

Biodiesel Update

Edward Lyford-Pike
Chief Engineer
Advanced Alternative Fuels

NBC Feb 5th, 2008





Biodiesel: Environmental Driver

- Biodiesel offers the environmental benefit of renewable energy
- Can also help reduce dependency on imported oil
- Provides overall emissions advantage with reduced PM, HC, CO and CO₂ (production/use cycle basis)
- Cummins is working with industry groups to standardize fuel specifications
- 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 B20 Approval Project



Technical Challenges addressed for higher blends than B5

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

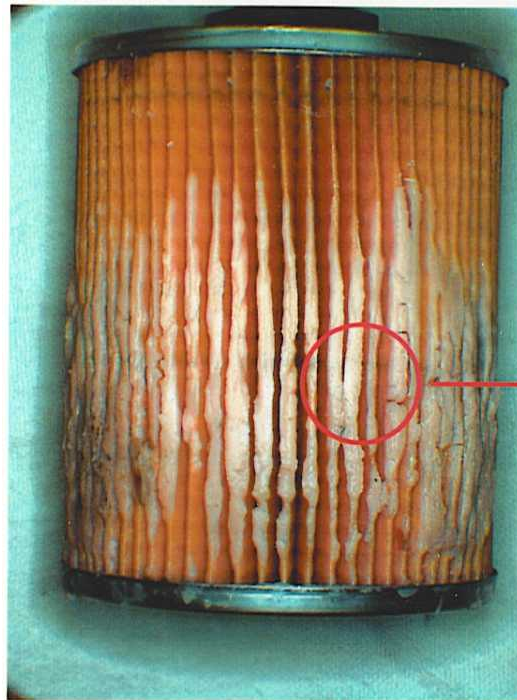


Fuel pump hsg deposits and corrosion from low use test

Fuel Quality

- **Oxidized Fuel**

- Sludge formation
- Deposits
- Filter plugging



Deposits from
oxidation in a B20
field test



Key Project Tasks

1. Robust Fuel Standard Implementation
2. Materials Compatibility Assessment/Counter measures across all target engine families
3. Oil Dilution Evaluation
4. Fuel Water Separation Requirements
5. Aftertreatment (for 2007 products)
6. Application Information / Education needs





B20 Approval

- Cummins Announces Approval of B20 Biodiesel Blends – March 21, 2007 (everytime.cummins.com)
- Approval limited to targeted engines - Additional approvals under evaluation/testing
- 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, and ISL, ISC and ISB engines certified to Euro III
- Off-Highway: QSX, QSM, QSL, QSC, QSB6.7 and QSB4.5 engines certified to Tier 3/Stage IIIA, QSM Marine and QSM G-Drive.
- 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. EMA spec / 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.



Requirements for Using Biodiesel Fuel in Cummins Engines

- There are specifications for biodiesel issued in Europe under **EN14214** and in North America under **ASTM D6751**. These specifications define **only** the biodiesel used as the blend component with diesel fuel. They are **not** applicable to fuel blends purchased by the end user.
- Despite the existence of these standards, the general **quality of available biodiesel remains inconsistent**.

CAUTION

To successfully use biodiesel, it is imperative that the fuel be of high quality and meet or exceed the specifications outlined in this bulletin or engine damage will occur.



Requirements for Using Biodiesel Fuel in Cummins Engines

- Cummins Inc. provides the specifications found in Table 1 of the Service Bulletin for diesel fuel and biodiesel blends up to B5. For biodiesel blends above B5 and up to B20, Cummins Inc. provides the specifications found in Table 4.
- The specifications in Table 4 of the Service Bulletin (next page) have been developed by the Engine Manufacturers Association (EMA), and are **not** an approved national or commercial fuel standard. All biodiesel fuel blends are to be comprised of petrodiesel meeting **ASTM D975**, and **B100** meeting either **ASTM D6751** or **EN14214**.

Table 4 from Service Bulletin: EMA Blend Spec.

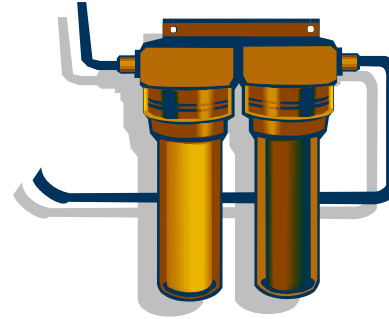


Item	Performance Characteristics	Requirements		Test Procedure
		D1 Blends	D2 Blends	
1	Flash Point, °C, min.	38	52	ASTM D93
2	Water and sediment, vol %, max.	0.05	0.05	ASTM D2709 or D1796
3	Physical Distillation, T90, °C, max.	343	343	ASTM D86
4	Kinematic Viscosity, cSt@40C	1.3~ 4.1	1.9~4.1	ASTM D445
5	Ash, mass%, max.	0.01	0.01	ASTM D482
6	Sulfur, wt%, max.	Per regulation	Per regulation	
7	Copper strip corrosion rating, max.	No. 3	No. 3	ASTM D130
8	Cetane Number, min.	43	43	ASTM D613
9	Cloud point ¹	Per footnote	Per footnote	ASTM D2500
10	Ramsbottom carbon residue on 10% distillation residue, wt%, max.	0.15	0.35	ASTM D524
11	Lubricity, HFRR@60C, micron, max.	460	460	ASTM D 6079
12	Acid number, mg KOH/g, max.	0.3	0.3	ASTM D664
13	Phosphorus, wt%, max.	0.001	0.001	ASTM D4951
14	Total Glycerin	-----	-----	N/A
15	Alkali metals (Na+K),ppm, max.	Nd	Nd	EN14108
16	Alkaline metals (Mg+Ca). ppm max.	Nd	Nd	EN14108
17	Blend fraction, vol. % ²	+/- 2%	+/- 2%	EN14078
18	Thermo-oxidative Stability, insolubles, mg/100 mL, max.	10	10	Modified ASTM D2274 ³
19	Oxidation Stability, Induction time, hours, minimum	6	6	EN14112 (Rancimat)

BQ-9000



- For North American markets, Cummins Inc. requires that the biodiesel fuel blend be purchased from a **BQ-9000 Certified Marketer**.
- The B100 biodiesel fuel used in the blend must be sourced from a **BQ-9000 Accredited Producer**.
- Certified Marketers and Producers can be found at the following website: <http://www.bq-9000.org>.
- For areas outside of North America, the local Cummins representative must be consulted 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.
- Make sure that the vehicle and storage **tanks are kept full** to reduce the potential for condensation accumulating in the fuel tank.
- 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.



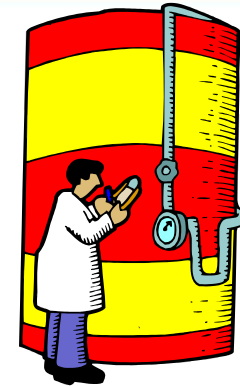
Biodiesel Fuel Storage

- Use biodiesel fuel **within six months** of its manufacture. Biodiesel has poor oxidation stability, which can result in long term storage problems. For this reason, Cummins Inc. does **not** recommend using biodiesel for low use applications, such as standby power or seasonal applications. Consult your fuel supplier for oxidation stability additives.
- The poor oxidation stability qualities of biodiesel can accelerate fuel oxidation in the fuel system, especially at **increased ambient temperatures**.

 **CAUTION** 

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

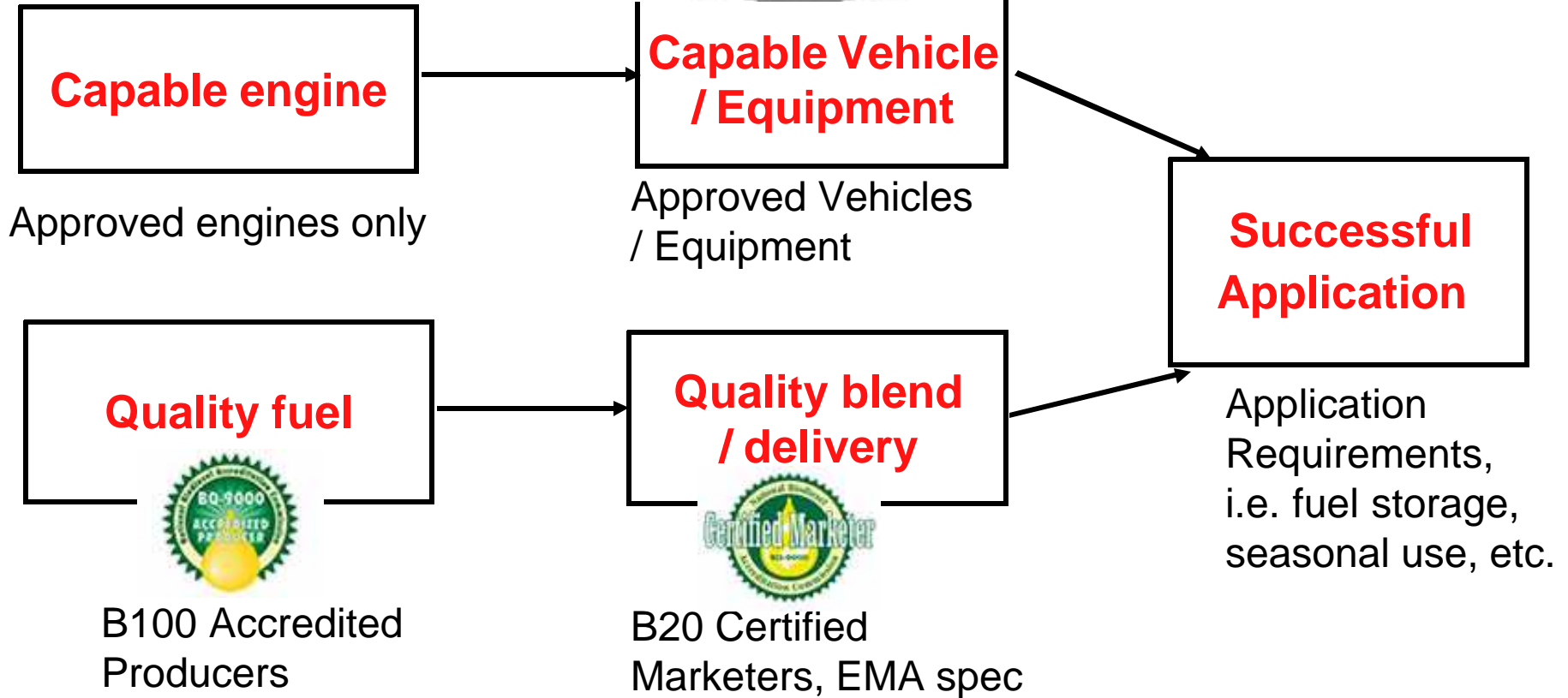
Biodiesel Fuel Storage (cont.)



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



Summary – Requirements





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 engines with confidence using B20 fuel.
- Only B100 biodiesel that meets ASTM 6751 or EN14214 and the EMA B20 blend test specification can be used. There are no specifications to define blends above B20. Recent national audit shows quality is still a big issue in the industry.
- Cummins is currently focused on supporting the B20 release and continued validation efforts to approve additional engines.
- Critical needs are to improve B100 standards, create B20 standards and improve biodiesel quality.

Biodiesel quality matters

- Poor quality biodiesel fuel in the market has caused operating problems
- A quality control system for biodiesel all the way to the pump is needed along with compliance and enforcement
- Cummins requires biodiesel used with our products to meet ASTM 6751 or EN14214, the EMA B20 test specification and be sold by a certified marketer (BQ9000 in the US)
- Cummins will continue to participate in improving specifications and quality

