Biodiesel and other Biofuels

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Renewable Fuels for Engines

- Diesel engine fuels
  - **Biodiesel – derived from vegetable oils, animal fats, or recycled fats/oils**
  - Ethanol – from corn, wheat, sugar by fermentation, biomass gasification
  - Dimethyl Ether (DME) – biomass gasification
  - Fischer-Tropsch liquids – biomass gasification
- Gasoline engine fuels
  - Ethanol – from corn, wheat, sugar by fermentation, biomass gasification
  - Fischer-Tropsch liquids – biomass gasification
  - Biogas – anerobic digestion of plant and animal waste
  - Methanol – biomass gasification

Biodiesel is not new

- Rudolf Diesel designed diesel engine in 1894 to run on peanut oil

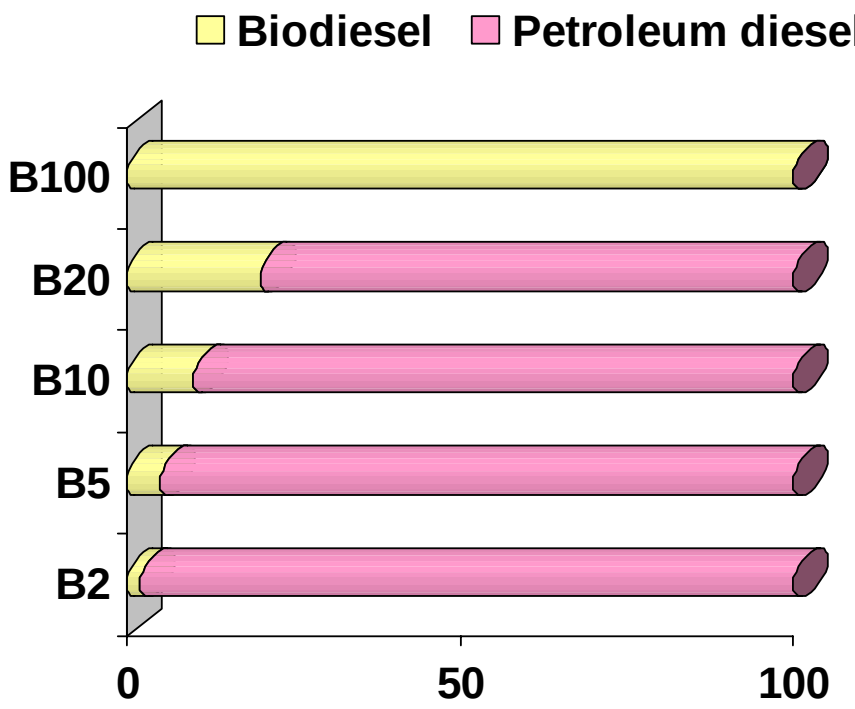
- *"The use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in the course of time as important as petroleum and the coal tar products of the present time."*
  Rudolf Diesel 1912

What is biodiesel?

- Alternative fuel for any diesel engine
- From renewable resources such as soybeans
- Is sometimes used in pure form (B100) but is usually blended with petroleum diesel

- Definitions:
  - Biodiesel, n—a fuel composed of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM (American Society for Testing & Materials) D 6751.
  - Biodiesel Blend, n—a blend of biodiesel fuel meeting ASTM D 6751 with petroleum-based diesel fuel, designated Bxx, where xx represents the volume percentage of biodiesel fuel in the blend.

Biodiesel Blends



B100 = 100% biodiesel

B20 = 20% biodiesel + 80% petroleum diesel

B10 = 10% biodiesel + 90% petroleum diesel

B5 = 5% biodiesel + 95% petroleum diesel

B2 = 2% biodiesel + 98% petroleum diesel

Biodiesel Feedstocks

- Soybean Oil
- Rapeseed Oil
- Other vegetable oils (corn, sunflower, palm)
- Beef Tallow, pork lard
- Recycled restaurant grease (yellow grease)

Dominant feedstock in U.S: soybean oil

- Soy Biodiesel (SME)
  - Over 10 years over research and testing

Soy Methyl Ester Biodiesel Production

100 lbs. of soybean oil

+

10 lbs. methanol

=

100 lbs. soy biodiesel (B100)

+

10 lbs. of glycerin

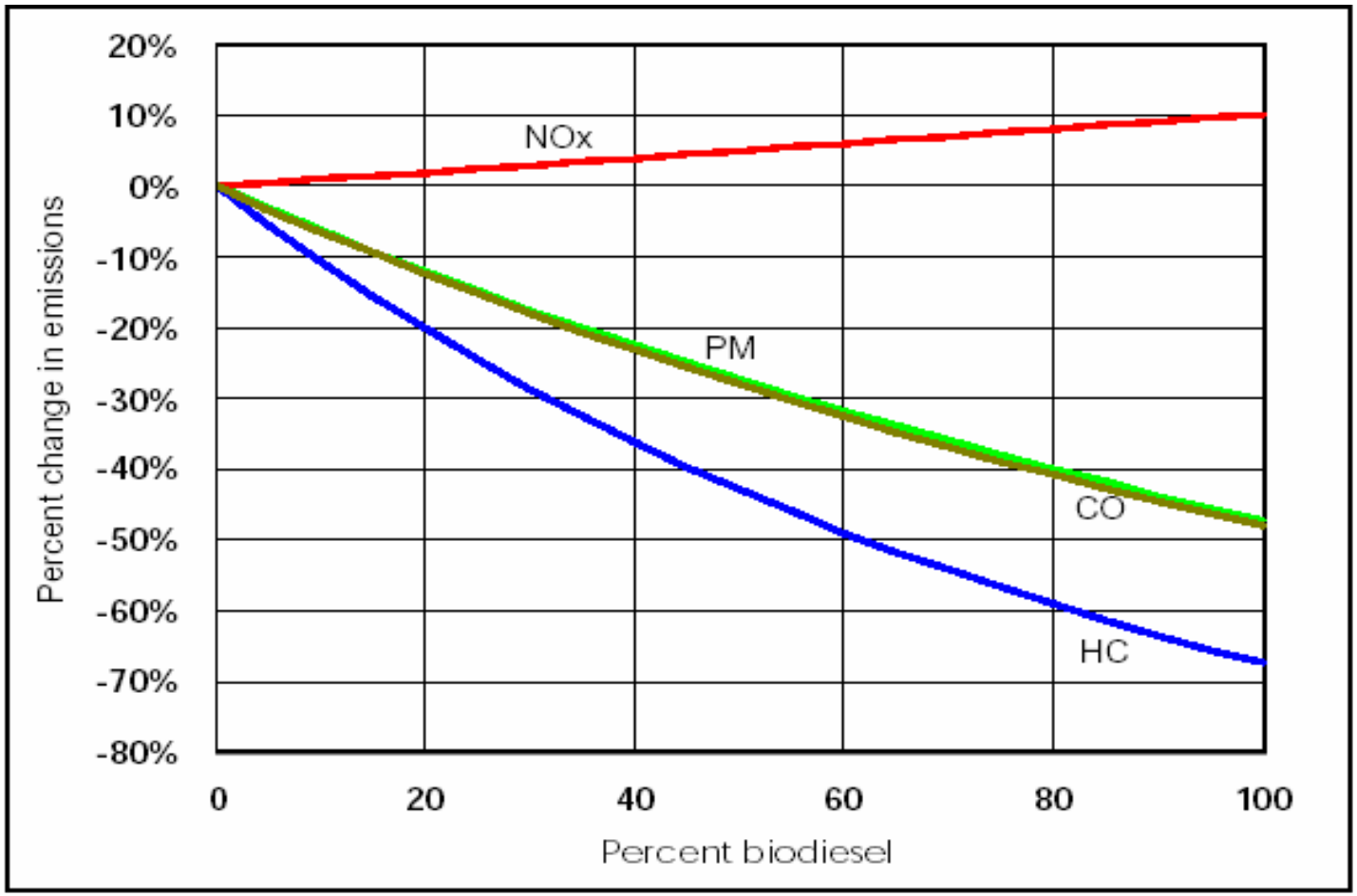
Properties of B100

- Less than 15 ppm sulfur
- No aromatics
- High Cetane, usually over 50
- High lubricity
- Biodegradable
- Non-toxic
- High flash point, over 260 F
- About 8 % less energy on a volume basis with a corresponding reduction in fuel economy

Other Properties

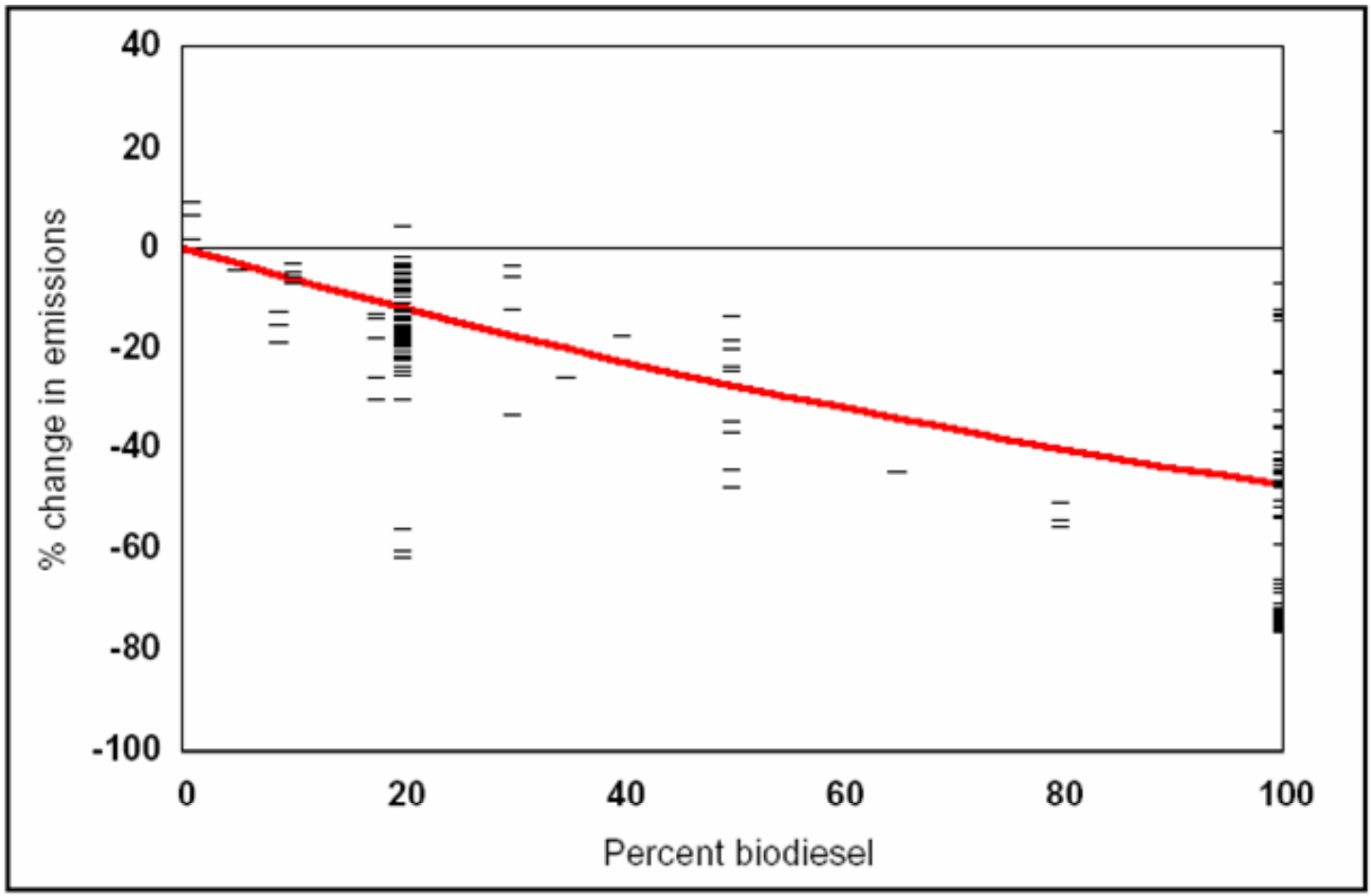
- Cold Flow
  - B100 cloud point
    - SME, RME typically 32 F
    - Recycled oils typically near 40 F
    - Animal fats, 40 – 60 F
  - Properties of blends dependent on base diesel fuel
  - Diesel fuel additives can improve pour point
- Resistance to oxidation an issue
- Additives for biodiesel being developed

Influence of Biodiesel on Diesel Emissions (Heavy-Duty)



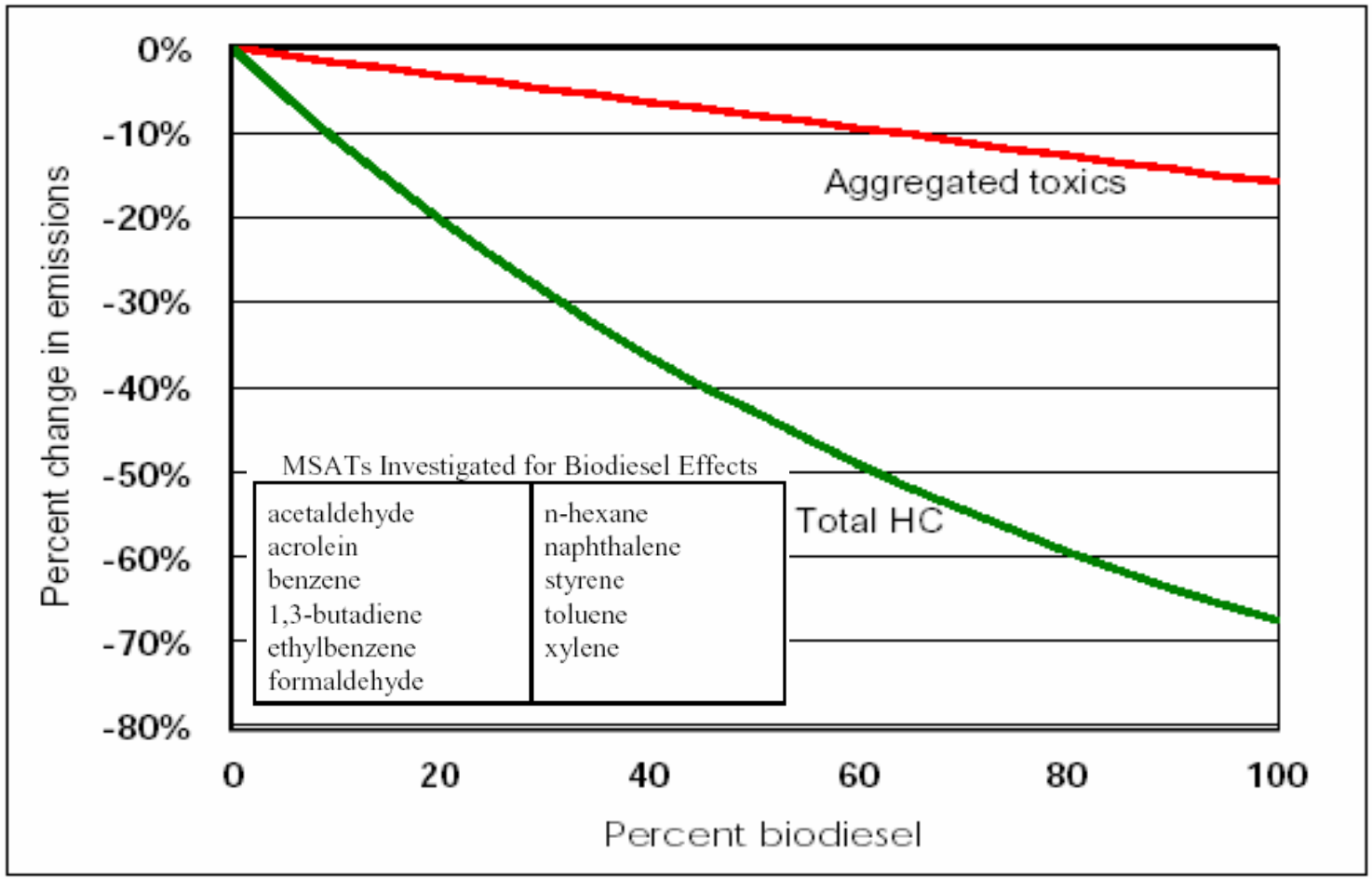
US EPA 2002

Influence of Biodiesel on PM Emissions (Heavy-Duty)– range of results



US EPA 2002

Biodiesel Also Leads to Significant Decreases in Air Toxics



US EPA 2002

Biodiesel Cost

- Federal tax credit
  - $0.01/gal/% biodiesel first use oils
  - $0.005/gal/% biodiesel recycled oils
- Current local SME prices at the terminal are about $2.80, or $1.80 with the credit
- Current local number 2 diesel fuel price at the terminal is about $1.80

Minnesota Biodiesel Mandate

- Legislation passed in 2002
- Requires that diesel fuel contain 2% biodiesel (B2)
- Railroads, taconite/copper mines, generators at nuclear power plants are exempt
- 8 million gallon biodiesel production in MN required

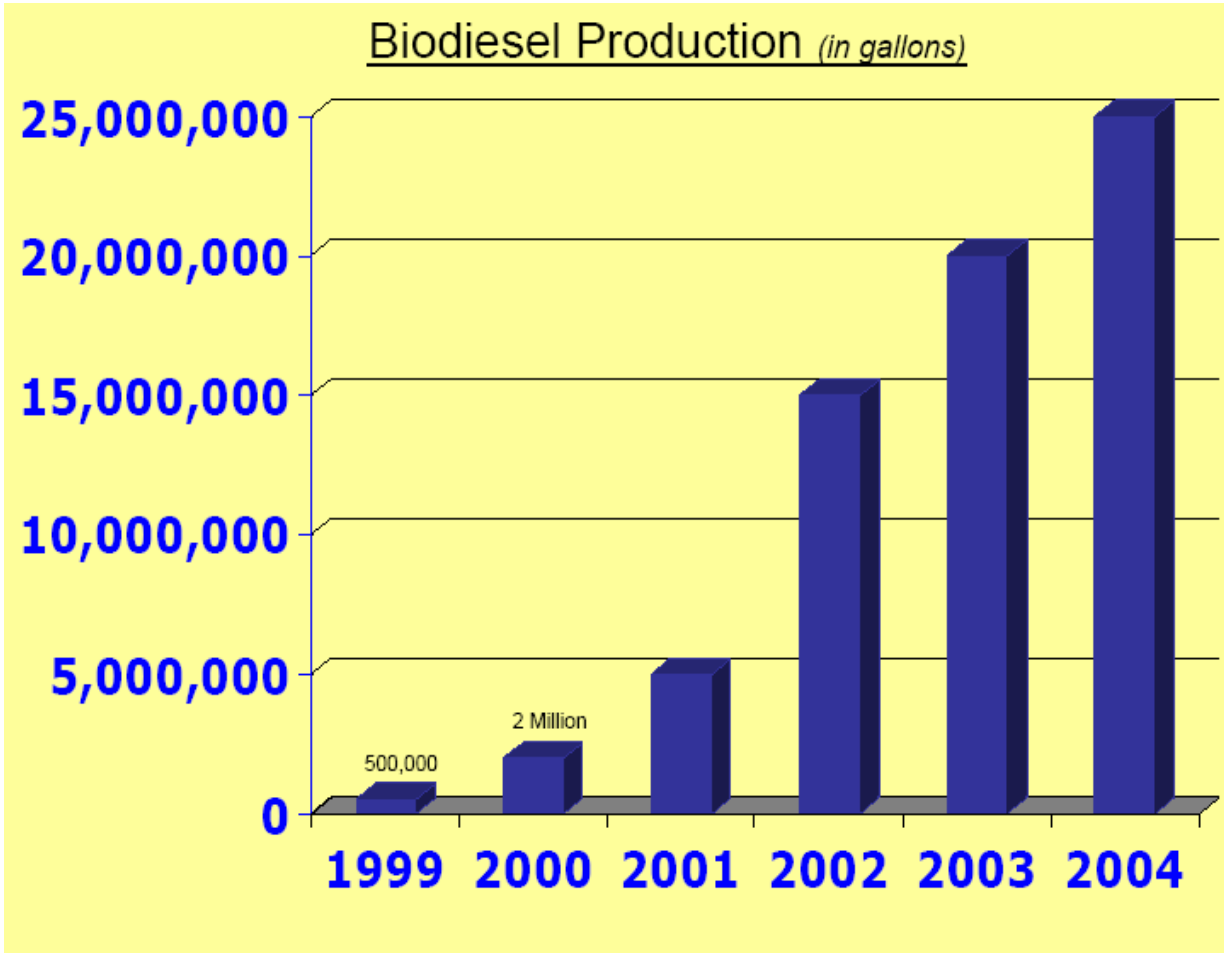
Minnesota Biodiesel Mandate - Status

- Three biodiesel production plants in MN
- Two plants came online in August/September
- 63 million gallon/year production capacity
- Mandate began Sept. 29, 2005

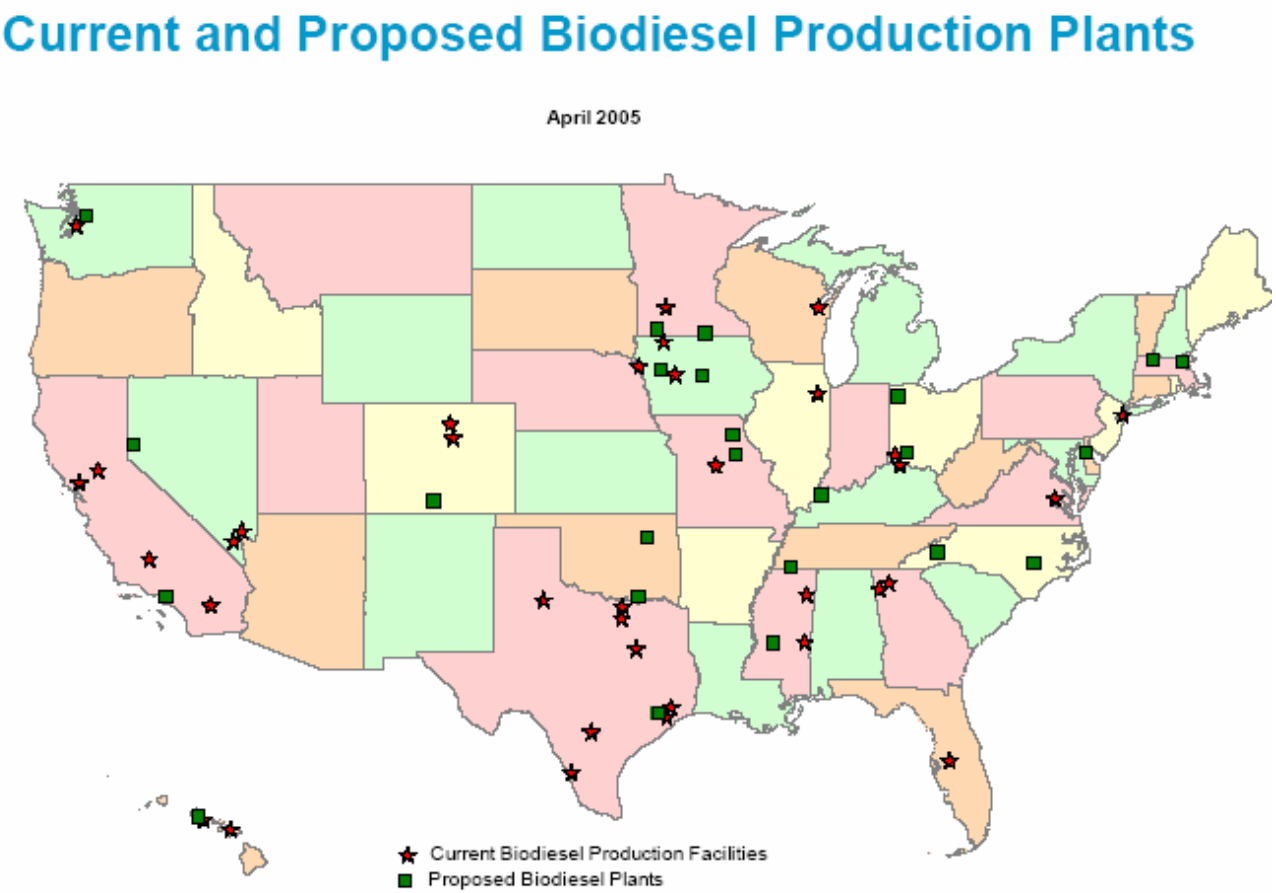
Minnesota Biodiesel Mandate – Temporary variances

- MN Dept. of Commerce issued 10-day variance on Oct. 28 because some biodiesel did not meet ASTM flash point spec.
- Issues with filter plugging resulted in second variance form Dec. 23 – Feb 10. Some fuel did not meet ASTM spec for total glycerine
- Biodiesel producers made process changes and are performing additional fuel tests to ensure fuel quality

Biodiesel Use in the U.S.



Biodiesel Plants in the U. S. (NBB April 2005)

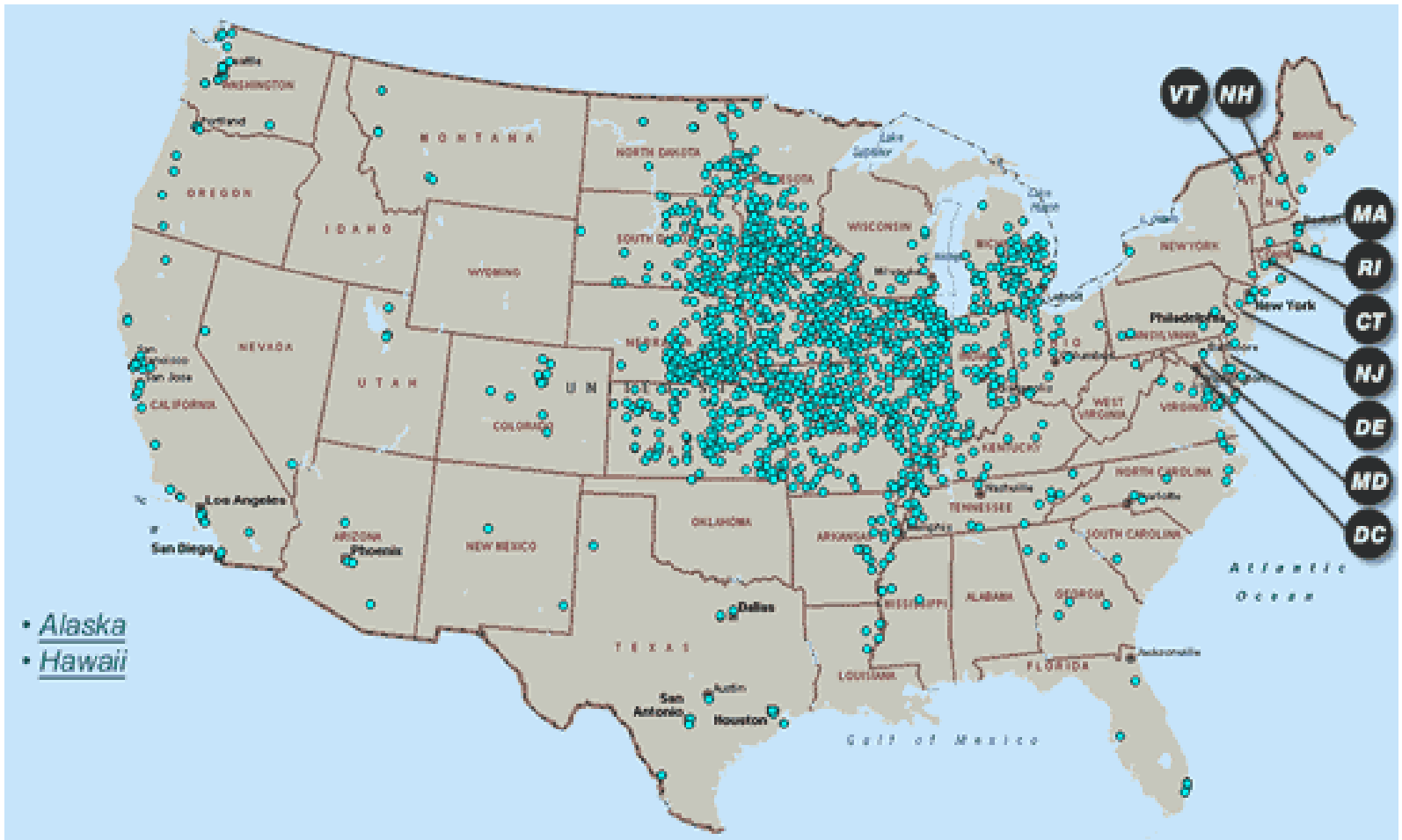


Biodiesel Production Capacity in the U.S.

- Dedicated production capacity (biodiesel production only): 180 million gal/yr
- Additional available capacity within oleochemical industry: 110 million gal/yr
- 54 companies have reported plans to construct dedicated biodiesel plants resulting in additional 570 million gallons/yr

» Source: NBB, September, 2005

Biodiesel distributors in the U.S. (NBB Sept 2005)



For more information

- National Biodiesel Board
  - (nbb.org or biodiesel.org)
- University of Minnesota Biodiesel Helpline
  - 651.330.0450
  - Outstate: 800.929-3437