Crude Oil Characterization Research Study Update

Presentation to
Crude Oil Quality Association

General Technical Meeting
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San Antonio, TX
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Presented by
David L. Lord, Ph.D.
Geotechnology & Engineering Department
Sandia National Laboratories
Albuquerque, NM 87185
Technical Team

• David Lord (Ph.D., Env E.), Project technical lead
  • Geotechnology & Engineering Department, Sandia National Laboratories
• Anay Luketa (Ph.D., Mech E.), Combustion/fluids modeling lead
  • Fire Science & Technology Department, Sandia National Laboratories
• Tom Blanchat (Ph.D., Nuclear Engr), Combustion testing lead
  • Fire Science & Technology Department, Sandia National Laboratories
• Chad Wocken (B.S., Chem E.), Hydrocarbon supply chain specialist
  • University of North Dakota Energy & Environmental Research Center
• Ted Aulich (B.S., Chemistry), Hydrocarbon supply chain specialist
  • University of North Dakota Energy & Environmental Research Center
• Ray Allen (B.S. Chem E.), PE (TX), HC sampling and testing specialist
  • President of Allen Energy Services engineering consulting firm
• David Rudeen (B.S., Mathematics), Data analyst and EOS modeler
  • GRAM, Inc. technical consulting
Outline

- Problem Statement and Objectives
- Project Governance and Workflow
- Overview of Task 2 – Task 3 Testing
- How COQA can help
- Project Management Contacts
- Project Publications
Technical Objectives

PROBLEM STATEMENT
Problem Statement

- Crude transport by rail poses risks recognized by US and Canadian regulators
- Hazards have been realized in a number of high-profile train derailments leading to oil spills, environmental contamination, fire, property damage, and fatalities
- Open debate on whether the types of crude (tight oil vs. conventional production) have significant bearing on severity of transportation accidents

DOE/DOT Project Objectives

- Determine what combinations of sample capture and analysis methods are suitable for characterizing selected physical properties of volatile crudes
- Evaluate selected physical properties of crude oils (tight vs. conventional production) that are moved within rail transport environment that may have some bearing on flammability risks
- Measure combustion properties (flame dimensions, surface emissive power) of selected crude oils (tight vs. conventional) in controlled burn scenarios that have bearing on hazard determination
- Compare combustion properties to existing published data on other flammable liquids, including methanol, ethanol, jet fuel, hexane
- Evaluate if selected tight oils exhibit measurably different combustion properties from conventional crudes and the reference fluids tested previously
PROJECT GOVERNANCE
Project Governance

Crude Oil Research Coordination Steering Committee

- US Department of Energy
- US Department of Transportation
- Transport Canada

Technical Lead Lab

- Sandia National Laboratories

Technical Services

- Allen Energy Services, Inc.
- UND Energy & Environmental Research Center
- GRAM, Inc.

In-kind sampling, analysis, data transfer.
Problem Definition Phase
Completed

Experimental Phase
Current/future SNL future work scope

• Task 1: Analyze existing data
• Task 2: Sampling method evaluation
• Task 3: Combustion experiments and modeling
• Task 4: Crude characterization, tight vs. conventional
• Task 5: Railcar combustion testing and modeling
• Task 6: Comprehensive oil characterization

Implementation Phase
All stakeholders

• Utilize knowledge gained during prior phases to inform decisions on:
  ➢ Industry best practices
  ➢ Standards
  ➢ Regulations

Public outreach

API: American Petroleum Institute
COQA: Crude Oil Quality Association
CCQTA: Canadian Crude Quality Technical Association
ASTM: ASTM International Standards
GPA: Gas Processors Association
SPR: Strategic Petroleum Reserve

Phase III
**Problem Definition Phase**
Completed

- Literature Survey
- Sampling and Analysis Plan

**Experimental Phase**
Current/future SNL future work scope

- Task 1: Analyze existing data
- Task 2: Sampling method evaluation
- Task 3: Combustion experiments and modeling
- Task 4: Crude characterization, tight vs. conventional
- Task 5: Railcar combustion testing and modeling

**Possible Future Work**

- Utilize knowledge gained during prior phases to inform:
  - Industry best practices
  - Standards
  - Regulations

**Public outreach**

API: American Petroleum Institute
COQA: Crude Oil Quality Association
CCQTA: Canadian Crude Quality Technical Association
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**Overall Project Workflow**

**Phase I**
Problem Definition Phase
Completed

**Phase II**
Experimental Phase
Current/future SNL future work scope

**Phase III**
Implementation Phase
All stakeholders

**Possible Future Implementation**

- SAND 2016-1635 C
## High-Level Project Schedule, Phase II

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>Year 1</th>
<th>Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Review new &amp; emerging data</td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>2</td>
<td>Evaluate sampling and analysis methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Large sample acquisition, combustion tests, modeling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Tight vs. conventional crude characterization</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crude Oil Property and Combustion Tests

TESTING OVERVIEW
Task 2 Overview

- Compare sample capture and analysis methods for two selected North American crude oils
  - Prefer upstream production or tank terminals handling tight oils
- Sandia National Laboratories and Transport Canada will administer parallel tests using a variety of sample capture and analysis methods
- Critical review of open vs. closed capture and applicability for use on minimally stabilized oils for measuring:
  - Crude vapor pressure $VPCR_x(T)$ at selected V/L and temperature
  - Pressurized GC light ends concentration
  - Unpressurized GC DHA and simulated distillation
  - Unpressurized physical property measurements MW, SG, viscosity
  - IBP based on 0.5 wt% determination
## Task 2 Test Matrix

<table>
<thead>
<tr>
<th>Sample Technique</th>
<th>Standard</th>
<th>Property Measurement</th>
<th>TVP</th>
<th>Composition 1</th>
<th>Composition 2</th>
<th>Composition 3</th>
<th>Avg MW</th>
<th>Relative Density</th>
<th>Viscosity</th>
<th>Flashpoint</th>
<th>IBP (0.5 wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPR Tight Line</td>
<td>ASTM D6377 &amp; BPP flash gas GC analysis</td>
<td></td>
<td></td>
<td>GPA2177 + ATM D7900 + ATM D7169</td>
<td>GPA2177 + ATM D7900 + ATM D7169 + GOR flash gas</td>
<td>frz pt dep</td>
<td>ASTM D5002</td>
<td>N/A</td>
<td>N/A</td>
<td>EOS with flash gas</td>
<td></td>
</tr>
<tr>
<td>Floating Piston Cylinder</td>
<td>ASTM D3700-14</td>
<td>ASTM D6377-M</td>
<td>GPA2103 M</td>
<td>GPA2177 + ATM D7900 + ATM D7169</td>
<td>GPA2177 + ATM D7900 + ATM D7169 + GOR flash gas</td>
<td>frz pt dep</td>
<td>ASTM D5002</td>
<td>ASTM D7042</td>
<td>ASTM D93 or D56</td>
<td>GPA 2103/2177</td>
<td></td>
</tr>
<tr>
<td>H₂O displacement</td>
<td>GPA 2174-14</td>
<td>ASTM D6377-M</td>
<td>GPA2103 M</td>
<td>GPA2177 + ATM D7900 + ATM D7169</td>
<td>GPA2177 + ATM D7900 + ATM D7169 + GOR flash gas</td>
<td>frz pt dep</td>
<td>ASTM D5002</td>
<td>ASTM D7042</td>
<td>ASTM D93 or D56</td>
<td>GPA 2103/2177</td>
<td></td>
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<tr>
<td>Boston Round</td>
<td>ASTM D4057-12</td>
<td>ASTM D6377-M</td>
<td>GPA2103 M</td>
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<td>GPA2177 + ATM D7900 + ATM D7169 + GOR flash gas</td>
<td>frz pt dep</td>
<td>ASTM D5002</td>
<td>ASTM D7042</td>
<td>ASTM D93 or D56</td>
<td>GPA 2103/2177</td>
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<td>Manual Syringe</td>
<td>ASTM D7975-14</td>
<td>ASTM D7975-14</td>
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</table>

<table>
<thead>
<tr>
<th>Color coding</th>
<th>Test Administrator</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>SNL</td>
</tr>
<tr>
<td>Red</td>
<td>TC</td>
</tr>
<tr>
<td>Blue</td>
<td>Both</td>
</tr>
</tbody>
</table>

- Test matrix will be run on two minimally stabilized North American crudes
- Objective is to compare multiple methods on a homogeneous sample
- **Note:** Oil variability across production regions or supply chain is addressed in Task 4, not Task 2
Task 3 Overview

- Subject four selected North American crudes to basic property and controlled burn testing
- Span a range from tight oils (Bakken, Eagle Ford) with high visibility, to baseline light sweet (WTI, LLS), to specially-stabilized crude from the Strategic Petroleum Reserve
- Compare results against existing hydrocarbon liquid combustion test data
Burn Test Configurations

Pool fire
- Surface emissive power (SEP)
- Heat flux to engulfed objects
- Flame height
- Fuel consumption rate

Fireball
- Surface emissive power (SEP)
- Heat flux to nearby objects
- Fireball diameter
- Fireball duration
Fireball Test SEP Instrumentation
## Task 3 Test Matrix - Highlights

<table>
<thead>
<tr>
<th>Oil</th>
<th>Properties</th>
<th>Pool Fire 2m, 5m</th>
<th>Fireball 40 gal, 400 gal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakken</td>
<td>VPCRx(T), Light Ends, SimDis, IBP, MW, SG</td>
<td>SEP, flame height, burn rate</td>
<td>SEP, fireball diameter &amp; duration</td>
</tr>
<tr>
<td>Eagle Ford</td>
<td>VPCRx(T), Light Ends, SimDis, IBP, MW, SG</td>
<td>SEP, flame height, burn rate</td>
<td>SEP, fireball diameter &amp; duration</td>
</tr>
<tr>
<td>WTI or LLS</td>
<td>VPCRx(T), Light Ends, SimDis, IBP, MW, SG</td>
<td>SEP, flame height, burn rate</td>
<td>SEP, fireball diameter &amp; duration</td>
</tr>
<tr>
<td>Stabilized SPR</td>
<td>VPCRx(T), Light Ends, SimDis, IBP, MW, SG</td>
<td>SEP, flame height, burn rate</td>
<td>SEP, fireball diameter &amp; duration</td>
</tr>
</tbody>
</table>
HOW COQA CAN HELP
How COQA can help

- Technical peer review of test plans, test reports
  - Working through COQA Executive Director, Dennis Sutton
- Access to sampling points for Tasks 2, 3, and 4
  - Sandia has 7-page sampling proposal (re: Tasks 2 and 3) for distribution to crude oil producers and/or terminal operators who may be interested in helping provide samples
  - Contact David Lord for more information (slide 23)
## Access to Crude Oil Samples

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Target Timeframe (Calendar Year-Quarter)</th>
<th>Preferred Sample</th>
<th>Approx Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 2 Parallel Test #1</td>
<td>CY2016</td>
<td>LACT or rail/pipeline terminal in central or southern U.S. that handles tight oil</td>
<td>15 gal (60 L)</td>
</tr>
<tr>
<td>Task 2 Parallel Test #2</td>
<td>Q2</td>
<td>LACT or rail/pipeline terminal that handles Bakken</td>
<td>15 gal (60 L)</td>
</tr>
<tr>
<td>Task 3 Burn Sample #1</td>
<td>Q3</td>
<td>Bakken</td>
<td>3,000 gal (72 bbl)</td>
</tr>
<tr>
<td>Task 3 Burn Sample #2</td>
<td>Q4</td>
<td>Eagle Ford</td>
<td>3,000 gal (72 bbl)</td>
</tr>
<tr>
<td>Task 3 Burn Sample #3</td>
<td>Q1</td>
<td>SPR stabilized oil</td>
<td>3,000 gal (72 bbl)</td>
</tr>
<tr>
<td>Task 3 Burn Sample #4</td>
<td>CY2017</td>
<td>WTI or LLS</td>
<td>3,000 gal (72 bbl)</td>
</tr>
</tbody>
</table>

Images courtesy of Intertek, Bosselman Tank & Trailer, Sandia National Laboratories
Project Sponsor Contacts

- **U.S. Department of Energy**
  - Evan Frye
    - U.S. Department of Energy, Office of Fossil Energy, Office of Oil & Natural Gas
    - evan.frye@hq.doe.gov
    - 202-586-3827

- **U.S. Department of Transportation**
  - Joseph Nicklous
    - U.S. Department of Transportation, Office of Hazardous Materials Safety
    - Pipeline and Hazardous Materials Safety Administration
    - joseph.nicklous@dot.gov
    - 202-366-4545

- **Transport Canada**
  - Barbara Di Bacco
    - Transport Canada, Transport Dangerous Goods Directorate
    - barbara.dibacco@tc.gc.ca
    - 613-990-5883
Sandia Project Contacts

- Sandia technical lead
  - David Lord
    - Sandia National Laboratories, Geotechnology & Engineering Department
    - dllord@sandia.gov
    - 505-284-2712

- Sandia geosciences program manager
  - Erik Webb, Senior Manager
    - Sandia National Laboratories, Geoscience Research & Applications
    - ekwebb@sandia.gov
    - 505-844-9179
Project Publications


END OF PREPARED SLIDES