US Biodiesel Overview

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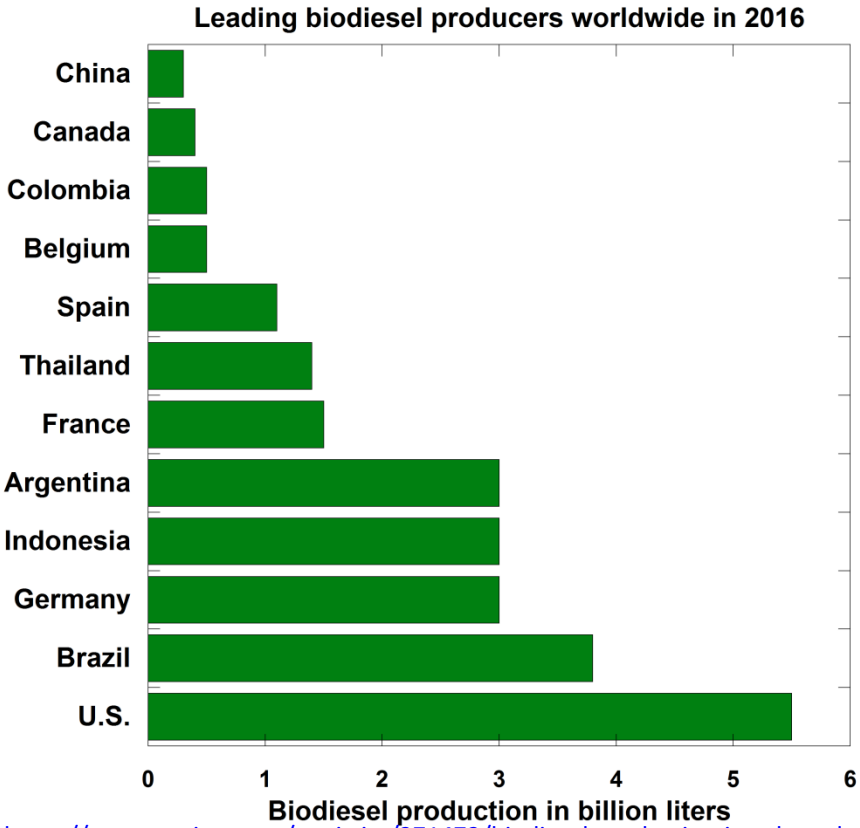
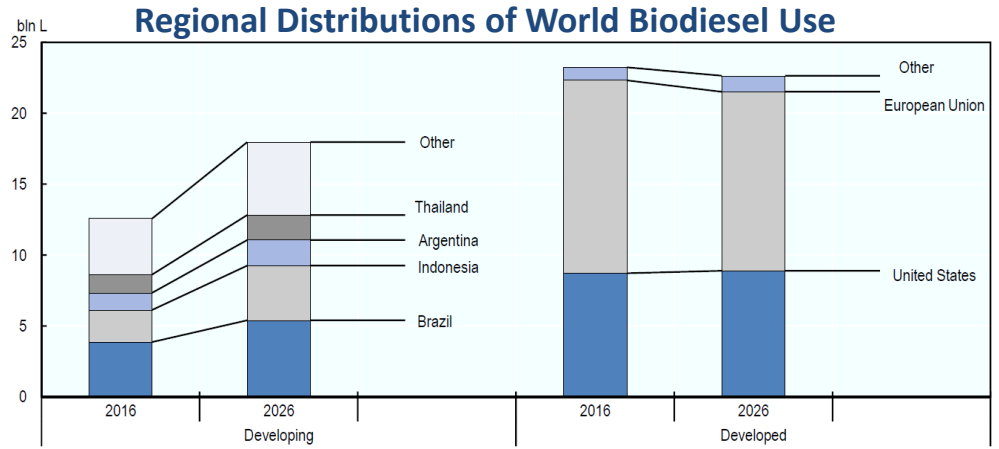
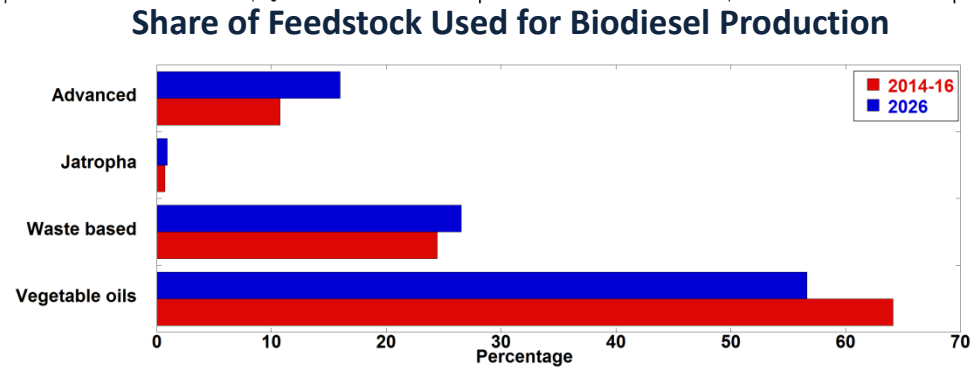
Biodiesel Production Overview





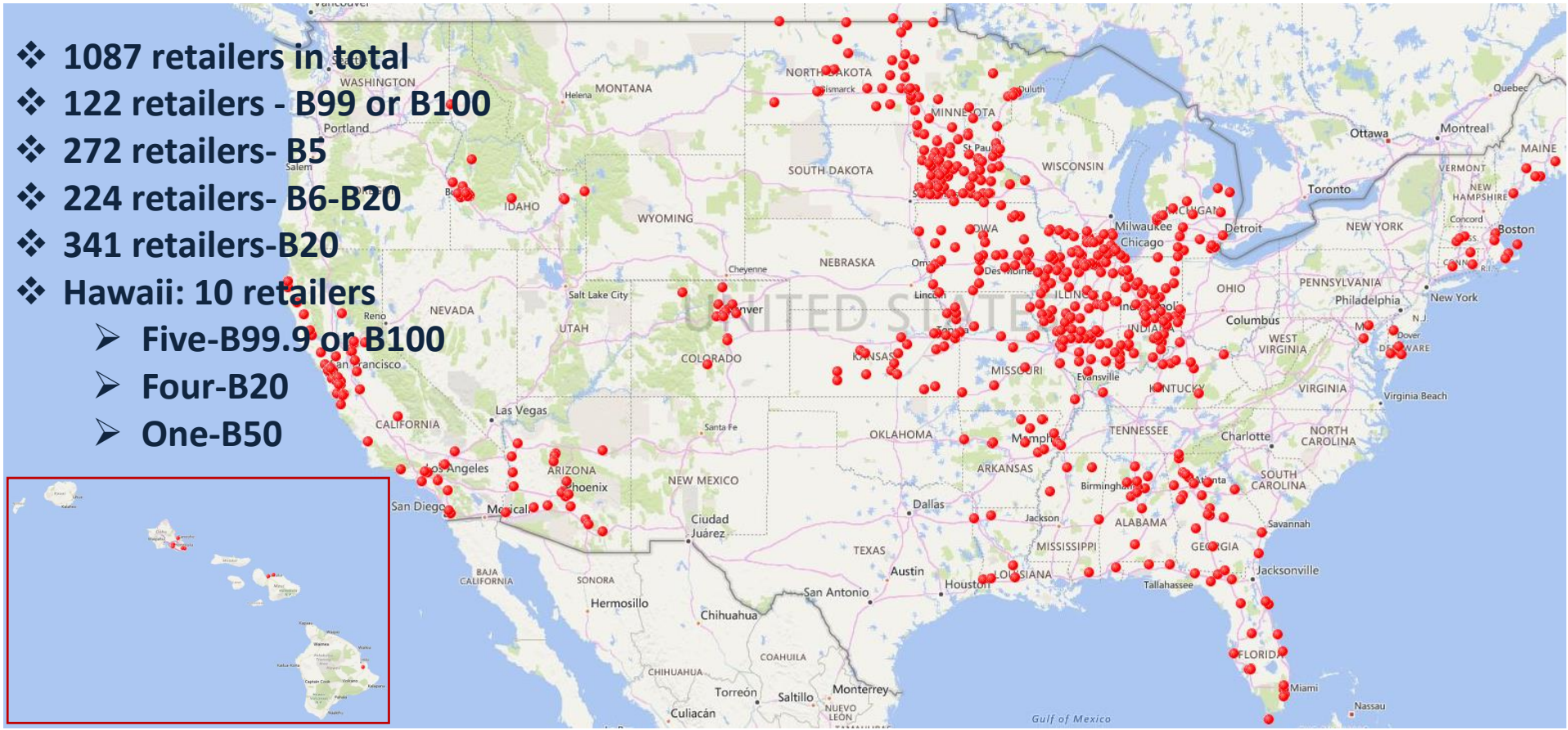


https://www.statista.com/statistics/271472/biodiesel-production-in-selected-countries/

http://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2017-2026/biofuels_agr_outlook-2017-13-en

U.S. Biodiesel Retail Locations

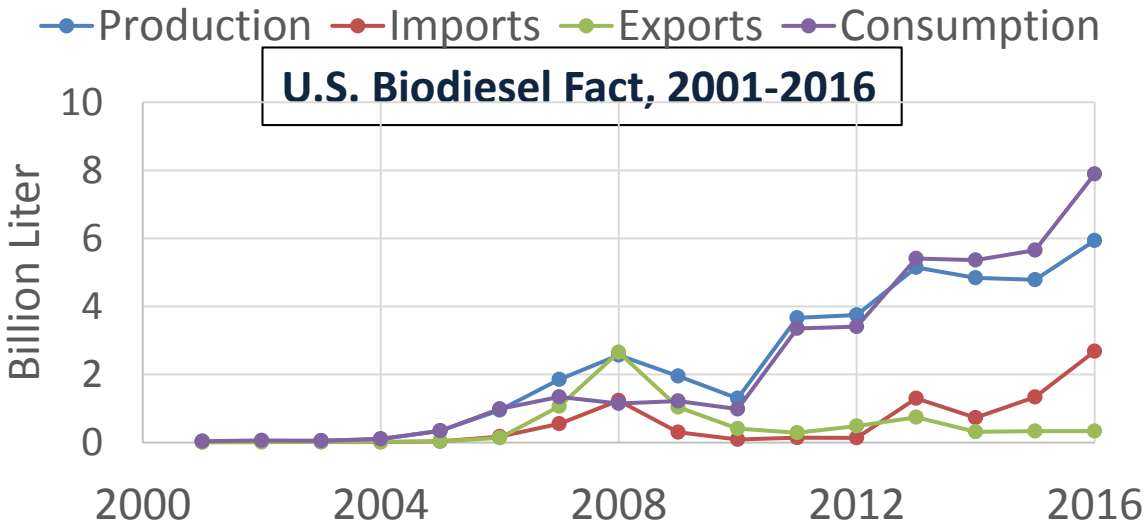
- 1087 retailers in total
- 122 retailers - B99 or B100
- 272 retailers- B5
- 224 retailers- B6-B20
- 341 retailers-B20
- Hawaii: 10 retailers
  - Five-B99.9 or B100
  - Four-B20
  - One-B50



http://biodiesel.org/using-biodiesel/finding-biodiesel/retail-locations/retail-map

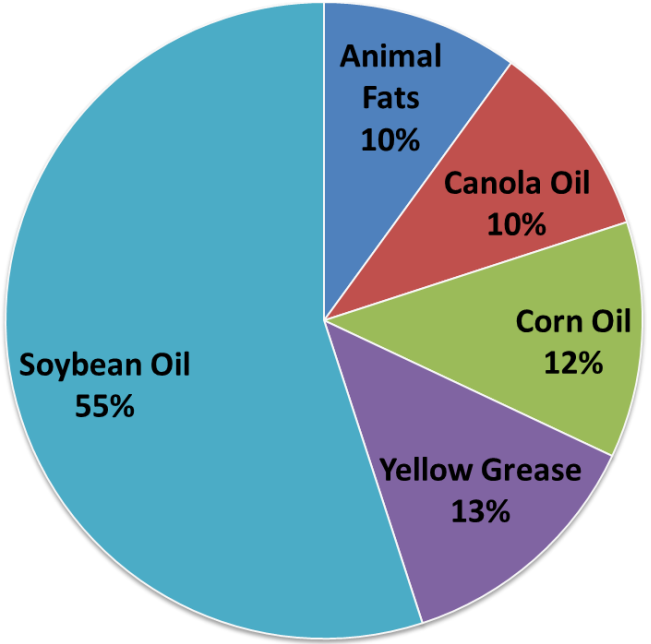
U.S. Biodiesel Production

- Total Production Capacity: 9.14 Billion liter
- Number of Manufacturers: 99 (Nov. 2017)
- Top States (>400 Million liter): Texas (18%), Iowa (18%), Missouri (9%), Illinois (8%), Washington (5%)
- Hawaii Production Capacity: 24 Million liter (0.3%)



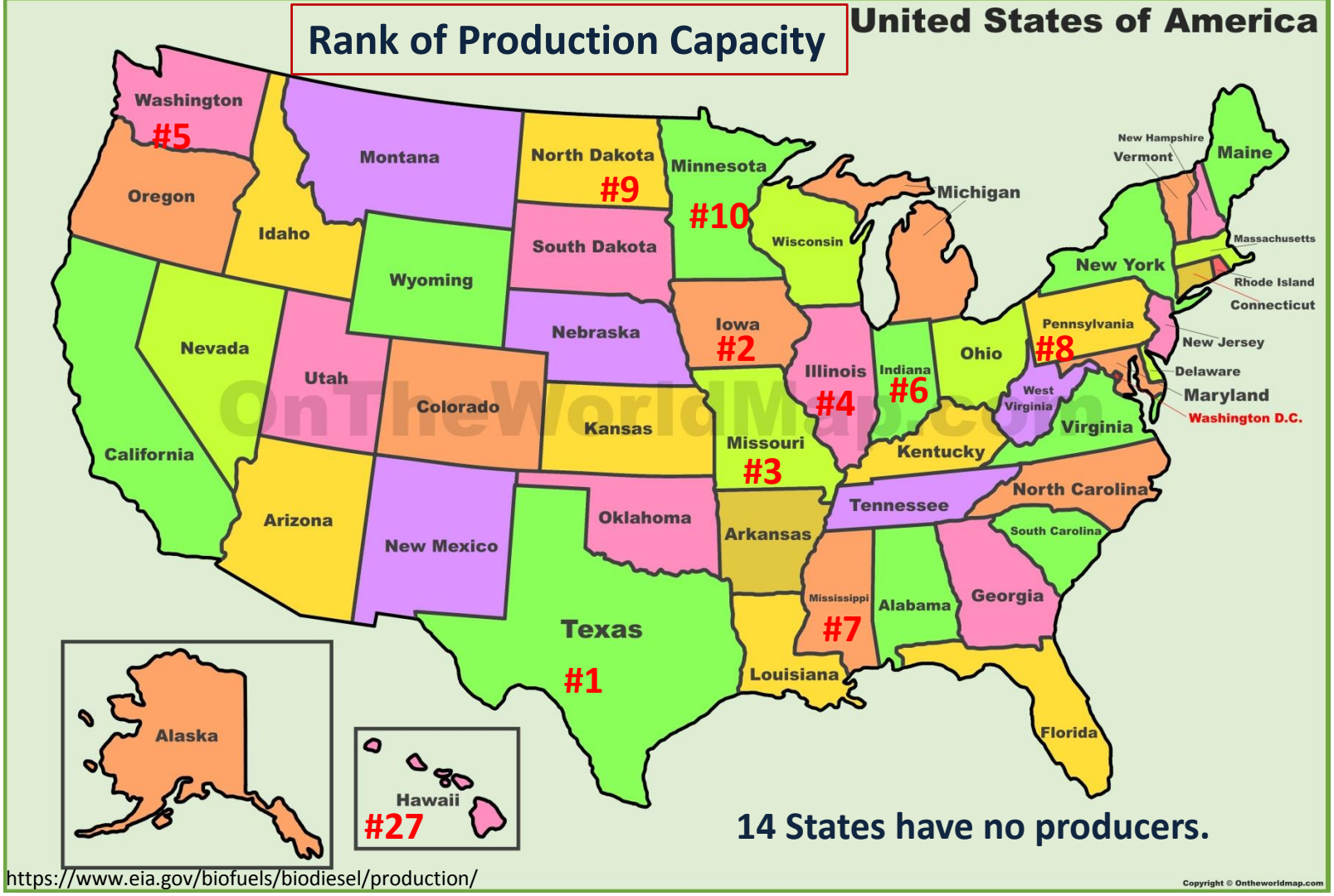
https://www.eia.gov/biofuels/biodiesel/production/

Feedstock Inputs, 2016



https://www.eia.gov/energyexplained/index.cfm?page=biofuel_biodiesel_home#tab2

Rank of Production Capacity



https://www.eia.gov/biofuels/biodiesel/production/

U.S. Federal Incentives

- Fueling equipment for diesel fuel blends containing a minimum of 20% biodiesel installed through December 31, 2017, is eligible for a tax credit of 30% of the cost, not to exceed $30,000.
- The Biomass Crop Assistance Program (BCAP; Section 9010) provides financial assistance to landowners and operators for a reimbursement of 50% of the cost of establishing a biomass feedstock crop, as well as annual payments for up to five years for herbaceous feedstocks and up to 15 years for woody feedstocks.
- The Biodiesel Fuel Education Program (Section 9006) provide competitive grants to educate governmental and private entities that operate vehicle fleets, the public, and other interested entities about the benefits of biodiesel use. (Reference Public Laws 113-79 and 112-240, and 7 U.S. Code 8106)
- A biodiesel blender that is registered with the Internal Revenue Service (IRS) may be eligible for a tax incentive in the amount of $1.00 per gallon of pure biodiesel, agri-biodiesel, or renewable diesel blended with petroleum diesel to produce a mixture containing at least 0.1% diesel fuel.

State Incentives and Regulations

❖ Texas (#1)

- The biodiesel portion of blended fuel containing taxable diesel is exempt from the diesel fuel tax. (Reference Texas Statutes, Tax Code 162.204)

❖ Iowa (#2)

- Retailers selling biodiesel blends containing a minimum of 5% biodiesel (B5) are eligible for a state income tax credit of $0.035 per gallon. Biodiesel blends containing a minimum of 11% biodiesel (B11) are eligible for a state income tax credit of $0.055 per gallon beginning January 1, 2018. (Reference Iowa Code 422.11P)

- Biodiesel distributors may apply for cost-share grants for infrastructure upgrades and installations at biodiesel terminal facilities. Facilities blending or dispensing blends ranging from 2% biodiesel (B2) to 98% biodiesel (B98) are eligible for up to 50% of the total project, up to $50,000. Facilities blending or dispensing B99 or B100 are eligible for up to 50% of the total project, up to $100,000. (Iowa Code 159A.13-159A.15)

- The Iowa Department of Transportation (IDOT) may purchase biodiesel for use in IDOT vehicles through the biodiesel fuel revolving fund created in the state treasury. (Reference Iowa Code 307.20)

State Incentives and Regulations

❖ Missouri (#3)

- At least 75% of the Missouri Department of Transportation (MoDOT) vehicles and heavy equipment that use diesel fuel must be fueled with biodiesel blends of at least 20% (B20). (Reference Missouri Revised Statutes 414.365 and 414.407)
- The Missouri Biodiesel Fuel Revolving Fund uses the money generated by the sale of Energy Policy Act of 1992 credits to cover the incremental cost of purchasing fuel containing biodiesel blends of at least 20% (B20) for state fleet vehicle use. (Reference Missouri Revised Statutes 414.407)

❖ Illinois: (#4)

- Tax exemption to the proceeds from the sale of biodiesel blends containing more than 10% biodiesel up to 99% biodiesel sold between July 1, 2003, and December 31, 2023. (Reference Illinois Compiled Statutes 120/2-10)
- Any diesel-powered vehicle the governmental entities and state educational institutions owns or operates must use a biodiesel blend that contains at least 5% biodiesel (B5) when fueling at a bulk central fueling facility. (Reference 20 Illinois Compiled Statutes 689/10 and 625 Illinois Compiled Statutes5/12-705.1)

State Incentives and Regulations

❖ Washington (#5)

- Waste vegetable oil, specifically cooking oil gathered from restaurants or commercial food processors, an individual uses to produce biodiesel for personal use is exempt from state sales and use taxes. (Reference Revised Code of Washington 82.08.0205 and 82.12.0205)
- At least 2% of all diesel fuel sold in Washington must be biodiesel or renewable diesel. (Reference Revised Code of Washington 19.112.010)
- At least 20% of all diesel fuel used to fuel state agency vehicles, vessels, and construction equipment must be biodiesel. (Reference Revised Code of Washington 43.19.642)

❖ Hawaii: (#27)

➢ Hawaii Senate Bill 2019 proposes on-road fuel sold in the State to contain no less than ten per cent biofuel by volume.

Biodiesel Specification-B100

ASTM D6751-Detailed Requirements for Biodiesel (B100) Blend Stocks

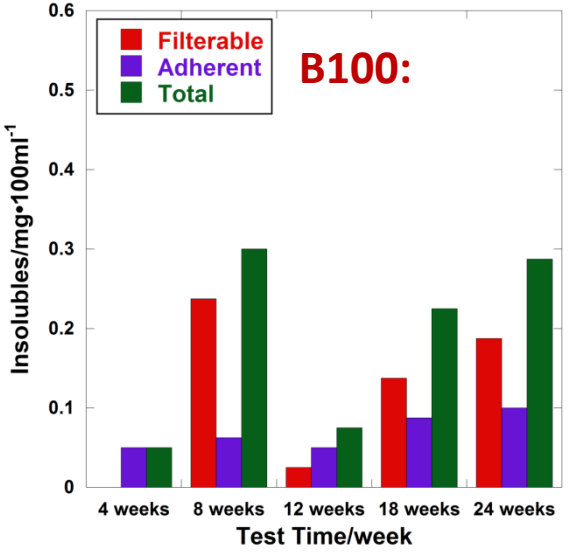
Property	Test Method[A]	Grade No. 1-B S15	Grade No. 1-B S500	Grade No. 2-B S15	Grade No. 2-B S500
Sulfur,[B] % mass (ppm), max	D5453	0.0015 (15)	0.05 (500)	0.0015 (15)	0.05 (500)
Cold soak filterability, seconds, max	D7501	200	200	360[C]	360[C]
Monoglyceride content, % mass, max	D6584	0.40	0.40	...	...
			Requirements for All Grades		
Calcium and Magnesium, combined, ppm (µg/g), max	EN 14538	5	5	5	5
Flash point (closed cup), °C, min	D93	93	93	93	93
Alcohol control					
One of the following shall be met:					
1. Methanol content, mass %, max	EN 14110	0.2	0.2	0.2	0.2
2. Flash point, °C, min	D93	130	130	130	130
Water and sediment, % volume, max	D2709	0.050	0.050	0.050	0.050
Kinematic viscosity,[D] mm^2/s, 40°C	D445	1.9-6.0	1.9-6.0	1.9-6.0	1.9-6.0
Sulfated ash, % mass, max	D874	0.020	0.020	0.020	0.020
Copper strip corrosion, max	D130	No. 3	No. 3	No. 3	No. 3
Cetane number, min	D613	47	47	47	47
Cloud point,[E] °C	D2500	Report	Report	Report	Report
Carbon residue,[F] % mass, max	D4530	0.050	0.050	0.050	0.050
Acid number, mg KOH/g, max	D664	0.50	0.50	0.50	0.50
Free glycerin, % mass, max	D6584	0.020	0.020	0.020	0.020
Total glycerin, % mass, max	D6584	0.240	0.240	0.240	0.240
Phosphorus content, % mass, max	D4951	0.001	0.001	0.001	0.001
Distillation temperature, Atmospheric equivalent temperature, 90 % recovered, °C, max	D1160	360	360	360	360
Sodium and Potassium, combined, ppm (µg/g), max	EN 14538	5	5	5	5
Oxidation stability, hours, min	EN 15751	3	3	3	3

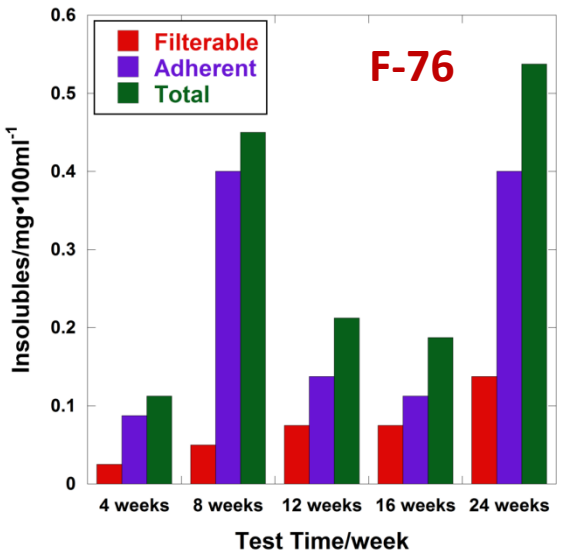
Biodiesel Specification-B6-B20

ASTM D7467-Detailed Requirements for B6 to B20 Biodiesel Blends

Property	Test Method	Grade		
		B6 to B20 S15	B6 to B20 S500[A]	B6 to B20 S5000[B]
Acid Number, mg KOH/g, max	D664	0.3	0.3	0.3
Viscosity, mm^2/s at 40 °C	D445	1.9-4.1[C]	1.9-4.1[C]	1.9- 4.1[C]
Flash Point, °C, min	D93	52[D]	52[D]	52[D]
Cloud Point, °C, max or LTFT/ CFPP, °C, max	D2500, D4539, D6371	[E]	[E]	[E]
Sulfur Content, (µg/g)[F]	D5453	15	...	...
mass percent, max	D2622	...	0.05	...
mass percent, max	D129	...	...	0.50
Distillation Temperature, °C, 90 % vol recovered, max	D86	343	343	343
Ramsbottom Carbon Residue on 10 % bottoms, mass %, max	D524	0.35	0.35	0.35
Cetane Number, min	D613[G]	40[H]	40[H]	40[H]
One of the following must be met:	D976-80[I]	40	40	40
(1) Cetane index, min.				
(2) Aromaticity, volume percent, max	D1319-03[I]	35	35	...
Ash Content, mass percent, max	D482	0.01	0.01	0.01
Water and Sediment, volume percent, max	D2709	0.05	0.05	0.05
Copper Corrosion, 3 h at 50 °C, max	D130	No. 3	No. 3	No. 3
Biodiesel Content, % (V/V)	D7371	6. - 20.	6. - 20.	6. - 20.
Oxidation Stability, hours, min	EN 15751	6	6	6
Lubricity, HFRR at 60 °C, micron (µm), max	D6079	520[J]	520[J]	520[J]

Long-Term Storage Stability (ASTM D4625)



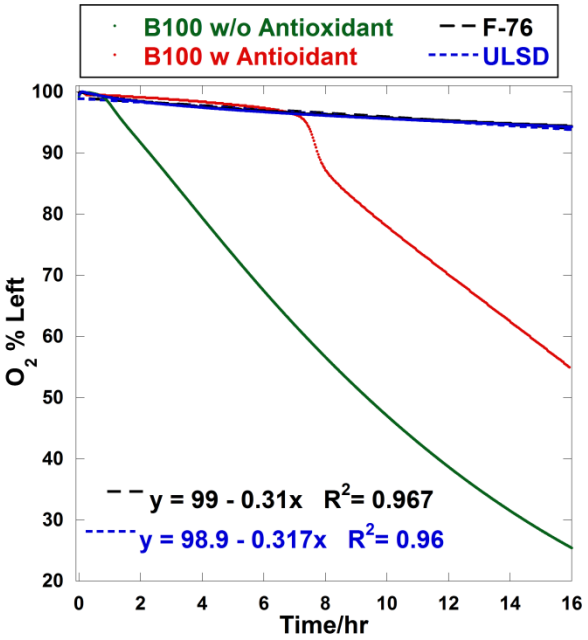


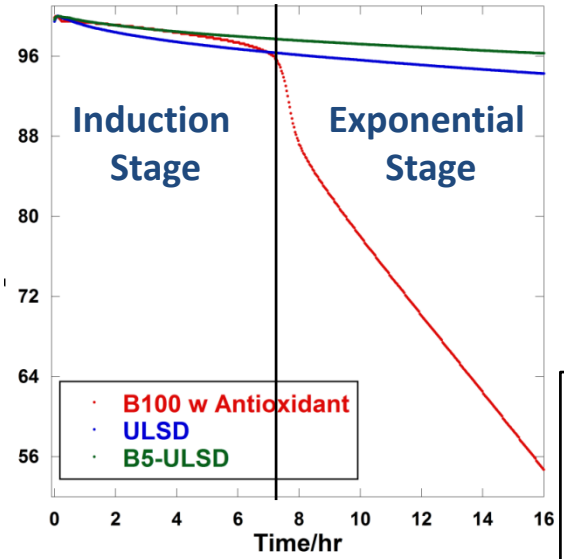
B100 was purchased from Pacific Biodiesel; F-76 is marine diesel

MIL-DTL-16884N (2014) specification <3.0mg/100ml for F-76

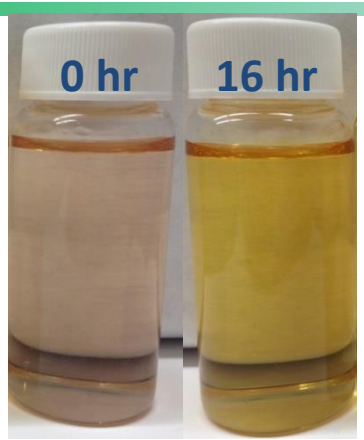
- A week of 43°C storage is roughly equivalent to a month of storage at normal (environmental) ambient temperatures, 21°C, i.e. 24 weeks oven storage simulates approximately 2 years ambient storage.
- The total amount of insolubles formed in B100 after 24 weeks storage is lower than that formed in F-76 samples, owing to the existence of antioxidant in B100.

Oxygen Consumption (ASTM D5304)





The oxidation of commercial biodiesel has three stages: (i) induction stage; (ii) exponential stage; (iii) termination stage.



B100 before and after oxidation

Identification of temperature and test duration combinations under oxygen at 800 kPa that yield approximately the same amount of insolubles as storage for 40 months at 20°C under air at atmospheric pressure.

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Article

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Effects of Biodiesel Contamination on Oxidation and Storage Stability of Neat and Blended Hydroprocessed Renewable Diesel

Jinxia Fu* and Scott Q. Turn

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Storage and oxidation stabilities of biodiesel derived from waste cooking oil

Jinxia Fu *, Scott Q. Turn, Brandon M. Takushi, Cassie L. Kawamata

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Full Length Article

Oxidation stability of biodiesel derived from waste catfish oil

Jinxia Fu [a,*], Bui Thi Buu Hue [b], Scott Q. Turn [a]

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Characteristics and Stability of Neat and Blended Hydroprocessed Renewable Diesel

Jinxia Fu* and Scott Q. Turn