Refining impact of the IMO bunker fuel sulphur decision

EGCSA Workshop

30 November 2016
Outline

- IMO Decision
- Fuel Availability Studies
- Fuel composition considerations
- Transition
- Refinery sulphur balance
- Conclusions
IMO Decision

IMO press briefing – October 27, 2016

“In a landmark decision for both the environment and human health, 1 January 2020 has been set as the implementation date for a significant reduction in the sulphur content of the fuel oil used by ships.”

“IMO Secretary-General Kitack Lim welcomed the decision which he said reflected the Organization’s determination to ensure that international shipping remains the most environmentally sound mode of transport.”

“Further work to ensure effective implementation of the 2020 global sulphur cap will continue in the Sub-Committee on Pollution Prevention and Response (PPR).”
Fuel Availability Studies

• Regulation 14.8 of MARPOL Annex VI calls for a review of the global fuel sulphur limit to determine the availability of compliant fuel oil
  – UK and the NL submitted a formal proposal in 2014 to initiate the Fuel Availability Study
  – A correspondence group (CG) was created to develop the Study methodology
  – Terms of Reference approved by MEPC 68 (May 2015), Steering Committee established
  – Award of contract to CE Delft/Stratas: Sept 2015

• Ensys and Navigistics sought support to undertake a supplementary study to the IMO Fuel Availability Study
  – Objectives: provide additional insight, reduce uncertainty and place the IMO in a stronger position to make a sound decision
  – Support was obtained from IPIECA, BIMCO, Canadian Fuels Association, Japanese Petroleum Association and FuelsEurope/Concawe
  – Study executed on independent basis
  – Final report made available to MEPC

• Both studies available at MEPC 70 to inform decision – October 2016
Two Studies Deliver Different Conclusions

Regulation 14.8 of MARPOL Annex VI calls for a review of the global fuel sulphur limit set in regulation 14.1.3 to determine the availability of fuel oil to comply with that requirement.

CE Delft and Ensys studies reach very different conclusions:

- **Conclusion CE Delft (Executive Summary, July 2016, MEPC 70/5/3, p. 58)**
  - “The modelling results indicate that the refinery industry can produce sufficient amounts of marine fuels of the required quality in the base case, the high case and the low case while at the same time supplying other sectors with the petroleum products they require.”

- **Conclusion EnSys (15 July 2016, MEPC 70/5/5, p. 18)**
  - “Given this outlook, Model results point to extreme difficulty – and indeed potential infeasibility - for the refining sector to supply the needed fuel under the Global Sulphur Cap and to simultaneously meet all other demand without surpluses or deficits. Market impacts are projected as very substantial across all products and regions worldwide, not just marine fuels, and, consequently, potentially significant impacts across economies and sectors.”
Two Studies Deliver Different Conclusions

- Demand assessment is comparable between the two studies
- Different assumptions on 2020 0.50% S fuel formulations
  
  **CE Delft:**
  - 2020 0.50% assumed to be blended fuels*
  - No fuel specification provided
  - Fuel stability not considered

  **EnSys:**
  - Assumes mix of distillate and blended fuels* to meet 0.50% S
  - High and low distillate cases
  - Fuel stability considered via product specifications & blendstock limits

- Refining unit capacity projections are generally similar
  - Differences do not explain the different conclusions of the two studies
  - Significant differences in modelling assumptions
  - Both studies recognize that H₂ production and S recovery unit capacities will be critical
    - CE Delft assumes refineries will make sure adequate capacities will be in place
    - EnSys makes a detailed analysis on likelihood of availability

- Different interpretation of modelling outcomes to formulate conclusions
  
  **CE Delft:**
  - Some key assumptions made are not referenced in conclusions
  - Sensitivity analysis does not identify significant risk of non-availability
  - Impact other products not analysed

  **EnSys:**
  - Assumptions clearly documented
  - Expresses caution on modelling results – may understate impacts
  - Analyses potential impact on other fuel product markets

* Blends of heavy fuel oil with distillate and desulphurised heavy fuel oil components
Asia to produce highest volume of 0.5% S fuel, followed by Europe

- **Hydrotreated Atmospheric Residue** is the highest volume component
- Followed by hydrotreated light distillate and **H-Oil Bottoms**
- Atmospheric residue is typically used to fill Vacuum Distillation capacity
- Use of light distillate is very surprising – may be difficult to meet Flash Point >60°C requirement

*Data Source: MEPC 70/INF.6*
Different Fuels Across the Regions

- Fuel formulations projected by CE Delft/Stratas vary widely across Regions
- Could lead to the following issues:
  - Wide variation in maximum centrifuge throughput and fuel pre-heat temperature prior to injection when using consecutive fuel deliveries with varying viscosities
  - Risk of incompatibility - In many cases it would not be advisable for ships to commingle fuels from different regions

Data Source: MEPC 70/INF.6
Categorization of Fuel Components: IPIECA on basis of definitions on page 8 of MEPC 70/INF. 6
• Text preceding Table 95 “In all cases, marine HFO blends adhere to the International Standard ISO 8217 residual marine fuels categories RMG 180 and RMG 380 on sulfur content and kinematic viscosity at 50°C.”
• Whilst technically true (no minimum viscosity in ISO 8217), there is an implicit understanding in the industry that if the viscosity drops significantly to a level below the maximum level of a lighter grade, the fuel should be assigned to that grade.
• None of the 7 regional fuels would need to be assigned to the RMG 380 grade since they all meet the viscosity specification of RMG 180 or lighter grades

**Wide Range of Fuel Viscosities (CE Delft/Stratas)**

![Bar chart showing regional fuel oil viscosities](chart.png)

**Data Source:** MEPC 70/INF.6  
**Fuel Oil grades viscosity:** ISO 8217:2012
Considers two different types of fuels to meet 0.50% S requirement
- Marine distillate
- Heavier grades – similar to the heavier ECA fuels

Two different scenarios considered
- High distillate: 90 % distillate, 10 % heavier fuels (initial situation ?)
- Low distillate: 50 % distillate, 50 % heavier fuels (after some time)

Heavier fuels modelled within ISO 8217 RM grade specifications
- Fuel stability concerns taken into account
Differences in modelling approach

**CE Delft/Stratas**
- 7 regions to model global refining
- External module to project future market prices
- Modelling restricted to 2020 global cap scenario

**EnSys/Navigistics**
- 23 regions, global integrated
- Economic data integrated in the model – estimated future cost of production is a model output
- Assessed switch from 2020 base case without global cap

![Diagram showing the comparison between CE Delft/Stratas and EnSys/Navigistics models](image-url)
Transition – EnSys/Navigistics Study

Increased coker unit throughputs to upgrade residual streams
- Carbon removal process \( \rightarrow \) more crude oil required (+ 0.2-1.2 mb/d)

Vacuum unit throughputs increase producing more vacuum gasoil (VGO)

Shifting Fluid Catalytic Cracking feedstock from VGO to residual feedstock
- Can lead to increased refinery \( \text{SO}_2 \) emissions
- Regulatory constraints – need for added abatement facilities

Increased severity on desulphurization/hydrocracking units
- Substantial increases in \( \text{H}_2 \), sulphur recovery plant throughput
- Decreases catalyst life – may not be sustainable

20% of export crude trade changes

Trade of non-crude supply, intermediates and finished products increases
- 30% changing trade routes

2 – 4.5% increase in global refining \( \text{CO}_2 \) emission
- 7-10% if emissions from petroleum coke included
Handling of Sulphur in the Refining Process

- Crude contains varying levels of sulphur
- Without targeted refining processes to remove it, the sulphur contained in crude will end up in the fuel products
  - The highest sulphur levels will be found in the heavier product streams
- Refineries can remove sulphur from refinery streams through hydrodesulphurization operations
  - Treatment with hydrogen at high pressure and temperature in the presence of a catalyst results in the formation of \( \text{H}_2\text{S} \) that is evacuated as an offgas
  - \( \text{H}_2\text{S} \) containing offgas is treated in a Sulphur Recovery Unit (SRU) where sulphur is recovered as elemental sulphur
- Another pathway whereby sulphur is removed is through regeneration of Fluid Catalytic Cracking (FCC) catalyst
  - Sulphur in coke deposits on the FCC catalyst is converted to \( \text{SO}_x \) emissions in the flue gas
  - Quantities of \( \text{SO}_x \) can be important if high sulphur feedstock is used in the FCC unit
  - In such cases a Wet Gas Scrubber unit is often used to avoid excessive emissions of \( \text{SO}_x \)
Conclusions

Significant challenges ahead for refining industry

- Models optimize at a global level
- Refining investment decisions are made by individual refiners
- Bunker fuel supply industry preparations by individual companies

Refining industry will invest based on global market conditions and regulatory outlook

- Refining industry will respond to market forces
- Some market signals may not become evident until after implementation
- Refining is an integrated business with numerous interdependencies – changes impact what products are produced and all fractions must be used