TESTING SYNTHETIC FUELS FOR USE IN U.S. ARMY GROUND VEHICLES

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PANEL: NEW FEEDSTOCKS AND REPLACEMENT FUELS

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OSD Assured Fuels Initiative

Vision: To catalyze commercial industry to produce clean fuels for the military from secure domestic resources using environmentally sensitive processes as a bridge to the future.
Fischer-Tropsch Process

Natural Gas
Coal
Pet Coke
Biomass
Wastes

Synthesis Gas Production

FT Liquid Synthesis

Product Recovery

Power Generation

Oxygen Plant

Air

Hydrogen Separation

An Option

O₂

CO
H₂

FT

Liquid Fuels

Wax

Hydrogen Recovery

H₂

Liquid Fuels

Wax Hydrocracking

Hydrogen

Transportation Fuels

Hydrogen Recovery

Tail Gas

Transportation Fuels
Enhanced Oil Recovery (EOR)

Domestic Resources

- 1.4 trillion barrels (shale)
- 900 billion barrels of FT (coal)
- 0.15 billion barrels (pet coke)
- 22.7 billion barrels oil reserves
- 32+ billion barrels of oil (EOR)
- 100 million pounds of pulp waste/year

Total 2.3+ trillion barrels equivalent
OSD Assured Fuels Initiative Goals

• **Total Energy Development (TED)**
  – Catalyze the industry to produce fuels for the military from domestic energy resources
  – Develop a roadmap to provide fuel for the Joint Battlespace Use Fuel of the Future program and implementation

• **Joint Battlespace Use Fuel of the Future (J-BUFF)**
  – Develop fuel specifications that include non-petroleum components, for use in military equipment, aircraft, ships and ground vehicles
  – Validate use of the fuels in all tactical vehicles, aircraft and ships
  – Provide a transition plan for DoD wide deployment
Research Participants

- Air Force
  - Air Force Fuels Research Laboratory/NAFRC
  - University of Dayton Research Institute
- Army
  - TARDEC Fuels & Lubricants Laboratory
  - Southwest Research Institute
- Navy
  - NAVAIR Fuels and Lubricants Laboratory
  - Naval Fuels and Lubricants Integrated Product Team
- DOE
  - National Energy Technology Laboratory
- Syntroleum Corp.
Nitrile Elastomer Coupon & O-Ring
Volume Changes With Switches Between Synthetic FT "JP-8" & JP-8

<table>
<thead>
<tr>
<th>Switch #</th>
<th>Fuel Aromatic Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FT &quot;JP-8&quot; = 0% vol.</td>
</tr>
<tr>
<td>2</td>
<td>JP-8</td>
</tr>
<tr>
<td>3</td>
<td>FT &quot;JP-8&quot; = 0% vol.</td>
</tr>
<tr>
<td>4</td>
<td>JP-8</td>
</tr>
<tr>
<td>5</td>
<td>FT &quot;JP-8&quot; = 0% vol.</td>
</tr>
<tr>
<td>6</td>
<td>JP-8</td>
</tr>
</tbody>
</table>

Average Volume Change (%)
Predicted Fuel Blend Properties

- Cumulative Quantity of JP-8 in Continental U.S. vs. Aromatic Content Level
- Additional S-8 Conc. Possible in S-8/JP-8 Blend to Meet Just 8.0 vol. % Aromatic Content
- Max. S-8 Conc. Possible in S-8/JP-8 Blend to Meet 8.0 vol. % Aromatic Content & 0.775 kg/L Density
- JP-8 Wt. Mean Density at JP-8 Aromatic Content Level
- Density of S-8/JP-8 Blend with a 8.0 vol. % Aromatic Content
- Min. Density Limit JP-8 Spec

JP-8 Aromatic Content Levels, vol. %

- 0.775 kg/L Minimum Density (JP-8 spec)

Conc. of S-8 in S-8/JP-8 Blend (as % of total blend volume)

Cumulative Quantity of JP-8 in Continental U.S. (as % total JP-8 quantity)

S-8/JP-8 Blend Density (calc., kg/L)

JP-8 Density (wt. mean, kg/L)
### Lubricity of treated synthetic fuel

<table>
<thead>
<tr>
<th>Test</th>
<th>Pump</th>
<th>Duration (hours)</th>
<th>Change&lt;sup&gt;1&lt;/sup&gt; (mm)</th>
<th>FT Fuel CI/LI (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>95.6</td>
<td>0.096</td>
<td>Untreated</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>150.7</td>
<td>0.068</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>500</td>
<td>0.007</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>500</td>
<td>-0.006</td>
<td>(Min.²)</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>500</td>
<td>0.005</td>
<td>22.5</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>500</td>
<td>0.002</td>
<td>(Max.²)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Change in roller-to-roller dimension pre- & post- test.

<sup>2</sup> Min. and Max. treat rates per QPL-25107.

Testing in rotary injection pump test rig established improvement in neat FT fuel treated with lubricity improver additive, CI/LI, indicative of acceptable field performance.

[SAE 2004-01-2961]
Next Army Steps

Next Army steps: Progressive engine, fuel system, equipment, vehicle and fleet tests thru 2009, leading to qualification for use in Army ground vehicles, aircraft and equipment. Air Force and Navy timetables are comparable.

- Document engine performance of blend fuels versus petroleum JP-8
- Continue research in the effects on elastomer seals of switch-loading petroleum and synthetic fuels, and additives to promote seal swell in non-aromatic fuels.
- Continue research in lubricity of blended fuels and potential lubricity additives.
- Develop a knowledge-based qualification approach to minimize expense and time.