New Technology for Heavy Oil Desulphurization and Upgrading “DSU”

IBIA Annual Convention
November 4, 2014
Field Upgrading Overview

- Technology development company based in Calgary, Canada
- Focused on heavy oil desulphurization and upgrading
- Core technologies based on oil industry experimental work paired with CoorsTek ceramic ionic conductor technology
Field Upgrading Overview

- Building $18 million, 10 bpd (500 TPA) pilot plant
  - Private and government funding in place
- World-class leadership and staff
  - Chairman: Former president and founder of several multi-billion dollar oil companies: Chauvco, Fort Chicago Energy Partners, Western Oil Sands
  - CEO: Former executive at Shell, Petro-Canada and Suncor Energy
  - CoorsTek staff and lab
  - Technical team with deep oil refining and marketing experience
  - Advisory Committee comprised of members from major oil companies and bunker industry

Sister Company Pilot Plant, Alberta, Canada

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Field Desulphurization & Upgrading (DSU) Process Overview

High Sulphur Feed → Reactor → Oil-Solids Separator → Oil Product < 0.5% S

- Bitumen
- Heavy Oil
- Resid
- Refinery Intermediates
- Vac resid

- Hydrogen

- Sodium Sulphide

- Sodium

- Metals

- Power

- Liquid Sulphur
Field DSU

<0.5% S Bunkers From High Sulphur Feeds

<table>
<thead>
<tr>
<th>Property</th>
<th>DSU Feed: Vac Resid</th>
<th>DSU Raw Product</th>
<th>DSU Blended Product</th>
<th>ISO 8217 2010 RMG 380 Specs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur, wt%</td>
<td>6.24</td>
<td>0.49</td>
<td>0.46</td>
<td>Varies</td>
</tr>
<tr>
<td>Density, kg/m³</td>
<td>1,040</td>
<td>975</td>
<td>963</td>
<td>991 Max</td>
</tr>
<tr>
<td>Viscosity at 50° C, cSt</td>
<td>2,778,233</td>
<td>943</td>
<td>357</td>
<td>380 Max</td>
</tr>
<tr>
<td>Acid Number, mg KOH/g</td>
<td>1.9</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>2.5 Max</td>
</tr>
<tr>
<td>MCRT, wt%</td>
<td>22.4</td>
<td>14.6</td>
<td>13.6</td>
<td>18 Max</td>
</tr>
<tr>
<td>CCAI</td>
<td></td>
<td></td>
<td>824</td>
<td>870 Max</td>
</tr>
<tr>
<td>Flash Point, ° C</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>60 Max</td>
</tr>
<tr>
<td>Pour Point, ° C</td>
<td>&gt;30</td>
<td>&lt;12</td>
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<td>30 Max</td>
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<tr>
<td>Compatibility, Spot#</td>
<td></td>
<td></td>
<td>1</td>
<td>Not required</td>
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<tr>
<td>Vanadium, wppm</td>
<td>309</td>
<td>4</td>
<td>4</td>
<td>350 Max</td>
</tr>
<tr>
<td>Aluminum + Silicon, wppm</td>
<td>4</td>
<td>&lt;4</td>
<td>&lt;4</td>
<td>60 Max</td>
</tr>
<tr>
<td>Ash, wt%</td>
<td>0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>0.1 Max</td>
</tr>
<tr>
<td>Sodium, wppm</td>
<td>&lt;100²</td>
<td>&lt;100²</td>
<td></td>
<td>100 Max</td>
</tr>
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</table>

- Demonstrated ability to reduce 6.2% S vac resid to 0.46% S ISO spec blended product
- Expect 0.1% S bunker from 2% S vac resid feed
- Significant density and viscosity reduction
- Removes nearly all metals and acids
- Sulphur and metals are the only byproducts

17% distillate in DSU Blended Product
²Process will be designed to meet ISO spec
Unprecedented Change in Bunker Market

Bunker Fuel Oil Sulphur Specifications

<table>
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<tr>
<th>Date</th>
<th>ECAs</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>1.0%</td>
<td>3.5%</td>
</tr>
<tr>
<td>January 2015</td>
<td>0.1%</td>
<td>3.5%</td>
</tr>
<tr>
<td>January 2025</td>
<td>0.1%</td>
<td>0.5%</td>
</tr>
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</table>

New specs and increasing resid supply lead to 200 MTPA “excess” HSFO by 2025 <0.5% S FO demand up by 200 MTPA

Forecast Bunker Fuel Oil Demand and “Excess” HSFO

Refiner’s Options

- Do nothing: Sell HS RFO into new markets
- Invest in resid destruction: Sell MDO, less RFO
- Invest in resid desulphurization: Sell LS RFO

Vessel Operator’s Options

- Do nothing: Buy LS RFO or MDO
- Install scrubbers: Buy HS RFO
- Invest in LNG: Buy LNG

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Spec Changes Create Large Desulphurization Opportunity

Bunker Pricing: Low Sulphur vs. High Sulphur Fuels

- **2014**:
  - Uplift from 3.5% S to LS: $45/tonne
  - Volume: 30 MTPA (0.6 MBPD)
  - Total Uplift: $1 B/yr

- **2025**:
  - Uplift from 3.5% S to LS: >$270/tonne
  - Volume: 200 MTPA (3.8 MBPD)
  - Total Uplift: >$55 B/yr

Desulphurize/blend 3.5% S to 1% S RFO for $45/tonne uplift
Desulphurize 3.5% S to 0.5/0.1% S RFO for >$270/tonne uplift

Bunker Pricing:  Low Sulphur vs. High Sulphur Fuels

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Desulphurize/blend 3.5% S to 1% S RFO for $45/tonne uplift
Desulphurize 3.5% S to 0.5/0.1% S RFO for >$270/tonne uplift

$45/tonne ($7/bbl)
30 MTPA (0.6 MBPD)
$1 B/yr

>$270/tonne (>40/bbl)
200 MTPA (3.8 MBPD)
>$55 B/yr
Field DSU Plant Layout

Typical Layout for 10,000 bpd (500,000 TPA) Field DSU Plant

- Modular design
- Process units pre-fabricated in 12’x12’x48’ (4mx4mx15m) building blocks or “skids”
- 45 skids for 0.5 MTPA plant
- Minimal on-site construction
- Lower CO₂ intensity & minimal SOₓ.
- Utilities:
  - 20 MW power supply
  - 5 mmscfd hydrogen supply
# Field DSU Commercialization Timeline

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<td><strong>LAB</strong></td>
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<td>Core lab work: 2012-2014</td>
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<td><strong>PILOT:</strong> 500 TPA (10 bpd)</td>
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<tr>
<td><strong>COMMERCIAL DEMO:</strong> 50,000 TPA (1,000 bpd)</td>
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LARGE-SCALE DEPLOYMENT
Field DSU Summary

- Spec changes will create large increase in demand for resid desulphurization
- Field DSU is a unique, lower cost technology for sulphur removal from resid
- Demonstrated to desulphurize 6% S resid to ISO spec bunkers with <0.5% S
- Expected to desulphurize 2% S resid to ISO spec bunkers with <0.1% S
- Significant reduction of metals, acids, viscosity, density
- Commercial 50,000 TPA plants available by 2020
THANK YOU!

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