

# 16-1903: Quality Monitoring of Engine Oils for Equipment on Extended Drain Intervals



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# Outline

1. Engine Oil
2. Study Objectives
3. Sampling and Analysis
4. Results
5. Conclusions
6. Future work



# 1. Engine oil composition

- Base oil
  - Mineral (*conventional*)
  - Polyalphaolein (PAO) (*synthetic*)
- Additives
  - Friction and viscosity modifiers
  - Lubricity and wear modifiers
  - Detergents and dispersants





# 1. Engine oil during use

- Chemical degradation
  - Reaction of base oil with oxygen, nitrogen, sulfur
  - Harmful compound formation & additive depletion
- Viscosity degradation
  - Increase – thickening from soot intrusion
  - Decrease – thinning from dilution
- Contamination
  - Dilution from water, fuel, or glycol
  - Wear metals
  - Dirt



# 1. Engine oil parameters

Parameter	Threshold
Viscosity	12.5 – 16.3 cSt SAE300 (40 wt)
TBN	4 mg KOH/g
Water	> 0.2%
Fuel	> 7%
Glycol	50 ppm Na & K
Oxidation	> 20
Nitration	> 15

Contaminant	Threshold
Copper	> 30 ppm
Iron	> 100 ppm
Aluminum	> 15 ppm
Chromium	> 10 ppm
Soot	> 3%
Silicon	> 10 ppm
Sodium	> 50 ppm (w/ K)
Potassium	> 50 ppm (w/ Na)



## 2. Study objectives

### RP 2015-11 Preventive Maintenance Criteria

#### Objectives:

1. *Monitor oil quality for extended drain intervals*
2. *Quantify rates of degradation and/or contamination*
3. *Assess existing PM schedule and provide recommendations*



# 3. Sampling and Analysis

- Studied equipment
  - 0209 Utility trucks: International 7300
  - 0210 IMAP trucks: Ford F350
  - 0303 Mowing tractor
  - 0311 Slope mowing tractor



# 3. Sampling and Analysis

- Collected three 150 ml samples
- OSA4 TruckCheck
  - Benchtop oil analyzer
    - Dual Atomic Emission Spectrometer (AES)
    - Infrared Spectrometer
    - Viscometer





# 4. Results – Fresh oil

	<b>Conventional</b>		<b>Synthetic</b>	
	Conoco HD Fleet Supreme® 15W-40		Shell Rotella T6® 5W-40	
	<b>Published*</b>	<b>Measured<sup>+</sup></b>	<b>Published*</b>	<b>Measured<sup>+</sup></b>
Viscosity@100C (cSt)	15.2	14.99	14.2	12.84
TBN (mg KOH/g)	9.5	9.33	10.6	9.66

*\*Published typical values subject to variation*

*<sup>+</sup>Measured values are average of:*

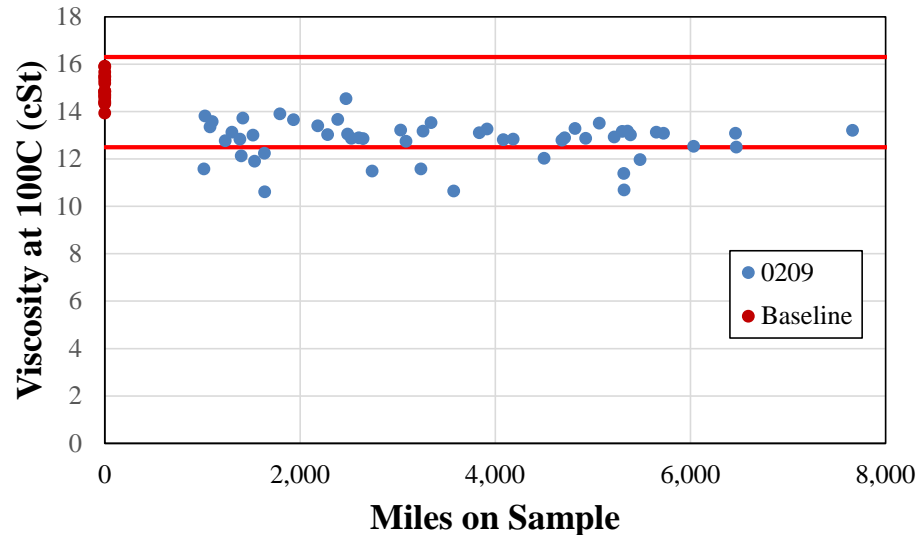
*30 synthetic oil samples*

*18 conventional oil samples*



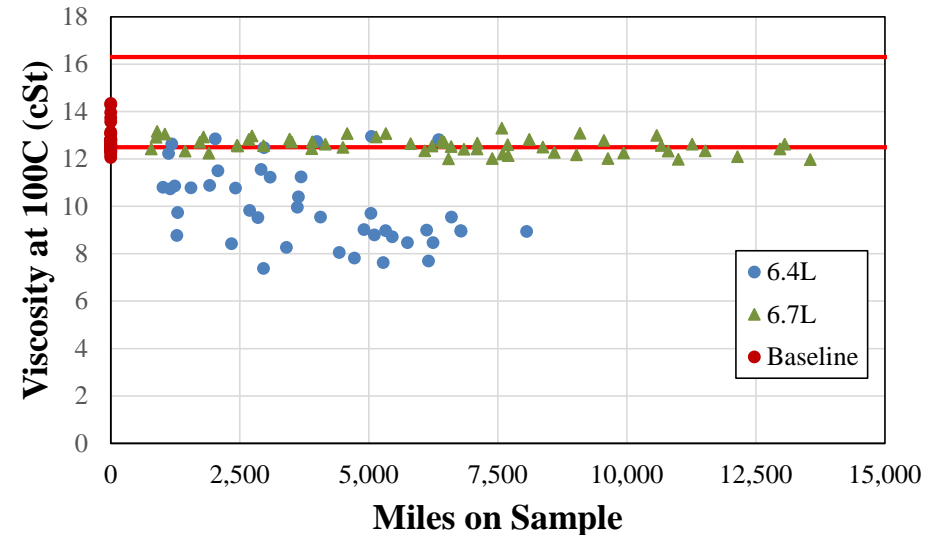
# 4. Results - Viscosity

Conventional 10W-40  
Class 0209



- No change to age 6k miles
- Small initial decrease, may be due to shear down or fuel dilution

Synthetic 5W-40  
Class 0210

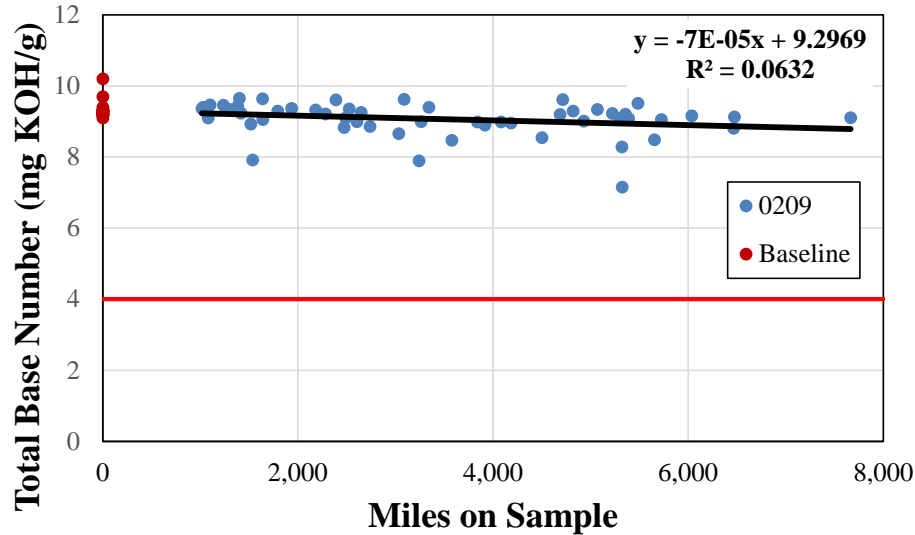


- *6.7L engines* – No change to age 13k miles, at min. value
- *6.4L engines* – Significant reduction due to fuel dilution, approx. 30 wt. oil



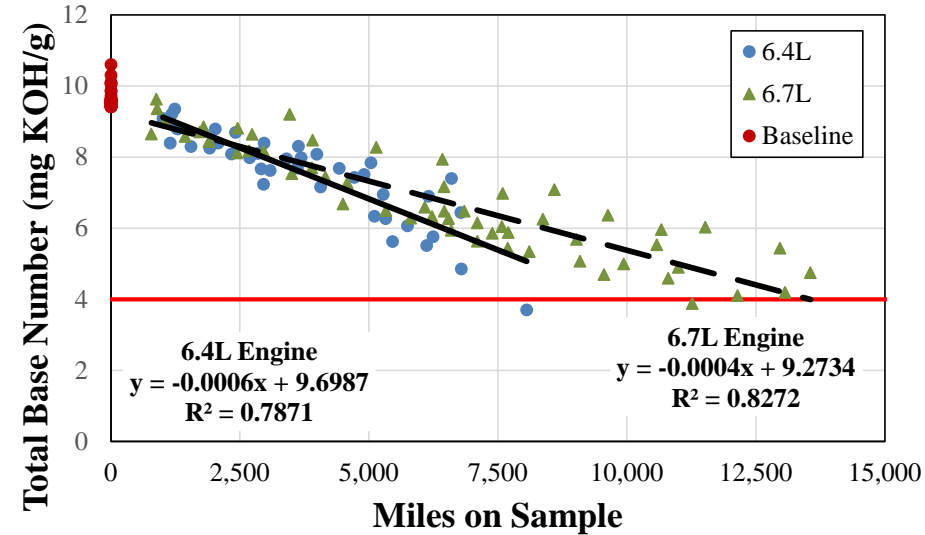
# 4. Results - TBN

Conventional 10W-40  
Class 0209



- Very little decrease to age 6k miles

Synthetic 5W-40  
Class 0210

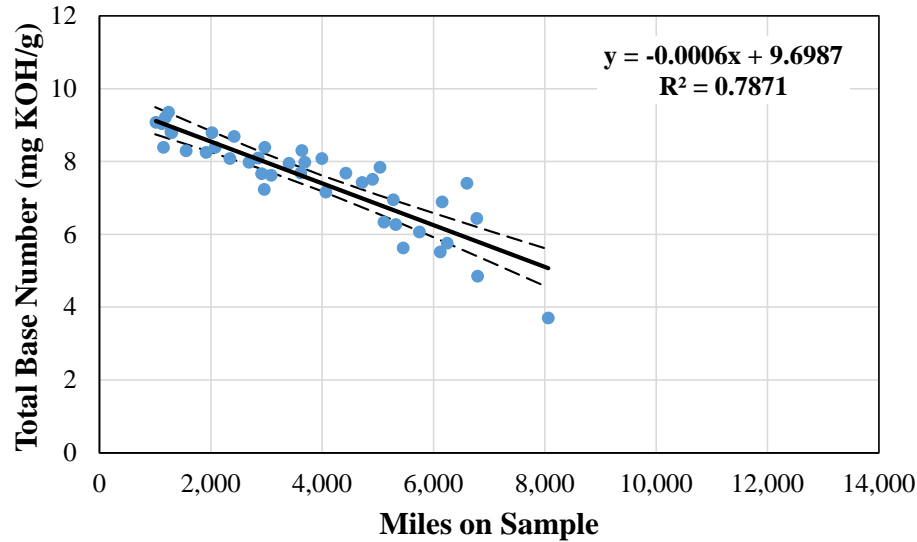


- 6.7L engines – No change to age 13k miles, at min. value
- 6.4L engines – Significant reduction due to fuel dilution, approx. 30 wt. oil

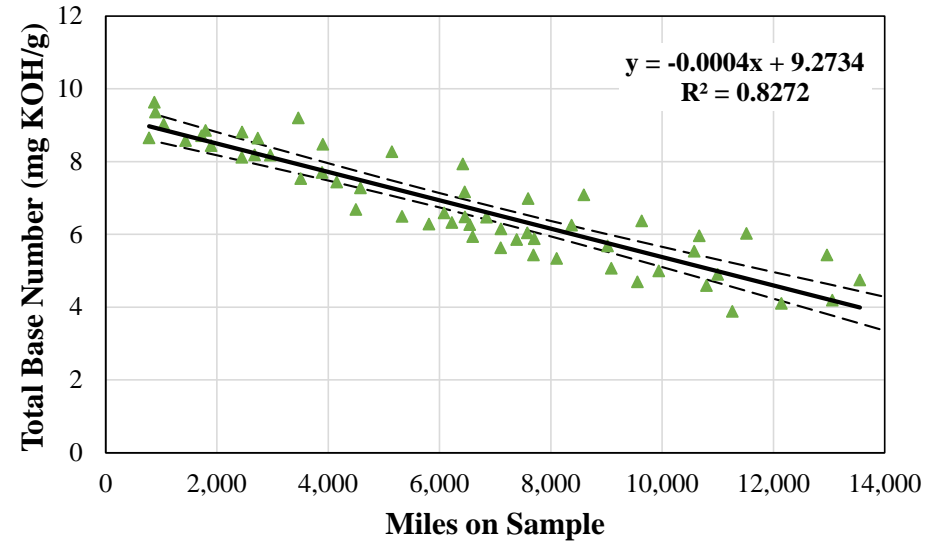


# 4. Results – TBN Class 0210

0210 Trucks w/ 6.4L Engine



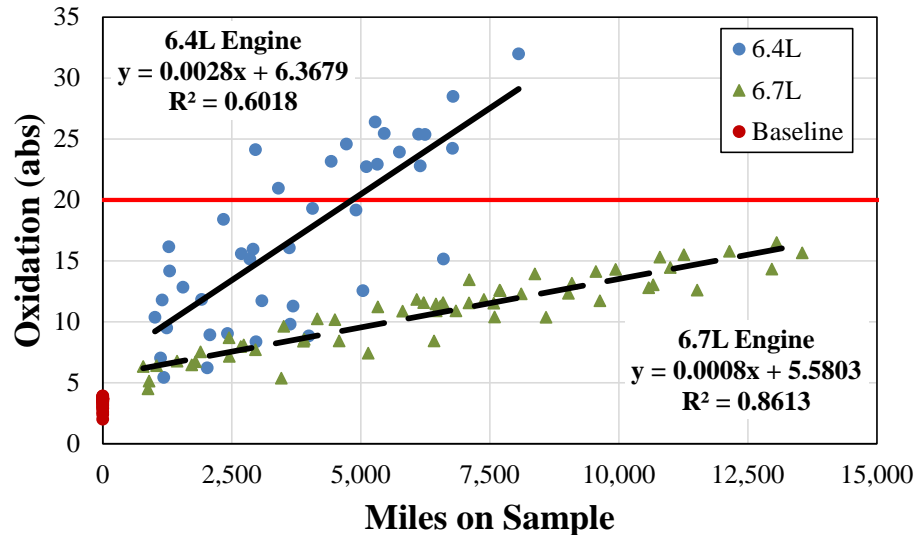
0210 Trucks w/ 6.7L Engine



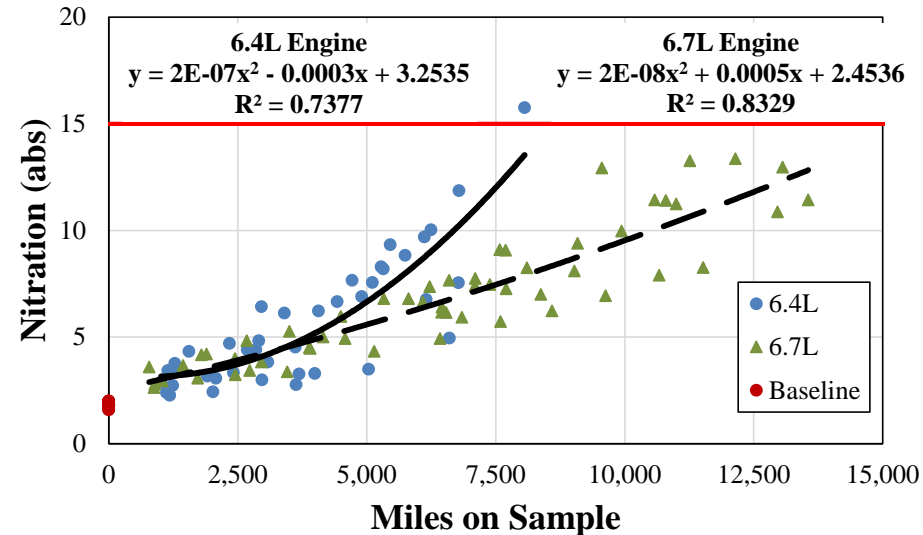


# 4. Results – Oxidation/Nitration

Class 0210



Class 0210



- 6.7L engines – No oxidation issues to 13k miles
- 6.4L engines – 3.5x oxidation rate, threshold met at 5k miles

- 6.7L engines – No nitration issues to 13k miles
- 6.4L engines – 1.6x nitration rate, threshold met at 8k miles



*Very little oxidation/nitration in conventional oil*

# 5. Conclusions

- OSA4 TruckCheck provides timely analysis
- Contamination not an issue (in this equipment)
- Collectively consider oil parameters
- Conventional oil performs very well
  - *10k mile drain interval likely possible*
- Synthetic oil performs well
  - *5k mile drain interval for 6.4L engines*
  - *10k mile drain interval for 6.7L engines*



# 6. Future work

- Outside lab to measure fuel dilution
- Outside lab to verify parameters of fresh synthetic oil
- Test conventional oil in 6.7L engines
- Assess economical and environmental impact of extended drain intervals



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