Crude quality definitions

- Light sweet (LSW) crude oils are defined as having APIs above 30-32 API and sulfur content less than 1%. Light sour (LSR) crude oils are defined as those above 30-32 API and sulfur content greater than 1%. Heavy sour (HSR) crude are those below 24 API and have sulfur content greater than 1%. Heavy Sweet (HSW), high TAN crude oils are defined as those with a whole crude TAN above 1.0 mg KOH/mg. Medium crudes fall somewhere in between the extremes of the API range reserved for light and heavy crudes (API between 24 and 32) and can be either sweet (sulfur content lower than 1% by weight) or sour. Term “condensate” is applied to segregated, light condensate streams produced from gas fields. Condensates typically have gravities of 50 API or higher.

- That being said, there are not strict definitions on crude quality and we do use some latitude when characterizing certain crude oils that are near the limits for certain classifications, because it is useful to group crude oils together that are generally competitive and interchangeable for analytical purposes.

Notes:
1. Crude oils from Saudi Arabia / Middle East with API less than 28 classified as Arab Heavy / Heavy sour.
2. Heavy sweet synthetic crude oils from Venezuela and Canada classified as Heavy Sour.

Source: IHS Markit
Global crude production by quality in 2018

Percentage

North America

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>58%</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>1%</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>22%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>4%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

Europe

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>76%</td>
</tr>
<tr>
<td>Medium Sweet</td>
<td>1%</td>
</tr>
<tr>
<td>Heavy Sweet</td>
<td>10%</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>6%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

Africa

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>56%</td>
</tr>
<tr>
<td>Medium Sweet</td>
<td>15%</td>
</tr>
<tr>
<td>Heavy Sweet</td>
<td>12%</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>8%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

CIS

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sour</td>
<td>56%</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>37%</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>1%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

Asia

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>17%</td>
</tr>
<tr>
<td>Light Sour</td>
<td>47%</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>21%</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>11%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

Middle East

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sour</td>
<td>27%</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>47%</td>
</tr>
<tr>
<td>Heavy Sour</td>
<td>10%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>7%</td>
</tr>
<tr>
<td>Light Sweet</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

World

<table>
<thead>
<tr>
<th>Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Sweet</td>
<td>27%</td>
</tr>
<tr>
<td>Medium Sour</td>
<td>21%</td>
</tr>
<tr>
<td>Heavy Sour</td>
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</tr>
<tr>
<td>Heavy Sour</td>
<td>4%</td>
</tr>
<tr>
<td>Segregated Condensate</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit
Growth in US and Brazil will shift global slate lighter and sweeter

**Shift in future crude slate by major producers**

<table>
<thead>
<tr>
<th></th>
<th>2018 crude supply</th>
<th>Mideast sour</th>
<th>US sweet</th>
<th>Latin sour</th>
<th>Brazil sweet</th>
<th>Canada sour &amp; other</th>
<th>2019 crude supply</th>
<th>Mideast sour</th>
<th>US sweet</th>
<th>Latin sour</th>
<th>Brazil sweet</th>
<th>Canada sour &amp; other</th>
<th>2020 crude supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMb/d</td>
<td>77.0</td>
<td>77.5</td>
<td>78.0</td>
<td>78.5</td>
<td>79.0</td>
<td>79.5</td>
<td>80.0</td>
<td>80.5</td>
<td>80.0</td>
<td>79.5</td>
<td>79.0</td>
<td>79.5</td>
<td>80.5</td>
</tr>
</tbody>
</table>

Source: IHS Markit © 2019 IHS Markit

**Crude quality properties of major streams minus global 2018 average**

- WTI: -0.88, 5.99
- WCS: 2.62, -10.51
- Iran Heavy: 0.47, -2.01
- Merey: 0.97, -14.31
- Lula: -0.96, -3.41

Note: Global 2018 average is 1.33 sulfur, 32.69 API gravity

Source: IHS Markit © 2019 IHS Markit
The path to self-destruction: Recap of Venezuela’s struggle

Venezuela

**Humanitarian crisis**
Since 2014, approximately 3 million Venezuelans have fled the country owing to the failing economy, lack of basic goods (food, water, medical equipment), and jobs. In February, President Nicolas Maduro blocked an international attempt to bring aid into the country.

**Crude exports**
- May 2017: 1.63 MMb/d
- May 2019: 0.78 MMb/d
- Quality to United States: January 2017: 18.12º API November 2018: 16.81º API*
- *Decline due to decreasing US imports of Hamaca.

**Diluent crisis**
Venezuela requires naphtha to produce Orinoco extra-heavy crude and to upgrade it into DCO export blend.

**Temporary solutions**
PDVSA is using light eastern grades to replace US naphtha, but this is a temporary solution as eastern conventional production is declining rapidly.

**Refinery runs**
- February 2017: 745,000 b/d
- May 2019: 65,000 b/d

**Western conventional oil**
- February 2017: 760,000 b/d
- May 2019: 308,000 b/d

**Orinoco Belt**
- February 2017: 600,000 b/d
- May 2019: 268,000 b/d

**Eastern conventional oil**
- February 2017: 695,000 b/d
- May 2019: 168,000 b/d

**Major events in 2019**
- **24 January:** Juan Guaidó is sworn in as interim president, challenging Maduro’s authority. Currently, he is recognized by 50 countries as the legitimate ruler.
- **28 January:** The United States imposes sanctions directly on PDVSA, blocking its exports of crude and imports of US naphtha.
- **7 March:** US Special Representative for Venezuela Elliott Abrams announced upcoming sanctions that could target all crude and product flows being shipped in and out of the country.
- **7 and 25 March:** Two blackouts caused by a wildfire near the Guri hydroelectric dam caused countrywide blackouts for a minimum of 10 days. In both blackouts, production plunged below 500,000 b/d, shutting down Orinoco production and closing down the already troubled Jose terminal.
- **April 30:** Guaidó calls for a May Day protest to increase the pressure on President Maduro after a day of violent clashes on the streets of the capital.

Since 2014, approximately 3 million Venezuelans have fled the country owing to the failing economy, lack of basic goods (food, water, medical equipment), and jobs. In February, President Nicolas Maduro blocked an international attempt to bring aid into the country.

Venezuela requires naphtha to produce Orinoco extra-heavy crude and to upgrade it into DCO export blend.

PDVSA is using light eastern grades to replace US naphtha, but this is a temporary solution as eastern conventional production is declining rapidly.

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Source: IHS Markit
Venezuela tumbles close to Ecuador’s and Argentina’s production levels
Share of crude oil imports from Venezuela for key markets in 2019 YTD

**Chinese crude oil imports by country in 2019 YTD**

- Saudi Arabia: 1,600 Thousand b/d
- Russia: 1,200 Thousand b/d
- Angola: 800 Thousand b/d
- Iraq: 600 Thousand b/d
- Brazil: 400 Thousand b/d
- Oman: 200 Thousand b/d
- Iran: 100 Thousand b/d
- Venezuela: 50 Thousand b/d
- Kuwait: 30 Thousand b/d
- UAE: 20 Thousand b/d

Source: IHS Markit © 2019 IHS Markit

**Indian crude oil imports by country in 2019 YTD**

- Iraq: 1,200 Thousand b/d
- Saudi Arabia: 900 Thousand b/d
- Nigeria: 600 Thousand b/d
- UAE: 500 Thousand b/d
- Iran: 300 Thousand b/d
- Mexico: 200 Thousand b/d
- Kuwait: 100 Thousand b/d
- Venezuela: 50 Thousand b/d
- United States: 30 Thousand b/d
- Angola: 20 Thousand b/d

Source: IHS Markit © 2019 IHS Markit

**US crude oil imports by country in 2019 YTD**

- Canada: 4,000 Thousand b/d
- Mexico: 3,000 Thousand b/d
- Saudi Arabia: 2,000 Thousand b/d
- Colombia: 1,500 Thousand b/d
- Iraq: 1,000 Thousand b/d
- Venezuela: 500 Thousand b/d
- Ecuador: 400 Thousand b/d
- Nigeria: 300 Thousand b/d
- Brazil: 200 Thousand b/d
- Kuwait: 100 Thousand b/d

Source: IHS Markit © 2019 IHS Markit
Canadian crude-by-rail volumes fell sharply in February, but weekly railcar loading data indicate a revival is on the horizon.
Iran crude oil exports will fall above zero

Crude and condensate imports from Iran

- **July 2012**: President Barack Obama imposes sanctions for the purchase or acquisition of Iranian oil. Countries determined to significantly reduce purchases of Iranian crude oil receive waivers.
- **16 January 2016**: Sanctions revoked.
- **August 2018**: President Donald J. Trump reimposes sanctions starting 5 November 2018; waivers offered for six months.
- **April 2019**: Trump decides to not reissue waivers.

Note: Data are until April 2019. IHS Markit Global Trade Atlas imports data through latest available; IHS Markit Commodities at Sea arrivals after. Other category includes UAE, for which data are inconsistent before 2017.

Source: IHS Markit

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US production and refinery diet skew ever lighter

API gravity (weighted average) of US crude inputs, monthly

- Permian production surge (2017–18)
- US production declines (2015–16)
- New pipelines bring US LSW crudes to US Gulf Coast refining hubs

Source: IHS Markit
The API and sulfur content of China’s seaborne crude imports are expected to average at 30.85 and 1.44, respectively, in April.
Imports from Venezuela rise in March, as in-transit shipments arrive; trend not likely to sustain further amid US-led sanctions

Share of total imports by key countries

Source: IHS Markit © 2019 IHS Markit
Thank you

Ha Nguyen
Director, Oil Markets Research
Ha.Nguyen@ihsmarkit.com
Crude Oil Supply Analytics: Drill Down into the Global Crude Oil Supply Outlook

- Provide key assumptions and detail on forecast drivers for 21 critical producing countries, with information on:
  - Above-ground risk factors
  - Historical and current crude oil and condensate production by terrain
  - Anticipated base decline rate of current production
  - Projects under development including onstream date, volume, and terrain
  - Discoveries that are not yet sanctioned, but included in our production outlook including onstream date, volume and terrain
  - Estimate of "yet-to-find"—the amount of undiscovered oil that will be found and developed in the time frame of our outlook
  - Full cycle cost estimate for each component of future supply
  - Breakdown of crude oil quality by API (light, medium, and heavy)
  - Access to IHS Markit Crude Oil Markets experts
Crude Oil Supply Analytics (COSA) Quarterly changes

Third Quarter Oil Supply Review – August 2018 | 3Q2018 versus 2Q2018 recap

U.S. unconventional volumes increased by 2 million barrels per day. IHS Markit expects a 400 thousand barrels per day build in 2023.

Production continues to decline steeply in the near term because of Petróleos de Venezuela, S.A.’s (PDVSA) cash crisis, reduced investment by foreign companies,...

Venezuela

Iran

Only a few countries, such as China, Russia, and potentially India, are likely to defy these sanctions given the long reach of the US financial system and potential for repercussions.

US onshore capex/cash flow balance to be essentially flat in 2018 and 2019, as operators work to pay down debt and strengthen balance sheets. US onshore capex is expected...

Saudi Arabia will play a major role in rebalancing the oil market, following the Vienna decision to allow spare capacity holders to increase production in order to offset supply shortfalls. Saudi Arabia leads the charge along with Kuwait, UAE, and Russia,...

+2 MMB/d

Dated Brent Oil Price (1975-2018F)

The marginal barrel

$50 to extract a barrel of oil globally

IHS Markit Crude Oil Supply Analytics quarterly service

Gain access to the most credible insight across global oil.

Analyze field-by-field breakouts from key assumptions and above ground risks underpinning our crude and condensate supply forecasts to more granular detail on the new source of supply.

- Detailed short-term and long-term crude and condensate supply outlooks from 1990-2040
- Global crude supply data derived from the IHS Markit Annual Strategic Planning Workbook and other proprietary databases balanced against global demand and long-term price

- Interactive Tableau dashboard with 20,000 field-by-field breakouts by terrain, development, operator, basin, crude quality and breakeven tranche
- Priority country reports cover expert perspectives on:
  - Assumptions & above ground risks underpinning forecasts
  - Analysis of base declines by basin, complex or major field
  - Analysis on major projects by fields or complex
- Field build-up to feed into crude streams and API gravity allowing the user to customize own crude quality cuts and crude slate changes
Appendix: Links to IHS Markit Crude Oil Markets resources

- Oil Markets, Midstream and Downstream Services
- Latin America Energy
- Article A Slowing Growth Story (5 June 2019)
- Interview Naphtha’s reemerging role as an essential product and feedstock (21 May 2019)
- Oil Market Briefing: Brent backwardation: A sign of oil market tightness, but will the Vienna Alliance continue to restrain output? (15 May 2019)
- Article Naphtha’s reemerging role as an essential product and feedstock (21 May 2019)
- Oil Market Briefing: Friendship blues: Contaminated oil in Russian export pipeline reprises fears of supply interruptions (8 May 2019)
- Insight: The impact of Urals contamination on European refineries (7 May 2019)
- Latin American Crude Oil Markets Short-Term Outlook: April 2019—Latin sour rises as sanctions thicken (6 May 2019)
- Insight: New US sanctions bill targets existing Russian crude oil production: What would be the impact, and which companies might be affected? (3 May 2019)
- Europe CIS and Africa Crude Oil Markets Short Term Outlook - April 2019: Contamination adds to the uncertainty in the European sour crude market (2 May 2019)
- North American Crude Oil Markets Short-Term Outlook—April 2019: After a pause, US crude production set to resume growth (1 May 2019)
- India Crude Oil Market Short-Term Outlook—April 2019: Uncertainties of Iranian and Venezuelan supply loom large (29 April 2019)
- China Crude Oil Market Short-Term Outlook—April 2019: Independents to raise runs amid heavy state-owned maintenance (29 April 2019)
- Asia and Middle East Crude Oil Markets Short-Term Outlook, April 2019: Asian heavy sweet and light sweet crude markets diverge (29 April 2019)
- Article Navigating Choppy Waters IMO Study, Final Findings (March 2019)
- Article 2019 Downstream Oil Issues to Watch (February 2019)

Note: Access to individual reports depends on client subscriptions.