Demonstration of Biodiesel in Non-deployed Ground Tactical Vehicles/Equipment

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The NDCEE is operated by: Concurrent Technologies Corporation

Technology Transition – Supporting DoD Readiness, Sustainability, and the Warfighter
Stakeholder Team

- Joint Group on Pollution Prevention (JG-PP)
- Environmental Security Technology Certification Program (ESTCP)
- Naval Facilities Engineering Service Center (NAVFAC ESC)
- United States (U.S.) Army Tank Automotive Research, Development and Engineering Center (TARDEC)
- Air Force Petroleum Agency (AFPET)
- Naval Air Systems Command (NAVAIR)
- Navy Environmental Sustainability Development to Integration (NESDI) Program
Background and Objective

• The U.S. Navy tasked JG-PP to investigate expanding B20 use to non-deployed tactical vehicles

• The Tri-Service Petroleum, Oil, Lubricant (POL) Users Group expressed concerns with the use of B20 in tactical vehicles in their March 2006 Position Statement
  – Stability of the biodiesel
  – Accelerated deterioration in high temperature environments
  – Vehicle operation and fuel properties in low temperatures
  – Water affinity and microbial degradation
  – Material compatibility

• This effort will demonstrate tri-service operational parameters in non-deployed ground tactical vehicles
  – Determine if existing Department of Defense (DoD) fuel management infrastructure and handling procedures can satisfy user requirements
  – Recommend a minimum set of fuel quality tests for use by tactical fleet end users
  – Provide guidance for installation commanders to facilitate decisions on B20 use
President Obama recognized military leadership in biofuels during March 31, 2010 speech at Andrews AFB, referencing Light Armored Vehicle (LAV) participation in this demonstration project.
Approach

• Identified four DoD sites to span climatic conditions
  – Naval Base Ventura County (NBVC) – Oxnard, CA
  – Marine Corps Air Ground Combat Center (MCAGCC) 29 Palms – Twentynine Palms, CA
  – Naval Surface Warfare Center (NSWC) Crane – Crane, IN
  – Moody Air Force Base (AFB) – Valdosta, GA
  – TBD HI Site(s) utilizing sustainable (used cooking oil) feedstock B20

• Data gathered from some or all of these sites will be compared to POL Users Group Concerns
  – Stability of the biodiesel – All sites
  – Accelerated deterioration in high temperature environments – Moody AFB (hot/humid) and MCAGCC 29 Palms (hot/dry)
  – Vehicle operation and fuel properties in low temperatures – NSWC Crane
  – Water affinity and microbial degradation – All sites
  – Material compatibility – All sites
Approach (continued)

- Fuel samples from multiple points to evaluate fuel life cycle
  - Tanker truck sample at delivery (only point at which spec is valid)
  - Nozzle sample at distribution point
  - Vehicle fuel tank sample

**Nozzle and Vehicle Fuel Sample Analysis**

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Test Method</th>
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<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Number</td>
<td>ASTM D664</td>
<td>Color</td>
<td>ASTM D1500</td>
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<tr>
<td>Viscosity at 40 C</td>
<td>ASTM D445</td>
<td>Particulate Contamination</td>
<td>ASTM D6217</td>
</tr>
<tr>
<td>Water and Sediment</td>
<td>ASTM D2709</td>
<td>Oxidation Stability - Rancimat</td>
<td>EN14112</td>
</tr>
<tr>
<td>Total Water Content</td>
<td>ASTM E1064</td>
<td>Oxidation Stability</td>
<td>Modified ASTM D2274</td>
</tr>
</tbody>
</table>

Fuel lab personnel at Moody AFB collect samples and perform initial acceptance testing.
Delivery samples evaluated for adherence to ASTM D7467-08 defined properties, requiring testing in addition to nozzle and vehicle fuel sample analysis.

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</tr>
</thead>
<tbody>
<tr>
<td>Flash Point</td>
<td>ASTM D93</td>
<td>Ash content</td>
<td>ASTM D482</td>
</tr>
<tr>
<td>Cloud Point</td>
<td>ASTM D2500</td>
<td>Copper strip corrosion</td>
<td>ASTM D130</td>
</tr>
<tr>
<td>Sulfur Content</td>
<td>ASTM D5453</td>
<td>Density</td>
<td>ASTM D4052</td>
</tr>
<tr>
<td>Distillation Temperature</td>
<td>ASTM D86</td>
<td>API Gravity</td>
<td>ASTM D1298</td>
</tr>
<tr>
<td>Carbon Residue, 10% bottoms</td>
<td>ASTM D524</td>
<td>Biodiesel Content</td>
<td>ASTM D7371 modified</td>
</tr>
<tr>
<td>Cetane Index</td>
<td>ASTM D976</td>
<td>Demulsification</td>
<td>ASTM D1401</td>
</tr>
<tr>
<td>Aromaticity</td>
<td>ASTM D1319</td>
<td>Trace Metals</td>
<td>ASTM D5185/D4951</td>
</tr>
</tbody>
</table>
Interim Status

- Gradual increase noted in water content and particulate contamination versus time
- All delivery samples meet specifications
- Database developed to manage information as it is received
- Joint Oil Analysis Program (JOAP) testing is conducted to evaluate material compatibility – data analysis pending

The use of similar test and control vehicles allows valid comparison of B20 performance against baseline fuel
Analysis of Fuel Samples

- Composite graphs show trends across test sites as well as outliers in the data
- Multiple test points (supply, nozzle, vehicle) allows causal determinations
- Fuel analysis conducted by NDCEE
JOAP Testing of Oil Samples

- Oil analysis provides insight into engine wear, including both metals and gasket materials.
- Test and control vehicles allow impact of B20 use to be assessed.
- JOAP oil analysis conducted by TARDEC.
Path Forward

• Implement program and initiate sampling at fifth site
• Incorporate maintenance and weather data to identify causal relationships
• Identify B20 impacts on oil analysis
• Perform trend analysis to identify control points and key parameters of B20 programs
  – Temperature and humidity
  – Limited use vehicles
  – Extended B20 storage
  – Maintenance cost impacts
Path Forward (continued)

- Investigate B20 sustainability on Oahu
  - Investigate potential volumes of used cooking oil at DoD sites on Oahu
  - Determine volume of biodiesel and B20 that can be manufactured from
  - Compare to local DoD fuel needs

- Document current and future availability of local biodiesel
  - Oahu production capabilities
  - Hawaii production capabilities
  - Impacts of imported biodiesel
Points of Contact

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