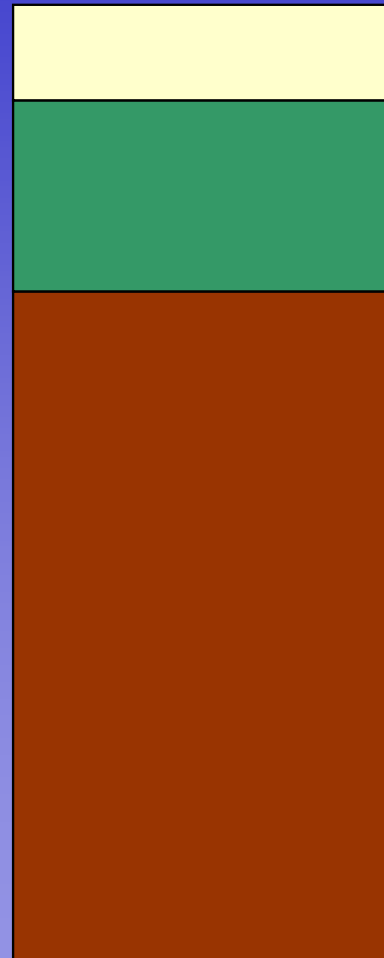
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Key Questions

- How will 2007 diesel engine lubricants be different from today?
- What will the chemical composition changes be?
- How are these changes expected to change emissions quality and quantity?
- What uncertainty is there in our current understanding?

Lubricant Formulation



Viscosity modifier

Detergent Inhibitor

Basestock

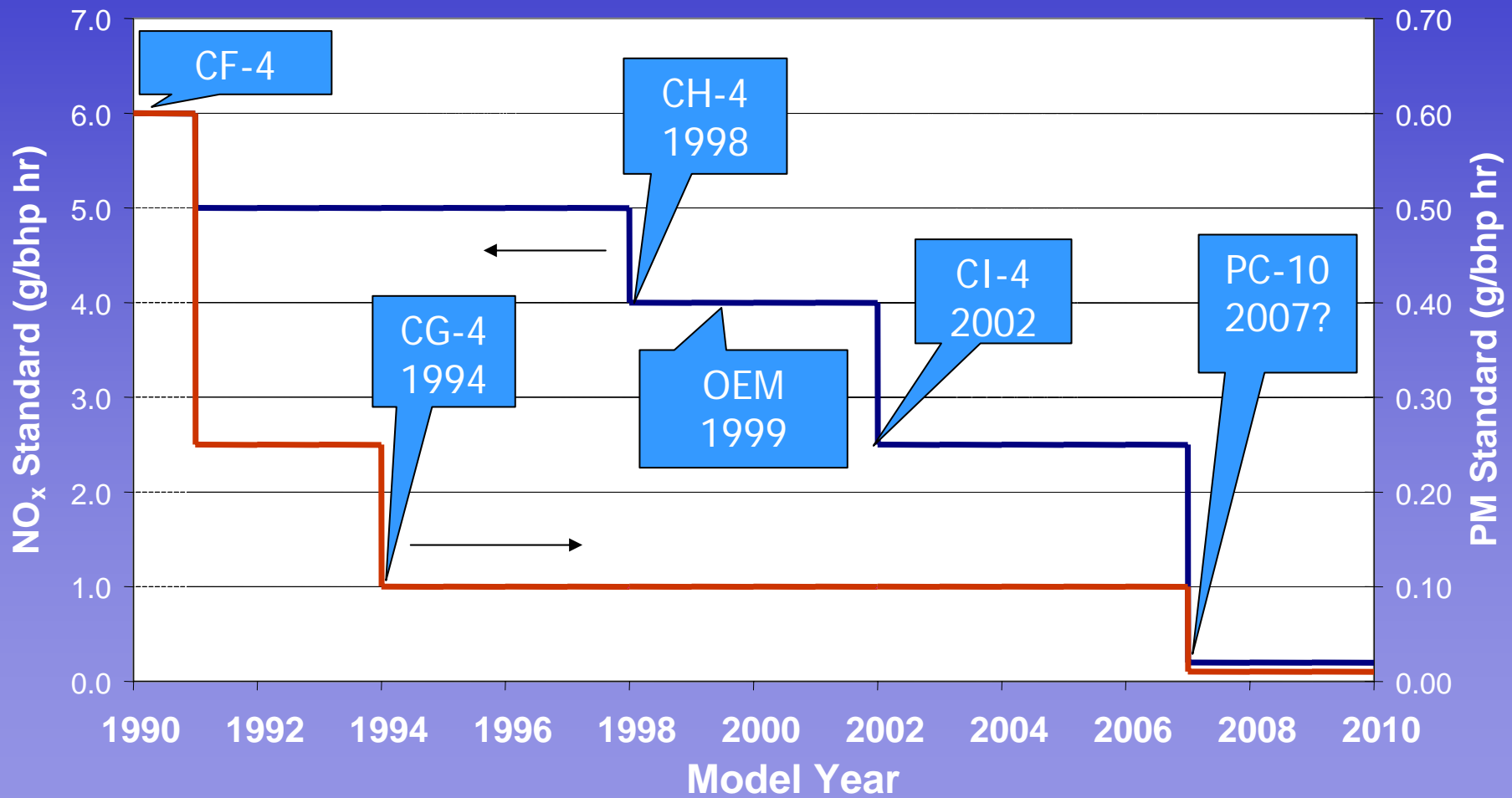
Detergent Inhibitor Additives

- **Detergent** – acid neutralizing additives; usually calcium or magnesium based.
- **Anti-wear** – most commonly zinc-dialkyl-dithiophosphate (ZDDP); forms a surface film to protect metal surface.
- **Antioxidant** – protects oil from breakdown at elevated temperatures; ZDDP is an effective AO.
- **Dispersant** – keeps particles (soot) small and in solution

API 1509 Base Oil Groups

	Sulfur (%)		Saturates (%)	Viscosity Index
Group I	> 0.03	and/or	<90	80-120
Group II	<0.03	and	>90	80-120
Group III	<0.03	and	>90	>120
Group IV	Any polyalphaolefin (synthetic)			
Group V	All others			

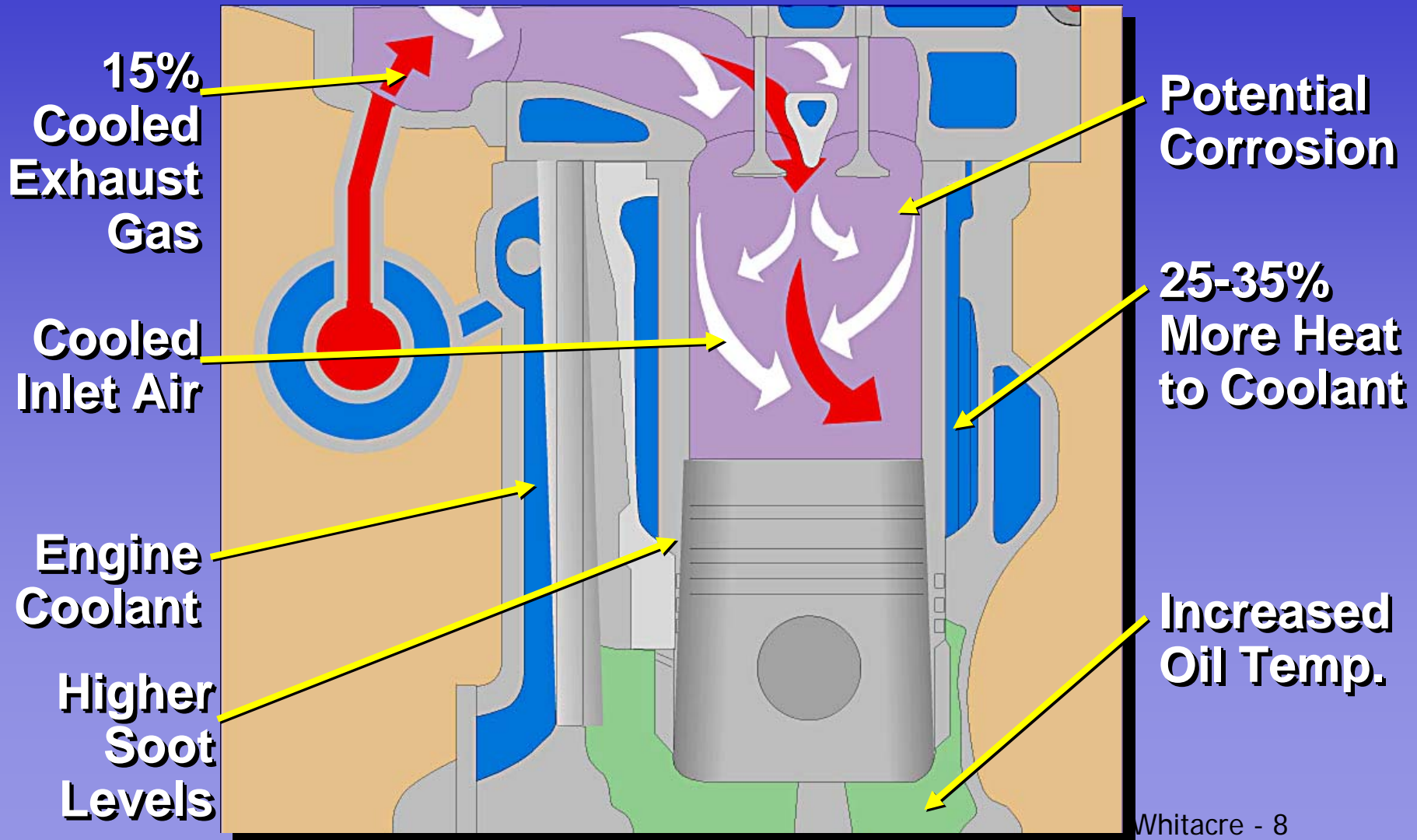
HD Diesel Emission Standards



CI-4: For EGR engines

- A new category of engine oils was introduced in 2002 for use in EGR equipped engines.
- Relative to previous formulations, these oils contain:
 - Higher TBN and higher sulfated ash (1.4-1.5%)
 - Roughly 5000 ppm sulfur
 - Boosted anti-wear additive content
 - Dispersant and antioxidant boost
 - Group II (hydrotreated) basestocks

EGR Impact on Lubricant



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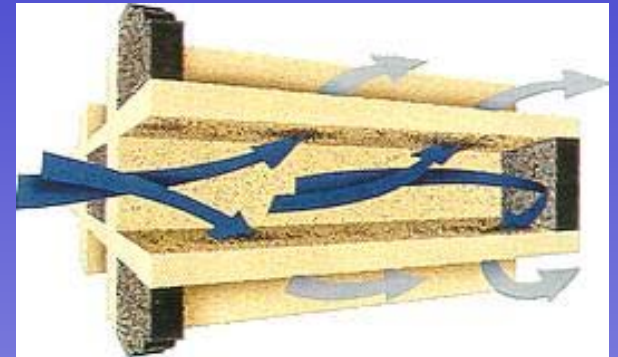
Source: SAE 2002-01-1673

Catalyst Compatible Lubricants



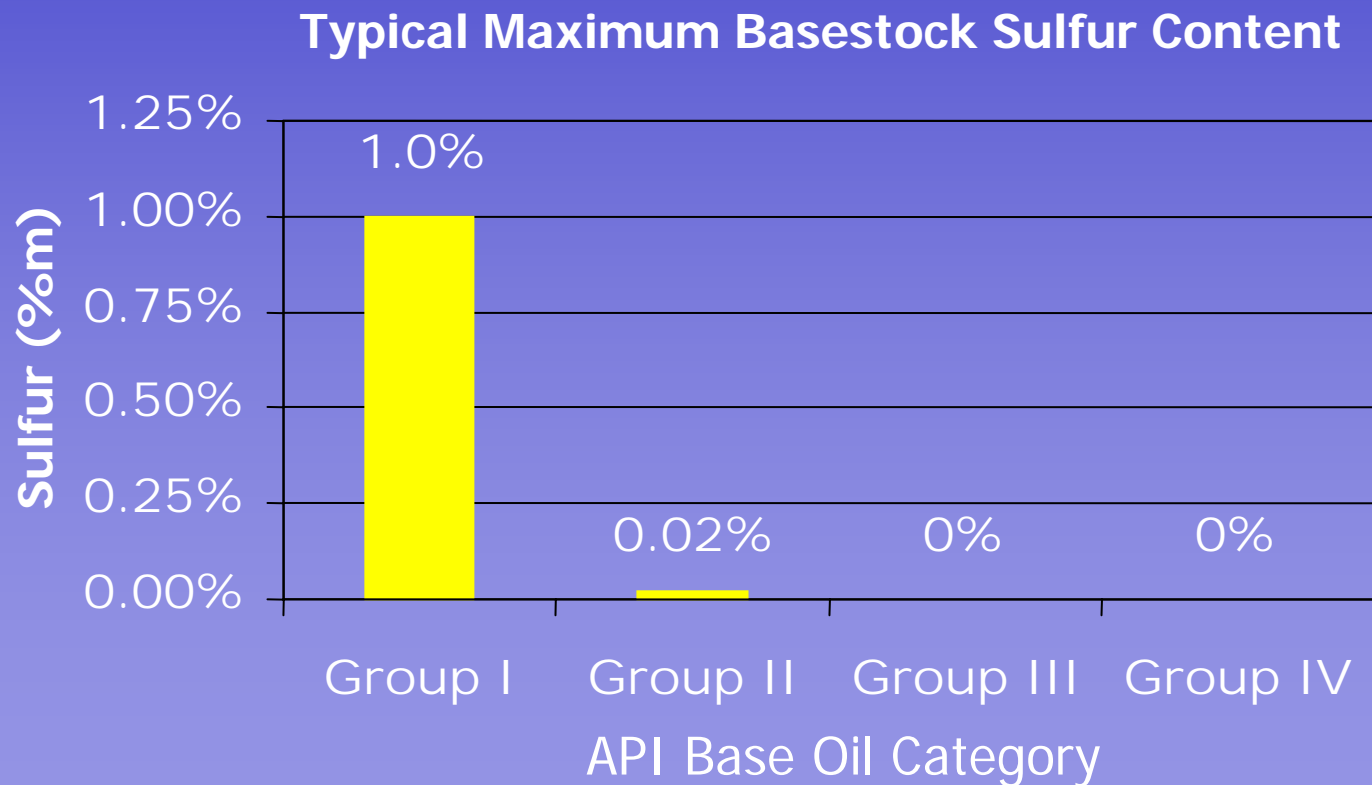
Technology Drivers

- Diesel Particle Filters (DPFs)
 - Intolerance to lube ash
 - Frequency of maintenance
- NO_x Adsorber Catalysts
 - Intolerance to sulfur
 - Other “poisons” (phosphorus, etc)?
- Ultra-low sulfur diesel fuel
 - 80/20 phase-in
- System design will dictate lubricant effect



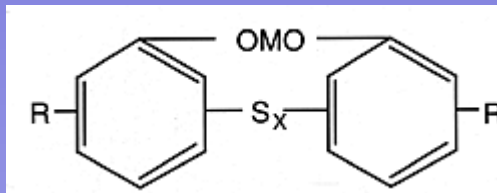
Sources of Lube Oil Sulfur

- Base oil

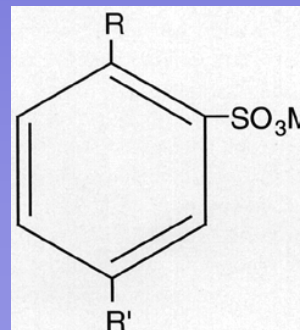


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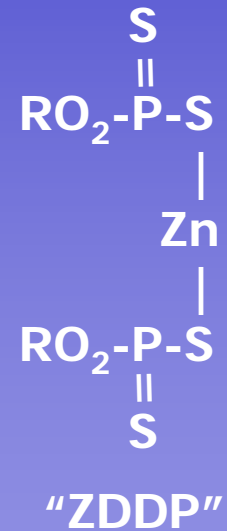
- Sulfur containing additives
 - Anti-wear agents (ZDDP, others)
 - Detergents (sulfonates, phenates)
 - Corrosion inhibitors
 - Friction modifiers
 - Anti-oxidants



Sulfur Coupled Phenate



Sulfonate



The bottom line....

- Oils in the 2007-2010 timeframe will likely:
 - contain lower ash content
 - contain less total sulfur (primarily in the base oil?)
 - be less volatile
- Lubricant requirements are tough to define until system designs are finalized
 - Could see significant diversity amongst OEMs
- Requirements will change from 2007 to 2010
 - Emission phase-in
 - Fuel sulfur phase-in