On Line Contaminant Monitoring Project Update

- Overview
- Project Goals
- Interested Parties
- Project Scope
- Key Contaminants
- Work to Date
  - Technology Review
  - Ongoing work
On Line Contaminant Monitoring Overview

- Contaminants in crude oil tend to be variable in concentration and poorly tracked in refinery feed
- Contaminants tend to impact plant operation more than finished product quality
- Most incidents of crude contamination impact on plant operation are poorly documented
  - Investigated post occurrence!
  - Insufficient data!
On Line Contaminant Monitoring Project Goals

- To develop on-line monitoring tools for the purpose of measuring key contaminants in refinery feed
- Use the data generated above to quantify the impact of contaminant concentrations and their variability on plant operation
On-Line Contaminant Monitoring

Interested parties

- Cenovus
- Shell
- Nexen
- ConocoPhillips
- Corrillo Resources
- Maxxam Analytics
- ARC
- United Refining
On-Line Contaminant Monitoring Project Scope

- Identify target contaminants for monitoring
- Determine capabilities of existing technologies
- Select a location/plant for testing of existing/new technologies
- Determine effectiveness of monitoring tool(s)
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Key Contaminants

• Possible contaminants of interest
  – Salt
  – Metals
  – Inorganic solids
  – Asphaltenes
  – Sulfur

• At this point no agreement has been reached on target contaminants
• Two potential technology providers have been identified

• Process NMR
  - Nuclear Magnetic Resonance
  - Electron Spin Resonance
  - FTIR with ATR

• Progression Inc.
  - Nuclear Magnetic Resonance
  - Laser Induced Breakdown Spectroscopy
On-Line Contaminant Monitoring NMR

- On-line NMR packages are already available for installation in Class 1, Div 1 areas, in a package similar in size and shape to a refrigerator
  - Most applications focused on measuring bulk properties of oil
On-Line Contaminant Monitoring
ESR

- Measures concentration and composition of chemical species with unpaired electrons
- For crude oil, possible applications might include organic free radicals, condensed aromatics (such as asphaltenes), transition metal ions
- Seems to have potential for on-line application, more test work required
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LIBS background

- Laser induced breakdown spectroscopy
- LIBS well suited to on-line use as the laser beam and emissions beam can be carried by fiber optic to/from electronics unit

Example of LIBS hardware
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LIBS background

- LIBS can be used in a laboratory or in an on-line configuration
- Capable of simultaneous multi-element detection with reasonable sensitivity
- Many applications have been tested, mostly on solids and gases, some liquids
  - Most liquid testing has focused on water, but some studies have been done on a petroleum based materials
On-Line Contaminant Monitoring
LIBS background

<table>
<thead>
<tr>
<th>Element</th>
<th>Wavelength (nm)</th>
<th>Detection limit (µg ml⁻¹) (this work)</th>
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<tbody>
<tr>
<td>Pb</td>
<td>405.87</td>
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<tr>
<td>Si</td>
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<td>Ca</td>
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<td>Cr</td>
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</tr>
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</table>

Results obtained for 12 elements in oil

* The sensitive lines are reported, as well as the detection limits obtained.

- Results extracted from Analytica Chimica Acta 429 (2001) 269 – 278
On-Line Contaminant Monitoring Work to Date

• Two refinery sites have expressed interest
• Technology suppliers presently testing equipment capabilities using crude oil samples supplied by the project
• Process NMR willing to assist/conduct LIBS application development testing, if an instrument can be provided (lease/loan)
• Once applicability has been established, an on-line analyzer can be designed by Process NMR/Progression Inc.
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