JOEL SCHMITTIGAL
Near-Infrared Fuel Analysis

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

TARDEC

RDECOM
# Near-Infrared Fuel Analysis

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<table>
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**14. ABSTRACT**

**15. SUBJECT TERMS**

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**17. LIMITATION OF ABSTRACT**  
SAR

**18. NUMBER OF PAGES**  
22
METHODOLOGY

- Portable, Ruggedized, Near Infrared Spectrometer

- Chemometrics using Principal Component Analysis and Partial Least Squares or Soft Independent Modeling of Class Analogies Method (SIMCA)

- Manufactured by Micron Optical Systems Inc.
  - Suffolk, VA

- Army Small Business Innovative Research (SBIR)
  - Phase II awarded 1/11/2001

![Graph showing spectral data with wavelength on the x-axis and Ag counts on the y-axis]
SPECTROMETER CONFIGURATION

Size
- 4.25" x 5.25" x 11.75"

Detector
- Substrate: InGaAs one dimensional array
- Pixels: 512 pixels
- Electronic Shutter: Integration from 1 ms to minutes
- Readout and Display Update: 50 spectra / second

Spectrograph
- Grating: Volume Holographic transmission grating
- Spectral Range: 1000-1600 nm
- Spectral Dispersion: 1.56 or 0.98 nm/pixel

Source
- Feedback-Stabilized High-Intensity tungsten halide lamp with peak intensity at 1100nm.
ADVANTAGES

- Small Size: 4.25” x 5.25” x 11.75”
- Light Weight
- Adaptable fiber optic probe
- Easy to use
- Fast Analysis: Results in less than 1s
- No hazardous waste generated

LIMITATIONS

- Correlative measurement: the accuracy of your results are dependent on the accuracy of the ASTM data used to build the models
- Correlation to properties dependent on molecular structure
- Range/Quantity of fuel samples
- Sensitivity directly related to composition of fuel
<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Method</th>
<th>ASTM Reproducibility</th>
<th>SEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling point at 10% dist</td>
<td>D 86</td>
<td>3.74 - 12.02 °C</td>
<td>8.35 °C</td>
</tr>
<tr>
<td>Boiling point at 90% dist</td>
<td>D 86</td>
<td>3.74-10.52 °C</td>
<td>9.40 °C</td>
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<tr>
<td>Dist End Point</td>
<td>D 86</td>
<td>10.5 °C</td>
<td>12.87 °C</td>
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<tr>
<td>Density</td>
<td>D 1298</td>
<td>0.0012 g/mL</td>
<td>0.0041 g/mL</td>
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<tr>
<td>API Gravity</td>
<td>D 1298</td>
<td>0.3</td>
<td>0.9384</td>
</tr>
<tr>
<td>Flashpoint</td>
<td>D 93</td>
<td>6 °C</td>
<td>5.141 °C</td>
</tr>
<tr>
<td>Viscosity at 40 °C</td>
<td>D 445</td>
<td>0.013 - 0.046 cSt</td>
<td>0.156 cSt</td>
</tr>
<tr>
<td>Cetane Index</td>
<td>D 976</td>
<td>2</td>
<td>1.183</td>
</tr>
<tr>
<td>Aromatics %</td>
<td>D 1319</td>
<td>1.5-3.3%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Cloud Point</td>
<td>D 2500</td>
<td>4 °C</td>
<td>5.8 °C</td>
</tr>
<tr>
<td>Freeze Point</td>
<td>D 5972</td>
<td>.80 °C</td>
<td>0.75 °C</td>
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<tr>
<td>Net Heat of Combustion</td>
<td>D 4809</td>
<td>0.046 MJ/kg</td>
<td>0.098 MJ/kg</td>
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<tr>
<td>Hydrogen Content</td>
<td>D 3343</td>
<td>0.012-0.015%</td>
<td>0.22 %</td>
</tr>
</tbody>
</table>
BOILING POINT AT 10% DISTILLED

\[ R^2 = 0.8371 \]
\[ SEV = 8.3502 \]
\[ ASTM = 3.74 - 12.02 \, ^\circ C \]
BOILING POINT AT 90% DISTILLED

$R^2 = 0.941$
$SEV = 9.403$
$ASTM = 3.737 - 10.518 \degree C$
$R^2 = 0.9711$
$SEV = 0.0041$
$ASTM = 0.0012 \text{ g/mL}$
\[ R^2 = 0.9384 \]
\[ SEV = 0.8159 \]
\[ ASTM = 0.3 \]
FLASHPOINT °C

R² = 0.762
SEV = 5.141
ASTM = 6 °C
\[ R^2 = 0.5844 \]
\[ SEV = 0.75 \degree C \]
\[ ASTM = 80 \degree C \]
HYDROGEN CONTENT

\[ R^2 = 0.7196 \]
\[ SEV = 0.2188 \]
\[ ASTM = 0.012-0.015\% \]
Obtaining fuels needed for modeling effort:
- Jet A
- Diesel 1
- JP-5
- Off Specification fuels (procuring or manufacturing)

Improve laboratory results for modeling
- Pour Point
- FSII detection
Harris, Marsha G CONT TARDEC/PraxisCom

From: Harris, Marsha G CONT TARDEC/PraxisCom
Sent: Monday, April 24, 2006 10:03 AM
To: Schmitigal, Joel A MR TARDEC
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Marsha

Marsha Harris, Contracted Coordinator TARDEC Technical Information Center

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4/24/2006