Lubricants for Low Emissions Diesel Engines

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Diesel Engine Emissions Reduction Workshop

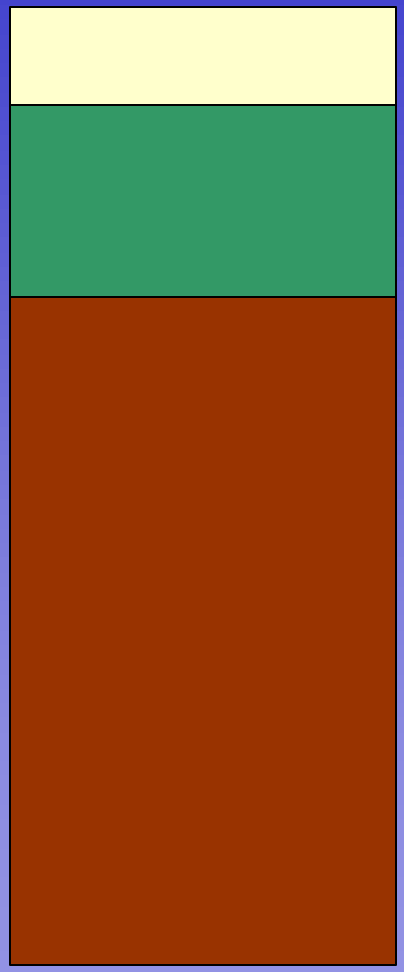
Outline

- Background
- Emissions standards and category development timeline
- Performance demands on modern lubricants
- Catalyst compatible lubricants
- Future directions

Background

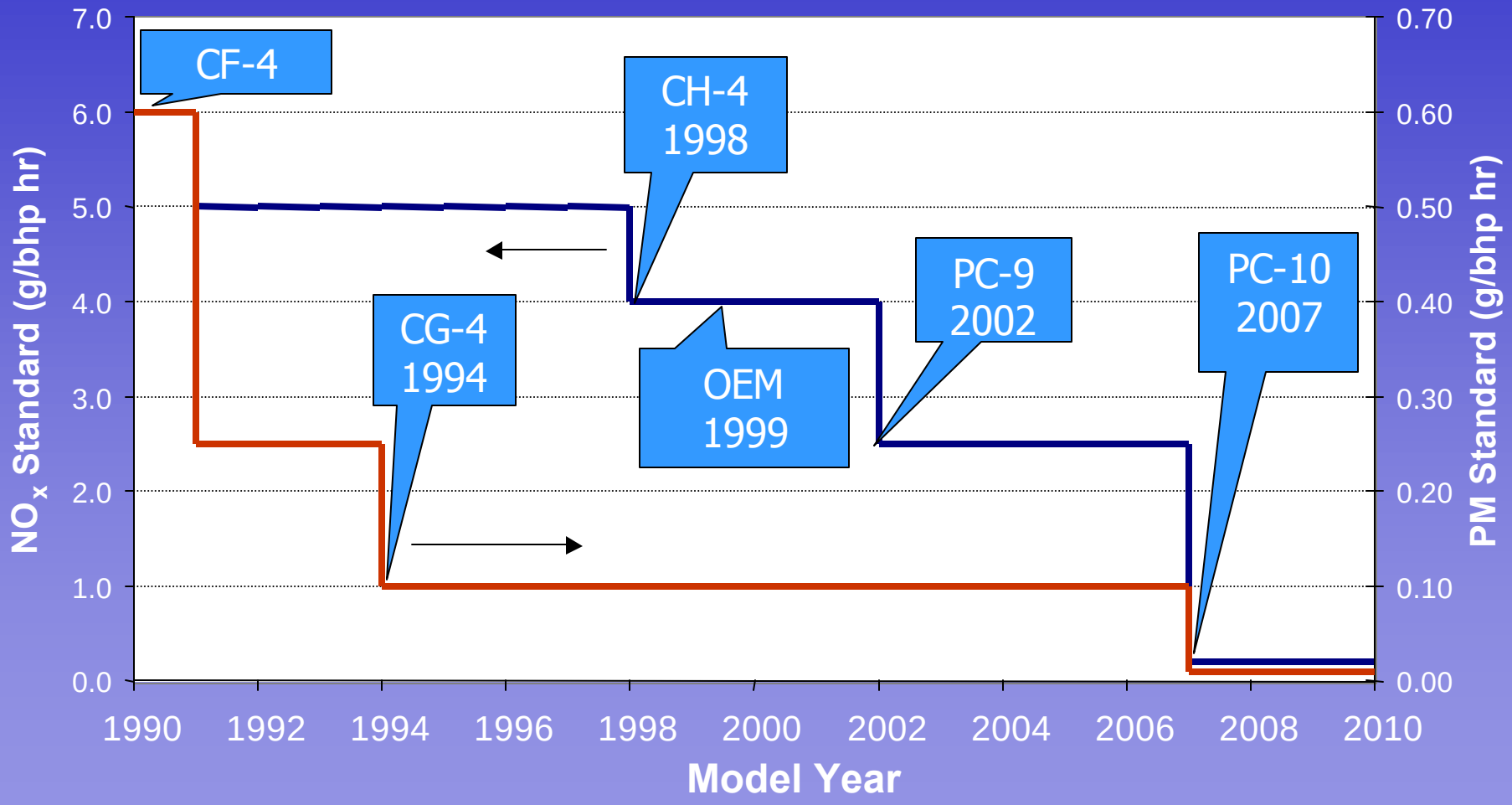
- Rapidly changing emissions standards have led to stringent lubricant requirements.
- Specifications change every 2-3 years
- Formulators faced with conflicting demands:
  - Customer demands
  - OEM demands
  - Engine protection
  - Profitability

What's in the can?



Emissions Standards and Category Development

HD Diesel Emission Standards



Performance Demands on Modern Lubricants

A real juggling act…

Customer demands

Regional requirements

Cost/profit

OEM requirements

Development timeline

Marketability

Emissions standards

Customer Demands

- Increased oil drain interval (50K+ miles)
- Improved fuel economy
- Long engine life
- Low cost

OEM requirements

- Protect engine from soot aggravated wear and viscosity increase
- Oil consumption control
- Low volatility
- Oxidative stability
- Material compatibility
- Corrosion protection in EGR environment
- Low temperature performance

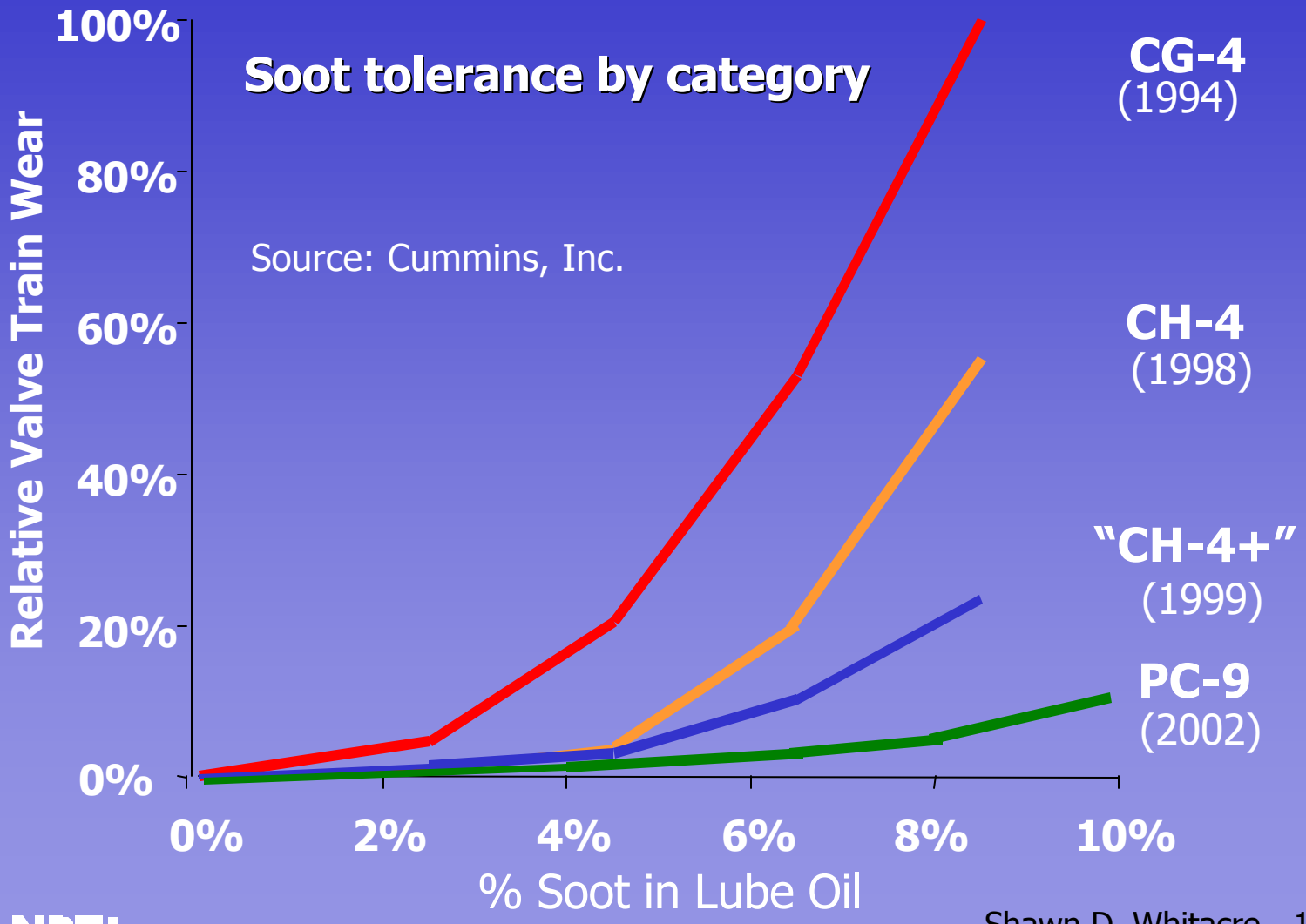
PC-9: For EGR engines

- A new category of engine oils will be introduced in 2002 for use in EGR equipped engines.
- Relative to previous formulations, these oils will 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

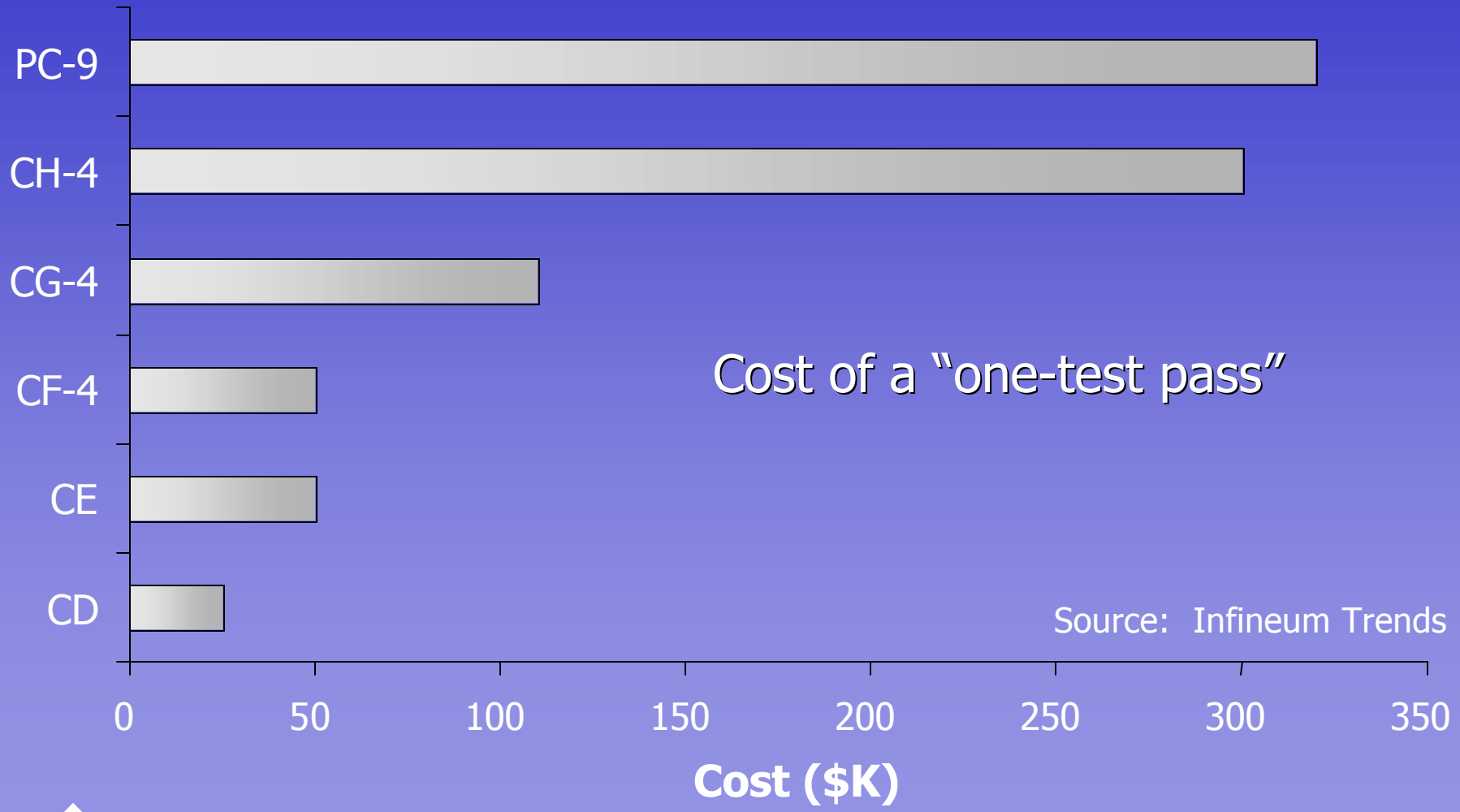
PC-9: Testing Requirements

- Mack T10-EGR
- Mack T8-E
- Cummins M11-EGR
- Caterpillar 1R
- Caterpillar 1N
- GM RFWT
- Navistar HEUI Aeration
- Elastomer compatibility
- HT Corrosion Bench Test
- Bosch Shear Stability
- Foaming
- Used oil viscometrics
- Volatility

Wear control at high soot levels



Testing costs on the rise



Regional Requirements

- Performance demands vary throughout the world
  - North America
  - Europe
  - Asia
- Recent push to globalize standards

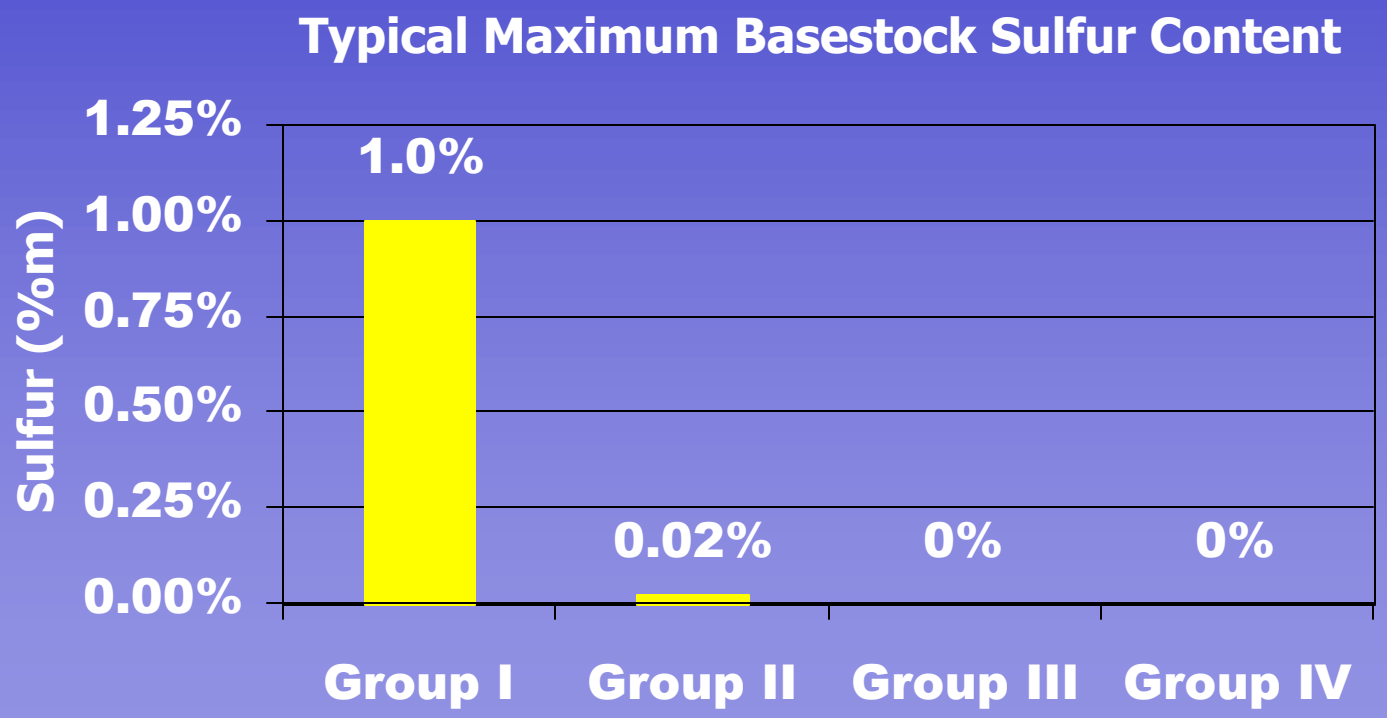
Catalyst Compatible Lubricants

Catalyst compatible lubricants

- 2007 HD standards and Tier 2 LD standards will require aftertreatment
- Growing concern over lube oil sulfur and ash
  - Potential to interfere with catalyst performance
  - NOx adsorber poisoning
  - PM trap plugging
- Research has been initiated to quantify the effects

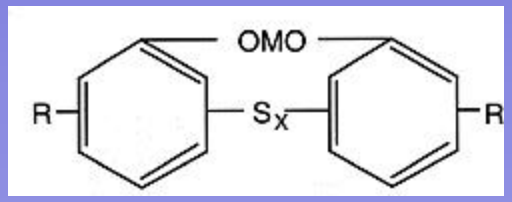
Sources of Lube Oil Sulfur

- Base oil

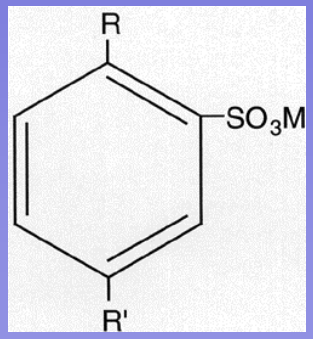


Sources of Lube Oil Sulfur

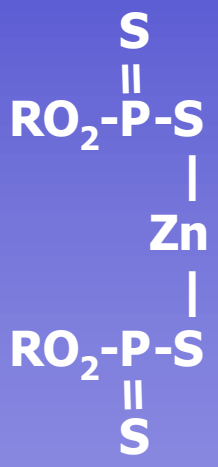
- Sulfur containing additives
  - Anti-wear agents (ZDDP, others)
  - Detergents (sulfonates, phenates)
  - Corrosion inhibitors
  - Friction modifiers
  - Anti-oxidants



Sulfur Coupled Phenate



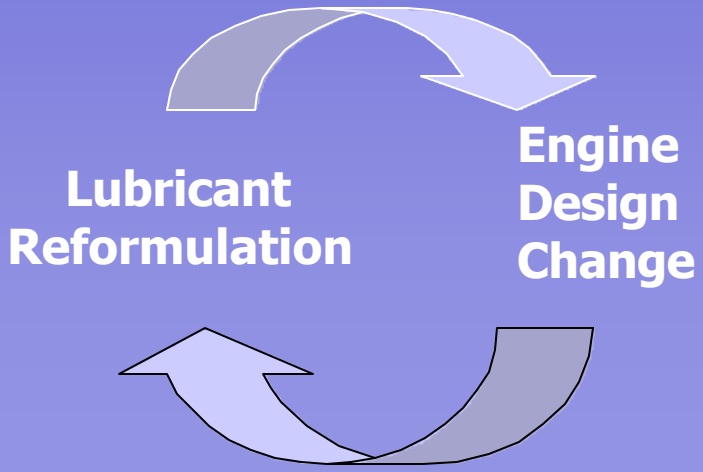
Sulfonate



"ZDDP"

Technical Hurdles

- Maintaining backward compatibility
  - Older engines still on the road
  - Implications of misapplication
- Conflicting demands
  - Compliance may necessitate EGR + aftertreatment which differ in appetite



The road ahead

- Lubricant development will require novel approaches that satisfy conflicting demands.
- New components, better basestocks
- Renewable "biolubes" on the horizon
- "Fill for life"