

Biodiesel
Specifications and Life Cycle

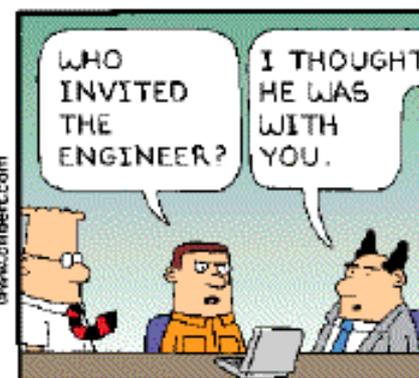
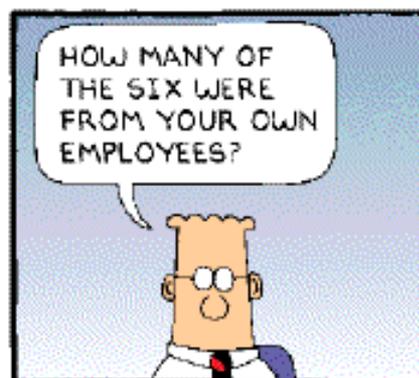
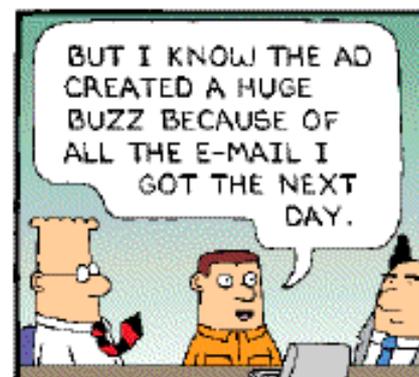
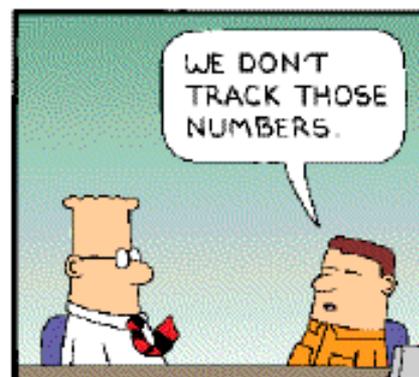
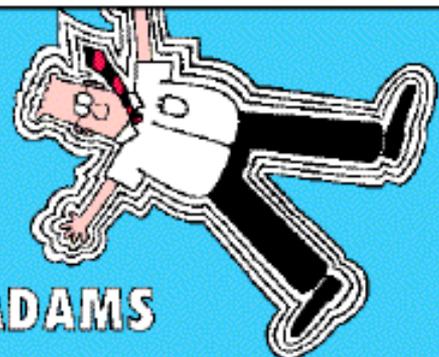
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DILBERT[®]

BY
SCOTT ADAMS

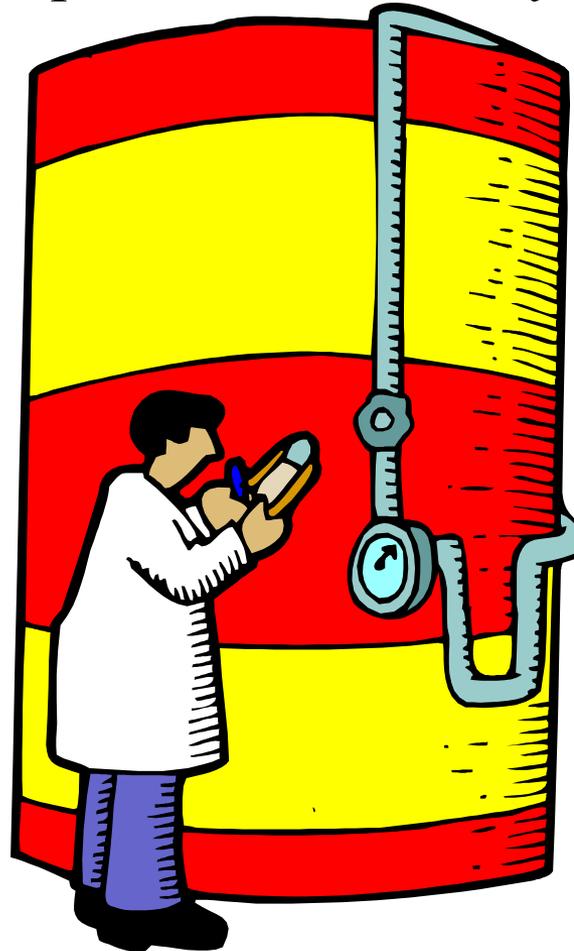


The Biodiesel Reaction

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

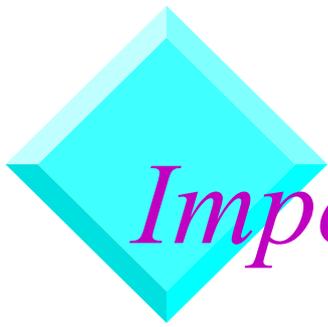
- ❖ Nomenclature

- B100 = 100% pure Biodiesel, AKA “neat”
- B20: 20% Biodiesel / 80% petrodiesel
- B2: 2% Biodiesel / 98% petrodiesel



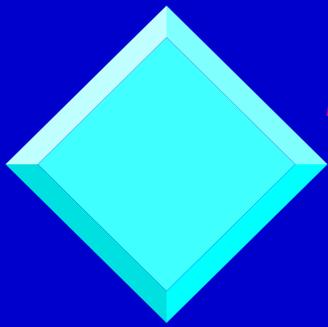
Biodiesel is NOT:

- ❖ 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 O2 Diesel
- ❖ Or anything else organic



Important Biodiesel Parameters

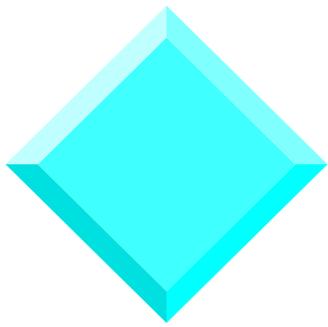
- ❖ Complete Reaction, No Un-reacted Oil
 - ❖ Removal of Glycerine
 - ❖ Removal of Catalyst
 - ❖ Removal of Alcohol
 - ❖ Absence of Free Fatty Acids
-
- ❖ Insured through ASTM D 6751



ASTM Biodiesel Specification

ASTM 6751 (July 2003)

| <u>Property</u> | <u>ASTM Method</u> | <u>S 15 Limits</u> | <u>S500 Limits</u> | <u>Units</u> |
|---------------------------------|--------------------|--------------------|--------------------|-----------------------|
| Flash Point | 93 | 130 min | 130 min | degree C |
| Water & Sediment | 2709 | 0.05 max | 0.05 max | vol. % |
| Carbon Residue (100% sample) | 4530 | 0.05 max | 0.05 max | wt. % |
| Sulfated Ash | 874 | 0.02 max | 0.02 max | wt. % |
| Kin. Viscosity, 40C | 445 | 1.9 - 6.0 | 1.9 - 6.0 | mm ² /sec. |
| Sulfur | 5453 | 15 max | 500 max | ppm |
| Cetane | 613 | 47 min | 47 min | |
| Cloud Point | 2500 | Report | Report | degree C |
| Copper Corrosion | 130 | No. 3 max | No. 3 max | |
| Acid Number | 664 | 0.80 max | 0.80 max | mg KOH/g |
| Free Glycerin | 6854 | 0.020 max | 0.020 max | wt. % |
| Total Glycerin | 6854 | 0.240 max | 0.240 max | wt. % |
| Phosphorous | 4951 | 10 max | 10 max | ppm |
| Distillation, T90 AET | 1160 | 360 max | 360 max | degree C |



D 6751 S15/S500 Grade

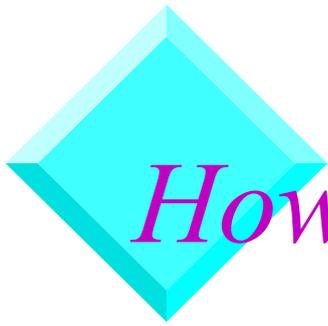
- ❖ Stand alone D6751-03 available from ASTM web site or hard copy in 2-3 months
- ❖ S15/S500 designation only applies officially to B100 at this time, not to blends
- ❖ Petrodiesel, D975, plans to use same nomenclature
- ❖ When applied to blends:
 - S15 B20 is B20 with total sulfur level less than 15 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



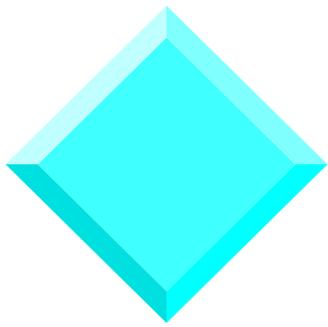
ASTM B20 Fill and Go Spec

- ❖ 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