Low sulphur bunker fuel oil: what are the options?

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4th Asian Refining Summit
9-10 March, 2017, Singapore

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Presentation outline

- Existing Legislation
- Expected Impacts at 2020
  - Shipping
  - Refining
- Eni’s approach
- Conclusions
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- **Existing Legislation**
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In 2008, IMO has adopted a resolution to amend Annex VI of the MARPOL Convention that came into force on July 1st 2010. Annex VI introduces, moreover, more stringent limits to sulphur content for marine fuel:

- **SECA area**: 0.10 wt.% from January 1\(^{st}\) 2015
- **Outside SECA**: 3.50 wt.% from January 1st 2012 and 0.50 wt.% from January 1st 2020 or from 2025
- **By decision of October 27\(^{th}\) 2016 IMO has established the transition at January 1\(^{st}\) 2020**
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According to CE Delft a study, in 2020 (base case projection)

- Global marine fuel demand will be 320 Mt/y
- The use of HSFO for ships equipped with scrubbers will be limited to 36 Mt/y
- The demand of LNG as alternative fuel will be limited to 12 Mt/y

The shift to low sulphur marine bunker in 2020 will result in a demand for 233 Mt/y of HFO with a sulphur content of 0.50 wt.% or less

The decision is a milestone: after sulphur removal in gasoline and diesel, now is the time of fuel bunker for further and significant reduction of \( \text{SO}_2 \) emission
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Expected impact on the shipping system

Three possible options to adapt ship emissions:
1. Switch to LNG
2. Scrubber installation
3. New bunker fuel 0.5 wt.%S
1. Switch to LNG as main fuel:

- no emission of SOx
- reduction of NOx and PM emissions
- more compliant with the tendency to de-carbonization policy of fuels
- doubled storage capacity for fuel
- expensive retrofitting of existing fleets
- need for new port infrastructure
- possible only short/medium range routes
Expected impact on the shipping system

2. Exhaust gas cleaning systems (scrubbers)

- On board complex and interconnected system in large vessels
- Difficult and expensive to retrofit small cabotage vessels
- Port facilities for treatment of sludge produced by closed-circuit or hybrid scrubbers
- On board expertise to manage both the control system as well as the waste products
- Continuous monitoring of the abatement systems to ensure and prove to Authorities the correct operation and use of compliant fuel
+ Possibility to stay in business utilizing HS HFO
3. Using new bunker fuel 0.5% S (LS HFO)

**No investment for shipping industry:**
- no additional bunker tanks and piping systems
- no scrubbers to reduce PM and SOx
- no fuel treatment equipment
- same engine maintenance

**Bunker fuel onboard plant & maintenance:**
- provides safer working environment for ships’ staff and shore side workers
- avoids carriage of multi-fuels and fuel blending switching problems
- reduces control and monitoring requirements
- lowers burden for crew
- lessens harmful impact of bunker spills
The estimate price of the new bunker fuel, between diesel and LFO, will affect only marginally the freight cost

Source: Clarkson
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What can the refining industry do to cope with this change?

1. Process ultra low sulphur crude (e.g. African crudes such as Djeno Melange, Sarir, Western Desert, Asian crudes, North Sea crudes)

2. Make major investments in bottom of the barrel conversion plants
Expected impact on refining industry

- Several commercial technologies conversion of vacuum residue to lighter products
- Increase of low H/C of residue to higher H/C of products via thermal or catalytic:

  **carbon rejection (thermal)**

  Coking offers high feedstock flexibility but poorer quality of distillates loss of liquid yield, ca. 30% wt of low value coke

  **hydrogen addition (catalytic)**

  Fixed bed (low metals content feed) but Ebullating bed (relatively higher metals feed) limits the maximum conversion achievable fuel oil remains a fatal product
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Eni’s refining system

Eni’s refining system and green refineries[a]

North Sea 1%

Other areas 2%

Schwedt
[8.33%] Capacity: 19 kbbl/d

Bayernoil
[20%] Capacity: 41 kbbl/d

Sannazzaro
Capacity: 200 kbbl/d

Venice
Capacity: 350 ktons/y

Livorno
Capacity: 84 kbbl/d

Taranto
Capacity: 104 kbbl/d

Milazzo
[50%] Capacity: 100 kbbl/d

Gela
Ongoing reconversion

North Africa 12%

CIS 47%

Middle East 20%

West Africa 2%

[a] Data on capacity relate to Eni’s share of balanced capacity in 2015.
Eni’s solution for Bottom of the Barrel conversion

A hydrocracking process based on two unique features:
- Nanodispersed (slurry) non-ageing catalyst
- Homogeneous & isothermal slurry bubble column reactor

EST process scheme
- allows the total conversion of the bottom of the barrel to good quality middle distillates
- feedstock conversion >92%
EST catalyst vs. conventional HCK catalysts

- The active phase is unsupported molybdenite ($\text{MoS}_2$) in isolated layers with excellent dispersion
- Generated in situ from oil-soluble precursors
- High surface area
- No plugging from metals and coke deposits
EST: the Slurry reactor

- The tailored-designed slurry bubble column reactor is:
  - homogeneous due to the small size of catalyst particles
  - isothermal in both axial and radial profiles due to the high back mixing fluid-dynamically driven
EST product yields and quality

Naphtha
- Sulphur < 5 wtppm
- Nitrogen < 5 wtppm

Diesel (Euro V)
- Sulphur < 5 wtppm
- Nitrogen < 5 wtppm
- Cetane Index min 51
- Polyaromatics < 8.0 wt%

VGO (new spec bunker oil or to HDC/FCC)
- Sulphur <500 wtppm
- Nitrogen <500 wtppm
- Metals <1 wtppm
EST Vs. Other Processes – Vol.% yields comparison

- High conversion to desired products
- 35% products yields higher than DC and EB
Eni’s approach to fuel quality evolution

Eni’s policy approach on product quality is to anticipate environmental legislation.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Eni commitment (year)</th>
<th>Legislation Endorsement (year)</th>
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<tbody>
<tr>
<td>Zero lead gasoline</td>
<td>1987</td>
<td>2000</td>
</tr>
<tr>
<td>1% max vol Benzene</td>
<td>1997</td>
<td>2000</td>
</tr>
<tr>
<td>Max S 10 ppm diesel</td>
<td>2002</td>
<td>2009</td>
</tr>
<tr>
<td>Max S 10 ppm Gasoline</td>
<td>2004</td>
<td>2009</td>
</tr>
<tr>
<td>2% wt PNA Diesel</td>
<td>2010 locally, 2016</td>
<td>nd</td>
</tr>
<tr>
<td>10% renewable Diesel</td>
<td>2016</td>
<td>2020</td>
</tr>
<tr>
<td><strong>0.5% S bunker fuel</strong></td>
<td><strong>2016</strong></td>
<td><strong>2020</strong></td>
</tr>
</tbody>
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EST Unit at Sannazzaro Refinery allows Eni to achieve the goal of free sulphur in all fuels responsible for large amounts of SO\textsubscript{2} emissions into the environment.
In the future the e.e. will be more and more produced from renewables

Coke and HSFO will be hardly sold

EST, latest industrial proven technology in the world, means:
- Very High conversion (> 92%) to light and middle distillates
- Feed flexibility
- **Premium, clean fuels production like new low sulphur bunker fuel according to IMO GSC 2020**
- Environment-friendly technology (coke or fuel oil production reduced/eliminated)
- High energy efficiency
- Excellent option for natural gas valorization
- Integration with Petrochemicals
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- The new sulphur specification completes the sulphur removal in all fuels, with very beneficial effects on the environment.

- LNG in the medium to long term should be attractive in the case of new ships. Most depends on development of Ports facilities.

- Installation of scrubbers appears, at the time, another possible solution but difficult to implement and to monitor the performance of cleaning system on board.

- The higher cost of the new fuel could impact freights moderately, as in the past where the shipping industry already faced fuel prices of 600 USD/t with minor effects on freights.

- Eni has heavily invested in R&D of new deep conversion technologies. This has originated EST technology, suitable for the production of light distillates and low sulphur bunker fuel <0.5% and/or <0.1%.