IMPACT OF ENGINE OIL CONSUMPTION ON DIESEL ENGINE EMISSIONS

USDOE/NREL WORKSHOP

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Outline

- Motivation - Impact of Oil Consumption on Emissions
- Measurement Methods
- Sensitivity to Engine Make, Engine Type, and to Operating Conditions
- Sensitivity to Oil Properties
- Real-Time Steady-State Measurements
- Real-Time Transient Measurements

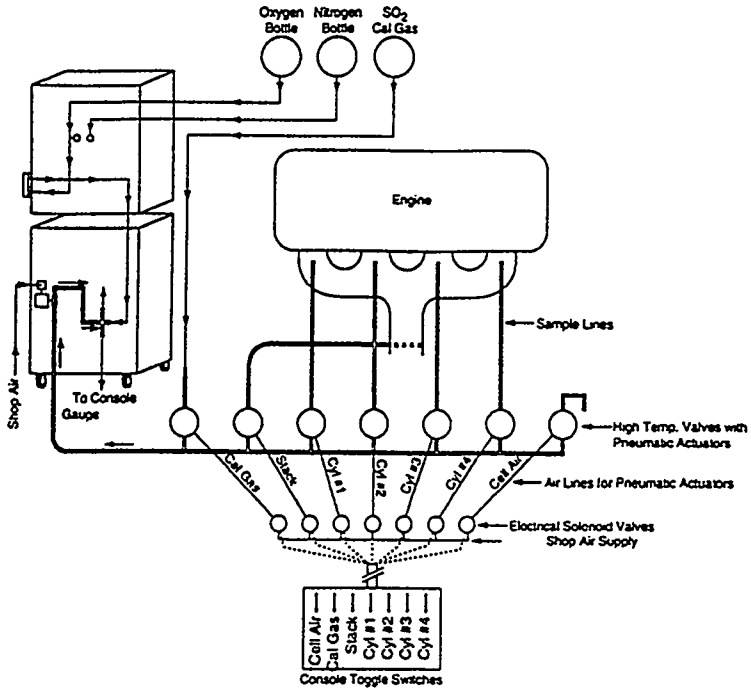
Motivation for R&D in Oil Impact on Emissions

- Customer Satisfaction
- Regulated Engine-Out Emissions
- Regulated Tailpipe-Out Emissions - Catalyst Deterioration
- Unregulated Emissions

Measurement Methods

- Gravimetric (Direct)
- Volumetric
- Tracer
  - SO_2
  - Tritium
  - Pyren
  - Oil Additives
- This Presentation Will Focus on Results Obtained With SwRI's SO_2-Analyzer

Experimental Setup: SO_2-Tracer Technique

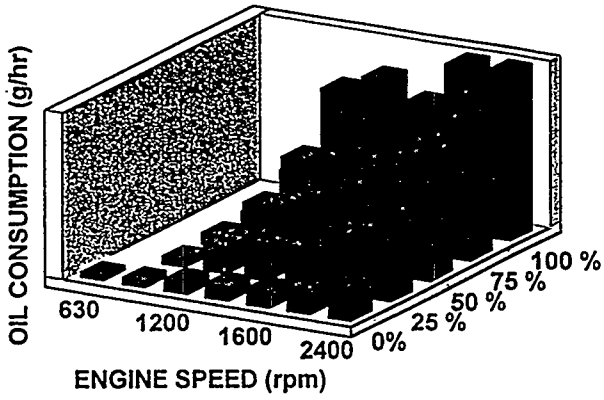


Advantages SO_2-Tracer Technique

- Real-Time Steady-State Engine OC
- Real-Time Transient Engine OC
- Component Break-Down OC:
  - Power-Cylinder
  - Valve
  - PCV-Valve
  - Turbocharger
- Burned and Unburned Engine OC

Sensitivity to Operating Conditions

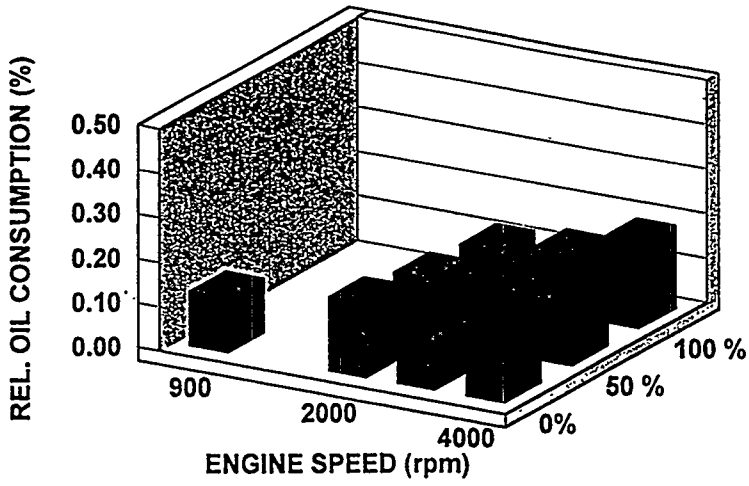
HD DI-MEDIUM
MY 1994, ~7 l



Absolute Oil Consumption Not Appropriate for Comparison Between Operating Conditions

Sensitivity to Operating Conditions

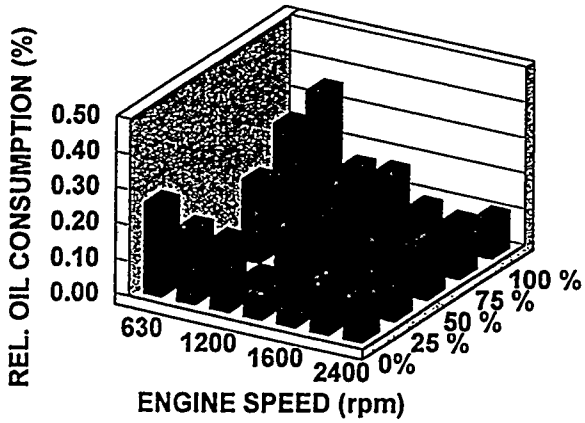
DI-MEDIUM
MY 1997, 2 l, I-4



Good Diesel Engine As of Today Less Than 0.10% Relative Oil Consumption Regardless of Operating Condition

Sensitivity to Operating Conditions

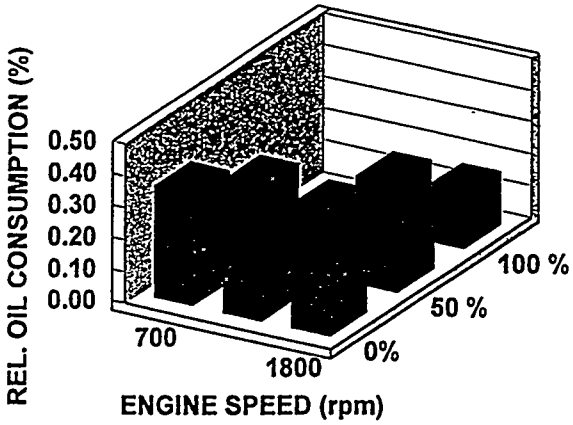
HD DI-MEDIUM
MY 1993, ~7 l, I-6



Characteristic: Low Speed Problems

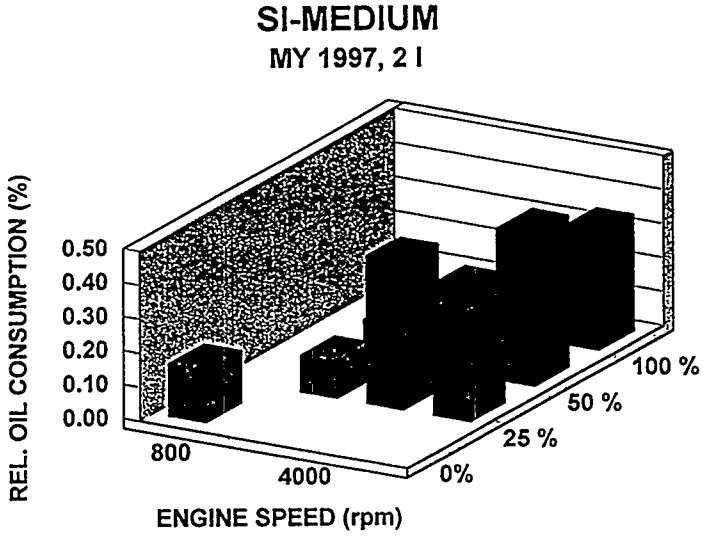
Sensitivity to Operating Conditions

HD DI-LARGE
MY 1994, >10 l, I-6



Characteristic: Low Load Problems

Sensitivity to Operating Conditions



Relative Oil Consumption Enables A Comparison Between Operating Conditions and Engines!

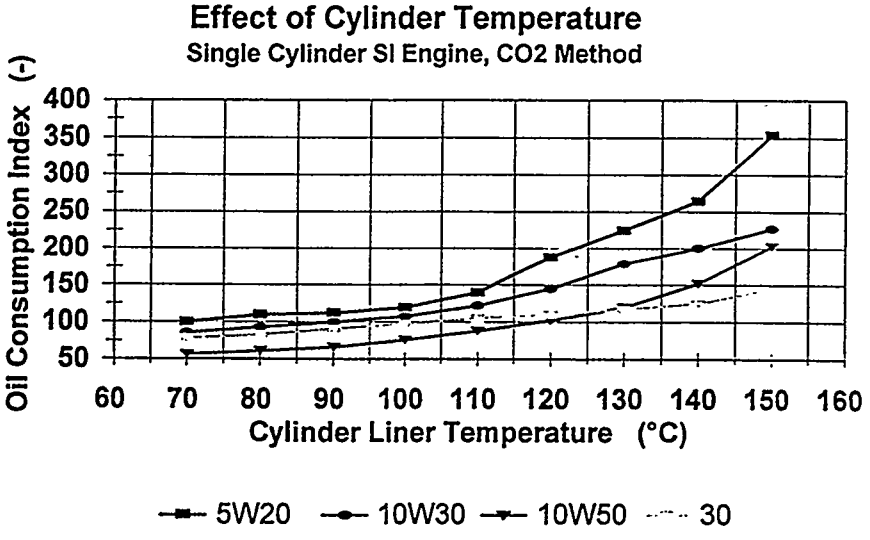
Summary of Findings

- Relative Oil Consumption is a Good Data Analyzing Tool for Comparing Engine Conditions and Engine Makes
- Gasoline Engines With Less Than 0.2% Relative Oil Condition Is Considered Good (1998)
- Diesel Engines With Less Than 0.1% Relative Oil Consumption is Considered Good (1998)

Summary of Findings (Cont'd)

- Every Engine is Exhibiting its Own Oil Consumption Characteristics - It Leaves a "Fingerprint"

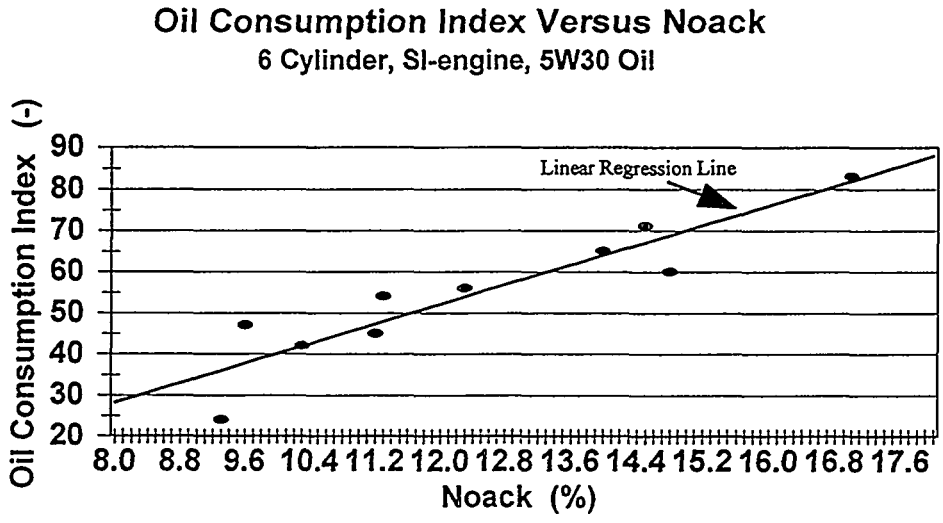
Viscosity



Decreasing Viscosity Increases Oil Consumption!

Ref.: Furuhama et al., Lub. Eng. 1977
Ref.: Froelund et al., SAE Paper 971699

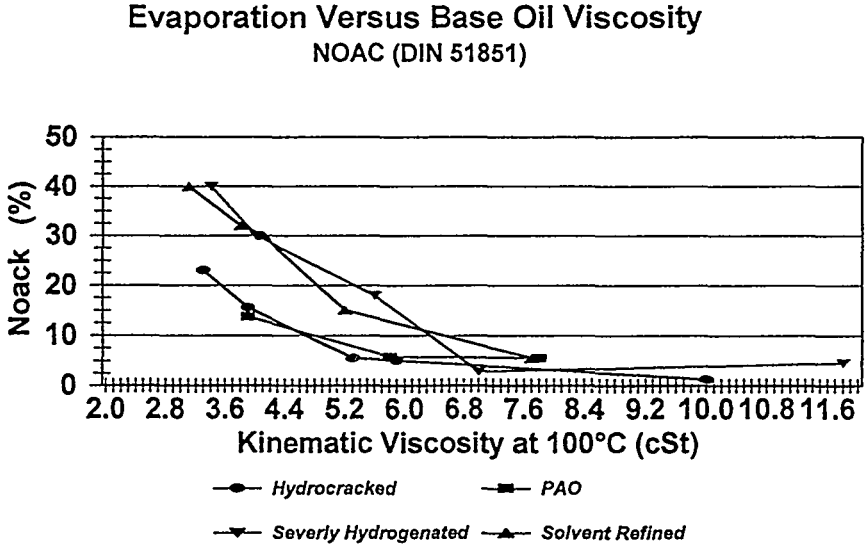
Volatility



Increasing Volatility Increases Oil Consumption!

Ref.: Hanada et al., Nissan Motors, JSAE Review 1990

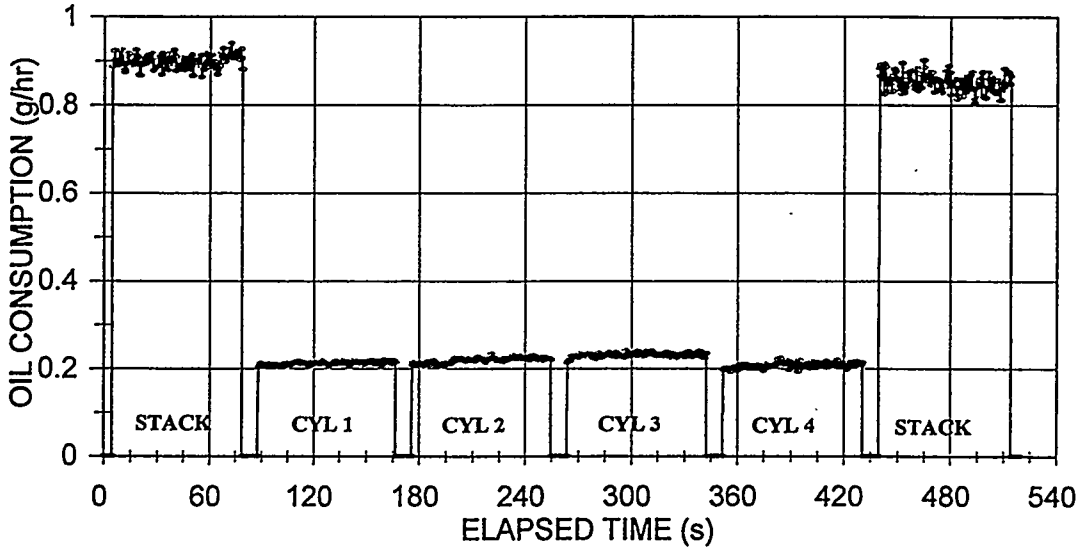
Coupling Viscosity and Volatility



Desirable Oil: Lowest Volatility at Any Given Viscosity!

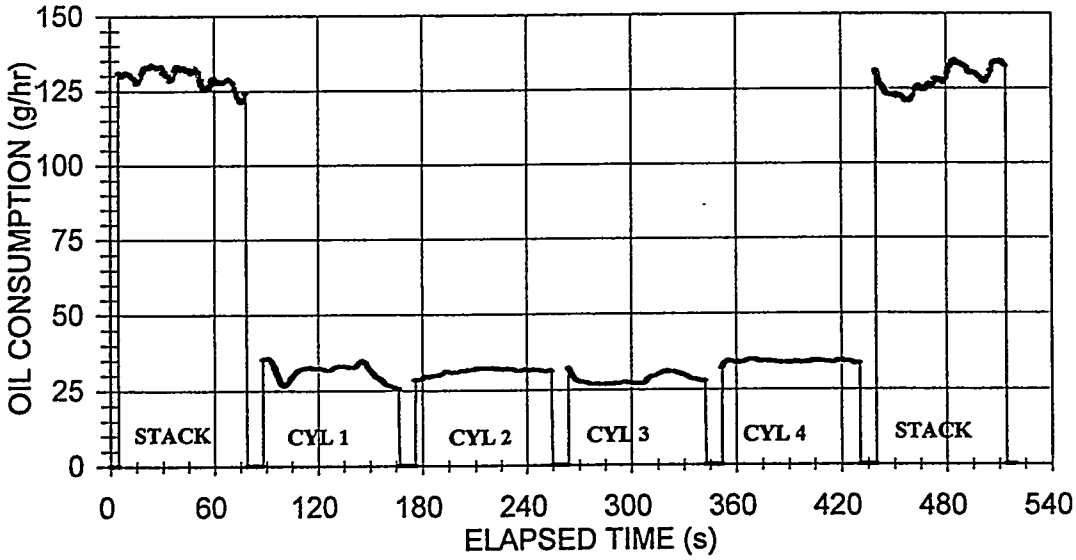
Ref.: Kiovsky et al., BP Oil Company, Lub. Eng. 1993

800 rpm Under 0% Load (Idle)



- TOC Constant in Time
- IOC Constant Among Cylinders

6000 rpm Under 100% Load (Rated Power)



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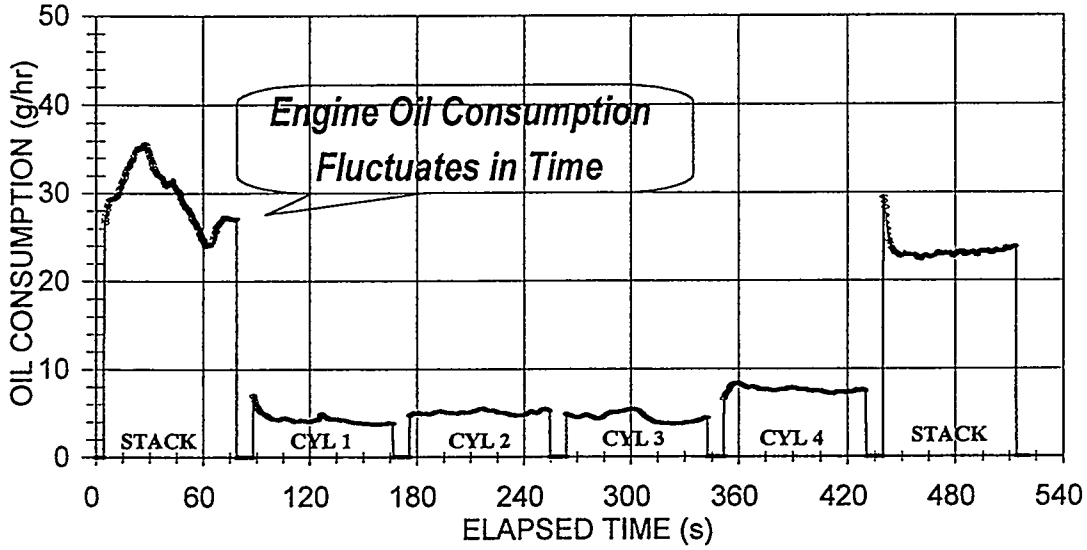
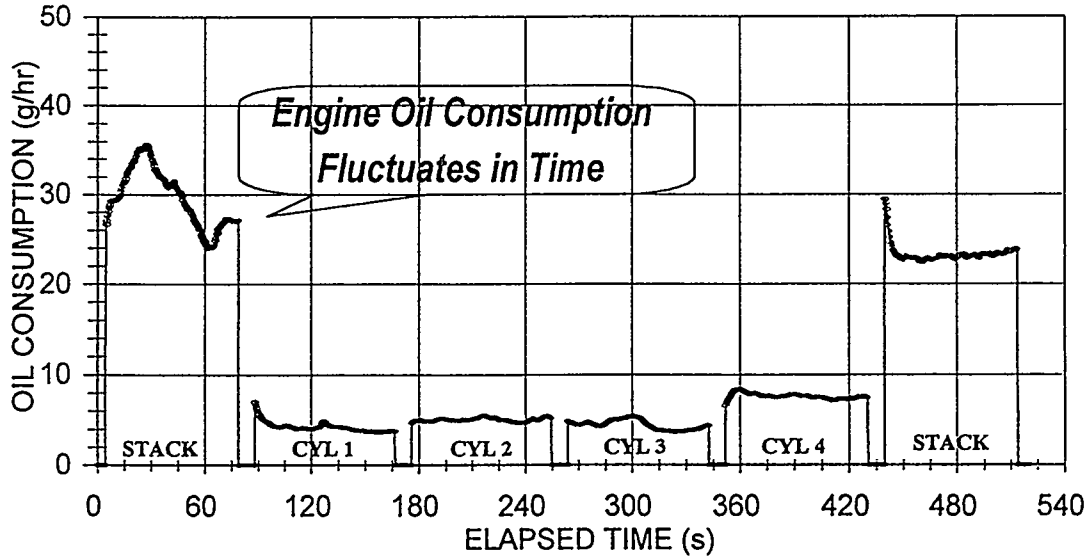
4000 rpm Under 25% Load
1'st Run



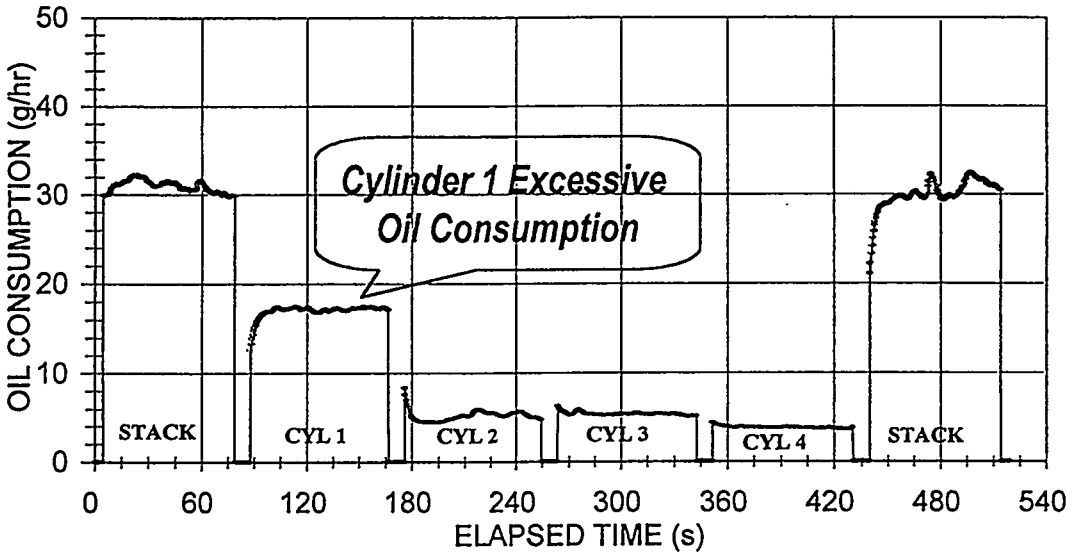
☞TOC Fluctuates in Time
☞IOC Varies Among Cylinders

4000 rpm Under 25% Load
1'st Run



☞TOC Fluctuates in Time
☞IOC Varies Among Cylinders

4000 rpm Under 25% Load
2'nd Run - Repeat Next Day



- TOC Constant in Time
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