

Terminal Operations, Pipeline, Fuel Distribution Fundamentals



Race to Success

With

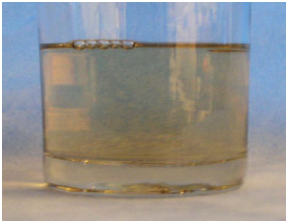
America's Advanced Biofuel

Overview

- Introduction
- Product and Processes
- Supply Chain Management
- Storage Tank
- Fuel Tank Maintenance
- Purchasing
- Conclusion



Finished Fuels



Bulk Fuel Transmission



Bulk Fuel Storage



Local Terminals



Fueling



Utilities

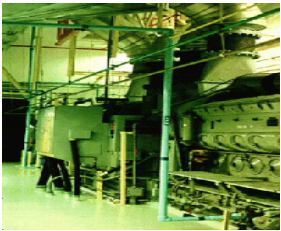


The heavy reliance of diesel or biodiesel blended fuel is not just for on-highway use but falls across the entire spectrum of industries that rely on compression ignition, turbine and open combustion produced energy for non-critical and critical power and heating applications.

Telecommunications



Emergency Systems



Agriculture



Aviation



Ground



Industrial



Rail



Marine



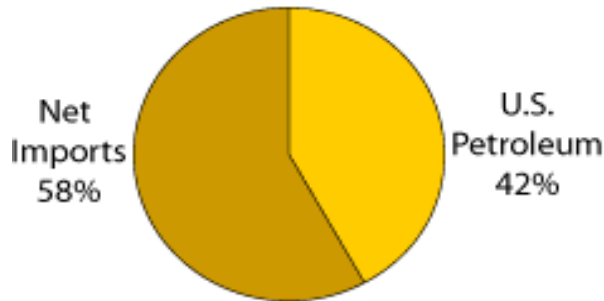
Supply & Demand

Although the U.S. is the third largest crude oil producer, most of the petroleum we use is imported.

Western Hemisphere nations provide about half of our imported petroleum.

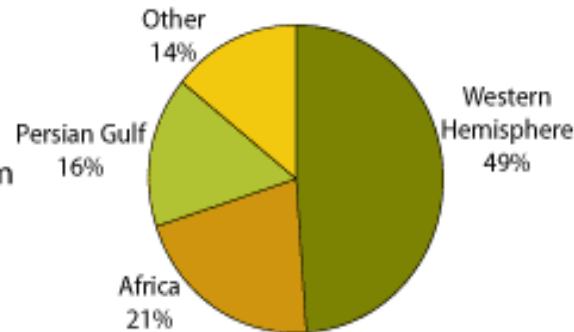
Net imports have generally increased since 1985 while U.S. production fell and consumption grew.

Net Imports and Domestic Petroleum as Shares of U.S. Demand (2007)

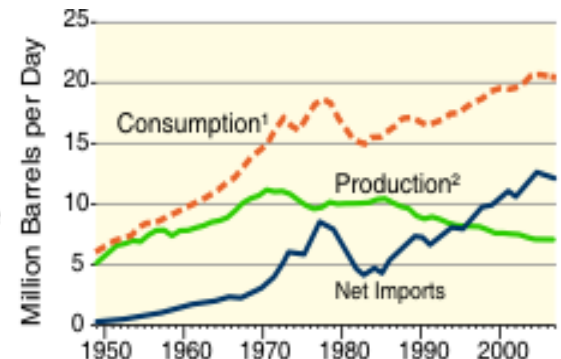


Source: Energy Information Administration

Sources of U.S. Petroleum Imports (2007)



Source: Energy Information Administration



¹Petroleum products supplied is used as an approximation for consumption.
²Crude oil and natural gas plant liquids production.

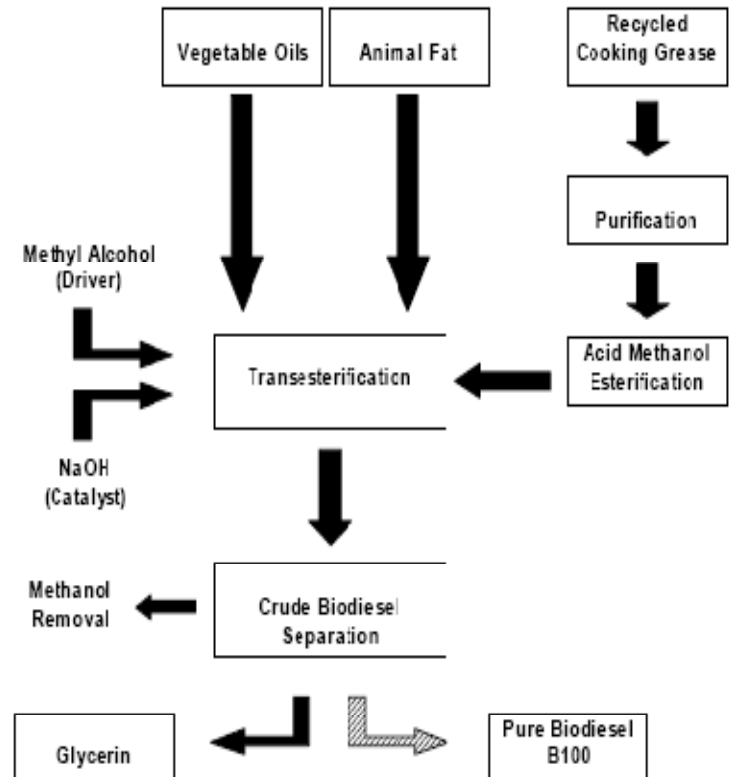
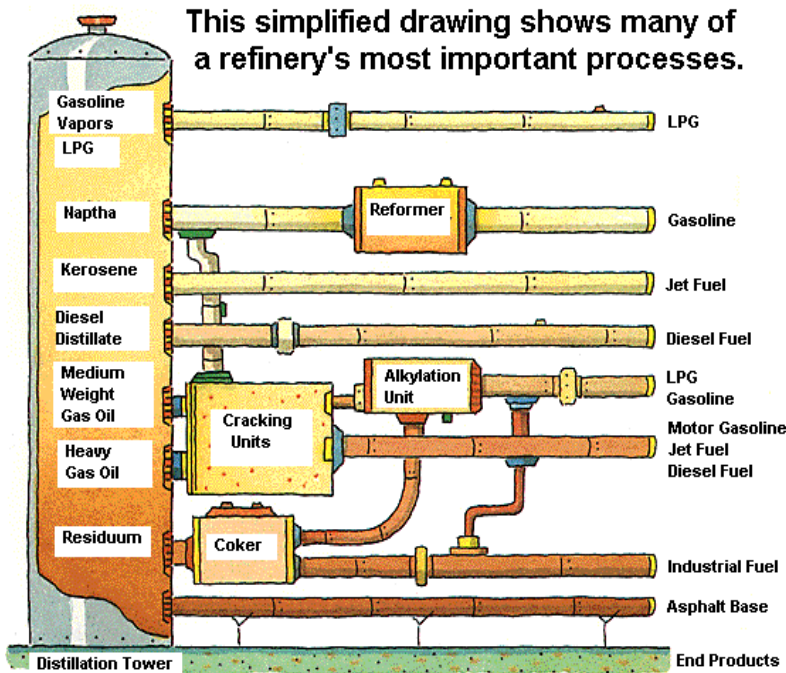
Source: Energy Information Administration, *Annual Energy Review 2007*-Table 5.1. (June 2008)

Production Process Comparison

Petroleum Diesel
Distillation Process

vs.

Biodiesel
Transesterification Process



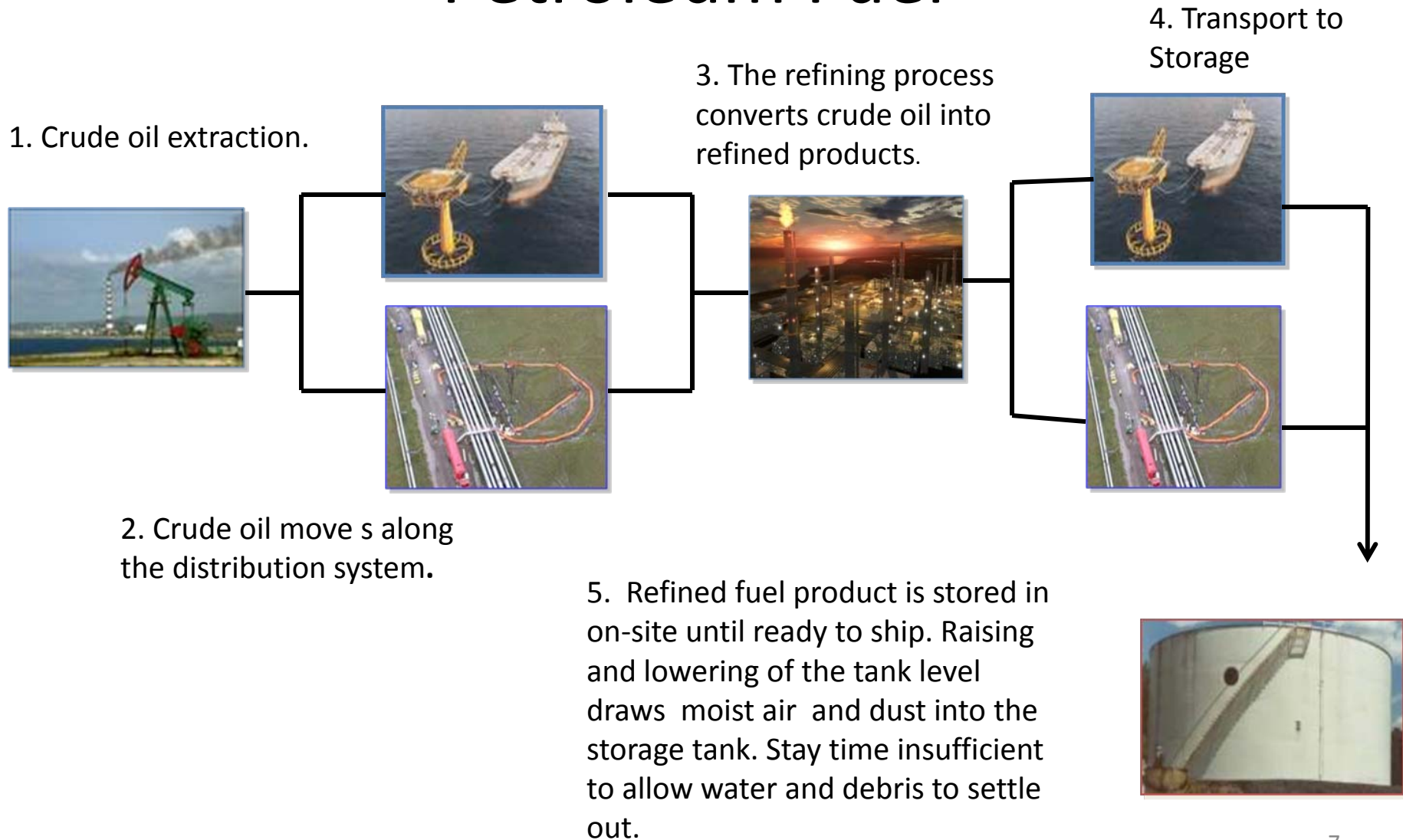
Source: *Understanding Biodiesel Fuel Quality and Performance*

Net Positive for Food Supply



- All materials used for biodiesel are ag by-products.
- Soybeans are grown based on the demand for their 80% protein meal
- By increasing the value of the 20% oil portion, you are lowering the cost of the healthy protein portion used for food and feed.
- In 2009, the soybeans used to make 247 million gallons of soybean oil based biodiesel produced soybean meal for **72 billion rations of protein.**

Storage, Distribution and Contamination Petroleum Fuel



Storage, Distribution and Contamination Petroleum Fuel

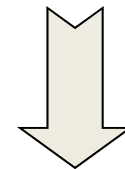


6. Refined fuel cools along the distribution system condensing water and microorganisms to form active pools/bio-films distributing microorganisms and their corrosive metabolites downstream to ASTs and USTs



7. Poor ballast stripping sends water and microbes with offloaded fuel.

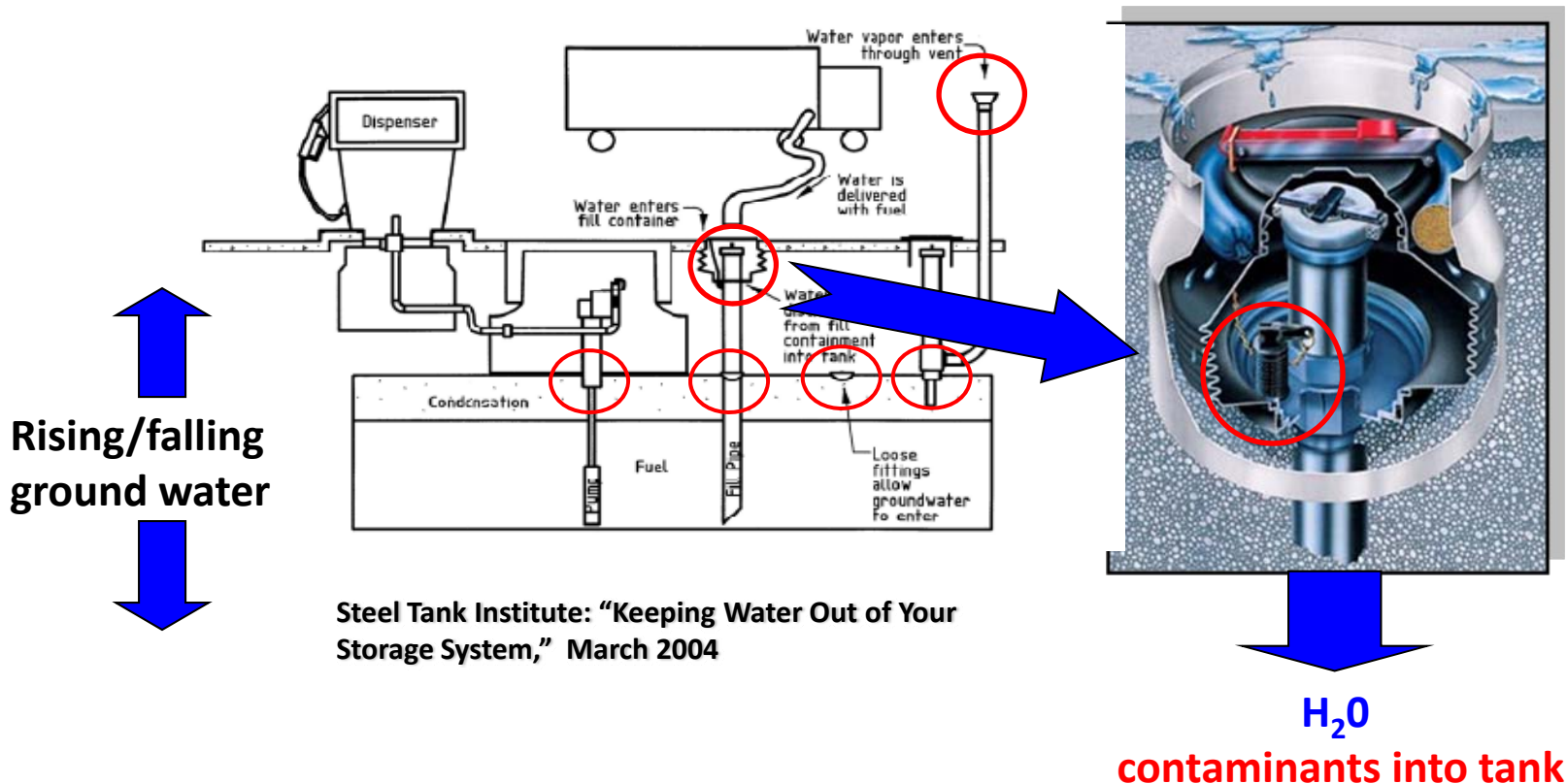
8. Pipelines and storage tanks are contaminated from upstream product tenders



Downstream Retail Market

Sources of UST Water and Contamination

Water, Microbes and Debris



Fuel Storage and Distribution

UST Microbial Contamination

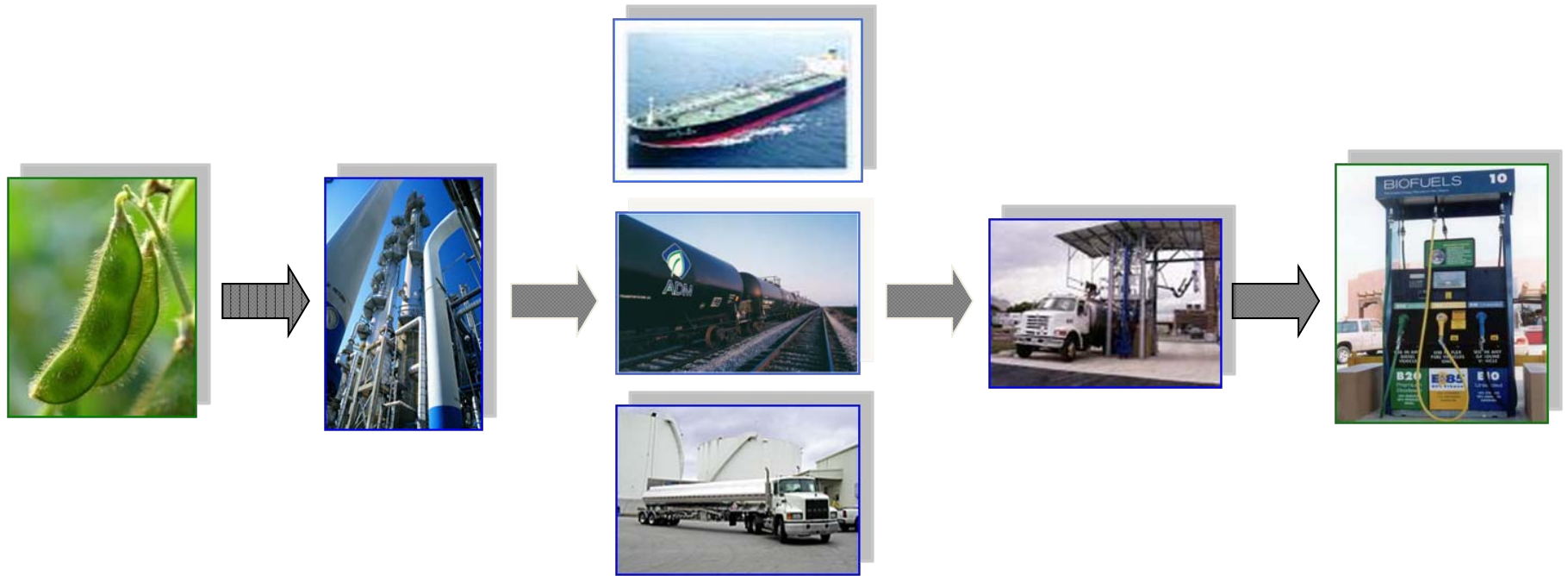


Fill End

Pump End



Storage, Distribution and Contamination Biodiesel



Production

Manufacturing

Bulk Shipping

Terminal Loading

Retail Sale

Consumption and Storage Diesel Fuel

- Generally diesel fuel is consumed 90-120 days following refining.
- Generally accepted shelf life of diesel fuel ≤ 12 months.
- Diesel fuel stored >12 months is classified by ASTM D975 as long term stored fuel.
- Biodiesel shelf life is generally 6 months.
- Storage of diesel or biodiesel blends beyond their recommended shelf life increases probability of fuel quality degradation and must be monitored.

Long Term Storage and Issues

| ISSUE | CAUSE | SYMPTOM(S) |
|---|---|--|
| Oxidative and thermal instability (ULSD can be more stable) | <ul style="list-style-type: none"> • Reactive olefinic species • Copper /zinc oxidative catalyst • Oxygen present in ullage • High temperatures in engine | <ul style="list-style-type: none"> • Formation of gums and soaps (sludge) • Filter plugging. |
| Microbial growth | <ul style="list-style-type: none"> • Water • Microbes | <ul style="list-style-type: none"> • Aerobic microbes form acids that cause general corrosion • Anaerobic microbes strong acids cause pitting corrosion • Filter plugging |
| Biodiesel, (shelf life 6 months) | <ul style="list-style-type: none"> • Fuel Oxidation • Cold Flow Management | <ul style="list-style-type: none"> • Filter plugging • Elastomer swelling (Over B20) • System Deposits |

Biodiesel? Renewable Diesel?

- *Biodiesel*: A fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats that meets the fuel specification requirements of ASTM D6751. Produced in free-standing facilities.
- *Renewable Diesel*: Defined in the Internal Revenue Code (IRC) as liquid fuel produced from biomass that meets the fuel specification requirements of ASTM D975 (petroleum diesel fuel) or ASTM D396 (home heating oil). Produced in free-standing facilities.
- *Co-Processed Renewable Diesel*: Renewable diesel that is produced when an oil company adds small amounts vegetable oils or animal fats to the traditional petroleum refining process when producing diesel fuel (co-processing). Scheduled to be produced in existing oil refineries. **NOT eligible for \$1/gallon tax credit.**

Imposter Biodiesel Quality Issues

Chemical By-Product

Effect

Free Glycerin

Corrodes non-ferrous metals, soaks cellulose filters, sediments on moving parts and lacquering resulting in filter clogging and Injector coking

Mono- & di- Glycerides

Precipitation Above the cloud point, sediments on moving parts and lacquering resulting in filter clogging and Injector coking

Free Fatty Acid

Causes swelling of some elastomers, nitrile rubbers to soften, swell or harden and crack resulting in potential fuel leakage. Provides electrolytes and hastens the corrosion of zinc, salts of organic acids, organic compounds formed corrosion of FIE, filter plugging and sediment formation on parts.

Source: Diesel Fuel Injection Equipment Manufacturers Common Position Statement

Imposter Biodiesel Quality Issues

Chemical By-Product

Effect

Methanol Carryover

Corrodes aluminum & zinc, Corrosion of FIE low flash point

Process Catalysts

Potassium and sodium compounds solid particles potentially blocking injection nozzles.

Source: Diesel Fuel Injection Equipment Manufacturers Common Position Statement



Biodiesel: Stringent ASTM Specifications

- Biodiesel is the ONLY renewable fuel for distillate blending with approved ASTM specifications:
 - D6751: B100 prior to blending
 - D975: On/off road blends up to 5% biodiesel
 - D7467: On/off road blends B6 to B20
 - D396: Home heating oil up to 5% biodiesel (Bioheat®)



SPECIFICATION FOR BIODIESEL (B100) – ASTM 6751-10

#Biodiesel (B100) and the petroleum diesel must meet their respective ASTM specifications before blending.

| Property | ASTM Method | Limits | Units |
|---|------------------------|-------------------------|-----------------------|
| Calcium & Magnesium, combined | EN 14538 | 5 maximum | ppm (µg/g) |
| Flash Point (closed cup) | D 93 | 93 minimum | °C |
| Alcohol Control (one to be met) | | | |
| 1. Methanol Content | EN 14110 | 0.2 maximum | mass % |
| 2. Flash Point | D93 | 130 minimum | °C |
| Water & Sediment | D 2709 | 0.05 maximum | % vol. |
| Kinematic Viscosity, 40 C | D 445 | 1.9 – 4.1 | mm ² /sec. |
| Sulfated Ash | D 874 | 0.02 maximum | % mass |
| Sulfur | | | |
| S 15 Grade | D 5453 | 0.0015 max. (15) | % mass (ppm) |
| S 500 Grade | D 5453 | 0.05 max. (500) | % mass (ppm) |
| Copper Strip Corrosion | D 130 | No. 3 maximum | |
| Cetane | D 613 | 47 minimum | |
| Cloud Point | D 2500 | report | °C |
| Carbon Residue 100% sample | D 4530* | 0.05 maximum | % mass |
| Acid Number | D 664 | 0.5 maximum | mg KOH/g |
| Free Glycerin | D 6584 | 0.020 maximum | % mass |
| Total Glycerin | D 6584 | 0.240 maximum | % mass |
| Phosphorus Content | D 4951 | 0.001 maximum | % mass |
| Distillation | D 1160 | 360 maximum | °C |
| Sodium/Potassium, combined | EN 14538 | 5 maximum | ppm (µg/g) |
| Oxidation Stability | EN 15751 | 3 minimum | hours |
| Cold Soak Filtration | Annex to D 6751 | 360 maximum | seconds |
| For use in temperatures below -12 °C | Annex to D 6751 | 200 maximum | seconds |



BQ-9000 Testing

- Certified producers must perform Full ASTM testing on the first 7 consecutive production lots and every 6 months.
- Critical Specification Testing on every production lot includes:
 - Alcohol Control
 - Water and Sediment
 - Cloud Point
 - Acid Number
 - Free Glycerin
 - Total Glycerin
 - Sulfur
 - Oxidation Stability
 - Visual Appearance
 - Cold Soak Filterability

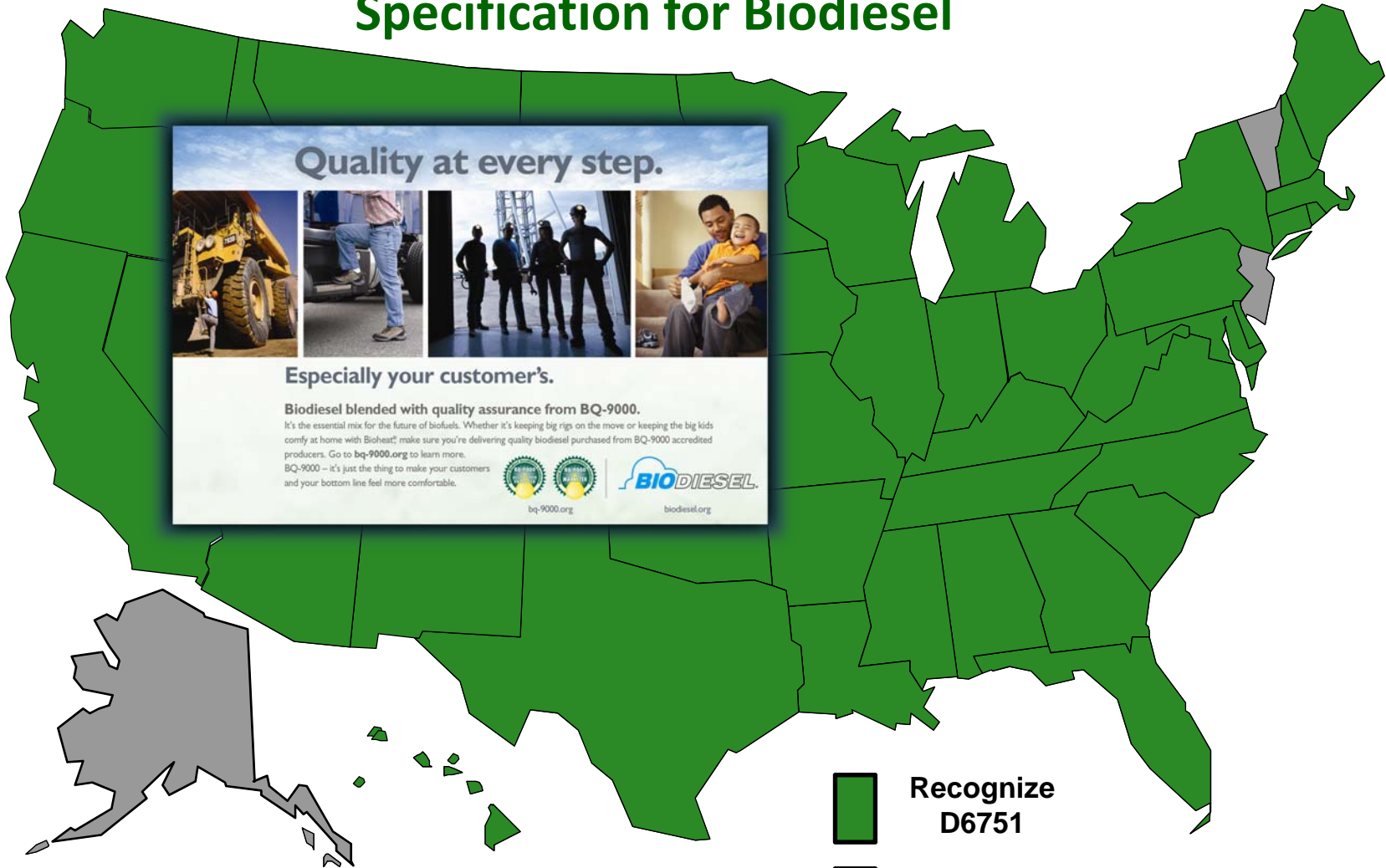
BQ-9000 Status



- Over 70% of the biodiesel produced in 2009 was by a BQ-9000 accredited producer
- Currently have:
 - 40 BQ-9000 Producers
 - 19 BQ-9000 Marketers
 - 1 BQ-9000 Lab (Iowa Central)
- Many large refiners (i.e. RFS2 obligated parties) are making BQ-9000 a pre-condition of purchase
- OEM's are requiring BQ-9000 for warranty support



47/18 (States Managing Quality)

Specification for Biodiesel



-  Recognize D6751
-  No Reference to D6751

ASTM D 6751-10 B100 , ASTM D 7467-10, B6-20

Supply Chain Management

Production

- ASTM D975 (Bulk Diesel Fuel)
- ASTM D6751 & BQ 9000 (Bulk B100)

Storage and Distribution

- ASTM D975
- ASTM D6751 & BQ 9000

Retail

- Short term critical storage
 - Long term storage with critical implication (ASTM D975)
-

Supply Chain Management Production

Petroleum Diesel

ASTM D975, product standard for No. 1, No.2 diesel, and B5 blend while “in commerce” to the retail level.

Biodiesel

ASTM D6751, product standards for B100 while “in commerce”.

BQ 9000 - is a combination of ASTM D6751 and a quality system program where the producer develops a program for:

- Proper sampling
 - Testing
 - Storage
 - Sample retention
 - Shipping protocols
 - Certificate of Analysis (COA)
 - Audits
-

Supply Chain Management Marketing

Petroleum Diesel

ASTM D975, product standard for No. 1, No.2 diesel, and B5 blend while “in commerce” to the retail level.

Biodiesel

ASTM D6751, product standards for B100 while “in commerce” to the terminal.

BQ 9000 - Marketer must:

- Must purchase B100 from an accredited producer or conduct fuel quality testing on all biodiesel purchased from non-accredited producers.
 - Maintain storage and distribution procedures that protect biodiesel quality.
 - Submit to regular audits
-

Supply Chain Management

Retail

Petroleum Diesel

ASTM D975, product standards for No. 1, No. 2 and No. 4 diesels while “in commerce” at the retail level.

Biodiesel Blend (BXX)

ASTM D975 for up to B5 or ASTM D7467 for B6-B20 while in commerce

National Distribution Capabilities

- Pipeline shipment continues to be explored.
- Available through direct shipment from over 1,459 petroleum distributors nationwide
- Approximately 1,321 retail filling stations nationwide, 200 locations are semi-truck accessible
- Some 1200 terminals cover the U.S. landscape, 158 handle biodiesel nationwide, 75 automated for distribution
- Numbers expected to grow with RFS2 implementation

Purchasing Biodiesel Blend Fuel

Additional Guidance Considerations

If necessary, establish a contractual agreement with supplier to ensure product quality on a consistent basis:

- Especially for short term critical application or long term storage with critical application.

General Considerations:

- Ensure purchased fuel complies with ASTM 6751 (B100) , ASTM D975 (ULSD), D975 (B5) and D7467 (B6-B20)
 - Encourage “in-line” mixing by blender to make BXX and ULSD homogeneous
 - If possible, visually confirm delivery truck bays are free and clear of water and sediment.
 - Obtain a quart retain sample of delivered fuel. Sample should be “Clear and Bright”. Save retain sample until next delivery and verify clear and bright.
 - If applicable, make sure BXX meets cold flow requirements for winter storage.
 - Be sure the storage tank is clean and free of water at all times
 - For added surety, purchase BXX from BQ 9000 accredited producers and marketers
 - For B6-B20 blends, ensure material compatibility of fuel storage system.
-

Storage Tank and Material Compatibility

Storage Tanks

- UST's are preferable to avoid temperature fluctuations.
- AST should be painted with a reflective paint to minimize summer heat.
- Avoid oxidative catalysts such as copper, brass, lead, tin, and zinc that can cause ULSD and BXX to degrade to soaps, gums and sediment.
- Monitor hoses , seals and gaskets for leaks. Replace as necessary.

Fuel Tank Maintenance

- Establish routine analysis of fuel and system to monitor key degradation performance parameters.
- Periodically and before deliveries check tank low point for water and sediment. If contaminated drain or clean tank
- Periodically check for microbial contamination. Treat with an EPA approved biocide if test results are positive.

Additional Resources

- Paul Nazzaro, Petroleum Liaison, National Biodiesel Board, 978-664-5923, paulsr@yourfuelsolution.com
- NBB, 605 Clark Avenue, Jefferson City, MO. 65101, 573-635-3892, info@biodiesel.org
www.biodiesel.org, www.bioheatonline.com,
www.bq-9000.org, www.biodieselsustainability.com
- Robert S. Cerio, CEM, BOC, BPI
Consultant to the National Biodiesel Board
401-738-9009, RSCerio@cox.net