

*Southwest Research Institute*®

**Engine Lubricants Research Department**

**Update on SwRI's IR&D Program To Study  
Engine Oil Formulation Effects on Catalyst  
Poisoning in an Engine Dynamometer Test**

**Presented to the  
GF-5 Emissions System Compatibility Improvement Team  
by  
Scott Ellis**

12 December 2006



# Recap of IR&D Project

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- **One-year funding by SwRI started in July '05**
- **Initial test cycle had thermal & chemical degradation of catalyst, high speed/load, high catalyst temps**
- **First test extreme thermal degradation, unresolved**
- **Six-month extension granted in July '06**
- **Changed course to lower speed/load, lower catalyst temps in September '06**



# Implemented Afton's Test Operating Conditions For Catalyst Aging

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- **2000 rpm**
- **65.5 kPa MAP**
- **Externally heated oil sump to 150 °C**
- **Catalyst inlet temp ~530 °C**
- **Target PCV rate ~110 L/min**



# PCV Condensate Study

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- Replaced PCV valve w/pneumatic control valve
- Flowed PCV gases into impinger at  $-65\text{ }^{\circ}\text{C}$ , 1000 sec
- Analyzed condensate collected for P, Ca,  $\text{H}_2\text{O}$



12 December 2006



# PCV Condensate Study

- Tested range of flow rates with OEM system

| PCV flow, L/min | P content, ppm | Ca content, ppm | P/Ca Ratio | Sample mass, g | H2O wt. % | Oil mass, g | Oil cons. 240 hr, Liter |
|-----------------|----------------|-----------------|------------|----------------|-----------|-------------|-------------------------|
| new oil         | 981            | 2092            | 0.469      | ---            | ---       | ---         | ---                     |
| 70              | 10             | 21              | 0.476      | 48             | 55.1      | 21.6        | 21.2                    |
| 88              | 17             | 45              | 0.378      | 24             | 9.6       | 21.7        | 21.4                    |
| 124             | 624            | 1429            | 0.437      | 193            | 25.4      | 143.9       | 141.8                   |



# PCV Condensate Study

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- Revised PCV system configuration
- Routed fresh air directly into crankcase above oil level in two locations
- Evacuate PCV gases out of both rocker covers



12 December 2006



# PCV Condensate Study

- Tested range of flow rates with revised PCV system

| PCV flow, L/min | P content, ppm | Ca content, ppm | P/Ca Ratio | Sample mass, g | H2O wt. % | Oil mass, g | Oil cons. 240 hr, Liter |
|-----------------|----------------|-----------------|------------|----------------|-----------|-------------|-------------------------|
| new oil         | 981            | 2092            | 0.469      | ---            | ---       | ---         | ---                     |
| 120             | 535            | 1129            | 0.474      | 72.7           | 21.3      | 57.2        | 54.2                    |
| 100             | 11             | 12              | 0.917      | 12.6           | 86.4      | 1.7         | 1.6                     |
| 110             | 15             | 12              | 1.250      | 12.9           | 97.8      | 0.3         | 0.3                     |

# Conversion Efficiency Measurements

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- Measuring catalyst performance on the test stand
- Air-to-air heat exchanger for exhaust temp control



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# Conversion Efficiency Measurements

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- Huge amounts of air required



# Conversion Efficiency Measurements

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- Automated sampling process before & after catalyst

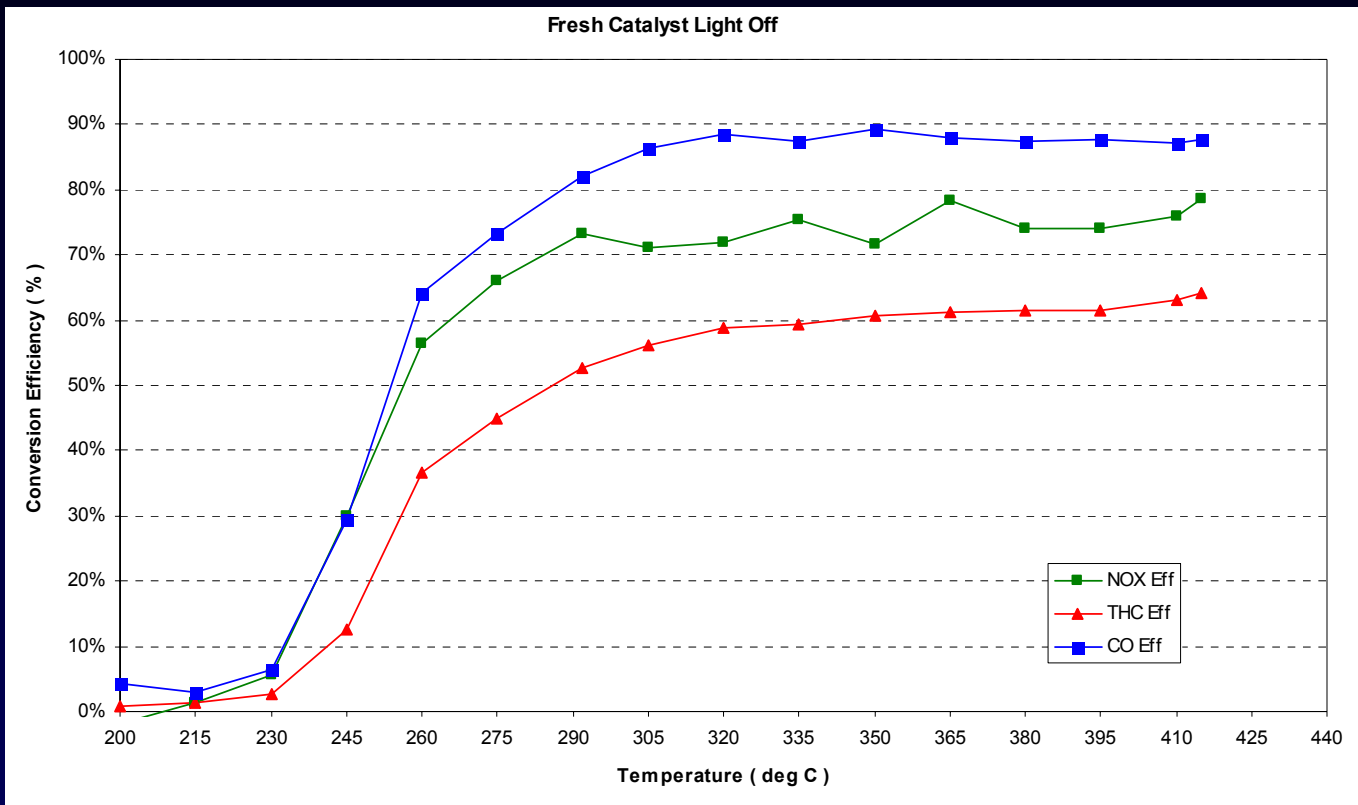


12 December 2006



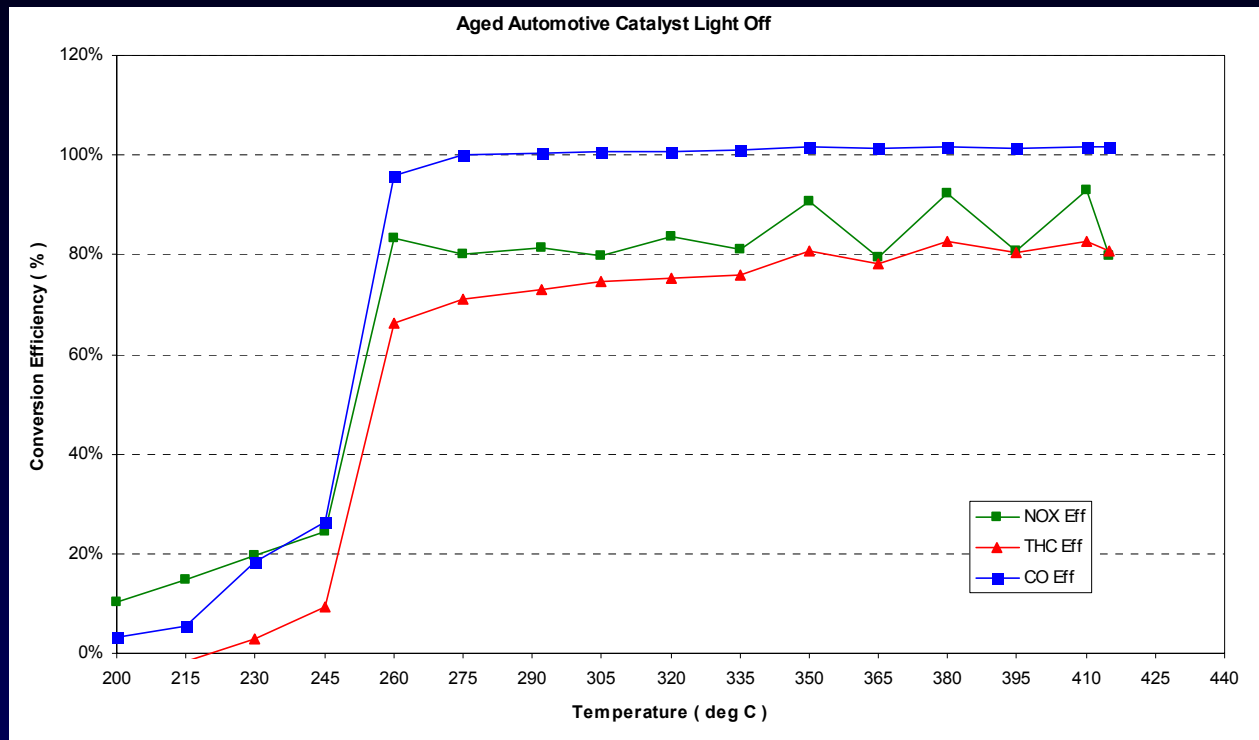
# Conversion Efficiency Measurements

- Practice catalyst



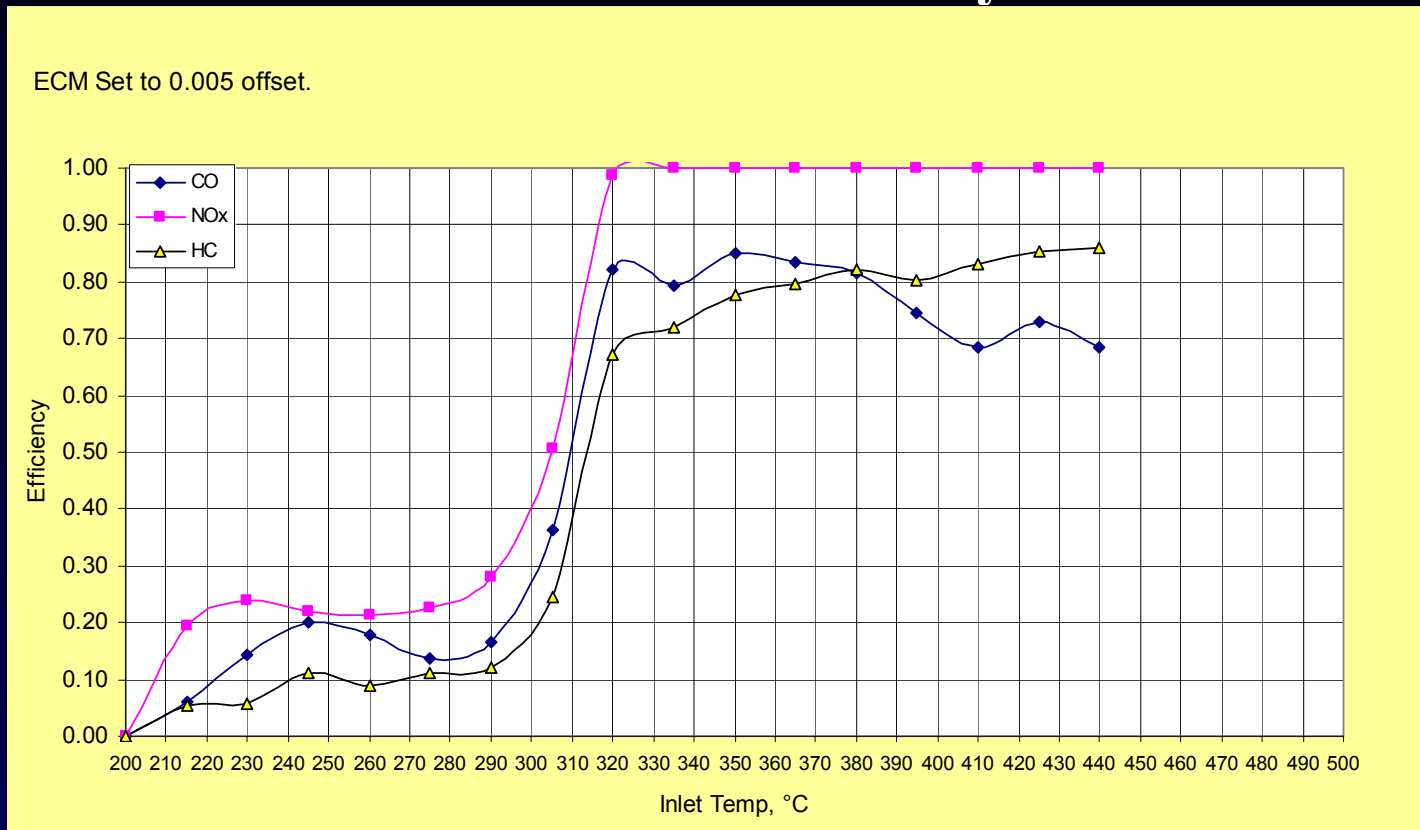
# Conversion Efficiency Measurements

- Used Catalyst from Afton



# Conversion Efficiency Measurements

- Afton's measurements on same catalyst



# Future Plans

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- **Request 6 month extension for project**
- **Further revise PCV and light-off procedures**
- **Conduct Test Matrix**
  1. **Oil 33**
  2. **Oil 33 (with PCV diverted to atmosphere)**
  3. **Oil 35 (no Phosphorus, discrimination?)**
  4. **Oil 33 (repeat-check)**

