Biodiesel Specifications and Life Cycle

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THE AD CAMPAIGN WAS A HUGE, HUGE SUCCESS!

DEFINITE "HUGE, HUGE SUCCESS." HOW MUCH DID SALES INCREASE?

WE DON'T TRACK THOSE NUMBERS.

BUT I KNOW THE AD CREATED A HUGE BUZZ BECAUSE OF ALL THE E-MAIL I GOT THE NEXT DAY.

HOW MANY MESSAGES DID YOU GET?

SIX, BUT THAT'S A LOT FOR ONE TOPIC. WOW! SIX!

HOW MANY OF THE SIX WERE FROM YOUR OWN EMPLOYEES?

WHO INVITED THE ENGINEER?

I THOUGHT HE WAS WITH YOU.

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The Biodiesel Reaction

In the presence of a catalyst

Combining

Vegetable Oil or Animal Fat (100 lbs.)
+ Methanol or Ethanol (10 lbs.)

Yields

Biodiesel (100 lbs.)
+ Glycerine (10 lbs.)
Biodiesel Raw Materials

Oil or Fat
- Soybean
- Corn
- Canola
- Cottonseed
- Sunflower
- Beef tallow
- Pork lard
- Used cooking oils

Alcohol
- Methanol
- Ethanol

Catalyst
- Sodium hydroxide
- Potassium hydroxide
What is biodiesel?

- **Chemically**
  - Long Chain Fatty Acid Mono Alkyl Ester

- **Functionally**
  - Surrogate for petroleum distillates

- **Nomenclature**
  - B100 = 100% pure Biodiesel, AKA “neat”
  - B20: 20% Biodiesel / 80% petrodiesel
  - B2: 2% Biodiesel / 98% petrodiesel
Biodiesel is NOT:

- Coal slurry
- Raw, unprocessed vegetable oil
- Used cooking oil from McDonalds
- Raw vegetable oil mixed with diesel
- Mixture of esters and diesel fuel
- Ethanol or E-diesel or 02 Diesel
- Or anything else organic
Important Biodiesel Parameters

- Complete Reaction, No Un-reacted Oil
- Removal of Glycerine
- Removal of Catalyst
- Removal of Alcohol
- Absence of Free Fatty Acids

- Insured through ASTM D 6751
<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Method</th>
<th>$S_{15}$ Limits</th>
<th>$S_{500}$ Limits</th>
<th>Units</th>
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<tbody>
<tr>
<td>Flash Point</td>
<td>93</td>
<td>130 min</td>
<td>130 min</td>
<td>degree C</td>
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<tr>
<td>Water &amp; Sediment</td>
<td>2709</td>
<td>0.05 max</td>
<td>0.05 max</td>
<td>vol.%</td>
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<tr>
<td>Carbon Residue (100% sample)</td>
<td>4530</td>
<td>0.05 max</td>
<td>0.05 max</td>
<td>wt. %</td>
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<tr>
<td>Sulfated Ash</td>
<td>874</td>
<td>0.02 max</td>
<td>0.02 max</td>
<td>wt. %</td>
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<tr>
<td>Kin. Viscosity, 40C</td>
<td>445</td>
<td>1.9 - 6.0</td>
<td>1.9 - 6.0</td>
<td>mm²/sec.</td>
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<tr>
<td>Sulfur</td>
<td>5453</td>
<td>15 max</td>
<td>500 max</td>
<td>ppm</td>
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<tr>
<td>Cetane</td>
<td>613</td>
<td>47 min</td>
<td>47 min</td>
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<tr>
<td>Cloud Point</td>
<td>2500</td>
<td>Report</td>
<td>Report</td>
<td>degree C</td>
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<tr>
<td>Copper Corrosion</td>
<td>130</td>
<td>No. 3 max</td>
<td>No. 3 max</td>
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<tr>
<td>Acid Number</td>
<td>664</td>
<td>0.80 max</td>
<td>0.80 max</td>
<td>mg KOH/g</td>
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<td>Free Glycerin</td>
<td>6854</td>
<td>0.020 max</td>
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<td>wt. %</td>
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<tr>
<td>Total Glycerin</td>
<td>6854</td>
<td>0.240 max</td>
<td>0.240 max</td>
<td>wt. %</td>
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<tr>
<td>Phosphorous</td>
<td>4951</td>
<td>10 max</td>
<td>10 max</td>
<td>ppm</td>
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<td>Distillation, T90 AET</td>
<td>1160</td>
<td>360 max</td>
<td>360 max</td>
<td>degree C</td>
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</table>
**D 6751 S15/S500 Grade**

- Stand alone D6751-03 available from ASTM web site or hard copy in 2-3 months
- S15/S500 designation only applies officially to B100 at this time, not to blends
- Petrodiesel, D975, plans to use same nomenclature
- When applied to blends:
  - S15 B20 is B20 with total sulfur level less than 15 ppm
  - S500 B20 is B20 with total sulfur level less than 500 ppm
  - Companies can market other levels if they want:
    - S30 B20 would be B20 that has less than 30 ppm
    - S30 B100 would be biodiesel with sulfur less than 30 ppm
Biodiesel--Physical Properties

- No Sulfur
- No Aromatics
- High Cetane
- High Lubricity
- Biodegradable
- Non-Toxic

- All Proven Through Scientific Study
How can Biodiesel be used?

- As a pure fuel
- As a blending stock with petrodiesel (B20)
- In low levels with petrodiesel (1 to 5%)

ANYWHERE #1 or #2 diesel is used
ASTM B20 Fill and Go Spec

- D 6751 has been very effective
- But there is an industry need to define the finished properties of the biodiesel blend
  - Purchasers, enforcement, engine designers
- ASTM has developed new philosophy for diesel fuels: Fill and Go Fuels
  - No engine changes, similar to petrodiesel but properties or test methods are slightly different
B20—Fill and Go

- Steve Howell, Chair
- Steve Westbrook, SwRI
- Rod Lawrence, Williams
- Pam Serino, DESC
- Msgt Tim Kearney, Scott Air Force Base
- Emilio Alfaro, WP AFB
- George Kopitke, Griffin
- Ron Hayes, MO Dept Ag
- Paul Henderson, TQS
- Andy Buczynsky, GM
- Rodica Baranescu, Internat’l
- Loren Beard, DaimlerChrysler
- Mike Lockhart, Growmark
- Joia Spooner-Wyman, P&G
- Gerry Downing, ADM
- Jon Lantz, Countrymark
- Donna Hoel, ExxonMobile
- Leo Stavinoha, consultant
- Bob McCormick, NREL
- Louis Villahermosa, TACOM
- Jill Tebbe, TACOM
- Dominique DiCicco, Ford
- Wolfgang Stieger, VW
B20—Fill and Go

- Specification should be part of D975
- Biodiesel must meet D6751 prior to blending
- Spec should cover all blends B20 and below
- Spec should cover No. 1 and No. 2 blends
- Blend properties should be set based on values needed for satisfactory engine operation
- Similar to D 975 properties, minor changes
  - Probably add acid number, thermal stability
- Ballot a specification in the Fall of 2003
NCWM Premium Diesel

- Premium Diesel Re-Defined by NCWM
- Must meet all four criteria:
  - Lubricity: 520 HFRR
  - Thermal Stability: 80% reflectance
  - Low Temp. Operability: 10th % Temp
  - Cetane number: 47 min.
Specifications and OEM’s

- OEM statements on biodiesel are a work in progress, dependent on experience
- B100 Must Meet ASTM D 6751
- B5 support across the board (EMA)
- Some support B100, some B20
- Some only recommend B5, even though use of B20 will not void warranty
- Problems caused by the fuel are the responsibility of the fuel supplier
  - This is the same case as with petrodiesel
NBB and OEM’s

- NBB is working cooperatively with most of the major engine companies to develop full B20 support in existing and new engines
- B20 Evaluation Team has been formed
- Detailed review of technical data and field experience with B20 under various scenarios
- B20 Fill and Go specification being balloted
- Education, data sharing to address concerns, ‘not tested here’ are biggest hurdles
Biodiesel Life Cycle Results

- Closed Carbon Cycle:
  - 78% Life Cycle Decrease In CO₂

- Energy Balance:
  - Soybean Oil, bare ground to consumer use
  - For every unit of energy to produce biodiesel, 3.24 units of energy are gained