Ship Efficiency by STG

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The Changing Face of Marine Fuels and The Effects on Ship Operators

Keith Forget
Manager, Marine Technical Solutions Centre

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The Fuel Purchaser's Dream

Fuels that meet ISO 8217:2005 will meet all my requirements and guarantee trouble free operation

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"Challenges" to ensure that fuel oil quality meets customers' expectations

- Sometimes fuel suppliers and/or customers only see Tables 1 and 2 of ISO 8217:2005 as the specifications.
- With the exception of DMX, DMA and DMB, there is no measure of ignition and combustion performance in ISO 8217:2005.
- Section 5 of ISO 8217:2005 is often ignored or overlooked or misunderstood.
- Section 5 of ISO 8217:2005 is difficult to test for.

There are Marine Fuels in the market that give problems whilst apparently meeting ISO 8217 !

- Fuels that block filters
- Fuels that damage engine
- Fuels that are incompatible and form sludge
- Fuels that do not burn

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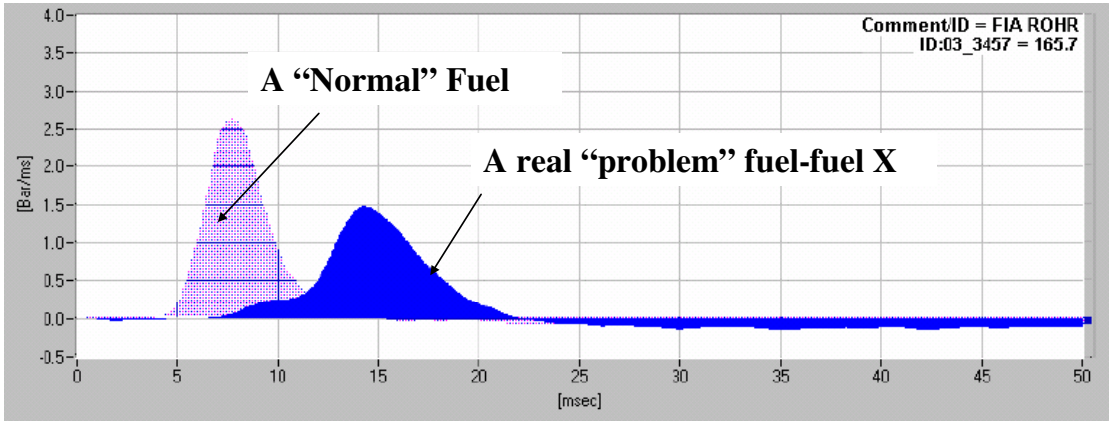
Example of a real ‘problem’ fuel, which fully met ISO 8217!



FIA CN <18.7 (The lower limit of the instrument at that time)

FIA (first version)

Piston of engine running on problem fuel

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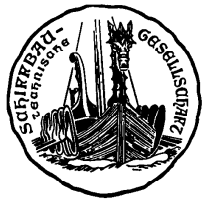
How to Control and Check for each of these Key Fuel Properties?

KEY FUEL PROPERTY	CONTROL
Stability	**?**
Flash Point	Certificate of Analysis
Al+Si	Certificate of Analysis
Ignition & Combustion	**?**
Density	Certificate of Analysis
Viscosity	Certificate of Analysis
Sulphur	Certificate of Analysis

Changing Environment

- Growing energy demand
- More demand for diesel in the EU
- Reduction of sulphur content of distillate fuels
- Increasing use of low sulphur crude oils and components
- Move to cleaner fuels, e.g. natural gas, distillates
- Increasing environmental pressures on international and local marine



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Changing Environment

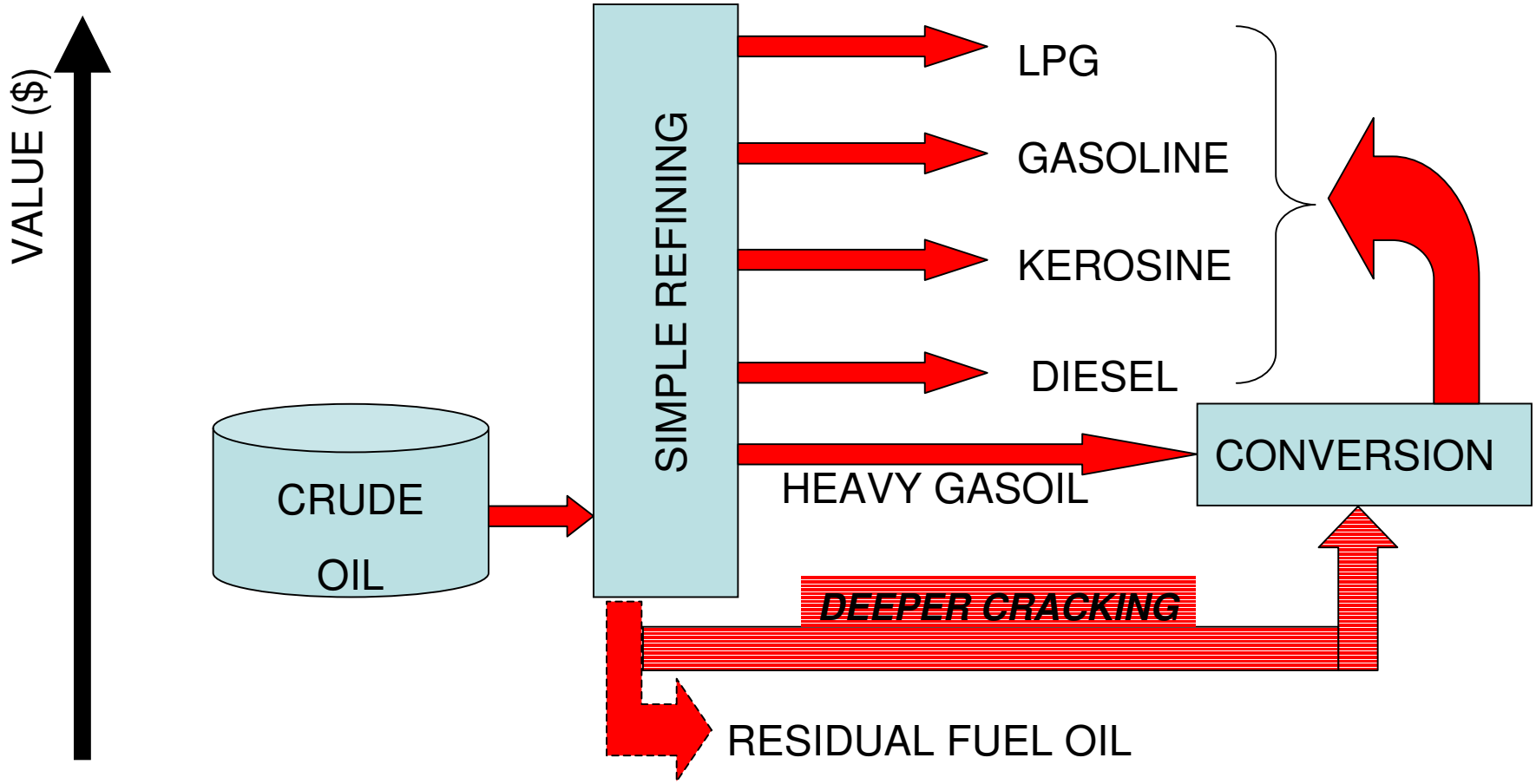
…leading to…:

1. More severe processing of refinery streams

2. Increasing use of ***low sulphur*** import streams, crudes ***and blending*** components

3. More complex vessel operations to comply with low sulphur emission legislation - *maybe*

1. More Severe Processing of Refinery Streams



Deeper conversion / cracking of the residue increases the aromaticity of marine fuel oil and affects its ***stability, ignition and combustion*** quality!

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2. Increasing Use of *Low Sulphur* Import Streams, Crudes *and Blending* Components

The increasing use of:

- ***low sulphur*** import streams,
- ***crude oils*** and
- ***blending*** components

to produce low sulphur marine fuels increases the likelihood of:

- ***incompatible fuels***, thereby affecting the ***stability*** of residual fuels onboard ship unless stringent storage and handling procedures are followed.

Managing Fuel Compatibility Onboard

- **The Shell Spot Test Kit allows vessel operators to determine the compatibility of onboard fuels.**

- If the fuels are compatible: treat as normal.
- If the fuels are not compatible the changeover needs to be carefully managed. E.g. run the Settling and Service tanks to low levels before introducing the new fuel.

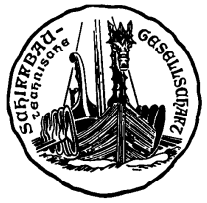
3. More Complex Vessel Operations

Options to comply with low sulphur emission legislation:

- **Switch to 100% Distillates or Low Sulphur Bunkers**
  - ❑ If operating entirely within the SECA or no other alternatives feasible **??**
- **Use and On Board Management of different Fuel Qualities**
  - ❑ If tank configuration allows, segregate High Sulphur and Low Sulphur fuels
  - ❑ Use gasoil to navigate or blend on board within SECA's
- **Burn High Sulphur Fuels and Clean up Exhaust Gases**
  - ❑ Commercially proven abatement technology required
  - ❑ Currently no offset trading of emissions to support investment
- **Burn High Sulphur Fuels and Buy Emission Credits**

Preferred option of vessel owners/operators is determined by various factors

- **Corporate global strategy of the vessel owner / operator**
- **View on Low Sulphur – High Sulphur premium, medium- and long-term**
- **Trade pattern: frequency, duration, predictability in SECA**
- **Existing Configuration of fleet bunker tanks**
  - ❑ Retrofitting has a cost & availability impact
- **Availability of an approved and commercially proven abatement technology**



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Operational Issues for Vessel Owners/Operators

- **Scheduling:**
  - ❑ Managing LSFO inventories through complex voyage patterns
  - ❑ Fuel switch-over procedures when transiting in/out SECA
- **Fuel Quality:**
  - ❑ **Compatibility** risks from onboard mixing of High Sulphur and Low Sulphur fuels
  - ❑ Potentially lower **combustion/ignition** quality of Low Sulphur Fuel Oil, depending on source
- **Lubrication:**
  - ❑ Potential requirement for handling two cylinder lubricants on vessels fitted with low speed engines

Marine Fuel Quality - Ignition

Overview of Shell R&D on ignition quality of marine fuels

- **First investigated by John Lamb with Shell Tankers in 1937**
- **CCAI development by Zeelenberg (1982-3)**
- **Fuel ignition testing in the "Bomb" by Stassen (early 1990s)**
- **Further R&D on CCAI algorithm by Schenk (1997-8)**
- **R&D based in the FIA started in 2002**
- **CIMAC 2007 (Vienna) –** Paper No. 198
  "The effects of a changing oil industry on marine fuel quality and how new and old analytical techniques can be used to ensure predictable performance in marine diesel engines"

Fuel Ignition and Combustion Analyser

FIA-100FCA (method IP 541/06)

- Considers physical-chemical properties of fuel in ignition & combustion
- Constant Volume – Reference temperature 500°C and Air pressure 45 bar
- Bosch single nozzle injector: 375-400 bar
- Injection temperature: 25-140°C
- Injection time: ~3 ms

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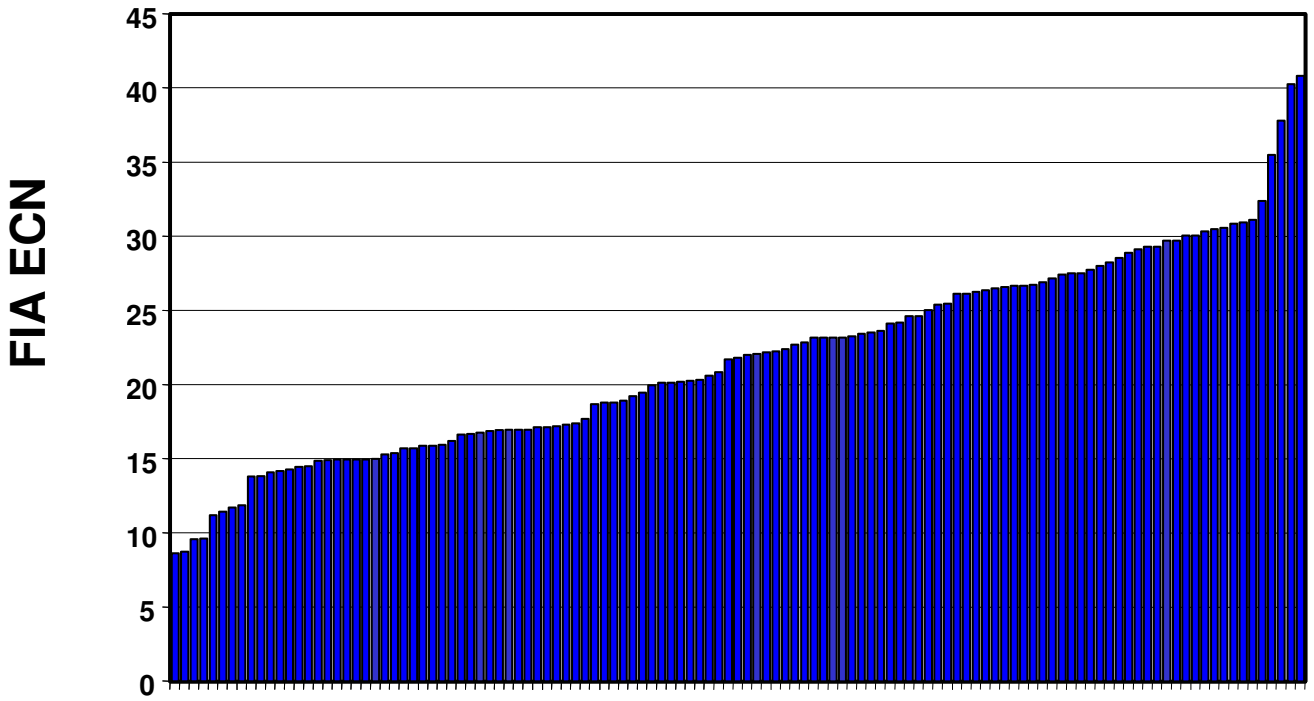
Marine fuel oils have a wide range of ignition quality

Ignition quality (FIA ECN) of >100 commercial marine fuels that meet ISO 8217



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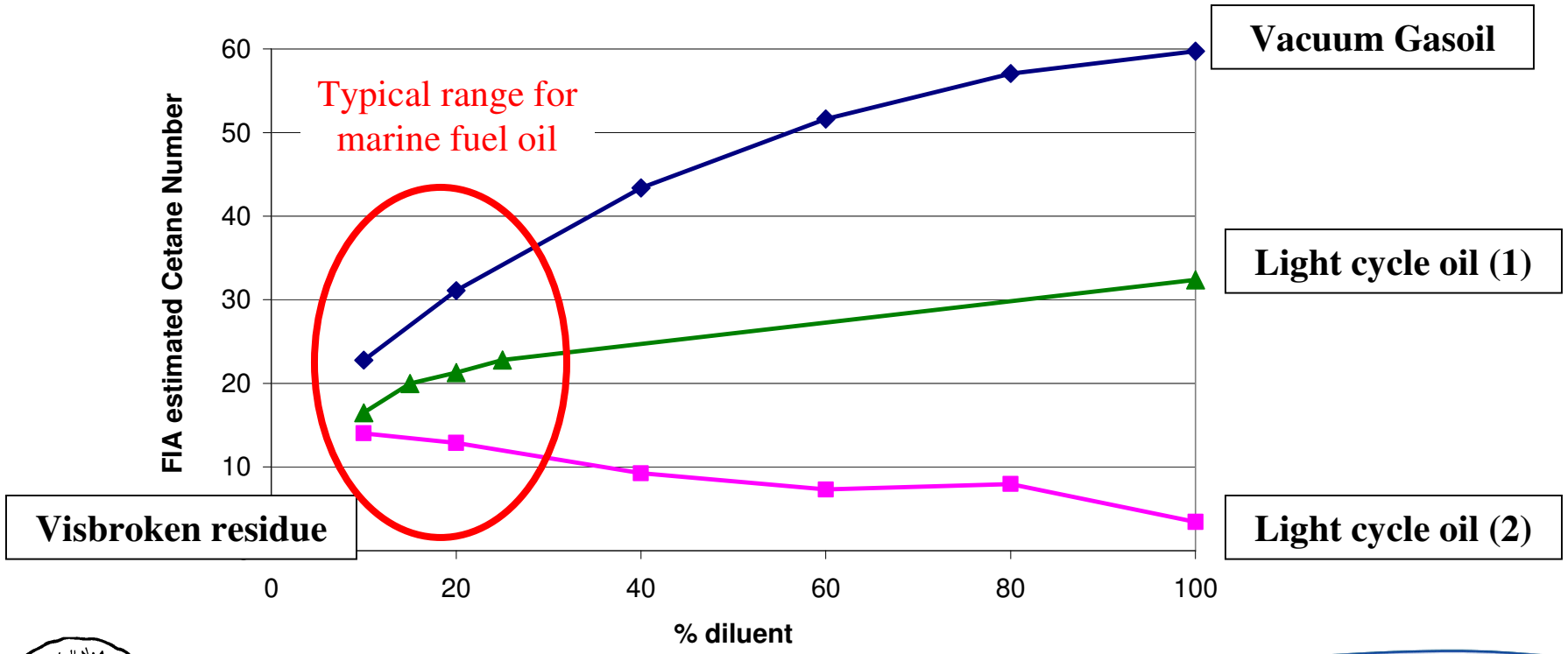
Composition is a major factor in determining the ignition and combustion performance of residual fuels

Example 1. Effect distillate component on the ignition quality of the same visbroken residue



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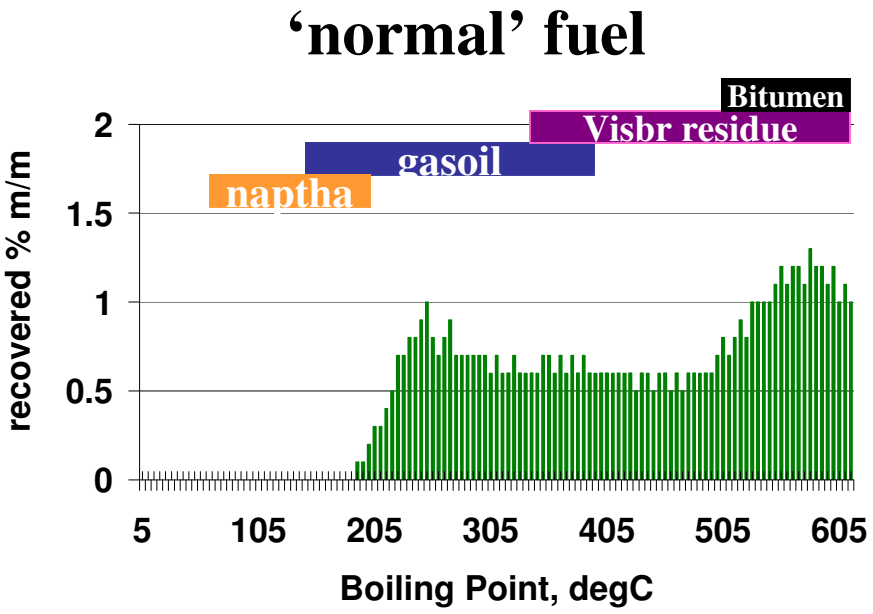
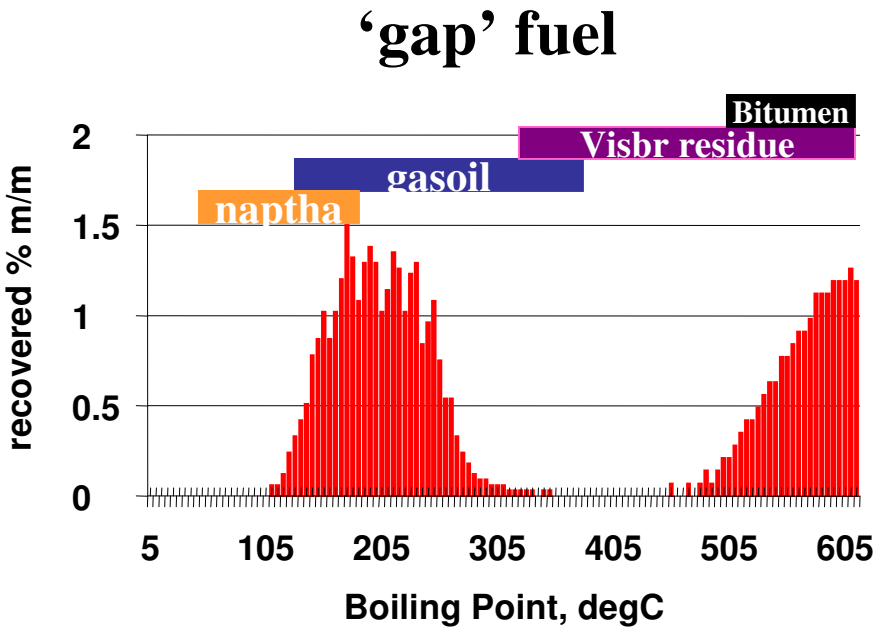
Composition is a major factor in determining the ignition and combustion performance of residual fuels

Example 2: Boiling point distribution of residual fuels





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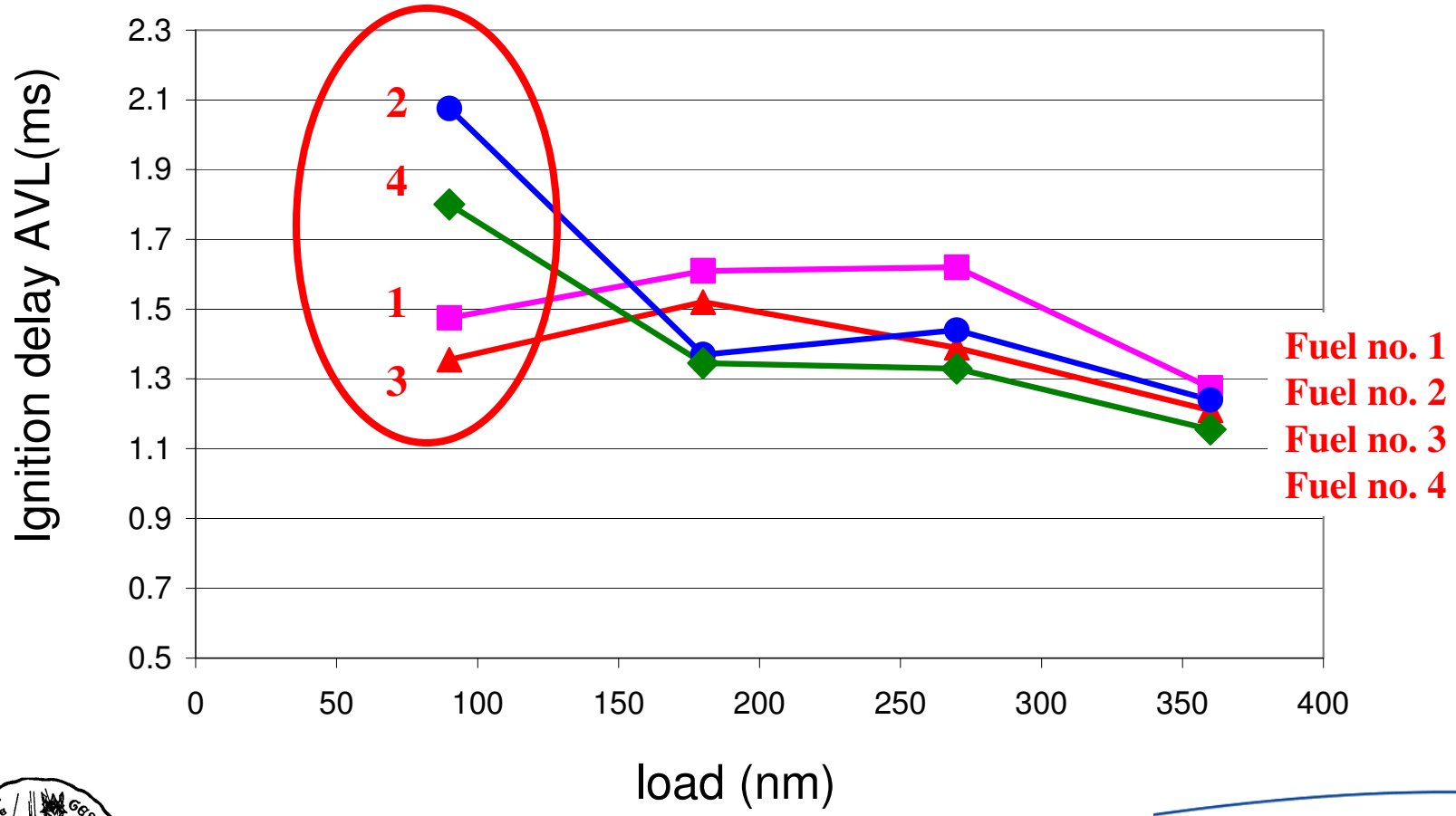
Four different fuels show different load dependence

i.e. fuel ranking on basis of ignition quality changes with load



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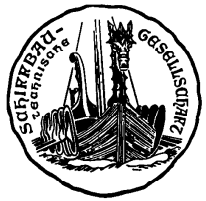
Summary of Current FIA R&D

- Work to date, carried out in our laboratory in Amsterdam and test engines in MPIC Hamburg shows that fuel ignition and combustion properties are strongly influenced by fuel composition
- Work is on-going to increase our understanding of the relationship between fuel composition and ignition/combustion properties
- FIA ignition correlates with ignition in the engine, however, it depends on engine type and engine conditions
- Current work does not show a clear relation between FIA derived parameters and the overall performance of the engine
- Currently involved in fuel testing on a full-sized marine diesel engine



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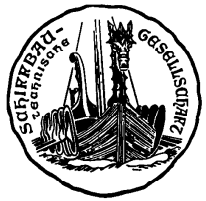
Low Sulphur Residual Fuels have poor Ignition/Combustion Characteristics

Fact or Myth?



FIA Work on low sulphur Fuels

As part of our overall fuel ignition studies a series of low sulphur fuels are being tested in:

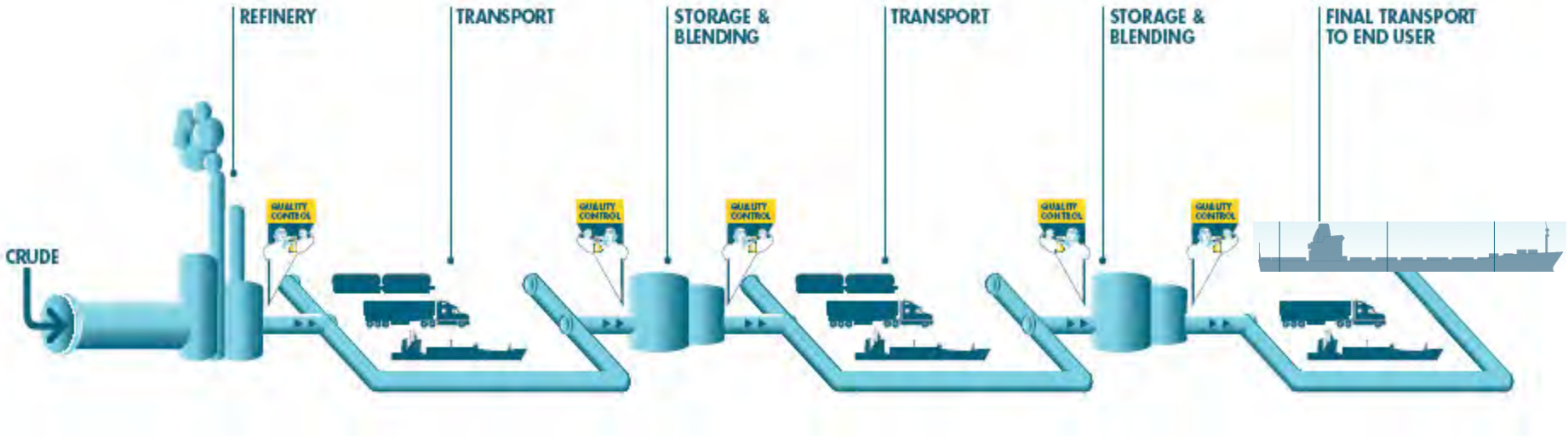
- FIA
- Full size low speed engine.
- Shell test engines

Conclusions on the Influence of Fuel Sulphur on Performance

- The sulphur content of the fuel oil has no direct influence on the ignition quality of marine fuels.
- Some low sulphur fuel oils have poor ignition and combustion qualities.
- Some high sulphur fuel oils also have poor ignition and combustion qualities
- The ignition and combustion performance of fuel oils are determined by the source and composition of the blend components

Fuel Oil Quality Assurance System

FOQAS allows us to better control the source and composition of the components used in Shell marine fuels.



FOQAS is a quality system that covers operating procedures for the COMPLETE fuel oil supply chain - starting from the manufacture through storage, transportation, up to the final delivery of the fuel oil to the vessel.

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Conclusion

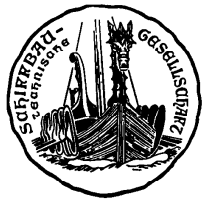
Understanding and controlling of Marine Fuel ignition and combustion quality requires access to a large database with:

- Physical and chemical properties
- FIA properties
- Compositional data and origin

Why do we continue investing in Marine Fuels Quality Management and R&D?

- To ensure that Shell marine fuels are **fit-for-purpose**
- To take the **risk out of bunkering**

Thank You



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