Chevron’s Crude Oil Assay Program

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Chevron’s Global Operations
Distillation & Processing Specialties Team
Performs full range TBP distillations for Chevron’s crude assay program

Global Laboratory Services
Provides analytical testing including the application of advanced chemistry and materials characterization tools, environmental chemistry, new analytical methodologies and targeted research.

Process Planning & Energy Technology
Maintain and expand the crude oil database and tools for use in economic and plant optimization and marketing of equity crudes.
Chevron’s Crude Oil Assay Process

Crude Tracking & Assay Validation

Testing

Analysis
Chevron’s assay validation and updating process relies on tracking Crude Cargo Data

- Crude quality is tracked via custody transfer information and monitored in AVEVA USC Assay Web
- Crude simulated yields are tracked for known blended crudes or pipeline delivered crudes
- Assays are updated when the current assay is determined to be “invalid.”
  - AVEVA USC Validation feature flags “invalid” assays

Assays are also updated when:

- Newer 3rd party assays are available
- Commercial intelligence indicates significant production changes
- Older assays need to be updated with current crude quality data or data from new or improved test methods

Crude Quality Changes over Time
Crude simulated yields show Recommended Assay Yield Profile no longer matches delivered Crude Yield Profiles

- Rapid Crude Yield Tracking for Blended Crudes or Pipeline Delivered Crudes
  - Same Crude, Similar API but Different Yields
    - REC ASSAY: Recommended Assay
    - RCY ASSAY: RCY Monitored Sample
      - Higher VRES Yield
      - Lower DSL Yield

<table>
<thead>
<tr>
<th>SAMPLE TYPE</th>
<th>YLD V%</th>
<th>API</th>
<th>Sulfur</th>
<th>IBP 100F</th>
<th>100F</th>
<th>350F</th>
<th>450F</th>
<th>650F</th>
<th>850F</th>
<th>1025F</th>
<th>FEP</th>
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<tbody>
<tr>
<td>REC ASSAY</td>
<td>3/23/22</td>
<td>43.13</td>
<td>0.11</td>
<td>4.61</td>
<td>30.12</td>
<td>10.78</td>
<td>21.15</td>
<td>15.68</td>
<td>10.54</td>
<td>7.79</td>
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<td>RCY ASSAY</td>
<td>7/7/2022</td>
<td>42.81</td>
<td>0.14</td>
<td>6.20</td>
<td>29.50</td>
<td>9.62</td>
<td>19.27</td>
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<tr>
<td>ABS DIFF</td>
<td>-0.32</td>
<td>0.03</td>
<td>1.29</td>
<td>-0.62</td>
<td>-1.15</td>
<td>-2.88</td>
<td>-1.38</td>
<td>0.77</td>
<td>4.20</td>
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</table>
Distillation & Processing Specialties Team
Performs custom blending and standard/custom distillation/fractionation

Global Laboratory Services
Perform analysis using ASTM tests for standard properties, and in-house developed tests for special properties, (i.e. RCY, vacuum distillation, asphaltene stability).

Contract Laboratories
Strategically located around the world to perform CVX equivalent batch distillations and lab testing
Chevron analysts work up the assays using AVEVA USC Desktop tools tuned to Chevron’s assay data and property correlations.

- Redundant and mass balanced measurements are collected for critical properties that impact a crude’s value
  - Mass Balance: Sulfur, Nitrogen, Yield, etc
  - Redundant measurements:
    - WVGO+VRES=ARES
    - LVGO+MVGO+HVGO=WVGO
- Property Curves are checked to detect errors and ensure consistency with historical assays of the same crude
- Scatter Plots for whole crude and cut property vs specific gravity data are used to validate property values and identify outliers.
Chevron’s 2021-2022 Assay Updates

Total 266

- Africa: 38
- Central Asia: 52
- Europe: 25
- Far East: 9
- Middle East: 102
- North America: 30
- South America: 10

Number of Assays

- API RANGE
  - 3 ≤ 10
  - 11 (10, 20]
  - 40 [20, 30]
  - 73 [30, 40]
  - 87 [40, 50]
  - 50 [50, 60]
  - 11 > 60

Assay Type

- Flash
- Full
- 3rd Party

2021 vs 2022
What is Carbon Intensity
Measure of carbon dioxide and other greenhouse gases (CO2e) per unit of activity, like generating a product

Chevron’s Portfolio Carbon Intensity (PCI) represents the full value chain carbon intensity of the products we sell, including our own emissions, emissions from third parties, and emissions from customer use of our products.

Chevron’s Portfolio Carbon Intensity Calculator tool is publicly available. The tool is subject to Chevron’s website terms of use.
Real-Time Crude

Chevron is currently evaluating AVEVA’s Real-Time Crude (RTC) technology for generating crude oil assays

- Process Insights ANALECT® RefinIR™
  - Extended-range infrared (IR) spectrum using small sample size (~20mL) in minutes (8-15 min)
- AVEVA RTC Software to analyze spectra to generate a complete crude oil assay

Use Case for RTC

- For reducing laboratory resource utilization:
  - Replace most of the current lab testing for Flash Assays and Rapid Crude Yield
- For optimizing Refinery crude processing with accurate and immediate data:
  - ‘Just-In-Time’ adjustment of assay upon the arrival of a crude cargo
    - Pipeline delivery with intermix / contaminations
    - Crude with wide swing of variation and seasonal changes
    - Offspec opportunity crudes
Real-Time Crude Assay Workflow

20 mLs Crude

**Needed to ensure samples are heated to the appropriate temperature**

** Basis crude assay is an existing assay in the AVEVA USC Assay Library

Required Lab Measurement: API/Density*

*ANALECT® RefinIR™*

Mid + Near IR Spectra

**AVEVA USC Desktop w/RTC + Basis Crude Assay**

Crude Assay Report

20 mLs Crude
# Real-Time Crude Data Evaluation

## Yield and API Comparison

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Type</th>
<th>Crude</th>
<th>15-70°C</th>
<th>70-100°C</th>
<th>100-150°C</th>
<th>150-200°C</th>
<th>200-250°C</th>
<th>250-300°C</th>
<th>300-350°C</th>
<th>350-450°C</th>
<th>450-500°C</th>
<th>500-550°C</th>
<th>550°C+</th>
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<tbody>
<tr>
<td>Yield (%)vol</td>
<td>Cut</td>
<td>First crude (TFA)</td>
<td>5.37</td>
<td>3.40</td>
<td>7.55</td>
<td>8.29</td>
<td>7.36</td>
<td>7.93</td>
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<td>2.39</td>
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<td>Second crude (IR)</td>
<td>5.54</td>
<td>3.55</td>
<td>7.59</td>
<td>7.55</td>
<td>7.84</td>
<td>7.64</td>
<td>7.79</td>
<td>2.70</td>
<td>12.22</td>
<td>6.70</td>
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<td>-0.04</td>
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<td>0.12</td>
<td>0.29</td>
<td>0.46</td>
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<td>-0.34</td>
<td>-0.34</td>
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<td>API</td>
<td>First crude (TFA)</td>
<td>27.70</td>
<td>36.45</td>
<td>66.57</td>
<td>55.34</td>
<td>50.42</td>
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<td>28.14</td>
<td>20.65</td>
<td>16.52</td>
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<td>Second crude (IR)</td>
<td>27.70</td>
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<td>66.89</td>
<td>56.74</td>
<td>51.03</td>
<td>43.10</td>
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<td>-0.21</td>
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<td>-0.09</td>
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<td>0.32</td>
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<td>-0.53</td>
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## Crude Oil Property Comparison

<table>
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<tr>
<th>Measurements</th>
<th>Viscosity at 20°C/68°F (cSt)</th>
<th>Viscosity at 40°C/104°F (cSt)</th>
<th>Sulphur (%wgt)</th>
<th>Nitrogen (ppm)</th>
<th>Basic Nitrogen (ppm)</th>
<th>TAN (mgKOH/g)</th>
<th>Pour Point (°C)</th>
<th>Wax (%wgt)</th>
<th>UOPK</th>
<th>C₇ Asphaltenes (%wgt)</th>
<th>MCR (ºC)</th>
<th>Vanadium (ppm)</th>
<th>Nickel (ppm)</th>
<th>Iron (ppm)</th>
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</thead>
<tbody>
<tr>
<td>First crude (TFA)</td>
<td>25.2</td>
<td>12.2</td>
<td>3.39</td>
<td>1364.0</td>
<td>366.0</td>
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<td>Second crude (IR)</td>
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<td>Difference</td>
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<td>0.08</td>
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<td>-0.38</td>
<td>-0.38</td>
<td>-0.25</td>
<td>-1.42</td>
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</tbody>
</table>

### KEY
- Difference more than 3 tolerances
- Difference between 2 and 3 tolerances
- Difference between 1 and 2 tolerances
- Differences not highlighted if one or more yields <0.2 % wgt

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All Data Extracted from AVEVA USC Desktop Crude Comparison Report

TFA=Transportation Fuels Assay

IR= IR Spectra (Real-Time Crude Assay)
The End

Questions?