An Inside Look at The Technical Advances of Bioheat™ Plus
Answers you are looking for

**Biodiesel and residential storage and heating equipment**

Mario Bouchard, VP, Granby Industries
Responsibilities of the manufacturers of oilheating equipment and storage.

• Manufacturers are held to Agencies Equipment Certifications to be allowed to have their equipment installed and used in buildings for heating of the air and water and the oil storage.

• Equipment certification bodies haven’t kept up to speed with the changes in the combustible liquids coming into the marketplace.

• This poses some challenges to the equipment manufacturers that want to follow the industry pressures towards the use of renewable combustible liquids such as biodiesel and renewable diesel.
Requirements about residential storage and heating equipment with biodiesel?

- Certification or approvals of equipment for their intended use.
- All heating appliance and storage equipment should hold a certification to be installed in buildings as per NFPA-31 installation code, here are some but not limited to;
  - UL726 for Oil-Fired Boilers
  - UL732 for oil-fired Storage Tanks Water Heaters
  - UL727 Oil-Fired Central Furnaces
  - UL296 Oil burners
  - UL80 Steel Tanks for oil burning equipment
  - UL142 Steel Above ground Tanks for flammable and combustible liquids
  - UL2258 Non-metallic Tanks for Oil Burner Fuels and Other Combustible Liquids
- All these certification standards must have in their scope the allowed use of biodiesel, in some level of blend.
Heating Equipment
Biodiesel and heating equipment

• Heating equipment (furnaces and boilers)
  • Heat exchangers
    • Heat exchangers are steel or cast-iron assemblies
      • Built for the sole propose of extracting heat produced combustion products from burners
      • Exchange that heat to the air or water

• In equal operating environments either be with fossil fuels or biodiesel, heat exchangers will not be subjected to any damages with either fuels considering that;
  • Same BTU/h input, same burner flame pattern, same draft requirements, adequate burner adjustments to allow proper combustion operation
    • Smoke trace, O2, CO, Excess Air, flue gas temperatures will be very similar
Biodiesel and heating equipment II

• Heat exchangers are not subjected to any added stress with either of these combustible liquids.
• Heat exchangers will provide very similar AFUE performance with either combustible liquids.
• The expected life expectancy of a heat exchanger operated with either combustible liquids will remain unchanged.
• As with any combustible liquid heating appliance, annual maintenance is key in maintaining proper and reliable operation and maintaining product warranty.
Biodiesel and heating equipment III
Does Biodiesel affect heating equipment

• Does converting a heating system currently using fossil fuel to biodiesel affect the heating equipment?

• The short answer is No!
  • According to heating equipment manufacturers
    • Heat exchanges are not affected by switching between fossil fuel and biodiesel considering that;
    • Same BTU/hr. input, same burner flame pattern, same draft requirements, adequate burner adjustments to allow proper combustion operation
      • Smoke trace, O2, CO, Excess Air, flue gas temperatures will be very similar
  • Burner manufacturers are evaluating the specifics of switching between fossil fuel and biodiesel.

• Components compatibility with both combustible liquids
• Combustion adjustments
Storage Tanks

• There are a few varieties of available combustible liquid storage tanks available on the market
  • Metallic (Steel)
  • Nonmetallic (High Density Polyethylene – HDPE or Fiberglass)

• The most common tanks found in the marketplace today are metallic tanks, made of carbon steel
  • The industry has been repeatedly informed, trained and understands well that fossil heating oil combined with water at the bottom of the tank will produce microbial corrosion which will lead to internal premature tank perforation.
    • NO WATER = NO CORROSION
  • THIS CONCEPT IS NO DIFFERENT WITH BIODIESEL

• A steel tank is at no greater risk of failing prematurely with the storage of Biodiesel compared to fossil fuel
• The key remains in good installation practices and annual maintenance of storage tanks
  • Verify for water presence annually and if water is found present, it should be removed
  • This is valid for all storage tanks, used with fossil or Biodiesel combustion liquid.

Steel Single Wall Tanks
UL up to B20

Steel Double Bottom Tanks
UL up to B20

2-in-1 HDPE Tanks
UL up to B100
Does biodiesel affect storage equipment

- Does converting an oil tank currently using fossil fuel to Biodiesel affect the storage tank?
  - It is a known fact that Biodiesel contains water in its molecule as does 100% LSD or ULSD fossil fuel contains water.
  - A tank in good overall condition, installed as per UL, NFPA codes and manufacturers instructions, annually serviced (as per UL, NFPA and manufacturers instructions) should not be more prone to internal corrosion by the simple addition of Biodiesel in the tank!!!
  - The key to a long-lasting steel oil tank REMAINS in preventing the constant presence of water at the bottom of the tank.

**NO WATER = NO CORROSION**
Does biodiesel affect storage equipment

- **Outdoor tanks**
  - Outdoor tanks are exponentially more exposed to condensation formation inside the tank
  - Outdoor tanks WILL accumulate more water from condensation at the bottom of the tank than indoor tanks
  - Bottom feed outdoor steel tanks installed properly as per manufacturer’s instructions UL and NFPA codes
    - With a slope towards the outlet and with a sloped oil line from the point of exit of the tank to the inside of the building
    - Should not accumulate any water at the bottom, should not fail prematurely, this is true if the tank is filled with Biodiesel AND Fossil Combustible liquids.
Technical Barriers to the Adoption of B20
There Aren’t Any

- A BNL compilation of studies done over the course of 25 years.
- Industry Survey on the Use of Biodiesel Blends April 2014
- Key Result: The results from the in-use fuel survey, which include over 13,000 buildings using at least B20, show that B20 and lower blends operate in the field in a similar manner as that of conventional heating oil. Thus based on this survey B6-B20 blends will operate as expected in the field.
Pump Testing

Legacy Pumps

Newer Model Pumps
Pump Seals & Elastomers

• *This recent testing shows common nitrile elastomers in typical heating oil burner pumps in the U.S. perform the same or better using B20 than those using conventional No. 2 heating oil.

*NORA Technical Note March 2020
**B20 Combustion Performance Conclusion**

- *The results in this section show that typical burners set up on No. 2 petroleum fuel oil can operate acceptably over the entire range of biodiesel blend levels without making changes in air/fuel ratio. However, as the blend level is increased, the operating excess air level will increase since biodiesel already contains some oxygen. The relatively small changes in B20 did not affect flame detector performance*

- *Section 5 BNL B20-B100 Blends as Heating Fuels*
# How Much Difference?

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## Flue Gas Analysis Report -

**DC710**

- **Fuel Type:** Light Oil
- **Carbon Monoxide (CO):** 0 PPM
- **Carbon Dioxide (CO2):** 11.7 %
- **CO Air Free:** Incalculable
- **Oxygen (O2):** 5.2 %
- **Excess Air:** 33 %
- **Temperature 1/Probe:** 497.0 °F
- **Internal Temperature:** 68.9 °F
- **Temperature Difference:** 428.1 °F
- **Efficiency (Gross):** 82.65 %

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## Flue Gas Analysis Report -

**DC710**

- **Fuel Type:** Light Oil
- **Carbon Monoxide (CO):** 0 PPM
- **Carbon Dioxide (CO2):** 11.5 %
- **CO Air Free:** Incalculable
- **Oxygen (O2):** 5.4 %
- **Excess Air:** 35 %
- **Temperature 1/Probe:** 506.7 °F
- **Internal Temperature:** 71.3 °F
- **Temperature Difference:** 435.4 °F
- **Efficiency (Gross):** 82.33 %

**#2 Oil**

**B20**
Flame Detector Performance

Cad Cell Resistance

#2 Oil

B20
Final Observations

• *Overall, the results of this work have not identified a clear technical barrier which would limit the use of biodiesel in home heating systems. It should be emphasized that these results are only applicable to biodiesel which has been properly processed from its parent oil/fat into biodiesel and that meets the stringent ASTM D6751 specification for B100 prior to blending.

• *BNL B20-B100 As a Heating Fuel
Moving Forward

- Extensive testing is ongoing by both manufacturers and NORA to be able to remove technical barriers to the adoption of higher blends and to meet the carbon reduction targets set forth by statute and the industry itself in the Providence Resolution.
MANAGING FUEL QUALITY THROUGHOUT THE SUPPLY CHAIN
ULSHO AND BIODIESEL BLENDS CREATE A CLEANER, SAFER, BETTER FUEL

- A Low Carbon Liquid Fuel Enabling Higher Efficiency Heater Technology
- Reduces Particulate and Greenhouse Gases
- Quicker Clean Outs / Heat Exchanger – Dealers
- Reduces Puff-Back Claims
- Better for Public Health
- Increased lubricity extending equipment life
MANAGING THE FUEL WHICH YOU BUY AND SELL

- **Cold Flow** – Understand your cloud and pour points and treat for the lowest anticipated temperature - PPDs help.
- **Water** – Freezes at 32F. Water Accelerates fuel aging and greatly increases the likelihood of microbial contamination
- **Corrosion** – Pitting and pin hole leaks increase operational costs and environmental concerns
- **Stability** – Manage your ULSHO and biodiesel for long term seasonal storage
- **Oxidation** – Yellow metals copper, bronze, brass cause oxidation on fuel
- **Sludge** – Impacts fuel quality and instigates service calls from sediment and sludge clogging filters, strainers, and nozzles
WHAT CAUSES DEGRADATION OF ULISHO AND BIODIESEL BLENDS?

- Water: Yes
- Oxygen: Yes
- Microbial: Yes
- Temperature: Yes
- Peroxide Formation: Yes
- Acidic Degradation: Yes
Today there is a little less sludge generated but a greater tendency to form peroxides and acids. 75% of all contaminants are organic* varnish & sludge also referred to as fuel degradation products. The wet side of the system was not a benefactor of the transition to ULSHO; however the heat exchanger was.
YOUR FUEL – YOUR RESPONSIBILITY

- **Tanks** – Plan for periodic access and inspection.
- **Lab Testing** – Designed to establish a prevent defense.
- **Fuel Degradation** – Helps extend the storage of ULSHO fuels.
- **Time, Temperature & Water** - Will accelerate oxidation of fuel.
- **Tanks** – Promote tank replacement with double wall tanks
- **Bottom Drain** - Valves can help remove water and sediment which accumulate during seasonal transitions.
STICK & PASTE, VISUAL EXAMINATION

Water detection paste can help reduce operational issues.
Establish a housekeeping plan to keep tank bottoms dry. Consider regular fuel testing that can mitigate exposure to performance issues and asset damage.
# UNDERSTAND YOUR FUEL

Lab testing can help to manage exposure to contamination

<table>
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<tr>
<th>Test</th>
<th>A 4000K Tank</th>
<th>B Tank 1</th>
<th>C Tank 2</th>
<th>D Tank 4</th>
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<tbody>
<tr>
<td>Sediment (Sediment mL/Total mL)</td>
<td>0.1/100</td>
<td>1/100</td>
<td>15/100</td>
<td>0.25/100</td>
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<tr>
<td>KF (ppm)</td>
<td>459.1</td>
<td>2347.3</td>
<td>4484.7</td>
<td>364.4</td>
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<tr>
<td>% Bio</td>
<td>0.04</td>
<td>1.44</td>
<td>0.32</td>
<td>0.23</td>
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<tr>
<td>Microbes (Start: 9-25-19, End: 9-27-19) counts per mL</td>
<td>&lt;1,000</td>
<td>100,000</td>
<td>10,000</td>
<td>100,000</td>
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<tr>
<td>Yeast (Start: 9-25-19, End: 9-27-19) counts per mL</td>
<td>&lt;1,000</td>
<td>&lt;1,000</td>
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<td>10,000</td>
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Sample from Class 8 truck fuel filter water separator. Results indicated positive microbial activity.
<table>
<thead>
<tr>
<th>Degree (°F)</th>
<th>Neat Fuel &amp; Blends</th>
<th>Base #2</th>
<th>Biodiesel</th>
<th>B5</th>
<th>B10</th>
<th>B20</th>
<th>B30</th>
<th>B40</th>
<th>B50</th>
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<tr>
<td></td>
<td>Distillate</td>
<td>0</td>
<td>37</td>
<td>0</td>
<td>10</td>
<td>16</td>
<td>16</td>
<td>21</td>
<td>27</td>
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### Pour Point Evaluation, B20 and Above

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<tr>
<th>Additive Blends</th>
<th>PPM</th>
<th>1:xxxx</th>
<th>Pour Point B0 -38 F, w. PPD</th>
<th>Pour Point B20 -27 F, w. PPD</th>
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<tr>
<td>2,000</td>
<td>500</td>
<td>38</td>
<td>-33</td>
<td>-60</td>
</tr>
<tr>
<td>1,000</td>
<td>1,000</td>
<td>44</td>
<td>-38</td>
<td>-60</td>
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<tr>
<td>750</td>
<td>1,333</td>
<td>54</td>
<td>-49</td>
<td>-60</td>
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<tr>
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<td>2,000</td>
<td>54</td>
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</tr>
<tr>
<td>250</td>
<td>4,000</td>
<td>&lt;59</td>
<td>-60</td>
<td>-60</td>
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*Generic #2 ULS heating oil from Boston Harbor, Biodiesel is used cooking oil (UCO) feedstock, compliant with MA APS program.

**Testing performed at Intertek, Chelsea, Massachusetts, September 2019
Strategies Designed To Protect Your Fuel And Your P&L

Combined with proactive Housekeeping Protocols a contemporary fuel treatment program can help...

- **Cold Weather Operation**
  - Protects Fuel from Gelling in Tanks and lines

- **Metal Deactivator**
  - Protects Fuel from Yellow Metals/Copper Lines

- **Corrosion Inhibitor**
  - Protects Entire Fuel System, Truck, Tanks

- **Tri-Stabilizer**
  - Tri-Stabilizers To Protect ULSHO, biodiesel blends

- **Dispersant**
  - Cleans Tank, Fuel Line, Filter, Strainer and Nozzle
• Contact
  • Paul Nazzaro, 978-880-5338