Enterprise Crude Knowledge Management

COQA, New Orleans March 2017

Presented by: Hege Damm, Schneider Electric
Agenda

Integrating Oil & Gas Value Chain

- Supply & Trading
  - Crude valuation
  - Crude & products trading
  - Crude blending
  - Constraint modeling
  - Inbound logistics

- Product Placement & Sourcing
  - Demand management and forecasting
  - Regional refinery planning
  - Unplanned event response
  - Buy / Make / Sell / Exchange tradeoffs
  - Exchange management

Schneider Electric – introduction

Oil Industry - Enterprise Challenges

Faster, Better Decisions

From Data to Wisdom

Increasing Complex Operations

Drowning in Data

Crude Blending and Risk Analysis

Summary
Schneider Electric holds market leading positions in Oil & Gas

#1 in Secure Power

#1 in Safety Systems

#1 in Fuel Supply Chain

#1 in Pipeline Management Systems

#2 in Operations Management Software
Solutions which deliver value through the Oil & Gas value chain

1. **Offshore:**
   We reduce offshore project CapEx by up to 5% and OpEx by up to 6%.

2. **Onshore:**
   By optimising resource utilization, we increase production efficiency by up to 5% while also maximising recovery.

3. **Pipeline operations:**
   We are the only company that provides an integrated software platform within our architecture that enables safe, reliable, and efficient operations from the field to the enterprise.

4. **LNG and gas processing:**
   We remove risk and complexity from a project’s critical path, ensuring on-time and on-budget execution.

5. **Refining and petrochemical:**
   We are the global leader in process safety, and our integrated simulation and control solutions reduce operating cost and increase availability by up to 5%.

6. **Fuel supply chain:**
   Improve efficiency with industry-leading supply chain automation and business intelligence tools.

**Schneider Electric solution partner**
As a worldwide leader, we intimately partner with our customers, listen to their unique requirements find the right solutions that mitigate risk and drive results, and ensure best-in-class global delivery and project management.

As a solution provider to the world’s largest refining and petrochemical facilities, we are the only partner to provide a unique blend of process simulation and mastery in operations, electrical distribution, and energy management.
Oil Industry - Enterprise Challenges – Faster and Better Decisions
Enterprise Challenges Facing the Oil Industry

Faster, Better Decisions
- Market Variability & Speed of Change
  - Crude Price volatility and risk
  - Reduced production/drilling cost
  - Changing demand patterns

Managing Compliance
- Managing the Bottom Line
  - Renewable Fuels
  - Keystone XL and all other pipelines
  - Crude Oil Export
  - Environmental (CO2, NOX, CAFÉ)

Drowning in Data
- Increasing Complex Operations
  - Deploying digitalization and IIoT
  - Smart refineries and oil field technologies

Skilled Resource Shortage
- Starved for Knowledge
  - Aging workforce

Do More with Less & Do it Better than Ever
Faster, Better Decisions

- Refining Values, Optimization and Globalization
  - Expanded crude slate and need for quick evaluation of blends

- Canadian crudes reach the international market and all coasts
  - Oil Sands operating costs below $40/bbl

- 20+ pipelines deliver crudes locally to USGC refiners today
  - Eagle Ford declining, but Permian keeps growing – quality change

- Increased blending flexibility and storage capacity in the USGC
  - Enterprise now has more than 24 (MMbbl) of storage capacity in the gulf

- Faster turnarounds and better predictive maintenance planning
  - Crude quality issues resulted in increased turnarounds
US crude exported globally as “US light sweet”

- Shale production growth has been light crude and condensate
- USGC crude export has been light shale crude (WTI and Eagle Ford)
Transformation of data into “Knowledge” and “Wisdom”

**RefineryWise**
Delivers value to the people, process and assets.

**Data** brings:
- Historized, operational performance baseline from your people, process, assets

**Information** brings:
- Contextualized process and asset data for improved decision support

**Knowledge** brings:
- Higher degree of process analysis, optimization and experience

**Transformation**
- Process
- Assets
- People

**Wisdom** brings:
- Closed loop operational efficiency across the enterprise

**Wisdom** includes:
- Judgement
- Experience
Example – Heat Exchanger

- **Data**: the temperatures and flows of the heating path and the product path
- **Information**: the estimated efficiency of the heat exchanger, and the estimated remaining useful life
- **Knowledge**: proximity to efficiency and maintenance schedule thresholds
- **Wisdom**: business value of no change, operating differently or changing the maintenance schedule
RefineryWise Benefits – 310,000 bpd, $ 50/bbl

Wise operations management:
reduced unplanned shutdowns, increased yield,

Wise energy management:
reduced energy conversion and consumption cost, reduced cost of crude for energy

Wise crude purchases:
reduced cost of purchases, reduced maintenance

Wise reliability:
reduced HSE incidents, reduced maintenance

Wise blending and oil movements:
reduced giveaway, no reworks, minimum inventory

Wise planning & scheduling:
reduced cost of crude purchases, increased throughput

Wise process performance:
longer equipment life, increased availability and quality

Wise production management:
reduced accounting loss, reduced inventory, reduced hydrogen and steam consumption

Benefits based on typical refinery performance
Time is of the essence
Oil Industry - Enterprise Challenges – Increased Complexity
Increased Complexity

• US oil production at 1970s levels but the 70s regulations has ended
  • Supply risk has never been lower and export has never been higher

• US export result in tighter crude quality spreads and new options
  • Producers have flexibility to hedge in either Brent or WTI.
  • WTI Houston quality versus WTI Cushing blended quality and LLS/Brent

• Less Logistics bottlenecks increase options for new trade flows
  • Increased pipeline takeaway capacity increase market liquidity
  • No need for segregation of Canadian or condensate streams

• More unknowns and “moving parts” in future supply chain evaluations creates the need for better risk analysis.
Frequent Update and comparison of Crude Quality

Crude quality data synchronized and shared with trading, planning and scheduling.
Crude Quality Profiles

Acidity profile, TAN

- Dilbit crude most TAN in VGO stream

Yield profiles

- SynDilBit blend; 65% bitumen, 35% mix of condensate, syncrude and conv. crude
Oil Industry - Enterprise Challenges – Drowning in data
Drowning in data - Technology Enablers for Enterprise Decision Support

• Industrial Internet of Things (IIoT)
  • Cloud hosting to simplify deployment, reduce IT burden and scale easily
    Cloud-based High-Performance Computing

• Cognitive computing
  • Enterprise wide increased communication of advise and lessons learned
    Siri and Alexa for the oil industry ……we might be asking Watson!

• Handheld field devises and wireless sensors
  • AFFORDABLE wireless sensors with smart technology provides
    information anywhere, anytime and on any devise (fouling etc.)

• Predictive Analytics
  • Augmented and Virtual Reality applied for crude oil knowledge
Enterprise Sharing of Crude Knowledge
Canadian Oil Behavior in US Refineries

- High SARA values, high TAN and high metals
- Dumbbell effect
- Poor feed, high in metals
- Preheat Fouling
- High TAN feed
- Too much light ends (diluent)
Shale Oil Behavior in US Refineries
Dashboards show operational KPIs; Safety, Environment, Crude Quality, Production Performance, Reliability, Energy efficiency etc. From multiple sources: Assay library, historian, LIMS, SAP, market data etc.

- Red/Green indicators and trending arrows with prediction
- Tooltips on indicators for key info
- Links to other dashboards and apps
- Bar Graphs – easy visualization
- Role based control – selective monitoring
- Tighter control of targets
Oil Industry - Enterprise Challenges – Crude Blending and Risk Analysis
Do refiners prefer to blend for themselves?

- Blending inside the refinery gate provides increased security.
  - Multiple gathering points with very different sampling processes
  - Streams get mixed due to limited storage capacity (Enbridge)
  - Blending Terminals test to meet pipeline specifications - which are VERY limited
  - Incompatible blending between shale oil and Canadian oil sands grades
  - Blending requires tank capacity – too risky to perform “in-line” direct blending?

- Enterprise Crude Knowledge Management (ECKM) systems with built in “expertise”, rules, and data validation reduce the overall risk
  - Increased real time data transformed to “wisdom” - lessons learned are easily available for all stakeholders “how to handle waxy Eagle Ford crude”
  - Visualize large amount of possible what-if scenarios/solutions
  - Incorporate industry standard/method for measuring crude oil compatibility
  - Pull in and structure Assay data from all publicly available sites
Monitor Unconventional Blends

Test for incompatibility prior and after transportation and blending.

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**Crude Comparison - Six Month Averages**

<table>
<thead>
<tr>
<th>Basic Analysis</th>
<th>Cold Lake (CL)</th>
<th>Western Canadian Select (WCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity (° API)</td>
<td>20.6 ± 0.8</td>
<td>20.5 ± 0.7</td>
</tr>
<tr>
<td>Sulphur (wt%)</td>
<td>3.80 ± 0.12</td>
<td>3.58 ± 0.11</td>
</tr>
<tr>
<td>MCR (wt%)</td>
<td>10.49 ± 0.36</td>
<td>10.02 ± 0.37</td>
</tr>
<tr>
<td>TAN (mgKOH/g)</td>
<td>0.98 ± 0.08</td>
<td>0.95 ± 0.06</td>
</tr>
<tr>
<td>Nickel (mg/L)</td>
<td>66.7 ± 2.5</td>
<td>63.9 ± 5.4</td>
</tr>
<tr>
<td>Vanadium (mg/L)</td>
<td>172.8 ± 16.7</td>
<td>146.9 ± 11.8</td>
</tr>
</tbody>
</table>

**Light Ends (vol%)**

<table>
<thead>
<tr>
<th>Cold Lake (CL)</th>
<th>Western Canadian Select (WCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butanes</td>
<td>0.91 ± 0.25</td>
</tr>
<tr>
<td>Pentanes</td>
<td>7.01 ± 1.09</td>
</tr>
</tbody>
</table>

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**Compatibility Criterion:** $S_{BN}$ of Mix > $I_N$ of Each Component

$I_N = \text{Insolubility No.}$  
$S_{BN} = \text{Solubility Blending No.}$

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**Heavy Oils and Tight Oils Do Not Mix**

<table>
<thead>
<tr>
<th>Crude</th>
<th>$S_{BN}$</th>
<th>$I_N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Lake</td>
<td>76</td>
<td>29</td>
</tr>
<tr>
<td>Athabasca</td>
<td>96</td>
<td>31</td>
</tr>
<tr>
<td>Maya</td>
<td>71</td>
<td>47</td>
</tr>
<tr>
<td>Tight Oil A</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Tight Oil B</td>
<td>3.2</td>
<td>0</td>
</tr>
</tbody>
</table>

**Most Insoluble: Low Vol% Heavy Oil in Light Oil**

Source: [www.SolubleSolutions.com](http://www.SolubleSolutions.com)

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**Challenge:** No CrudeMonitor website for shale oil and limited specifications for pipelines and terminals
The Dumbbell Effect
Advanced blending to predict necessary properties

<table>
<thead>
<tr>
<th>Stream</th>
<th>Property</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Blend</th>
<th>Blend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rejected</td>
<td>Warning</td>
<td>Rejected</td>
<td>West Texas Sour</td>
</tr>
<tr>
<td>C2 to C5 F</td>
<td>Yield (V) (%)</td>
<td>9</td>
<td>12.24</td>
<td>5.253</td>
<td>7.570</td>
</tr>
<tr>
<td>+1020 to FBP</td>
<td>Yield (V) (%)</td>
<td>7</td>
<td>15</td>
<td>18</td>
<td>20.74</td>
</tr>
<tr>
<td>IBP to FBP</td>
<td>API (none) (%e)</td>
<td>26</td>
<td>27</td>
<td>37</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Sulphur (Total) (%)</td>
<td>2.1</td>
<td>2.5</td>
<td>2.025</td>
<td>1.665</td>
</tr>
<tr>
<td></td>
<td>True boiling point (V) of 20% (%F)</td>
<td>270</td>
<td>340</td>
<td>213.7</td>
<td>277.1</td>
</tr>
<tr>
<td></td>
<td>True boiling point (V) of 50% (%F)</td>
<td>500</td>
<td>660</td>
<td>612.4</td>
<td>569.5</td>
</tr>
<tr>
<td></td>
<td>Pour Point (F)</td>
<td>35</td>
<td>55</td>
<td>-14.05</td>
<td>15.00</td>
</tr>
<tr>
<td></td>
<td>Nickel plus Vanadium (ppm)</td>
<td>75</td>
<td>100</td>
<td>108.5</td>
<td>16.77</td>
</tr>
<tr>
<td></td>
<td>Reid Vapour Pressure (psi)</td>
<td>8.6</td>
<td>9.6</td>
<td>5.567</td>
<td>3.768</td>
</tr>
<tr>
<td></td>
<td>Carbon Residue (MCRT) (%)</td>
<td>5</td>
<td>10</td>
<td>6.048</td>
<td>3.599</td>
</tr>
<tr>
<td>Lgt Gasoline</td>
<td>Yield (V) (%)</td>
<td>10</td>
<td></td>
<td>14.33</td>
<td>6.438</td>
</tr>
<tr>
<td>Lgt Naphtha</td>
<td>Yield (V) (%)</td>
<td>15</td>
<td></td>
<td>10.67</td>
<td>14.83</td>
</tr>
<tr>
<td>Hvy Naphtha</td>
<td>Yield (V) (%)</td>
<td>15</td>
<td></td>
<td>8.083</td>
<td>11.18</td>
</tr>
<tr>
<td>Kerosene</td>
<td>Yield (V) (%)</td>
<td>15</td>
<td></td>
<td>7.710</td>
<td>10.52</td>
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<tr>
<td>Atm Gas Oil</td>
<td>Yield (V) (%)</td>
<td>15</td>
<td>20</td>
<td>13.21</td>
<td>16.25</td>
</tr>
<tr>
<td>Atm Residue</td>
<td>Yield (V) (%)</td>
<td>45</td>
<td></td>
<td>46.00</td>
<td>40.79</td>
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<tr>
<td>Lgt Vac Gas Oil</td>
<td>Yield (V) (%)</td>
<td>15</td>
<td></td>
<td>11.07</td>
<td>12.79</td>
</tr>
<tr>
<td>Hvy Vac Gas Oil</td>
<td>Yield (V) (%)</td>
<td>18</td>
<td></td>
<td>16.15</td>
<td>16.15</td>
</tr>
<tr>
<td>Vac Residue</td>
<td>Yield (V) (%)</td>
<td>15</td>
<td></td>
<td>18.77</td>
<td>11.84</td>
</tr>
</tbody>
</table>
Rapid optimization allows many hundreds of Cases to be analysed quickly

Specialised Analytics explore operational scenario and the solution space

Analytics to assess risk probability
Summary

• The Petroleum Supply chain gets more and more complex; new discoveries, new blends, new markets, new trading vehicles and new processing technologies

• New technology with built-in refinery expertise and feedstock knowledge can handle the necessary risk and optimization analysis with real time data from unified data sources

• Enterprise Crude Oil Knowledge Management can model risk and uncertainty associated with refinery purchase and processing decisions, and enable faster and more accurate business decisions

• IIoT with Cloud enabled decision support solutions, COGNITIVE COMPUTING and predictive analysis can reduce the refinery downtime
Life Is On

Schneider Electric