Fuel Quality
“In Search Of”

Paul Nazzaro
Market Volatility

Crude Oil Prices
2010 Dollars

- OPEC 10% Quota Increase
- Asian financial Crisis
- Low Spare
- Production Capacity
- PDVSA Strike
- Iraq War
- Asian Growth
- Weaker Dollar
- Iran / Iraq
- War
- Iranian
- Revolution
- Suez
- Crisis
- Yom Kippur War
- Oil Embargo
- Gulf War
- Recession
- Libyan
- Uprising
- Series of OPEC Cuts
- 4.2 Million Barrels
- U.S. Price Controls
- 9/11


U.S. 1st Purchase Price (Wellhead)  "World Price"*

Avg U.S. $28.52  Avg World $30.54  Median U.S. & World $20.53

www.wtrg.com
(479) 293-4091
Fuel Slate Transitions – IMO-2020

How will you be impacted?

Figure 1. Global marine fuel sulfur limits
percent by weight

Source: U.S. Energy Information Administration
Don’t Worry About What Is Out Of Your Control
Saudi attacks send oil prices soaring
By Sheena McKenzie, CNN
Updated 5:34 a.m. ET, September 16, 2019

Oil prices trading at their highest levels since May

The attacks on key oil facilities in Saudi Arabia have disrupted about half of the kingdom's oil capacity, or 5% of the daily global oil supply.
U.S. Distillate Markets

Sales of Distillate Fuel Oil by End Use

- U.S. No 2 Diesel Sales/Deliveries to On-Highway Consumers
- U.S. Total Distillate Retail Deliveries

Source: U.S. Energy Information Administration

2017
62 / 41 BGY
Florida Consumption

Sales of Distillate Fuel Oil by End Use

Mgal

Source: U.S. Energy Information Administration
U.S. Biodiesel & Renewable Diesel Market

(millions of gallons)
Source: EPA EMTS*

*Biodiesel and Renewable Diesel

*Renewable Diesel

*Volumes reported under the RFS in the D4, D5, and D6 categories.
Low Carbon Liquid Fuels, Mandates/Incentives
Arbitrage Discretionary Blending Driving Markets

Petroleum Administration for Defense Districts

- CARB LCFS 800 MGY B20
- Bioheat® 200-800 MGY B5 – B20 NEFI Resolution B50 by 2030
What is Biodiesel?

- A domestic, sustainable, renewable fuel for blending into diesel and heating oil made from fats and oils, such as soybean oil and used cooking oil

- EPA designates biodiesel as a high-quality Advanced Biofuel, because it helps reduce GHG emissions between 57% - 86%

- Made through a chemical reaction called transesterification, raw vegetable oil, recycled cooking oil, RHD/Renewable Diesel are not biodiesel
Biodiesel Improves Diesel Fuel Properties

• High Cetane
  • Over 50 vs. average petrodiesel around 44

• Enhanced Lubricity
  • 2% biodiesel, can impart a 65% increase in value

• Virtually Zero Sulfur
  • Meets ULSD limits of 15 ppm or less
  • Up to 86% life cycle CO₂ reduction (per EPA)

• Zero Aromatics Reduces Toxicity and Burns Cleaner

• 11% Oxygen Provides Superior Lubricity and Reduces Black Smoke (Particulates)

• High Flash Point Makes it Safer to Store & Handle

• Low Carbon Liquid Fuel
The ASTM Minimum Standards

• ASTM D6751 (B100)
• ASTM D975 (Petroleum Diesel)
  • And Up to B5
• ASTM D7467 (B6-B20)
• ASTM D396 (Heating Oil)
  • 6-20% Falls Under D396

- B100 Specifications Originally Published in 1999/2002
- Specification Has Been Revised 23 Times
- 23 vs 14 Minimum Properties Evaluated for Biodiesel versus Diesel Fuel
Gasoline Marketing Trends
The Evolution at the Pump
All Gasolines are Created Equal, “What’s Your $”

63% of U.S. Drivers believe there is a difference in the quality of gasoline sold by different gas stations...

BUT ONLY 12% choose a gas station based on fuel quality.*

*gasoline that contains an enhanced detergent additive
Gasoline Direct Injection (GDI) Systems

Benefits
- More Power
- Significant Efficiency Improvements
- Greenhouse Gas Reductions

Challenges
- Injector Coking
Projected Growth Globally

• GDI Market Penetration Grew From **1% to 44%** In Last **17** Years

• Now Projected To Go To **62%** in the next **5** years

Source: IHS 2014
TOP TIER® Gasoline, An Overview

• Voluntary standard sponsored by OEM’s

• Addresses, combustion chamber deposits and valve sticking performance

• (~2½ times) more deposit control additive required vs LAC

• Participation requires all grades, all marketing areas
Next Generation Gasoline Marketing Increases
Diesel Fuel
America’s Work Horse
What’s Changed?

“Do You Know What’s In Your Saddle Tank”?
“Do You Know What Happens In HPFI Systems”? 
Ultra Low Sulfur Diesel
Removing Sulfur Chemically Changed the Fuel, Challenging.....

- Lubricity
- Stability
- Conductivity
- Winter Operability
- Solvency
- Density
Extreme Temperature & Pressures

600F / 38,000 PSI

Filter Blocking = Shortened PMI
Power Loss = Reduced Performance
Economy Deficits = Increased Fuel Costs

Injector Tip, Plunger Barrel and Injector Labyrinth, The “Impact Zone”
Filtration Challenges

Primary Fuel Filters

- New: 7-25 µm
- Historical: 10-50 µm

Secondary Fuel Filter

- New: 2-5 µm
- Historical: 2-15 µm
Filter Plugging & Mileage Depreciation

Have you ever burnt a burger while grilling?

Particles are masses of smaller, hydrogen rich carbonaceous particles
Diagnosing The Operational Issues, “Critical”
Microbial, Corrosion, Monoglycerides, Water, Paraffin and Thermal Instability
The Corrosion Controversy

Contract No. CON00008097
Study No 10001530
Final Report

Corrosion in Systems Storing and Dispensing Ultra Low Sulfur Diesel (ULSD), Hypotheses Investigation

Battelle Memorial Institute
505 King Avenue
Columbus, OH 43201

To
Clean Diesel Fuel Alliance
C/O Mr. Priestis Searles
American Petroleum Institute
1220 L Street, NW
Washington, DC 20005-4070

September 5, 2012
The Black Hole
### NCWM

**Current & Proposed Premium Diesel Spec’s**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cetane Number: 47 Minimum</td>
<td>Cetane Number, ASTM D613: 47 minimum</td>
</tr>
<tr>
<td>Lubricity: 520 Micron</td>
<td>Corrosion, NACE TM0172-2015: B+ rating minimum</td>
</tr>
<tr>
<td>Low Temperature Operability: Requiring the ASTM Guideline Using the Tougher LTFT Method</td>
<td>Filter Blocking Tendency, ASTM D2068, procedure B: 1.6 maximum</td>
</tr>
<tr>
<td>Stability: 80% Reflectance, 180-Minute Test</td>
<td>Injector Deposit, CEC DW-10 B: 2 % maximum power loss</td>
</tr>
<tr>
<td></td>
<td>Low Temperature Operability, Cloud Point, LTFT, or a restricted CFPP: ASTM D975 Guideline</td>
</tr>
<tr>
<td></td>
<td>• CFPP should be limited to a maximum of 6 C below the cloud point of the fuel.</td>
</tr>
<tr>
<td></td>
<td>• Lubricity Wear Scar Diameter, ASTM D6079: 460-micron maximum</td>
</tr>
</tbody>
</table>
• What is it?

• A voluntary program, endorsed by an alliance of engine makers.

• Driven by ULSD mandate, HPFI systems, EMA concerns about diesel quality and D975.

• Fuel contamination concerns, particulate matter, water and corrosion.

• Additives, Filtration & Housekeeping.

• What are the drivers?

• What are the performance standards
Additives, Situation – Solution - Strategy

• Target

What’s the challenge?

• Cold Flow
  • Pour Point, Home Heating, Terminals
  • Cold Filter Plugging Point, Diesel Focused
  • Cloud Point

What’s the approach?

• Detergent
• Dispersant
• Corrosion Inhibitor
• Stabilizers
• Metal Deactivators
• Defoamer
• Biocides
• Markers

What’s the solution?

• Multi-functional,
  • Balancing The Package, Physical Handling Characteristics, Housekeeping

What’s the rate of return?

✓ Monetizing The Treatment Cost
✓ Earning The Customers Confidence & Trust
Resources

www.yourfuelsolution.com
www.biodiesel.org
978-258-8360

Fuels Institute

Extending Filter Life in EPA Diesel Engines

The modern, high-efficiency diesel engine produces higher pressures and higher temperatures in order to increase fuel efficiency and reduce emissions.

The only problem?
Today’s even more severe diesel fuel can’t handle the heat.

By Paul Huesman
President
Advanced Fuel Solutions, Inc.