Looming IMO 2020 and Resulting Impact on Crude

COQA
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• What happens due to IMO 2020?
• Why is it important?
• How does IMO 2020 impact crude differentials?
• Conclusions
What happens due to IMO 2020?

Regulations Clean Fuels - Marine Bunker Fuels - MARPOL

- **Open Oceans (Global)**
  - Ships with scrubbers
  - Without scrubbers
- **Coastal Seas (SECAs)**

% Sulphur Content In Marine Fuel

- 2005: 5.0%
- 2010: 4.0%
- 2015: 3.5%
- 2020: 0.5%
- 2025: 0.0%
Bunker fuel is incremental “disposal” product for many US refiners

Bunker fuel represents bulk of untreated product sulfur

US refiners already running at historically light slate
  - Limited ability to further lighten to reduce fuel oil production

IMO 2020 introduces uncertainties
  - Market adherence, project economics, crude slate implications, timing

Why is IMO 2020 Important?
Who’s Producing Fuel Oil?

Why is IMO 2020 Important?
Disposal Product

PRISM Cash Margin Estimates for U.S. Refiners

<table>
<thead>
<tr>
<th>Refinery Configuration</th>
<th>% of US Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>No RFO</td>
<td>59%</td>
</tr>
<tr>
<td>Incremental RFO</td>
<td>34%</td>
</tr>
<tr>
<td>No bottoms upgrading</td>
<td>7%</td>
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</tbody>
</table>

Source: Baker & O’Brien PRISM™
Why is IMO 2020 Important?
Bulk of Untreated Sulfur

Bunker Fuel – The Sulfur Sink

### Product and Sulfur Disposition

<table>
<thead>
<tr>
<th>Product</th>
<th>Product Yield</th>
<th>Sulfur (ppm)*</th>
<th>% of Total Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>54%</td>
<td>15</td>
<td>1%</td>
</tr>
<tr>
<td>Distillates**</td>
<td>43%</td>
<td>60</td>
<td>4%</td>
</tr>
<tr>
<td>RFO</td>
<td>3%</td>
<td>21000</td>
<td>95%</td>
</tr>
</tbody>
</table>

* Sulfur estimates from PRISM modeling
** Includes diesel and jet
***NOTE: 75% of crude sulfur removed by hydrotreating

Source: Baker & O’Brien PRISM™
Why is IMO 2020 Important?
US Slate Historically Light Already

Lightening of US Crude Slate

Source: Baker & O’Brien PRISM™
How does IMO 2020 Impact Crude Differentials?

- **Market price reflects intrinsic crude value**
  - Product yields and quality adjustments

- **Valuing crude oil at the refinery**
  - Pricing at the refinery gate

- **Price setters are the incremental fuel oil producers**
  - Represent 34% of US refining capacity
  - Refiners make decisions on the incremental barrel
Objective: Estimate crude differentials for incremental fuel oil producers

Methodology
- Develop refinery model to represent fuel oil producing US refinery
  - Crude slate
  - Configuration
  - Products
- Perform product price step testing
How does IMO impact crude differentials?

- **Target properties**
  - Distillation
  - API = 32.2
  - Sulfur = 1.5%

- **Crude Blend**
  - 18.5% WCS
  - 42.5% Mars
  - 39.0% WTI

Source: Baker & O’Brien PRISM™
How does IMO impact crude differentials?

Crude Price Setter – Incremental Fuel Oil

Charge → Crude Unit → Desulfurization → Reformer
→ Gas Oil Upgrading → Distillate
→ Vacuum Unit → Bottoms Upgrading → Fuel Oil

Fuel Gas and LPG → Gasoline → Fuel Gas and LPG

Desulfurization
Reformer
Gas Oil Upgrading
Bottoms Upgrading
Fuel Oil
Distillate
Gasoline
Fuel Gas and LPG
Crude Oil Differential Results

- Modeling Results for WTI-WCS spread
  - 3.0% Fuel Oil Price
  - Distillate Price
  - 0.5% Fuel Oil Price

How does IMO impact crude differentials?
How does IMO impact crude differentials?

References for Modeling Crude Differential

• Adding some context
  – Blend value equilibrium
  – Fuel oil pricing references
  – Project value references
How does IMO impact crude differentials?

Sulfur Blend Value Equilibrium

Blending Visualization

Blend Balance

3% 1 Part + ~0% 5 Parts = 0.5% 6 Parts

Linear Blending (~0% = 100)

Everyone wants to blend

Equilibrium

No one wants to blend
How does IMO impact crude differentials?

Fuel Oil Pricing References

- **BTU Equivalent Cost to Coal**
  - Potential market - High sulfur fuel oil for electricity generation
  - Competes with coal on a BTU value basis
  - Potential floor for 3% fuel oil price

- **Low sulfur VGO**
  - Replacement fuel
  - Blend stock for diluting sulfur
  - Potential cap for 0.5% fuel oil price
Fuel Oil Project Economics

- **General project assumptions**
  - Average size projects - Returns improve for larger sizes and decline for smaller
  - Sufficient return to justify expenditure

- **Ship stack scrubber economics**
  - Value derived from spread between 0.5% and 3.0% fuel oil

- **Grassroots coker economics**
  - Value derived from product uplift from resid to light oil products
How does IMO impact crude differentials?

Results - Modeling Crude Differentials

Refiner WCS to WTI Valuation

Increasing WTI-WCS Spread

Source: Baker & O'Brien PRISM
How does IMO impact crude differentials?

Refiner WCS to WTI Valuation

Results - Modeling Crude Differentials

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<thead>
<tr>
<th>Category</th>
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<tr>
<td>Blending</td>
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<td>Blend Value</td>
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<tr>
<td>Price Reference</td>
<td>Blue</td>
<td>BTU Equivalent</td>
</tr>
<tr>
<td>Project Economics</td>
<td>Red</td>
<td>Ship Scrubber</td>
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<tr>
<td></td>
<td></td>
<td>Grassroots Coker</td>
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<table>
<thead>
<tr>
<th>WTI-WCS Spread ($) / B</th>
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<td>16</td>
<td></td>
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<tr>
<td>20</td>
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Source: Baker & O'Brien PRISM
• **Wide price spread for 0.5% and 3.0% fuel oil**
  – 0.5% price trends toward low sulfur blend stock
  – 3.0% price trends toward BTU value

• **WTI-WCS differentials to widen**
  – Resid volume and sulfur content adjustments
  – Increasing distillate prices also increase spread

• **Beneficiaries**
  – Bottoms upgrading refineries with no high sulfur fuel oil production
  – Producers of light, sweet crude to benefit while heavy, sour to suffer
  – Shippers with scrubbers
For a similar analysis of IMO 2020 impacts on European Crudes, see Baker & O’Brien’s presentation at the *Opportunity Crudes Conference “Growing U.S. Light Crude Exports and IMO 2020 Driven Discounts: Who Benefits?” October 22, 2018 Charles Kemp*
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- Technical and commercial expertise
- Active over full life cycle of assets: new project development -> business support -> commercial disputes

Consulting Staff

- Chemical, mechanical, and electrical engineers with business acumen
- Consultants average over 25 years industry experience
- Experienced problem solvers
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