Biodiesel, Ultra-Low Sulfur Diesel (ULSD) and Engine Performance

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Biodiesel Engine Performance Evaluation

John Deere Performance Assessment of Biodiesel Performance in Non-Road Engine through Tier 3/Stage IIIA

- Evaluation program was conducted in the 2006 – 2008 timeframe.
- Engine testing involved both dyno and field evaluations (engine in machines).
- The majority of testing was done using either B20 or B100 biodiesel blends.
- The B20 testing was done in North America (NA) and the B100 testing in the European Union (EU).

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Biodiesel Engine Performance Evaluation

John Deere Performance Assessment of Biodiesel Performance in Non-Road Engine through Tier 3/Stage IIIA cont.

- Only quality biodiesel was used, meeting ASTM D6751 in NA and EN14214 in the EU.
- Tier 2 and Tier 3/Stage IIIA engines were evaluated.
- The Tier 2 engines covered the following fuel systems: High Pressure Common Rail (HPCR), Electronic Unit Injector (EUI), Rotary, Mechanical Unit Pump (MUP) and Inline.
- The Tier 3/Stage IIIA engines only covered HPCR fuel systems.

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Biodiesel Engine Performance Evaluation

John Deere Performance Assessment of Biodiesel Performance in Non-Road Engine through Tier 3/Stage IIIA - Results

- There were no engine performance issues with B20, with either the Tier 2 or Tier 3/Stage IIIA engines.
- There were some injector fouling problems when high percent biodiesel blends were used in Tier 3/Stage IIIA engines.
- These deposits were primarily external forming at the injector tip and resulted in power loss.
- Use of certain detergent/dispersants in the fuel were found to clean up and prevent the formation of these deposits.

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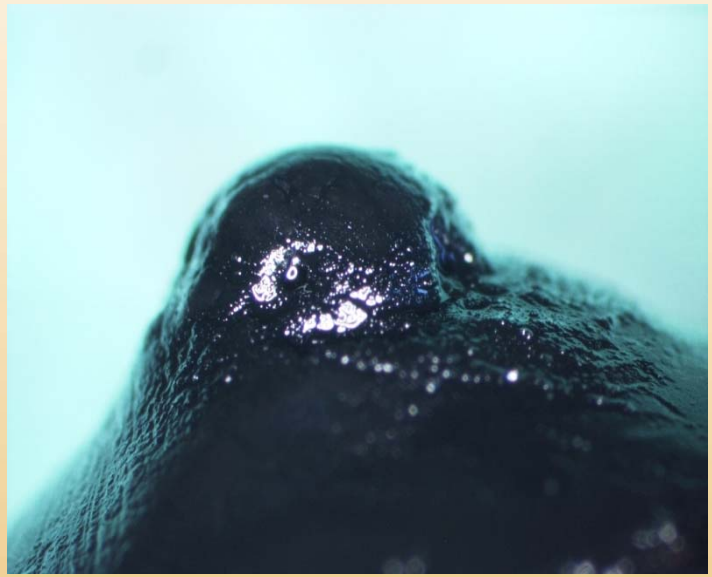
INJECTOR DEPOSITS – Through Tier 3/Stage IIIA Engines

Deposits at injector tips on a HPCR fuel system, leading to poor starting and running behavior (power loss, instability, smoke). Engine operated on RME B100 in a tractor in the field.



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John Deere Leadership in Biodiesel

Blends up to B100 allowed for general use in all John Deere products, with some caveats for blends B20 and higher – November 2007

2% biodiesel blend (B2) for U.S. factory fill when equipment leaves John Deere factories - March 2005. Will be moving to B5 in the near future.

John Deere's Position on Biodiesel

B20 or Lower Blends –

- Require that customers purchase biodiesel whose bio portion meets either ASTM D6751 or EN14214 (at a minimum) and obtain a Certificate of Analysis for that batch being sold.
- Product must be used within 3 months of the date the bio portion was produced.

Blends Above B20 –

- Require that the bio portion meet EN14214 and a Certificate of Analysis for that batch being sold be supplied.
- Product must be used within 45 days of the date the bio portion was produced.

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John Deere's Position on Biodiesel

Detergent Additives –

- For blends below B20, it is recommended that customers use a John Deere approved fuel conditioner with a detergent/dispersant additive.

- For blends B20 and above, it is required that customers use a John Deere approved fuel conditioner with a detergent/dispersant additive.

- These recommendations and requirements are to prevent and clean up any injector deposits that might form.

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ULSD and HPCR Injector Deposit Problems

ULSD/HPCR Injector Deposit Problems

- Industry wide problem, injector deposit problem impacting both on-road and non-road HPCR engines.
- Global Issue: Problems in both NA and the EU.
- All Tier 3 and IT4, and 2007 on-road HPCR engines impacted.
- Deposits are internal and difficult to remove.

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ULSD and HPCR Injector Deposit Problems

Cause

- ULSD Hydrotreating → Can result in a less stable fuel.
- HPCR = Higher Temperatures and Pressures.
- ULSD + HPCR = Oxidation/Deposits/Lacquering.
- Affirmed by Industry Discussions.
- Very few problems with CARB ULSD. Most CARB ULSD is hydrotreated and then hydrocracked in order to reduce the aromatics. The fuel is more stable.

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ULSD and HPCR Injector Deposit Problems

Challenge

- Current industry bench and engine deposit tests are not able to screen ULSD's propensity for forming deposits on HPCR injectors.

- In order to be able to screen ULSD fuels for their propensity to form injector deposits in current HPCR fuel systems (≥1600 bar) and additives for their ability to clean up and prevent injector deposit formation, either an engine or bench test needs to be developed.

- Because of the impact such deposits can have on fuel economy and emissions, development of such tests might be a good project for DOE to support.

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Questions

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