

2007 B100 Quality Survey Results

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Who is NREL?

- NREL is the National Renewable Energy Laboratory, a DOE research laboratory
- For biodiesel, research is focused on reducing barriers to market penetration
 - Including quality surveys, test method development, fuel impacts on emissions and emission control equipment
- Unbiased research and publication of results is a key part our work

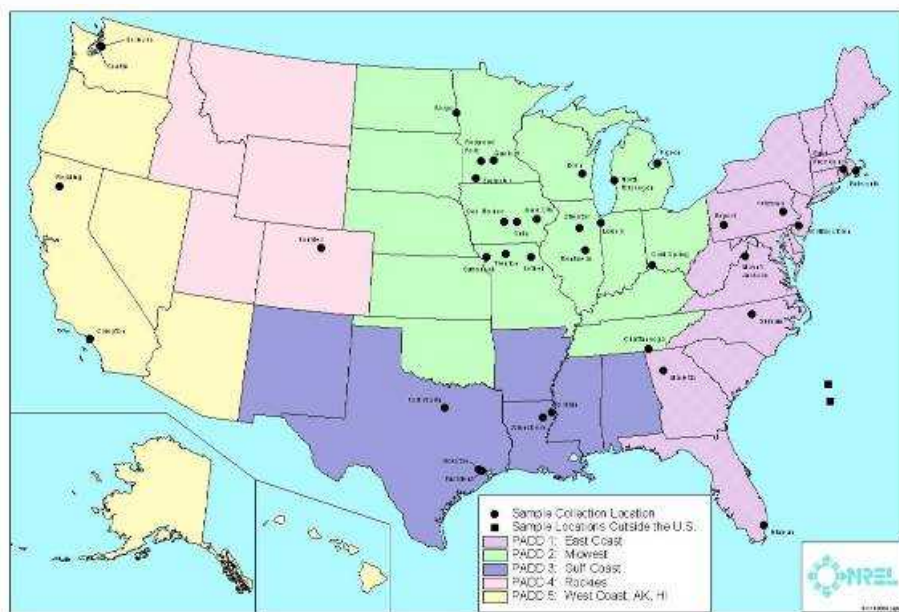
2004 B100 Quality Survey

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



- Four samples failed with high levels of:
 - phosphorus (lube oil contamination?)
 - total glycerin
 - acid number
 - acid number and total glycerin

2006 B100 Quality Survey



- 86 companies in the marketplace (250M gallons)
- A subcontractor visited the site of a biodiesel blender, usually a terminal operator or jobber, to collect the B100 sample
- 32 B100s, 6 B99s, and 1 B50

- 59% of B100 samples tested fail the D6751 specification
 - Importantly, 30% fail total glycerin – immediate operational problems in cold weather and long term injector damage
 - Other issue of concern is 20% failure rate for Na+K
 - Significant impact on emissions control systems
 - Compares to 15% failure rate in 2004 survey
 - Samples were collected randomly, not on production volume basis
 - ***Biodiesel, based on production volume, may have different failure rate***
 - ***Poor quality batch may have contaminated larger aggregated tanks at terminals or jobber locations***

2007 Survey Approach

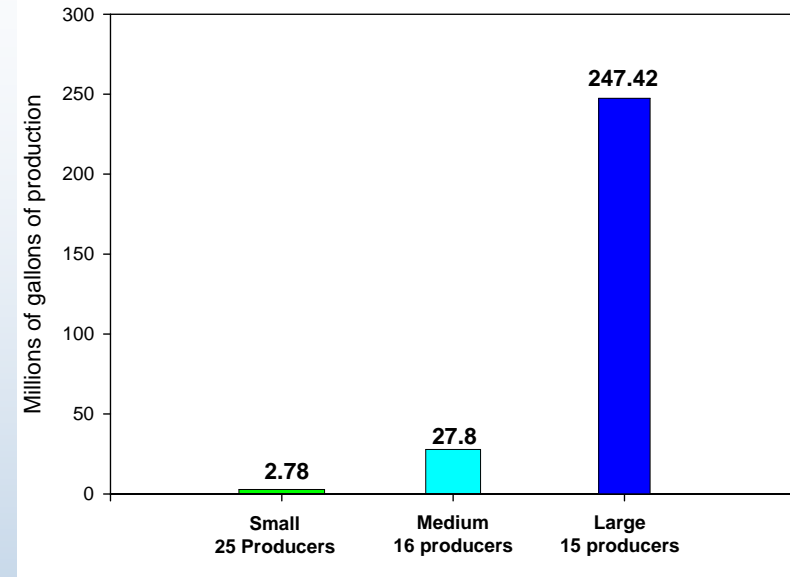
- Study conducted under guidance of Biodiesel Blend Evaluation Team (industry group of primarily engine OEMs)
- Collect B100 sample directly from producers
- Accompanying telephone survey to better understand marketplace
- Test samples for properties most likely to affect engine performance:
 - Flash point, free and total glycerin, oxidation stability, cloud point, acid value, water and sediment
 - Oxidation stability had only recently passed in D 6751 – samples were tested within 1 week of receipt
- Test samples for minor compounds that could affect new or future diesel after-treatment systems:
 - Phosphorus, Group I and II metals

Survey Volume Estimates

- NBB provided **only** binning information
- Estimate each producer has equal share of their volume bin
- Sample size is 70% of B100 market in 2007 or 278M gallons
 - Large producers: 89% (15 companies)
 - Medium producers: 10% (16 companies)
 - Small producers: 1% (25 companies)

Telephone Survey Results

- 56 out of 107 producers provided sample
 - Good representation of small, medium and large companies
 - 17 out of 19 BQ-9000 producers participated
- Wide variety of feedstocks compared to previous surveys
- Reasons for not participating vary, although most often due to no product available



Response	Number responding
Affirmative	56
No response	7
No product available	38
Not interested in participating	4
Plant upgrade	1
No longer exists	1

Test Specifications

Property	Test Method ^a	Specification Limit in D6751
Cloud point, °C	D2500	Report
Water and sediment, vol%	D2709	0.05 max
Phosphorus, ppm	D4951	10 max
Free glycerin, mass%	D6584	0.020 max
Total glycerin, mass%	D6584	0.240 max
Acid value, mgKOH/g	D664	0.50 max
Ca+Mg, combined, ppm	D7111	5 max
Na+K, combined, ppm	D7111	5 max
Flash point, °C	D93	93 min
Alcohol content ^b , mass%	EN14110	0.20 max
Meet one of the following	D93	130 min
Oxidation stability, h	EN14112	3 min

a: ASTM test method unless otherwise noted

b: Only tested if applicable

BQ-9000 Producer Results

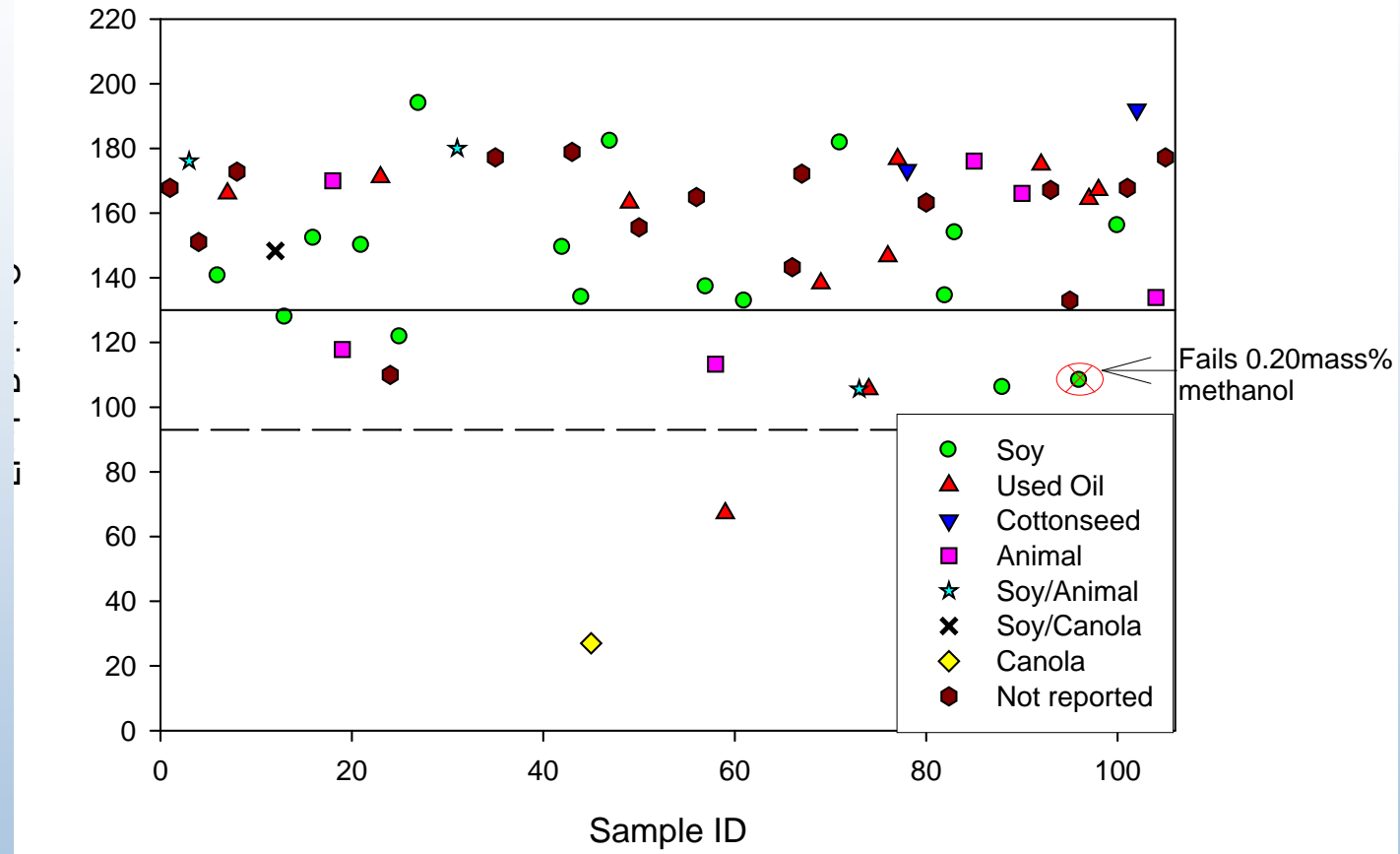
- 19 BQ-9000 producers in April 2007
 - 17 participated in survey
 - 14 large producers and 3 medium producers
 - One declined invitation to participate
 - One was shut down for plant upgrades ??
 - 74% of volume in survey
- BQ-9000 companies passed all tests, with only one exception
 - One sample failed for water and sediment, likely due to contamination
 - Prior surveys have never shown biodiesel to fail this requirement

Survey Test Results

Based on this study:

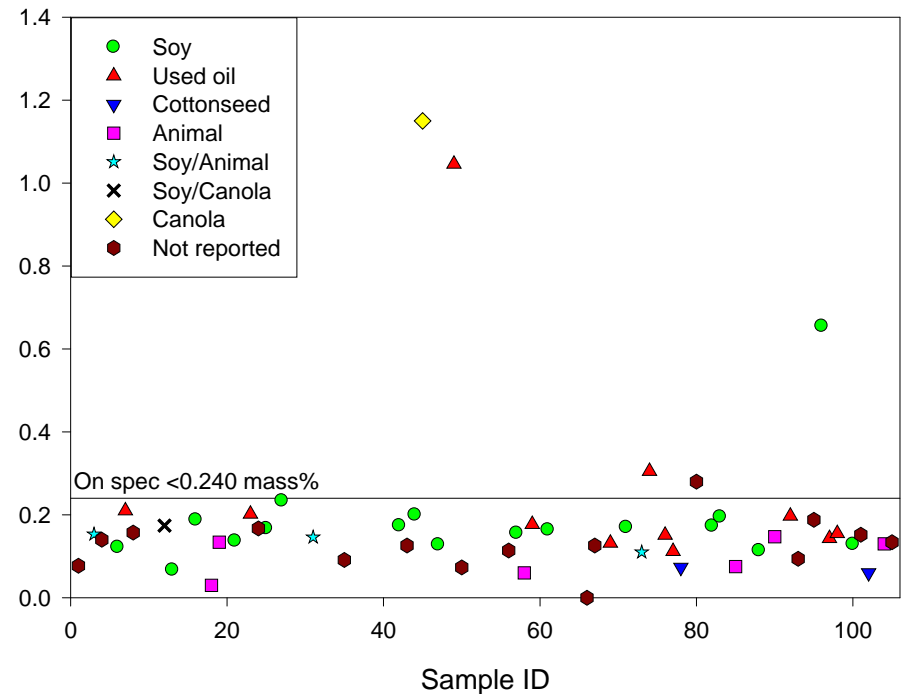
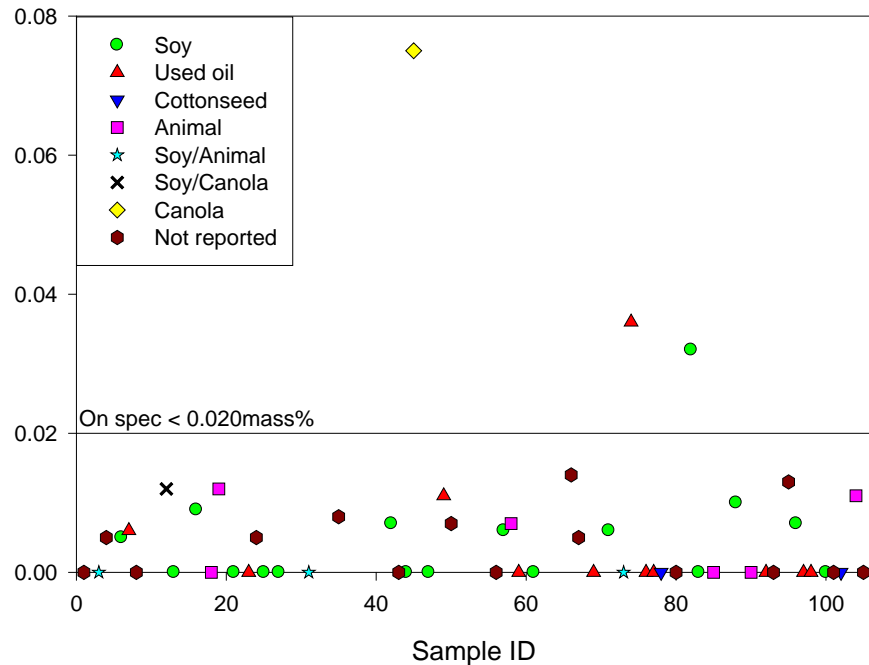
- Samples are representative of biodiesel market in US
- B100 is on-spec 89.6% of the time
 - 94% of the volume from large producers
 - 68% of the volume from medium producers
 - 28% of the volume from small producers
- Biodiesel industry focus on quality is working

Flash Point and Alcohol Content



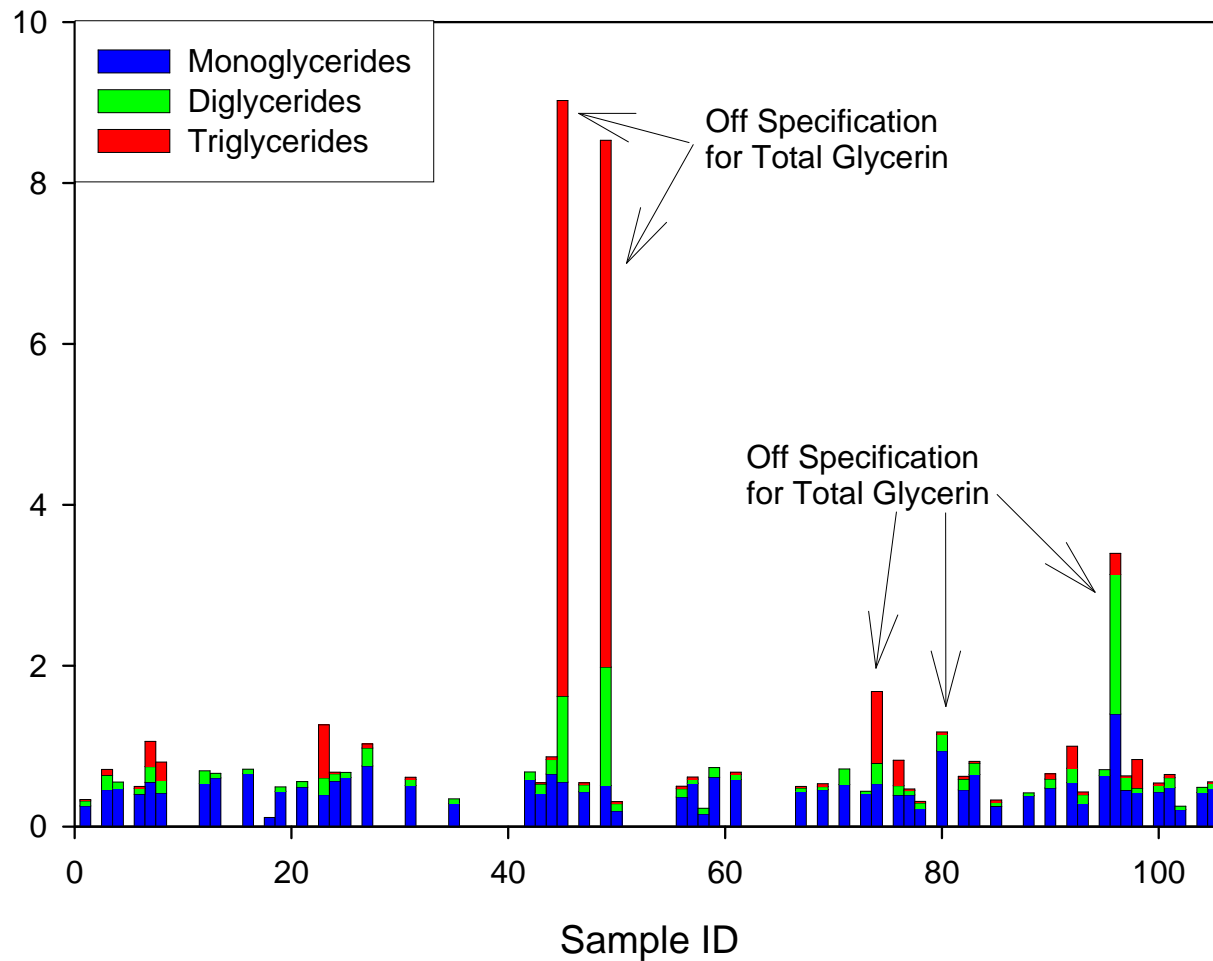
- <0.5M gallons off spec

Free and Total Glycerin

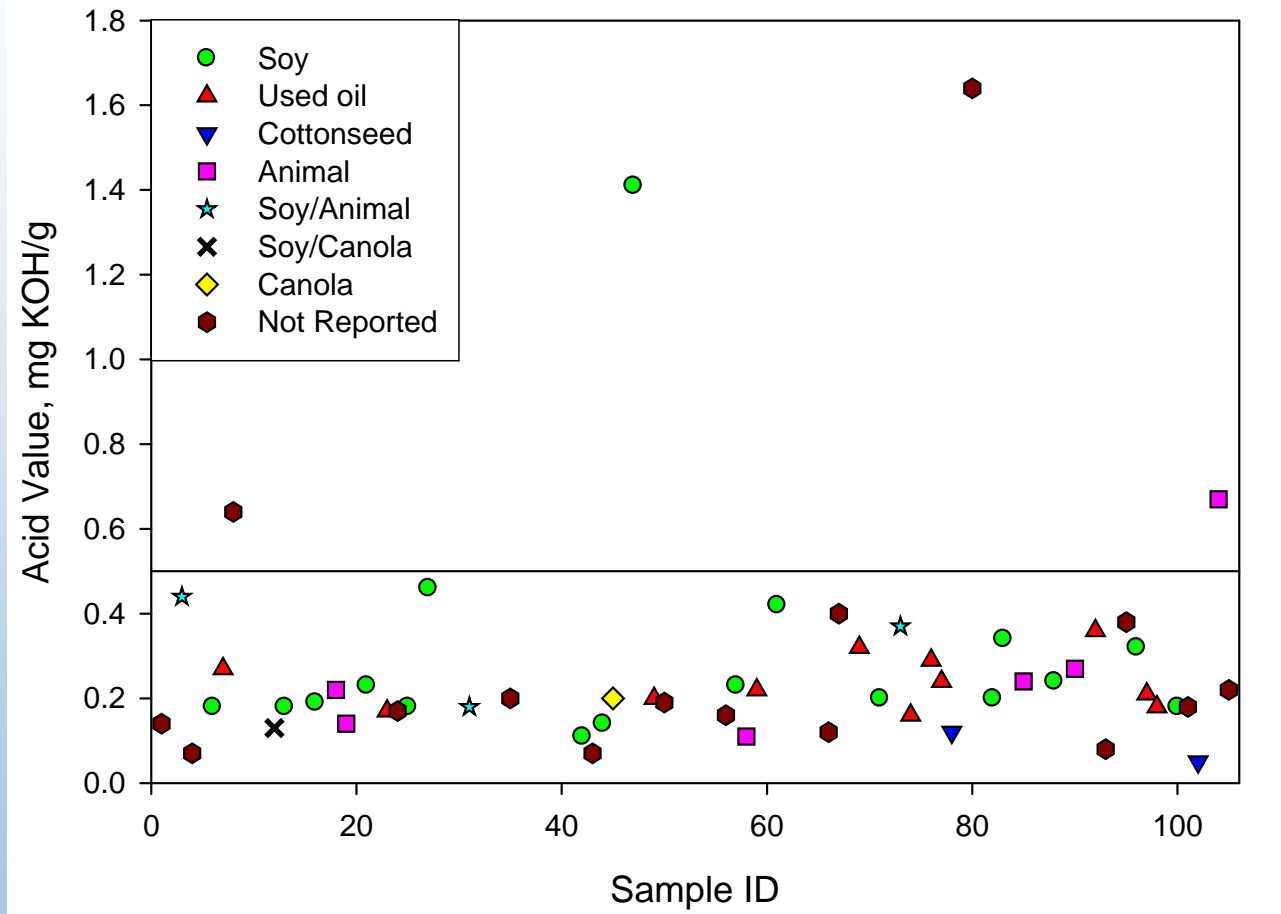


- ~2M gallons off spec for FG
- ~0.6M gallons off spec for TG

Glyceride Species



Acid Value

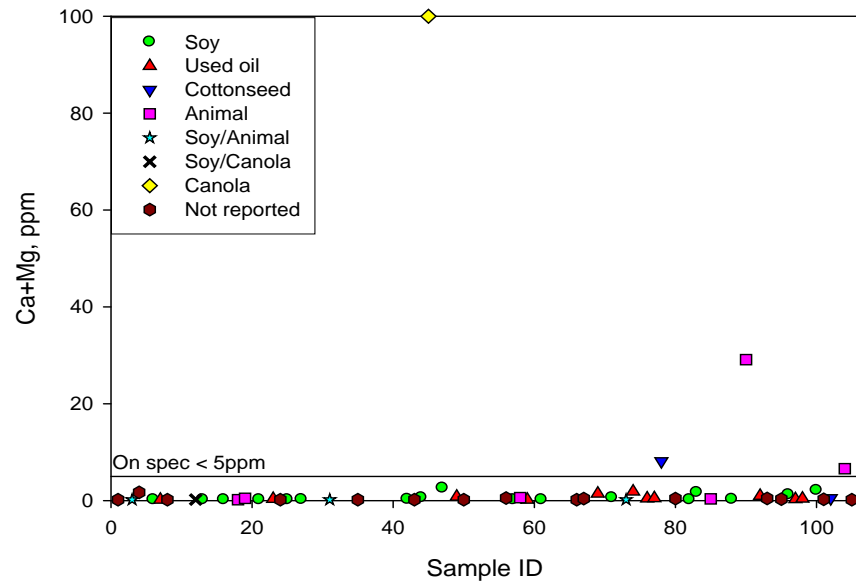
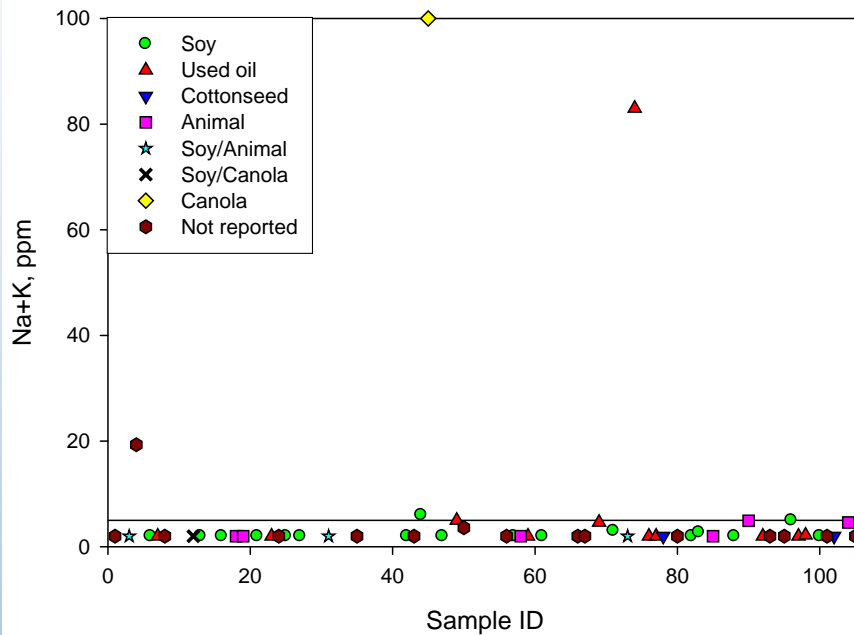


- 2M gallons off specification

Na+K and Ca+Mg

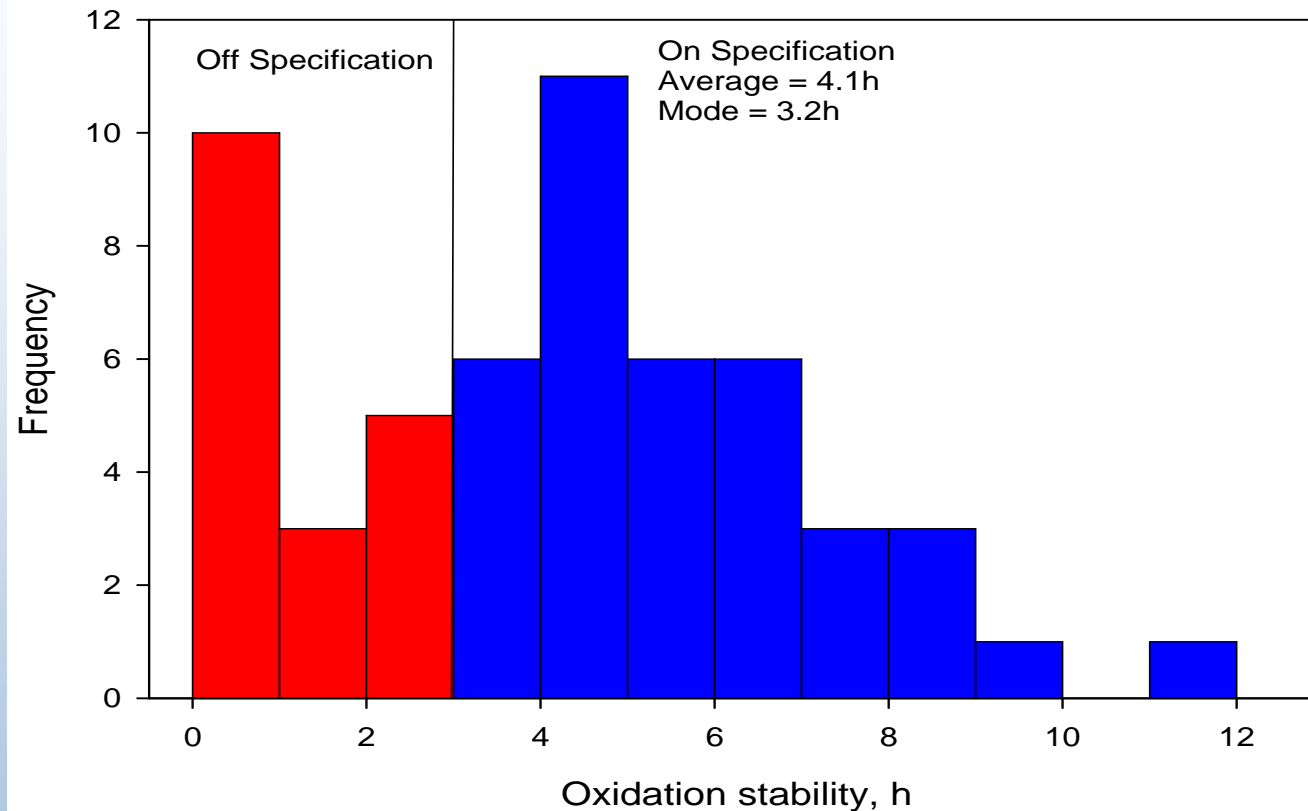
Na+K detection limit is 2ppm

Ca+Mg detection limit is 0.2ppm



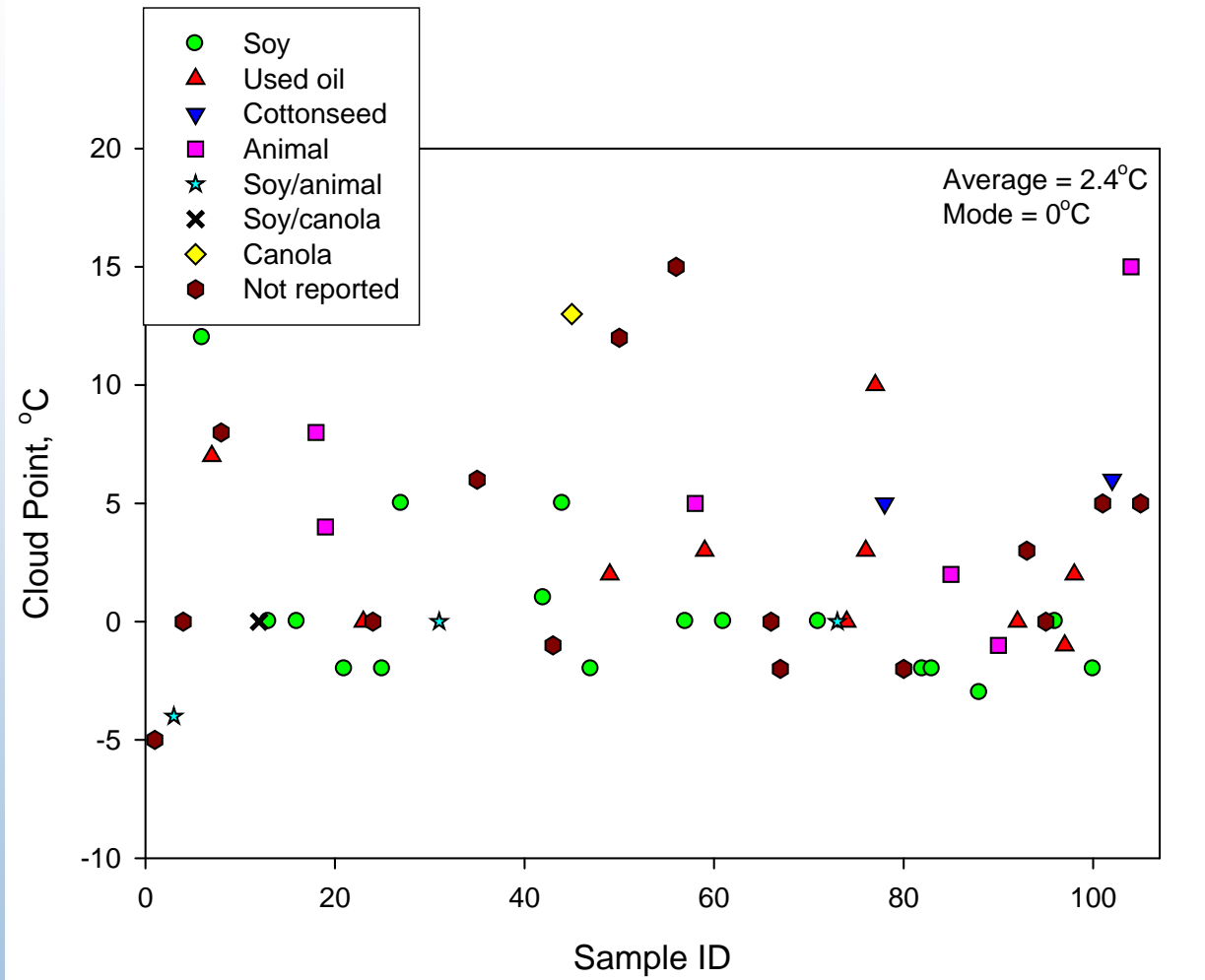
- <0.5M gallons off spec for Na+K
- 2M gallons off spec for Ca+Mg

Oxidation Stability



- ~8.5M gallons off specification
 - Most often from small and medium producers

Cloud Point



- No D6751 specification limit on cloud point

Other Results

- Water & sediment – 1 failure, likely due to contamination
- Phosphorus – 1 failure (sample failed multiple properties)

Summary

- 56 out of 107 producers participated in 2007 survey or 70% of the 2007 US market
 - Reasons for not participating are likely due to lack of feedstock availability
- Wide variety of feedstocks represented
- Meeting the specification is independent of producer size or feedstock
- Small producers failed specifications more often than medium or large producers
 - Small producers: 28% of samples passed
 - Medium producers: 68% of samples passed
 - Large producers: 94% of samples passed

Conclusions

- Samples in the survey covered 70% of the US market in 2007 and are believed to be representative
 - 89.6% of total biodiesel market was on specification
 - On specification samples represented all feedstocks and production size in the US market
 - Relatively high failure rate for oxidation stability, but small portion of total market (~8.5M gallons)
 - BQ-9000 producers have very low failure rate regardless of production volume
- Final report will be published on NREL website by mid-February
- NREL/TP-540-42787