Chevron ORONITE

# *Fuel Additive Strategies for Enhancing the Performance of Engines and Engine Oils*

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# Presentation Outline

- Program Motivation
- Technical Challenges
- Program Milestones
  - Identification of Candidate Chemistry
  - Proof of Concept Data
- Conclusion

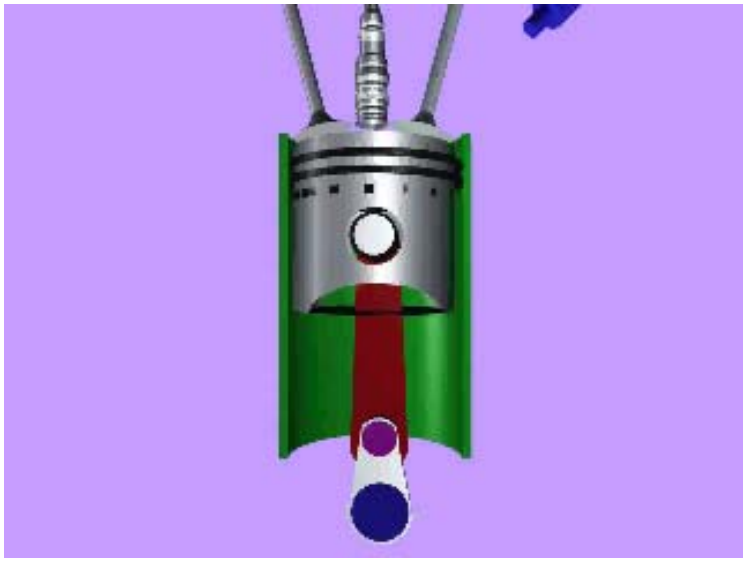
# Program Motivation

*Opportunity to Improve Performance*

- **Deposit Control Additives**
  - Keep new engines clean
  - Clean up dirty engines
- **Novel Targets for Fuel Additives**
  - Performance not tied to deposits
  - Consumer will notice the benefit
  - Make vehicles perform better than new

## Friction Modifier Delivery Mechanism

- Cylinder wall is the immediate target
- Long term gains are realized as the gasoline friction modifier collects in the crankcase



# Friction Modifying Gasoline Additive

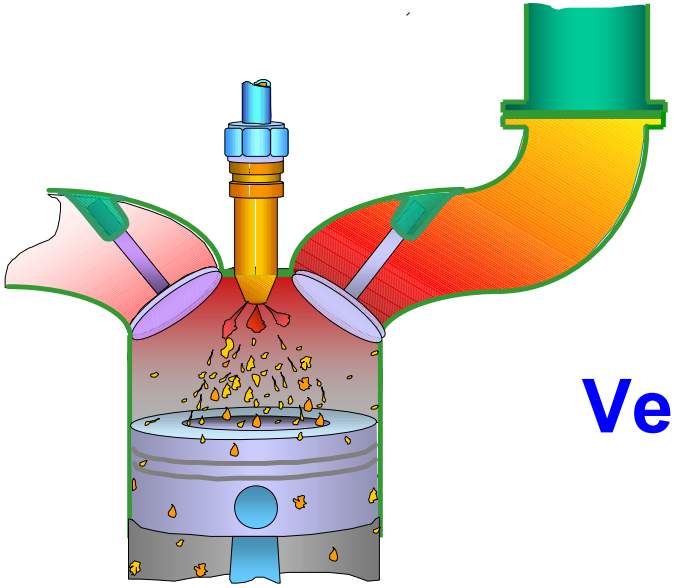
*Vehicle Performance Testing with Fuel $aver*

## *FTP HWFET Results*

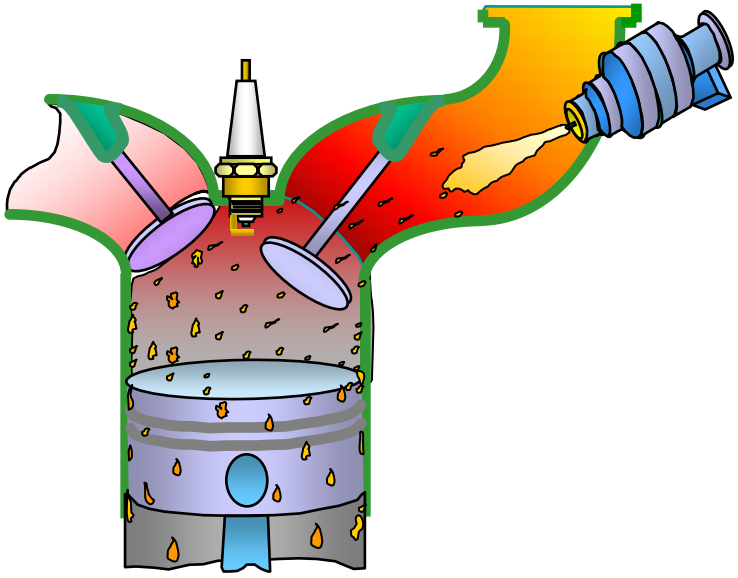
| Make | Model | Immediate Benefit Base Fuel + F$ | Long Term Benefit Base Fuel + F$ & F$ in Oil Sump |
|---|---|---|---|
| Jeep | 2002 Cherokee | 2.42% | 4.40% |
| Dodge | 1998 Caravan | 0.92% | 1.49% |
| Dodge | 1997 Intrepid | 2.08% | 2.55% |
| Toyota | 1997 Camry | 2.45% | 4.07% |
| Dodge | 1994 Ram 1500 | 1.71% | 2.84% |
| Average | | 1.92% | 3.07% |

# New Diesel Fuel Additives

## *Technical Challenges*



**Versus**

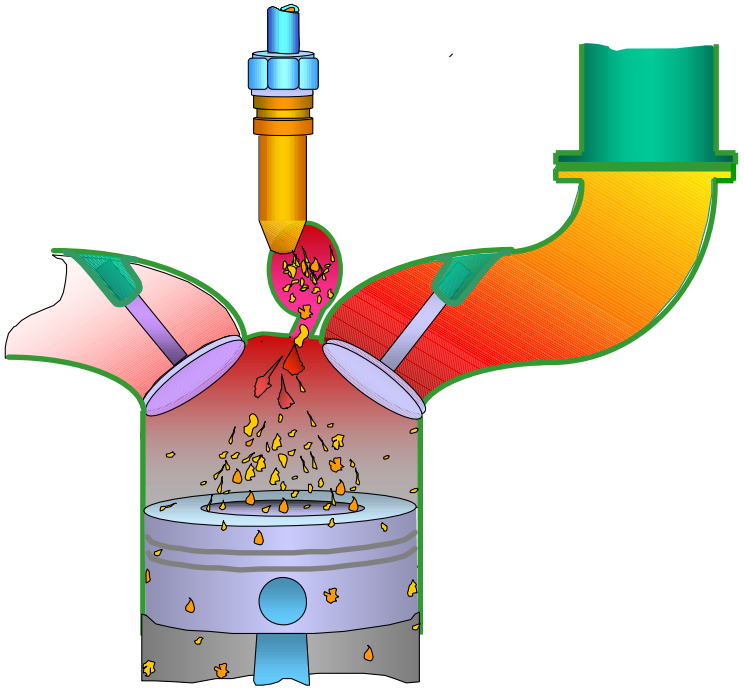


- **Diesel engine design has the injector spray fuel at the piston to minimize fuel hitting the combustion chamber wall**
- **The cylinder wall is exposed to fuel for far less time relative to that of gasoline engines**
- **Less surface area is exposed to the fuel relative to gasoline engines**

# New Diesel Fuel Additives

## *Technical Challenges*

- Various engine designs (DI and IDI)
- Range of injection pressures (250 to 3000 bar)
- The shear rate at the nozzle can impact the chemical integrity of the fuel additive



***Engine hardware may demand different chemistries***

***It is far more difficult for the additive to preferentially reach the fuel/lube interface***

# New Diesel Fuel Additives

## *Development Program - Chemistry*

- **Candidate Synthesis**
  - **Two distinct mechanisms are being pursued**
  - **Each mechanism requires the additive reaches the cylinder wall**
  - **Molecular weight and backbone type has been identified**
  - **Desired performance defines molecule's functionality**

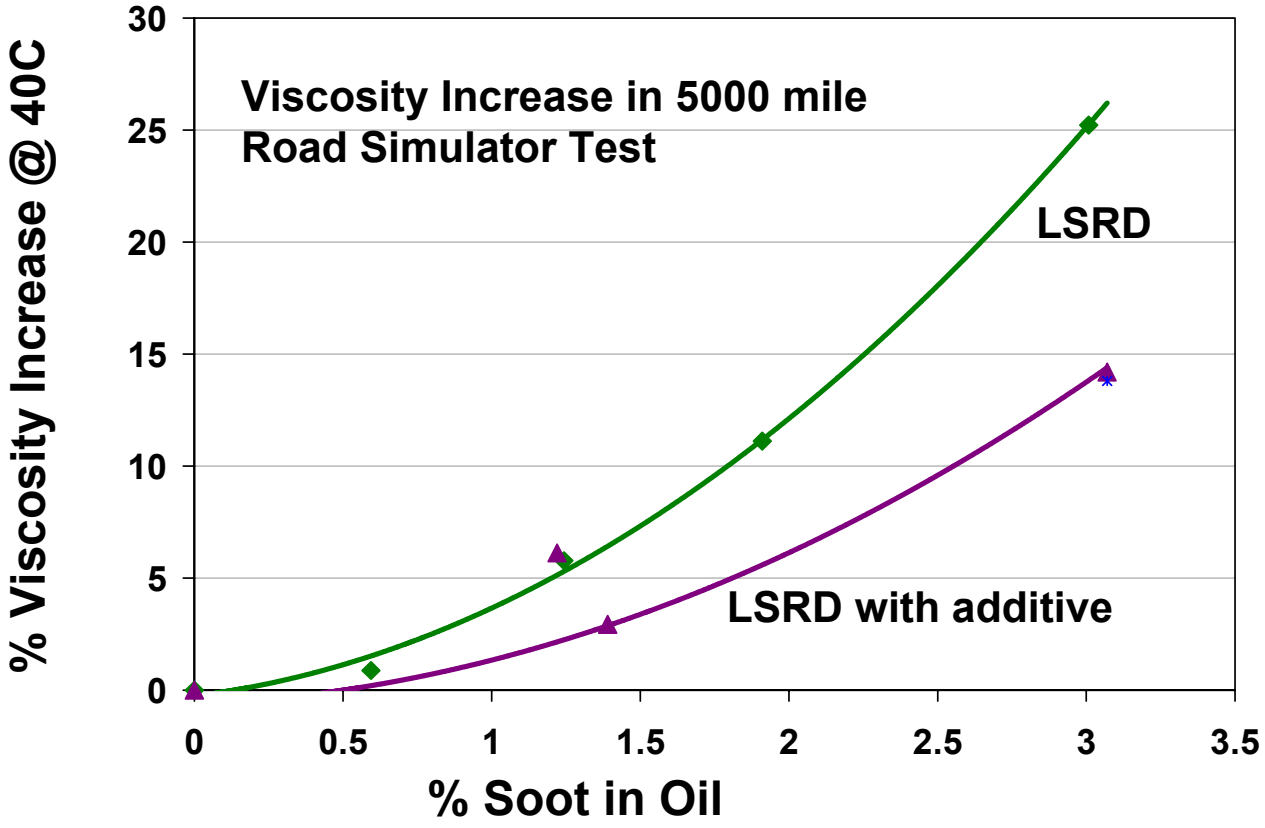
### Molecule Design Strategy

| | | |
|---|---|---|
| Backbone | --Hook--> | Backbone-H |
| Backbone-H | --Performance--> Additive | Backbone-H-P |

# Soot Dispersing Diesel Fuel Additive

## *Passenger DI Vehicle Performance Data*

- **Soot Dispersant Delivered to Lubricant via Fuel**



# Soot Dispersing Diesel Fuel Additive

## *Status*

- A soot dispersing additive was successfully delivered to the oil sump via the fuel in a small diesel engine test
- The additive remains chemically intact according to IR spectra
- The lubricant's viscosity increase control is continuously supplemented during the drain interval
- Retaining the viscometric characteristics of the oil during use yields a fuel economy benefit

# Soot Dispersing Diesel Fuel Additive

## *Performance Data*

- **Passenger Vehicle 1 on Base Fuel**
  - Accumulated Mileage = 7379
  - Weight % Soot in Oil = 3.7
- **Passenger Vehicle 1 on Base Fuel and Additive**
  - Accumulated Mileage =6952
  - Weight % Soot in Oil = 3.4

**Fuel Economy Improvement of 7.6%**

- **Passenger Vehicle 2 with Base Fuel**
  - Accumulated Mileage = 9659
  - Weight % Soot in Oil = 0.5
- **Passenger Vehicle 2 with Base Fuel and Additive**
  - Accumulated Mileage = 9651
  - Weight % Soot in Oil = 0.6

**No Fuel Economy Improvement Seen**

# Friction Modifying Diesel Fuel Additive

*Performance Data*

## DI Passenger Vehicle Test

| | |
|---|---|
| **Time** | 16 hrs conditioning followed by 12 hr hot/cool cycles |
| **Speed** | 2200 rpm in all stages |
| **Load** | 75 lb-ft during conditioning, 25 lb-ft during all other stages |

**Fuel Order:**

1. **Non-FM base fuel**
2. **Non-FM base fuel**
3. **FM treated fuel**

**FEI measurement: 3.- 2.**

**RESULTS:**

**Additive A = 1.9% FEI**

**Additive B = 2.0% FEI**

# Friction Modifying Diesel Fuel Additive

*Performance Data*

## Additional DI Passenger Car Vehicle Test Sets

- Non-FM treated fuel
- FM treated fuel
- FM treated fuel + treated oil

**RESULTS:**

Passenger vehicle 1 - No improvement
Passenger vehicle 2 - 1.04%FEI immediate benefit
- No appreciable predicted long term benefit

# Conclusions:

- Performance additives other than deposit control have been identified for both gasoline and diesel engine applications
- Fuel/lubricant interactions in diesel engines are intrinsically more difficult to develop than for gasoline applications
- Additive chemistries successful in one application is not necessarily transferable to another application
- Soot dispersant and friction modifying additives added to the fuel can provide benefits in some diesel engines
- The chemistry needs to be optimized to perform across the breadth diesel engine designs