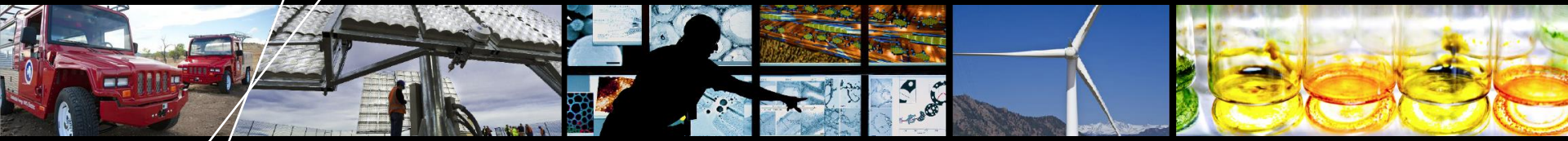
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

U.S. Biofuels Quality Update



Teresa L. Alleman

22 July 2013

NIST Biocorrosion Workshop, Boulder CO

How do we measure fuel quality?

- **Fuels need to have well-defined quality to allow for commerce**
  - Fuels have Certificates of Analysis (CoA) that provide property information
- **States regulate fuel quality and often look to ASTM International (www.astm.org) for specifications or to inform their specification activities**
  - Purchasing agreements may demand more stringent properties than prevailing requirements

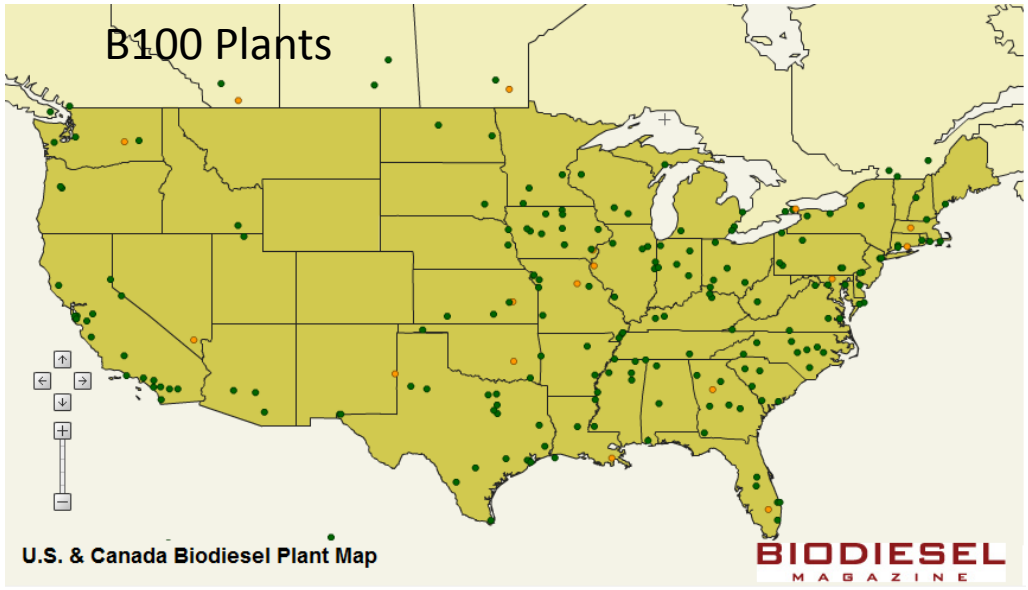
Diesel and Biodiesel Specifications

- **D975-13:** Standard Specification for Diesel Fuel Oils (allows for up to 5% biodiesel without labeling)
- **D6751-12:** Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels
- **D7467-13:** Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6-B20)

Biodiesel Station Locations

- **Biodiesel is an advanced biofuel under RFS and is sold everywhere**
- **Currently, 335 B20 public stations in U.S.**

B100 Plants



http://www.biodieselmagazine.com/plants/map/

B20 Stations

http://www.afdc.energy.gov/fuels/biodiesel_locations.html

Early B100 Quality Surveys

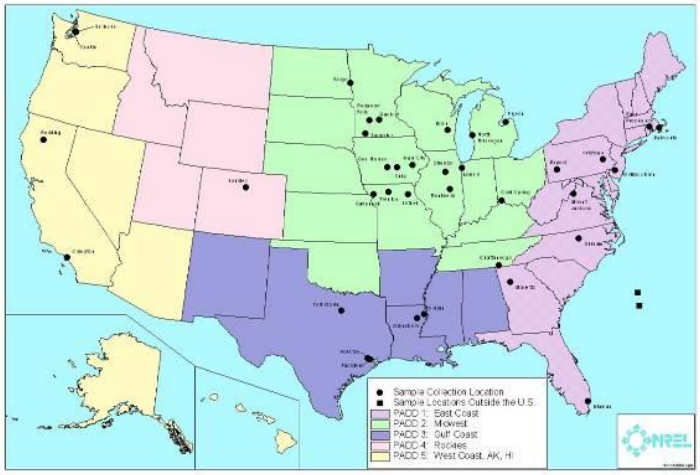
2004 B100 Quality Survey

- 22 producers in the marketplace (25M gallons)
- Samples obtained nationwide from biodiesel blenders (27 samples)
- *85% of samples tested met the ASTM D6751 specification*

http://www.nrel.gov/docs/fy06osti/38836.pdf

2006 B100 Quality Survey

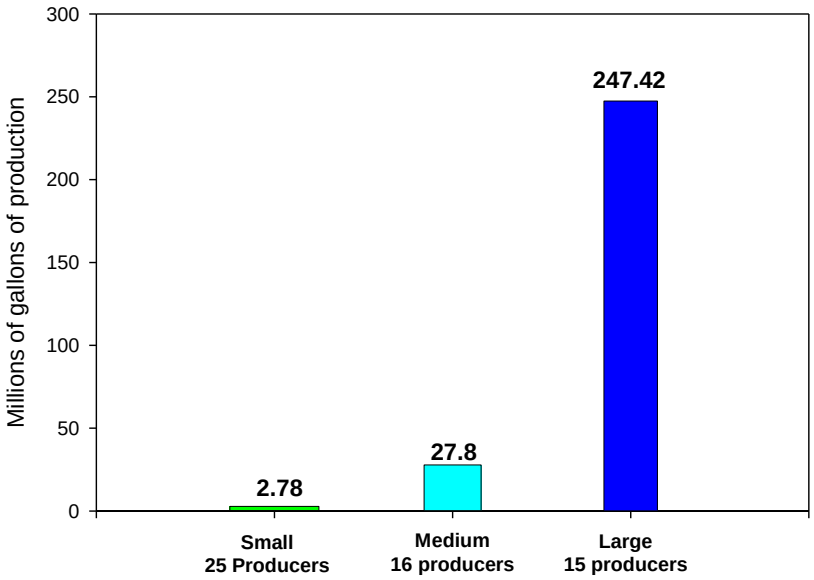
- 86 companies in the marketplace (224M gallons)
- ~40% of B100 samples met D6751 specification
- *Significant quality issue that needed to be addressed*



http://www.nrel.gov/docs/fy07osti/41549.pdf

2007 B100 Survey

- 105 producers in market (500M gallons)
- Samples collected from 56 producers
- Representative sampling of US market, results were weighted on production volume basis
- 89% of overall B100 in US met specification



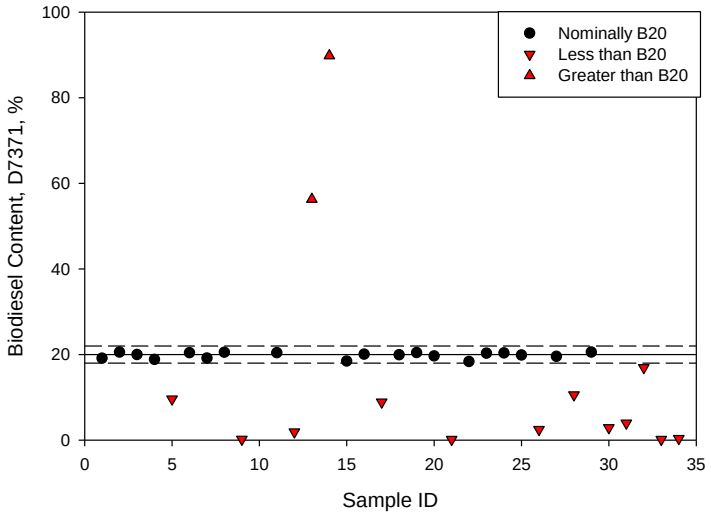
Most large producers met specification—this is by far the highest volume

Medium and smaller producers were more likely to fail the specification, although their overall volume is low

http://www.nrel.gov/docs/fy08osti/42787.pdf

2008 B20 Survey

- B100 market was 691M gallons
- B20 samples were collected from around the United States, from public pumps and fleets as part of joint effort of NREL, NBB and Engine Manufacturers
- D7467 was not enacted when these samples were taken
- 60% of blends were nominally B20
  - Distribution of non-B20 samples was different from that in last survey, with much less fuel above 20%; indicates less splash blending type issues but still room for improvement
- Average cloud point (CP) = -12.6°C (9°F)
  - No CP specification; determined by geography, time of year, customer
- 74% of samples met D7467 induction period stability requirements for B20

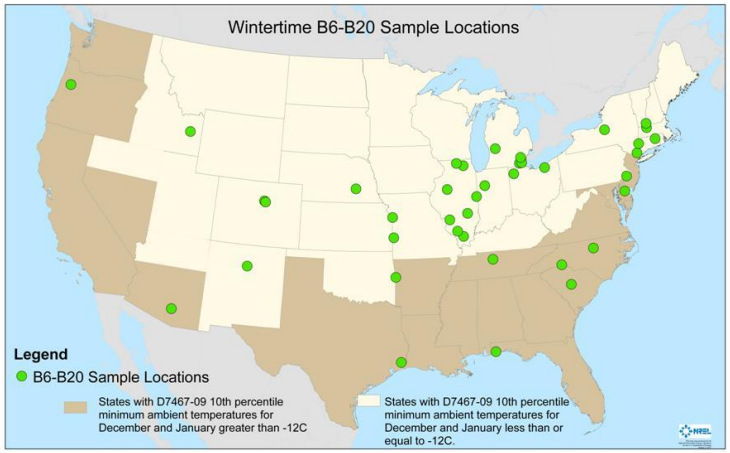


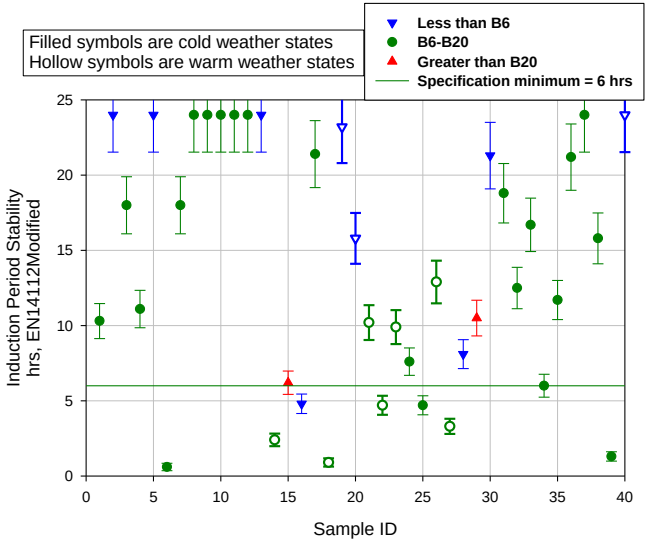
http://www.nrel.gov/docs/fy11osti/46592.pdf

2010 Wintertime B6-B20 Survey

- US market was 315M gallons
- Samples collected from public pumps across US
- Two thirds of samples from climates where 10th percentile min. ambient temp is <-12°C[1]
- 95% of the samples collected were B20 or less
- 80% samples passed oxidation stability, but no failures on AV
- Wide range of variability between 10th percentile minimum ambient temperatures and measured cloud point

1: Climate data can be found in the Appendices of ASTM D975 and D7467

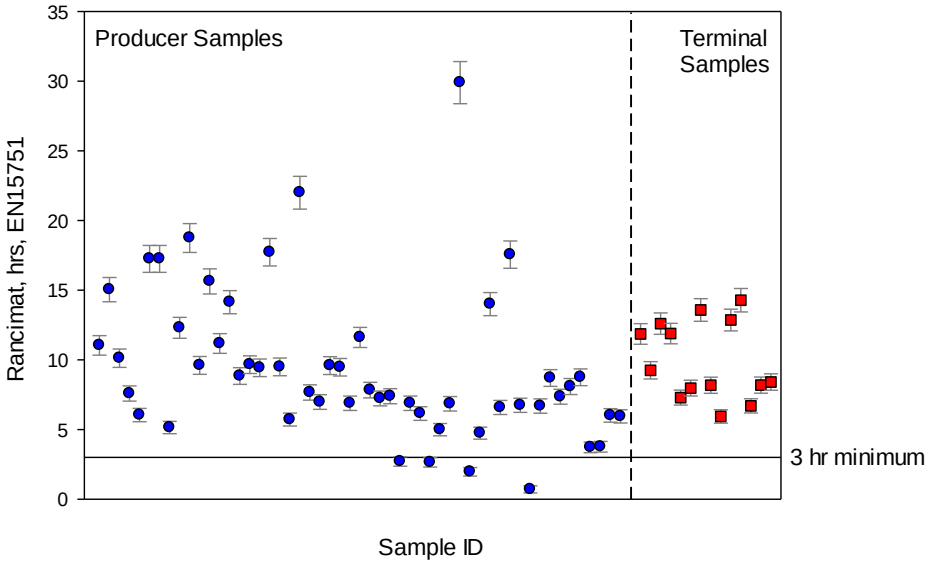




http://www.sciencedirect.com/science/article/pii/S037838201100052X

2011 US B100 Quality Survey Summary

- **Collected B100 samples from 53 producers and 14 terminals**
- **Samples represented 94% of the US market (1 billion gallons)**
- **95% of the samples met the D6751 quality specification**
  - 100% of the terminal samples met the spec, only failures were on samples collected directly from producers
  - One sample was clearly poor quality and failed multiple properties



Gasoline and Alcohol Specifications

- **D4806-13a:** Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel
- **D4814-13a:** Standard Specification for Automotive Spark-Ignition Fuel
- **D5798-13a**: Standard Specification for Ethanol Fuel Blends for Flexible-Fuel Automotive Spark-Ignition Engines
- **D7794-12:** Standard Practice for Blending Mid-Level Ethanol Fuel Blends for Flexible-Fuel Vehicles with Automotive Spark-Ignition Engines
- **Coming soon: Specification for butanol**

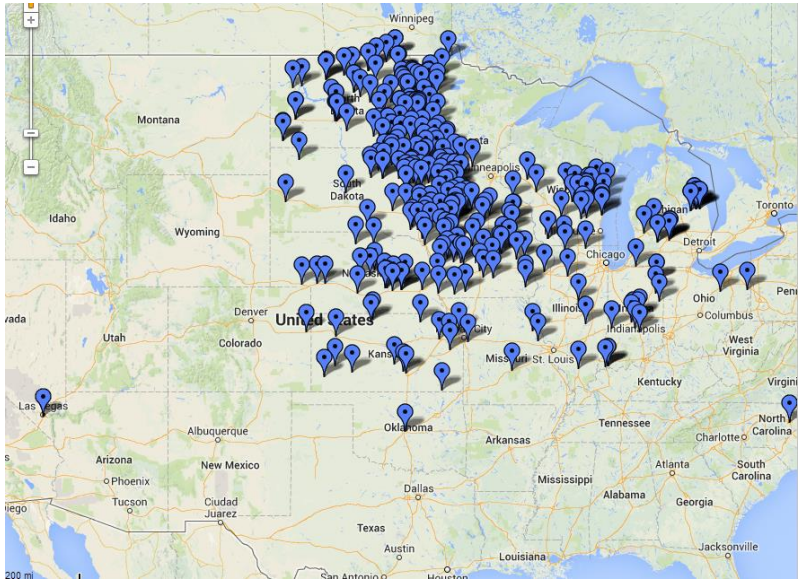
Flex Fuel Stations

- **Flex Fuel is still predominantly in the Midwest and Eastern US (2,347 stations)**
- **E-15-E50 (mid-level ethanol blends, MLEBs) are here and increasing market penetration**

Flex Fuel stations

http://www.afdc.energy.gov/fuels/ethanol_locations.html

MLEB (blender pump) stations

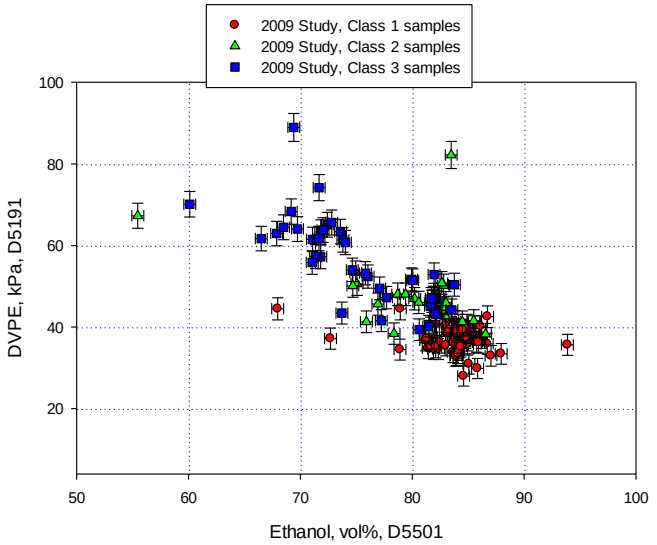


https://www.google.com/maps/ms?ie=UTF8&oe=UTF8&msa=0&msid=206745711849978065988.0004506e7cf3ae206a7c0

Flex Fuel Quality (CRC-E-85-1 and CRC-E-85-2)

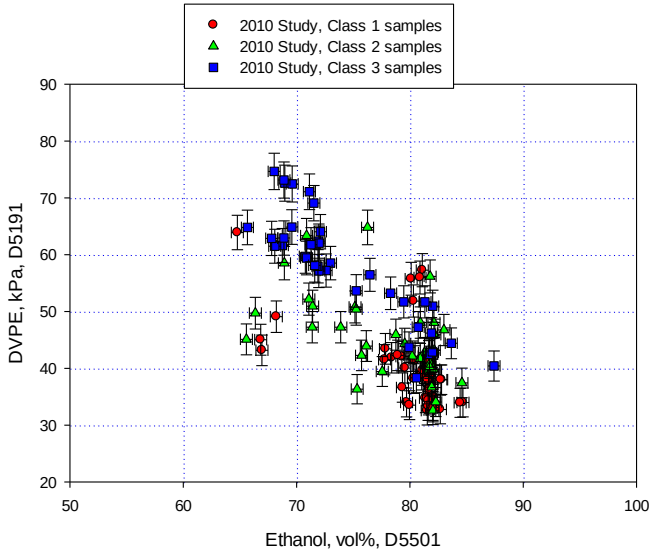
Ethanol content specification

Class	Year	Below Specification	On Specification	Above Specification
1	2008	4.3%	6.3%	89.4%
	2009	10%	80%	10%
	2010	7.1%	88.1%	4.8%
2	2008-09	3.8%	57.7%	38.5%
	2010	5.4%	91.9%	2.7%
3	2008-09	12%	83%	5%
	2010	2.7%	94.6%	2.7%



Volatility specification

Class	Year	Below Specification	On Specification	Above Specification
1	2008	53.2%	46.8%	0%
	2009	90%	10%	0%
	2010	31%	67%	2.4%
2	2008-09	61.5%	30.8%	7.7%
	2010	56.8%	43.2%	0%
3	2008-09	87.5%	12.1%	0.4%
	2010	70.3%	29.7%	0%



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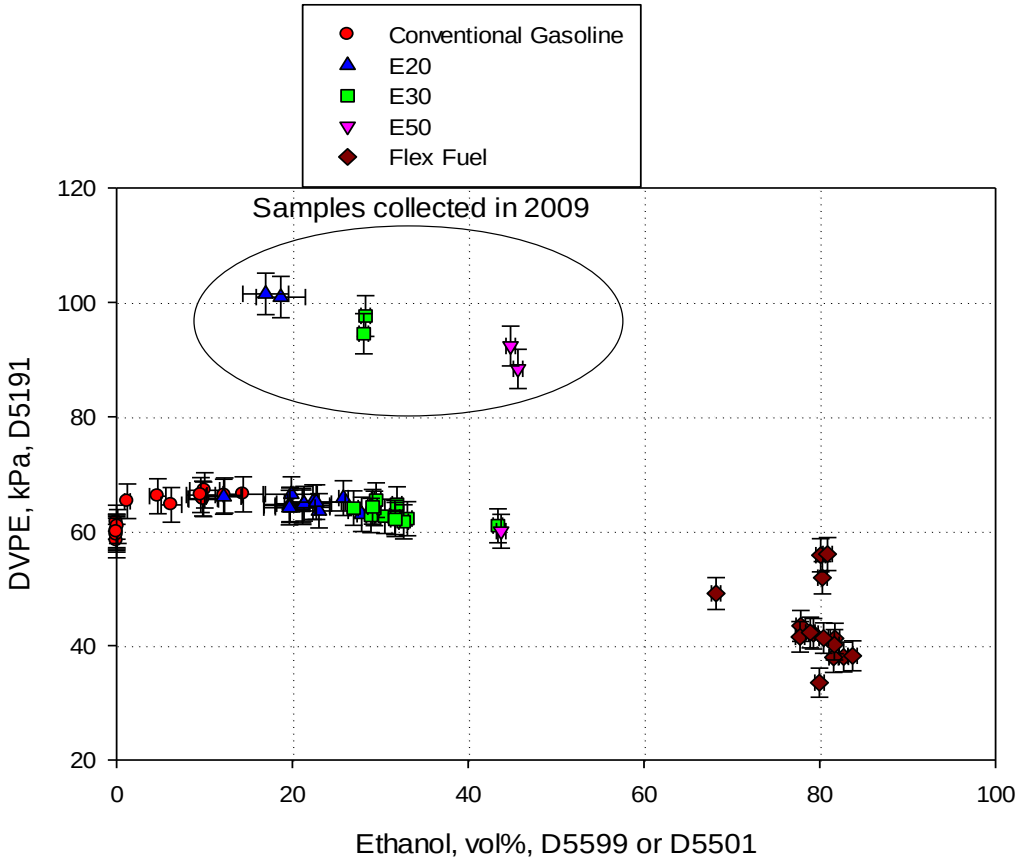
Blender Pump Quality (CRC E-95-1)

- **Blender pumps dispense pre-set MLEBs (E15, E20, E30)**
- **EPA allows up to E15 in 2001 and newer passenger cars, light trucks and SUVs**



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Closing Thoughts

- **Fuel quality is a moving target due to changes in the specifications**
- **Understanding fuel quality is critical to ensure the alternative fuel market continues to grow**
- **Specifications are set to promote commerce and to ensure product is fit-for-purpose**