Current Gasoline and Diesel Issues

The Role of Fuel Additives

NAMVECC
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Larry Cunningham
Where Are We Now?

- Liquid transportation fuels from fossil reserves will be around for many years.

- Crude oil is a variable product, but with processing-cost can meet demand for a specific fuel quality:
  - Refiners are configured to meet regional demands
  - Some flexibility, but…

- Additives widely used in gasoline and diesel to:
  - Meet specifications
  - Maintain and/or improve quality
  - Add functional features
  - Provide fuel formulation and process flexibility
  - Market fuels
The Storm

- Regulations
- APBF
- Tier 2
- Traps
- Emulsions
- SIDI
- Light duty
- Heavy Duty
- 42 volt
- Boutique Fuels
- OTC
- Toxics
- Fuel Cells
- Hybrids
- PZEV
- SUVs
- Ultra-fines
- Diesel
- NOx
- Smoke
- WWFC
- Oxygenates
- GTL
- MSAT
- CARB
- Phase III
- SCR
- CAFE
- I/M
- Euro IV
- Particulates
- SIPs
- SULEV
- NAAQS
- After treatment
- H₂
- Greenhouse gases
- Syncrude
- Unregulated Emissions
- EGR
- Lead
- NESCAUM
Gasoline Issues
Gasoline Issues
To Mention a Few

- Energy policy
- Oxygenates
  - MTBE issues
  - Renewable Fuel Standard
- Boutique Fuels
  - Good and Bad
- Gasoline - 30ppm average / 80ppm max. sulfur
  - Lubricity and wear especially with increased ethanol use
  - Conductivity
- Sulfur reduction and future sulfur levels
- Pressure on octane pool
- Mobile Source Air Toxics (MSAT)
Gasoline Issues

- Deposit Control
  - Fuel injectors, intake and exhaust valves, combustion chambers, fuel rails & CCD flaking
  - Problems with gasoline in the field
    - Fuel injector deposits a growing issue

- Fuel Economy / Greenhouse Gases

- Diversification of Hardware
  - Unique fuel injection system design
  - Hybrids
  - Direct Injection Gasoline
  - Aftertreatment technology

- Tier 2 emission standards

Used with permission from API
Injector Design

Hole size: 250 µm $\rightarrow$ 180 µm
Pressure: 350 kPa $\rightarrow$ 400 kPa
Performance Additives Used in Gasoline

Additives used to improve quality or performance
- Detergents
- Dispersants
- Friction modifiers
- Lubricity Additives
- Spark Enhancers
- Combustion modifiers

Performance additives are frequently formulated into packages for upgrading the quality of fuel at terminals
Other Additives Used in Gasoline

- Used by refiners to meet specifications
  - Octane improvers
  - Antioxidants
  - Metal deactivators
  - Corrosion Inhibitors / copper
  - Oxygenates

- Used in the distribution of gasoline
  - Rust inhibitors
  - Drag reducers
  - Demulsifiers
Future Vehicle Propulsion Systems

- **Boutique Vehicles**
  - Direct Injection Gasoline
  - Multi-hole Port Injection
  - Hybrid Powered Vehicles
  - Light Duty DI Diesel
  - Conventional Power
  - Fuel Cells

- **Slow to Change**

- **But fuel must work in all**
Diversification
Putting Pressure on Fuels and Additives

- Can one fuel / additive combination work all technology engines
  - For optimal performance, different technologies may require different fuels and / or additives
  - Starting to see injector fouling problems in the US even with additives that meet EPA’s detergency requirement
  - Problems showing up in “non” traditional injectors.

- Some fuel changes are pushing higher levels of additives that may not be harmless
  - Takes more than just a treat rate increase
  - Harm testing

- It’s challenging enough in the U.S.
Examples of Worldwide Fuel Additive Use

Additives are an established way to reduce emissions

**USA**
- **EPA**
  - Mandatory detergent-gasoline
  - RFG - Oxygenates
- **CARB**
  - Mandatory detergent-gasoline
  - Diesel fuel formulation
  - Retrofit program-combustion catalysts
- **States & Regions**
  - Considering higher cetane number, emulsions, fuel reformulations, etc.

**Europe**
- Fuel Borne Catalyst used to enable particulate traps
- Wide spread marketing use

**Far East**
- Widespread marketing use
- Mandatory detergents in Thailand

Some countries are still trying to remove lead from gasoline and lower sulfur for the first time

Additives are an established way to reduce emissions
Conclusions

- Liquid fuels from fossil reserves will be around for a long time
- Lot of changes and challenges ahead
- Hardware is becoming more diversified
  - Boutique vehicles?
- One size fuel and additive may not fit all
- Need to manage the proliferation of fuels and engine technology while finding a way to realize the benefits of lower emitting fuels and vehicles
- Fuel changes may lead to unexpected problems
Regulations should be performance driven where it makes sense, not composition driven
- Allows refiners & marketers to meet emissions targets in most cost effective manner
- Allows auto companies to use bin averaging

Fuel additives can help:
- Meet specifications
- Keep engines operating as designed
- Provide fuel formulation and processing flexibility
- Maintain catalyst efficiency

Diversity of fuels and hardware are making things more challenging
Don’t Forget the Consumer!!

If we are confused......
Is This the Filling Station of the Future?

- Regular Gasoline
- Premium Gasoline
- RFG Gasoline
- Regular Diesel
- Premium Diesel
- RFD Diesel
- Bio Diesel
- CNG
- Hydrogen
- Urea
- Light Duty Diesel
- Emulsions & e-Diesel
Diesel Issues
Diesel Issues

- Diesel - 15ppm max. sulfur
  - Lubricity
  - Low temperature operability
  - Distribution contamination
  - Conductivity
- Off-road
- Water and ethanol emulsions
- Biodiesel
- Light Duty Diesel Fuel (Passenger Car)
- Premium Diesel
- Vehicle aftertreatment
  - NO\textsubscript{x} (SCR / Urea or NO\textsubscript{x} traps)
  - Particulate traps
Additives used to improve quality or performance
- Detergents
- Dispersants
- Cetane improvers
- Lubricity additives
- Operability additives
- Demulsifiers
- Friction modifiers
- Combustion modifiers

Performance additives are frequently formulated into packages for upgrading the quality of fuel at terminals
Other Additives Used in Diesel Fuel

- Used by refiners to meet specifications
  - Pour point depressants
  - Stabilizers, antioxidants and metal deactivators
  - Cetane improvers
  - Copper strip improvers
  - Conductivity Improvers

- Used in the distribution of diesel fuel
  - Rust inhibitors
  - Demulsifiers and biocides
  - Pipeline drag reducers
Diesel Fuel Additives to Reduce Emissions

- **Cetane Improvers**
  - To reduce NO\textsubscript{x}, HC, CO, sometimes particulates
  - Reduce noise, white smoke and warm-up time

- **Combustion Improvers**
  - Reduce particulates

- **Additives for Aftertreatment**
  - **Fuel Borne Catalysts**
    - Enable / enhance particulate trap operation
    - Phosphorous and sulfur scavengers
    - Improves catalysts efficiency and durability
  - Urea for catalytic NO\textsubscript{x} reduction

- **Detergents and dispersants**
  - Maintain fuel system cleanliness
Cetane and NO\textsubscript{X}

- “The Effect of Cetane Number Increase Due to Additives on NO\textsubscript{X} Emissions from Heavy-Duty Highway Engines”
  - EPA Verified Retrofit Technology
  - [http://www.epa.gov/otaq/retrofit/techlist-cetane-enhancers.htm](http://www.epa.gov/otaq/retrofit/techlist-cetane-enhancers.htm)

- “Typical” US fleet operating on a “typical” NA diesel
  - 1,000,000 gallons of diesel fuel
  - ~ 3 tonnes of NO\textsubscript{X} reduction
**NO\textsubscript{x} Reduction**

As a Function of Cetane Number Improvement

<table>
<thead>
<tr>
<th>Increase in cetane number due to additives</th>
<th>Percent reduction in NO\textsubscript{x}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>5</td>
<td>1%</td>
</tr>
<tr>
<td>10</td>
<td>2%</td>
</tr>
<tr>
<td>15</td>
<td>3%</td>
</tr>
</tbody>
</table>

- Natural cetane = 40
- Natural cetane = 45
- Natural cetane = 50
DIESEL for 2006 AND BEYOND
How Do We Get to 2007????

- Solving 2004 was difficult enough
  - Cooled EGR, ACERT(CAT), rate shaping
- $\text{NO}_x$ reduction technology
  - SCR (urea or ammonia reductant)
  - $\text{NO}_x$ traps
  - Plasma catalysis
- Particulate
  - Traps, active oxidation catalysts
  - Fuel Borne Catalysts (FBC)
- APBF-DEC consortium
  - Lube and fuel issue effects

As of today, no proven technology exists at any cost capable of meeting 2007-2010 emission targets
Particulate Control

Engine Test Cell

Emission Equipment

Control Room
Dodge Ram Field Test
DPF Mounted Underbody
PSA Fuel Borne Catalyst Injection System

Principle of filter regeneration

Source - Peugeot
Light Duty Diesel Issues

- Higher pressure injection
  - Wear - pumps & injectors
  - Pressure independent of speed
  - Accurate fuel metering and timing
  - Pilot injection sequences
- Electronic control and interfacing with other vehicle functions
- Acceptable fuel
- Emission system durability
- NO\textsubscript{X} and Particulates
- Consumer image of diesel
Use of Additives in Reducing Emissions

- Key is performance driven regulations, not composition driven regulations
  - Allows refiners & marketers to meet emissions targets in most cost effective manner
  - Allows auto companies to use bin averaging

- Maintain engine cleanliness
  - Keeps engines operating as designed

- Protect aftertreatment from degradation
  - Sulfur and phosphorous contamination
Liquid fuels from fossil reserves will be around for a long time.

Diesel fuel use will continue to grow around the world.

Regulations should be performance driven where it makes sense, not composition driven.

Fuel additives can help:
- Meet specifications
- Keep engines operating as designed
- Provide fuel formulation and processing flexibility
- Enable aftertreatment devices
- Maintain catalyst efficiency

Diversity of fuels and hardware are making things more challenging.
The End

Ethyl Research Center
500 Spring Street, Richmond, Virginia