MARINE FUELS
MARPOL ANNEX VI 2020

Impacts on US and Canadian Crudes, Refining and Markets

EnSys Energy & Navigistics Consulting
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Topics

- EnSys & Navigistics
- 0.5% Sulphur Rule Overview and Developments
- Assessments of Rule impacts 2020
- Implications for North American / Other Markets
- Summary

EnSys Energy

Specialists in:

- Strategic and regulatory issues in global refining, markets & logistics
- Refining economics and fuels assessments
- North America logistics
- Global focus has brought wide range of clients
- Global integrated modeling “WORLD”

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NAVIGISTICS CONSULTING

Navigistics Consulting

Specialists in:

- Maritime Industry - issues in global and U.S. domestic shipping, markets, logistics, economics, energy efficiency, and regulations.
- Global marine fuel assessments (market, demand, efficiency, and emissions).
- North America marine/pipeline/terminal oil logistics specialists.
- Wilson Gillette Report covering the Jones Act Product Tanker Market.
- Global and US domestic focus has brought wide range of clients including oil companies, tanker owners, financial institutions, governments, and industry associations.

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IMO MARPOL Annex VI 0.5% Sulfur Rule

- Requires all ships starting Jan 1st 2020 operating outside ECA's (already 0.1%) to reduce SOx emissions by either:
  1) Burning 0.5% instead of 3.5% sulfur fuel
  2) Continuing to burn HS fuel but using onboard scrubber (EGCS) to reduce emissions
  3) Switching to an alternative low SOx fuel such as LNG, LPG
- Timing was finalized as 2020 (not 2025) at IMO MEPC70 meeting Oct 2016
- Responsibility for drawing up implementation guidelines/rules was designated to IMO Pollution Prevention and Response (PPR) sub-committee
  - Active – PPR5 meeting just held in London
  - But final recommendations not until 2019
- IMO has no enforcement ability
  - Currently only 'port states' or 'flag states'
  - Momentum for a 'carriage ban' which would strengthen enforcement powers
- No delays beyond 2020 or phase in being entertained

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For shipowners Annex VI is problematic

- Sector is poor financial condition and has to deal with ballast water rule
- Companies are split on path to follow
  - E.g. Carnival scrubbers/LNG, Maersk no scrubbers
- Few scrubber installations (only ~400 installations/orders to date)
  - So minor impact by 2020 (low volume of HS HFO scrubbed)
  - A 'common' view is that attractive economics in 2020 could lead to a surge of installations and partial reversion back to HS HFO demand post 2020
  - But concerns over operation, also longer term viability (NOx, GHG regulations)
  - So two scenarios: scrubbers succeed, scrubbers don't
- LNG a longer term option
  - Lot of interest but ship installation confined to newbuilds
  - Impacts potentially start to become significant post 2025

For refiners Annex VI is not a typical fuel rule

- 'Normal' rules are precise in terms of geography, fuel type/specs and usually strategically essential
- Inherent regulatory uncertainties make Annex VI difficult for refiners and ship-owners to prepare (i.e. invest)
  - Implementation date 2020 vs 2025 - now settled
    - Little/no incentive for refiners or shipowners to pre-invest - only 2 years left
  - But still
    - Three fuel compliance options
    - 0.5% fuel formulation options – any ISO 8217 grade – opportunities but also concerns
    - Plus prospect (short-term) of non-compliance (FONAR's)
  - Geography of production and purchasing potentially variable
    - International marine bunkers liftings can 'move', e.g. Rotterdam ⬇ versus Singapore ⬆
  - Marine fuels not a strategic product for many refineries
    - Hence the active blending / bunkering sector
  - Potential for partial reversion to HSHFO = deterrent to invest
    - Plus longer term alternative fuels (LNG)

- For both refining and shipping, a mixture of proactive and 'do nothing' strategies evident

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Net effect is neither sector fully investing to meet the Annex VI Sulfur Rule

- The ‘shipping’ solution of scrubbers likely to fill only 5-6% of compliance need in 2020 leaving the primary burden on refiners
- Navigistics projects a needed 2020 “switch volume” to 0.5% fuel of 3-4 mb/d (150-200 mtpa) to achieve full compliance
  - Level depends in part on vessel speed response
- “Only” 3-4% of global liquids demand but a shock to the system
  - Nearly halves total residual fuel demand
  - Being demanded ‘overnight’
  - Exacerbated if switch is mainly to distillate – likely early on

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EnSys Approach – Integrated Analysis of Global Liquids System (WORLD) Model

- High degree of bottom up detail
- Needed to get realistic representation / avoid over optimisation
- Proven over nearly 30 years of use

WORLD Model 23 Region Breakdown

- Recent increases in projected 2020 onstream refining capacity
  - Only limited instances of refiners investing for the Rule
- But also increases in global liquids demand (lower oil prices)
- Annex VI leads to expected very tight market especially 1H 2020
- Scrubber success could revert market after 3-4 years
- Scrubber none-success could extend tightness

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2017 WORLD simulations indicate global refining industry likely able to meet ~ 3 mb/d initial switch at ~101.7 mb/d global liquids demand in 2020

No Global Rule Normal Year

Market impacts sensitive to switch volume, available refinery capacity, global liquids demand, distillate/heavy 0.5% fuel mix

~3 mb/d switch looks to be max

Potential for non-compliance dependent on total needed switch 3-4 mb/d

Market Differentials / Strains Under Different Scenarios

Capacity Addition mb/cd	Switch Volume High MDO/Low MDO mb/d			
	Base (0)	Low (2.0)	Mid (3.0)	High/Full (3.7)
High (5.0)	n.r	Minor	High/Moderate	High
Mid (4.15)	Normal	High	Severe/High	Infeasible
Low (3.75)	Normal	High	Infeasible / Severe	Infeasible
V Low (3.35)	n.r.	Infeasible	Infeasible	Infeasible

Note: coloring/impacts based on gasoline/distillate versus HS HFO average differentials across 3 major-regions (USGC, Northwest Europe, Singapore). Left hand indicators are for High 0.5% MDO vs heavy 0.5% fuels (90:10) and right hand for Low MDO (50:50).

Source: EnSys-Navigistics Marine Fuels 2020 Assessment Service Q2 2017 Report

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Refinery Processing Impacts

- Distillation – higher throughputs ✓
- Upgrading units to max ~
  - Cokers & hydrocrackers
- Desulphurization units to max ~
  - Increased feed sulfur load
  - Decreases catalyst life – may not be sustainable
- H2, sulphur recovery plant look inadequate ✗
  - Large increase in sulfur recovery load
  - Some additional sulfur goes into petroleum coke

- 2 – 4.5% increase in global refining CO_2 emissions
  - 7-10% if emissions from petroleum coke included

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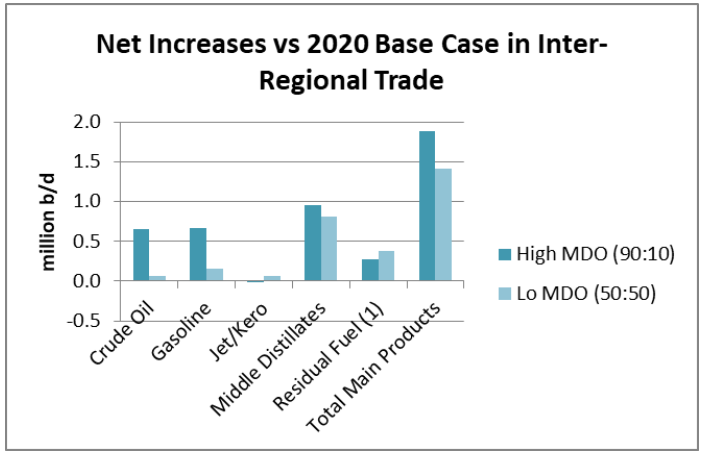
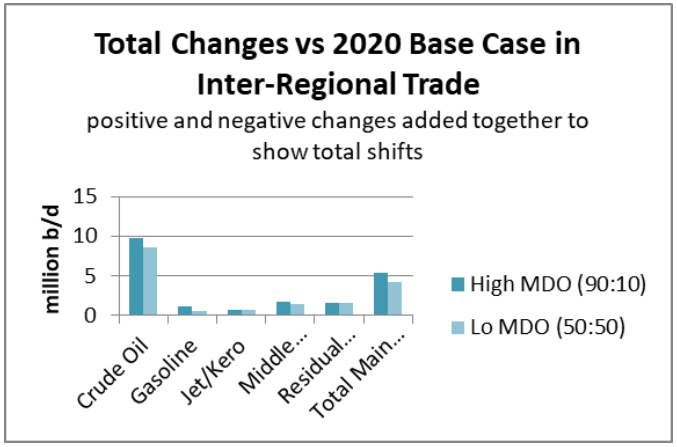
Refining / Trade Impacts

- Higher crude runs (+0.2 to 1 mb/d) – cokers & refinery fuel
  - US refinery throughputs increase moderately
  - US becomes a major supplier of 0.5% marine fuel
  - US crude and product exports and imports increase
- Wide changes in inter-regional crude oil and product marine trade





- Potential double/triple impacts on delivered costs:
  - Crude oils - higher world crude price, higher marine transport costs
  - Clean products - add effects of refining tightness

Source: EnSys-Navigistics Marine Fuels 2020 Assessment Service Q2 2017 Report

Market Impacts

- Refining is coproduct industry – production economics of all products closely inter-related
- The 0.5% Rule impacts all petroleum products across all regions
  - Major products: gasoline, jet, inland diesel, heating oil
  - Minor products: asphalt, lubes, anode & fuel grade coke
- Crude oil differentials correspondingly impacted
- Refining and oil trade adaptation will take months/year not days/weeks
  - No mechanism / incentive for starting early

Market Impacts

- Supply/demand balance will evolve over time
  - Initial – several weeks/months
    - *Initially demand/supply inelastic, refinery operations and trade change*
      - Impacts – potentially major - on supply costs / differentials
  - Short term – several months/year
    - *Then price elasticities / adjustments kick in*
      - Potential impacts on land fuels demands
      - Potential for expanded HS HFO outlets
        - Power / industrial boiler?
        - Storage (contango)?
      - Increasing use of heavy vs light 0.5% fuel formulations?
      - Crude supply impacts in economically sensitive regions?
        - E.g. US LTO versus Western Canada oil sands / heavy grades
  - Longer term – 2021 plus
    - *Supply/demand move towards a new 'equilibrium'*

Scrubber surge or flop?

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Implications for North Am / Other Markets

- Winners & losers
  - Light sweet crude producers ✚
  - Heavy sour crude producers ➖➖
    - On top of logistics constraints for WCSB
  - Light sweet cracking refiners ✚
  - Heavy sour deep upgrading refiners ✚ ✚
  - Inspection and testing companies ✚
    - More enforcement, more fuel grades/variations, compatibility concerns

- Refining investments/technology
  - High cost investments e.g. coking, resid HDS/HCR
  - Low cost investments/revamps e.g. catalyst change, revamps / debottlenecking
  - Novel partial upgrading and desulfurization processes
    - Could bring benefits medium to longer term
    - Potentially also impact logistics (reduced diluent)

Summary

- Global Sulphur Rule represents major challenges to refiners, bunkers suppliers, shipowners and charterers worldwide
  - A lot of “moving parts”
  - Key parameters still evolving
    - Crude slate, demand, scrubbers, alternative fuels, refinery capacity
  - Uncertainties will remain to and through 2020
- Immediate 100% implementation / compliance unlikely
  - Market strains – impacting crudes and all products not just marine
  - How IMO handles implementation important factor
    - Countries that have ratified Annex VI represent 96% of vessel tonnage
    - But over 100 countries have not ratified Annex VI and they possess 15 mb/d of refining capacity, plus 34 mb/d of refining capacity is inland
- Investment is needed for longer term resolution of the market
  - Refineries, ships (scrubbers), alternative fuels / LNG – ships and shore
  - The market will adapt but strains may linger
- Developments/dimensions can be tracked and evaluated

Questions?

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