

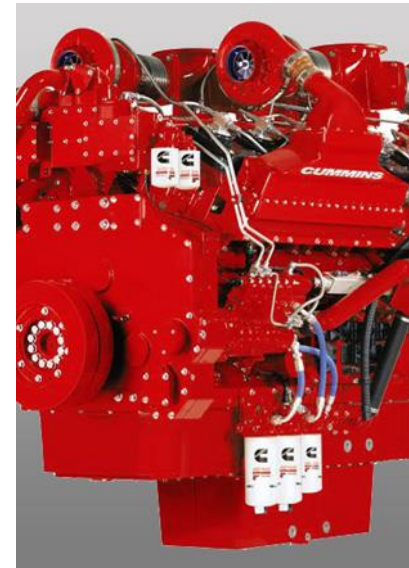


# Biodiesel Review

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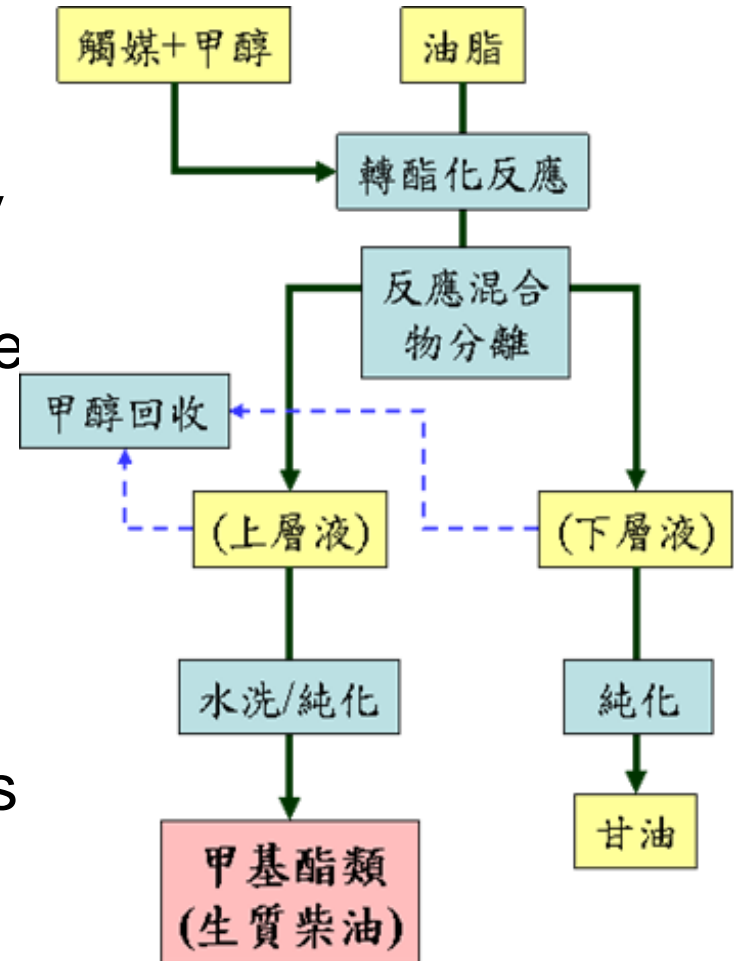
# Biodiesel

- Outline
  - What is Biodiesel?
  - Trends
  - Drivers
  - B20 Approval
  - Requirements
  - Biodiesel Update
  - Summary



# Biodiesel

- A fuel comprised of **methyl/ethyl ester-based** oxygenates of long chain fatty acids derived from the **transesterification** of vegetable oils, animal fats, and cooking oils. These fuels are commonly known as Fatty Acid Methyl Esters (FAME).
- Biodiesel properties are similar to that of diesel fuel, as opposed to gasoline or gaseous fuels, and thus are capable of being used in compression ignition engines.



# Biodiesel

- **B100** - A fuel containing 100 percent biodiesel.
- **Biodiesel Blend – A fuel comprised of a mixture of petrodiesel and B100 biodiesel.** A biodiesel blend is typically designated by the percentage of biodiesel in the blend. For example, B5 is a fuel containing 95 percent petrodiesel and 5 percent B100.
- **Rapeseed Methyl Ester (RME) diesel** - Biodiesel derived from rapeseed oil. RME diesel is the most common biodiesel used in Europe.
- **Soy Methyl Ester (SME or SOME) diesel** - Biodiesel derived from soybean oil. SME diesel is the most common biodiesel used in the United States.



# Biodiesel

- **Biodiesel is NOT raw vegetable oil or SVO (Straight Vegetable Oil) or refined oil or filtered used cooking oil.**

- **IT HAS TO BE MANUFACTURED:**

- Process reaction:

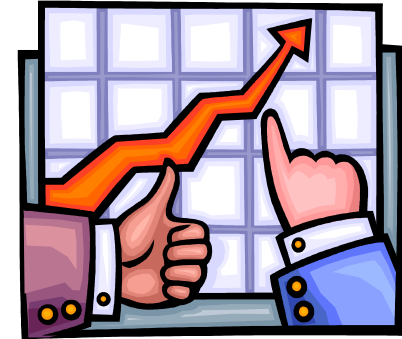


- Raw Materials:

- Oils or Fat: Soybean, Corn, Rapeseed, Cottonseed, Sunflower, Beef tallow, Pork lard, Used cooking oils (yellow grease), etc.
- Alcohol: Methanol, Ethanol
- Catalyst: Sodium hydroxide, Potassium hydroxide



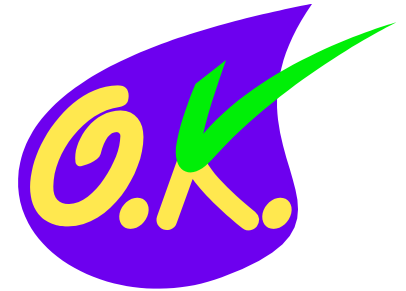
# Trends



- Production increasing globally
- Incentives & mandates increasing
- Biodiesel included in renewable energy policy / plans
- High instability in crude oil prices
- Shift from small to big players, integration upstream
- Distribution shifting from special handling to mainstream
- OEM's announcing support (most approve B5)
- Shift to higher blends B2→B5→B20
- Industry addressing quality

# Benefits

- PM, CO, UHC emissions reduction
- CO2 reduction on a life cycle basis
- Contains no sulfur, aromatics (B100)
- Better lubricity than 500 ppm S fuel
- Renewable energy content
- Local economy, jobs
- Energy security



# Biodiesel: Environmental Driver

- Cummins supports the responsible production and use of biodiesel
- We will use biodiesel in our operations where appropriate and produce products that are capable of operating with biodiesel
- Biodiesel must not harm the availability or economics of the global food supply
- Rain forests and water are resources that must be sustained





# Biodiesel: Environmental Driver

- Biodiesel offers the environmental benefit of renewable energy
- Can also help to reduce dependency on imported oil
- Provides overall emissions advantage with reduced PM, HC, CO & CO<sub>2</sub>
- Cummins is working with industry groups to standardize fuel specifications



# Technical Challenges Addressed for Higher Blends than B5

- Fuel quality
- Fuel oxidation stability
- Contamination, microbe growth
- Materials compatibility
- Fuel filter water separation efficiency
- Cleansing effect on fuel systems
- Potential increase in oil dilution
- Long term durability effects
- Impact on aftertreatment



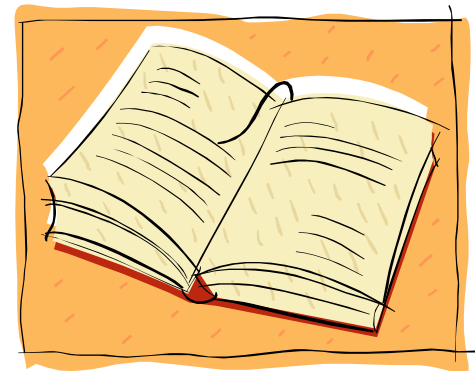
# B20 Approval

- Requirements specified in [Cummins Service Bulletin 3379001](#)
- Vehicle/equipment OEM's have their own specific requirements
- B20 approved engines
  - On-Highway: ISX, ISM, ISL, ISC and ISB engines certified to EPA '02 and later emissions standards; ISL and ISB engines certified to Euro III
  - Off-Highway: QSX, QSM, QSL, QSC, QSB6.7 and QSB4.5, QSB3.3 engines certified to Tier 3/Stage IIIA; QSM Marine and QSM G-Drive
  - High Horsepower Off-Highway built after January 1, 2008: QSK78, QSK60, QSK50, K2000E, K50, QSK45, QSK38, K1500E, K38, QST30, QSK23, QSK19 and K19. Also Marine QSK60, QSK50, K50 QSK45, QSK38, K38 QSK19, K19
- All future products will be compatible with biodiesel B20.



# Requirements for Using Biodiesel Fuel in Cummins Engines

- Customers choosing to run biodiesel blends **above B5** and up to B20 **must** adhere to the following requirements from Cummins Inc.
  1. B20 ASTM specifications / BQ9000 Suppliers
  2. Oil Sampling
  3. Fuel Water Separation
  4. Biodiesel Fuel Storage
  5. Energy Content
  6. Materials Compatibility
  7. Low Temperature Performance
  8. Microbial Growth
  9. Biodiesel Additives
- It is recommended that customers running biodiesel blends of B5 or below follow these precautions as well.



# New / Revised Biodiesel Standards Released in October 2008

- B100 ASTM D6751: *Revised B100* spec. now includes a cold soak test. The B100 fuel is cold soaked and filtered. The time it takes to pass is measured. The idea is to catch impurities or incomplete reactions resulting from the production process that may precipitate at temperatures higher than the expected cloud point.
- B6-B20 ASTM D7467: *New stand alone* specification for blends B6 - B20. Includes an oxidation stability requirement.
- #2 Diesel Fuel D975: *Revised* to allow up to 5% biodiesel in the diesel pool.



# BQ-9000



- Accreditation of producers and marketers of biodiesel fuel.
- Program ensures that company is using a system for monitoring the quality of biodiesel
  - Storage
  - Sampling
  - Testing
  - Blending
  - Shipping
  - Distribution
  - Fuel management

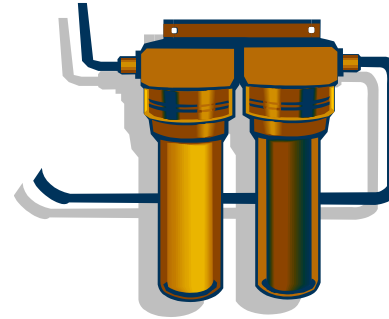
# BQ-9000



- In North American Cummins requires biodiesel fuel blend be purchased from a BQ-9000 Marketer
- B100 biodiesel fuel used in the blend must be from a BQ-9000 Producer
- BQ-9000 Marketers and Producers can be found at the following website: <http://www.bq-9000.org>
  - Over 70% of biodiesel comes from certified producers
  - 33 companies are certified producers
  - Canada, US and Mexico are included in the program
- Outside of North America, consult your local Cummins representative for applicable fuel quality standards



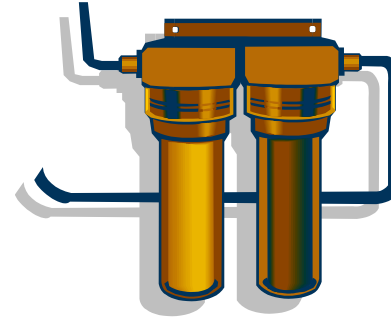
# Fuel Water Separation



- Biodiesel has a natural affinity to water, and water accelerates microbial growth.
- Storage tanks **must** be equipped with a fuel water separator to make sure that water is stripped out before entering the vehicle tank.
- Vehicle and storage tanks **must** be kept full to reduce the potential for condensation accumulating in the fuel tank.



# Fuel Water Separation



- Cummins Inc. requires
  - The use of StrataPore fuel filter media, and strongly recommends using Cummins Filtration filters equipped with StrataPore media. This filter media removes water more efficiently.
  - The use of a centrifuge filtration system for HHP marine applications to safeguard against water contamination

# Biodiesel Fuel Storage



- Use biodiesel fuel within six months of its manufacture
- Biodiesel not recommended for low use applications (standby power or seasonal applications)
- Consult your fuel supplier for oxidation stability additives.
- Poor oxidation stability can accelerate fuel oxidation in the fuel system at increased ambient temperatures.



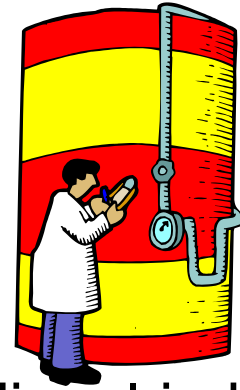
Avoid storing equipment with biodiesel blends in the fuel system for more than three months or fuel system damage can occur.

# Low Use / Seasonal Applications

- If biodiesel is used for seasonal applications, the entire vehicle fuel system **must be purged before storage** by running the engine on pure diesel fuel for a minimum of **30 minutes**.

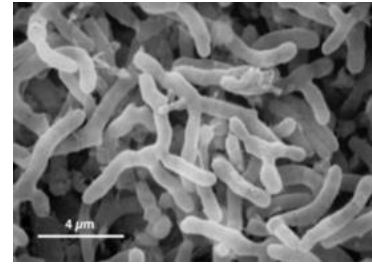


# Biodiesel Fuel Storage



- Care must also be taken when storing biodiesel in bulk storage tanks.
- All storage and handling systems must be properly cleaned and maintained.
- Steps must be taken to minimize moisture and microbial growth in storage tanks.
- Consult your fuel supplier for assistance in storing and handling biodiesel.

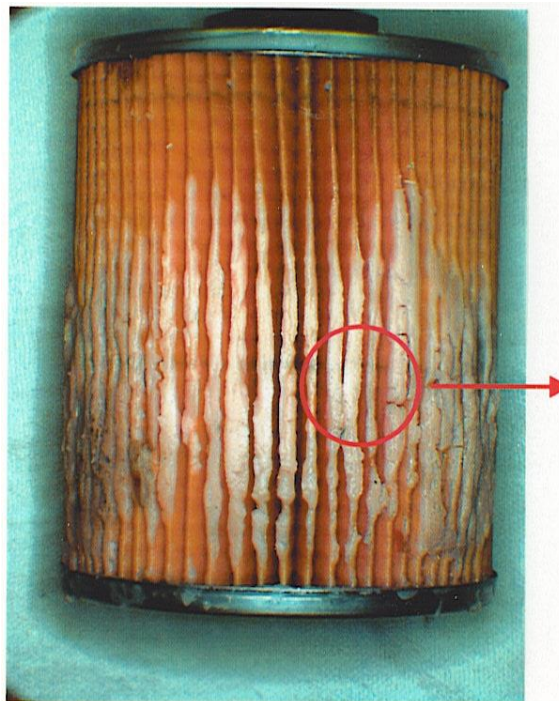
# Microbial Growth



- Biodiesel fuel is an excellent medium for microbial growth.
- Microbes cause fuel system corrosion and premature filter plugging.
- Consult your fuel and additive supplier for assistance.

# Fuel Quality

- Oxidized Fuel
  - Sludge formation
  - Deposits
  - Filter plugging



Deposits from  
oxidation in a B20  
field test

# Fuel Solvency

- Due to the solvent nature of biodiesel, and the potential for “cleaning” of the vehicle fuel tank and lines, **new fuel filters must be installed when switching to biodiesel** on used engines.
- Fuel filters will need to be replaced at half the standard interval for the next two fuel filter changes.



# Oil Sampling



- ISB 07 and ISC/ISL 07 products **require** oil sampling to determine appropriate oil change interval.
  - Oil samples should be taken during the first 6 month of operation
- High Horsepower engines equipped with the Eliminator Oil Change Extender System **require** oil sampling to determine appropriate oil change interval.
  - Oil samples should be taken every 250 hours
  - Repeat oil sampling for at least three oil change intervals to insure consistent oil behavior
- Fuel levels in lubricating oil **must not exceed 5%.**
- Additional information on oil contamination and oil sampling can be found in Cummins Engine Oil Recommendations, Bulletin 3810340.



# Energy Content

- B100 biodiesel provides approximately 7% to 10% less energy per gallon of fuel when compared to conventional diesel fuel.
- B20 biodiesel blends can potentially result in a slight decrease in fuel economy and/or power, depending on the application.
- To avoid engine problems when the engine is converted back to 100 percent petrodiesel, do not change the engine rating to compensate for the potential power loss.



# Summary – Key Requirements



**Capable engine**

**Capable Vehicle  
/ Equipment**

**Successful  
Application**

Approved engines only

Approved Vehicles/Equipment

**Quality fuel**

**Quality blend  
/ delivery**

Application  
Requirements,  
i.e. fuel storage,  
seasonal use, etc.



B100 Accredited  
Producers



B20 Certified  
Marketers, *B20 specifications*



# Since Cummins approved B20

- Production and use of biodiesel growing worldwide
- Continued to work closely with ASTM, resulting in an improved B100 spec. (ASTM 6751) and a stand alone B6-B20 spec (ASTM 7467).
- Over 70% of biodiesel supplied in North America is from BQ9000 certified suppliers
- Energy bill signed December 2007: expands renewable fuels standard, credit for B20 vehicles
- Innovation Award presented to Cummins by the National Biodiesel Board for leadership in B20 application



# Summary

- All Cummins products are approved for use with B5
- Cummins has completed the necessary testing and evaluations and developed guidance to ensure that customers can reliably operate selected equipment with confidence using B20 fuel
- Only use biodiesel that meets ASTM 6751 or EN14214 and ASTM D7467 for biodiesel blends B6-B20. There are no specifications to define blends above B20
- R&E efforts are on-going towards understanding issues relative to use of higher blends

