Marine Fuels

Presentation to

The Nautical Institute

November 2007

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1. Update on Environmental Legislation
2. Compliance with Regulations – Bunker Suppliers and Ships
3. Scrubbing Technology
4. Implications of using LSFO – Technical

1. Update on Environmental Legislation

The implications of Annex VI - Sulphur oxides (SOx)

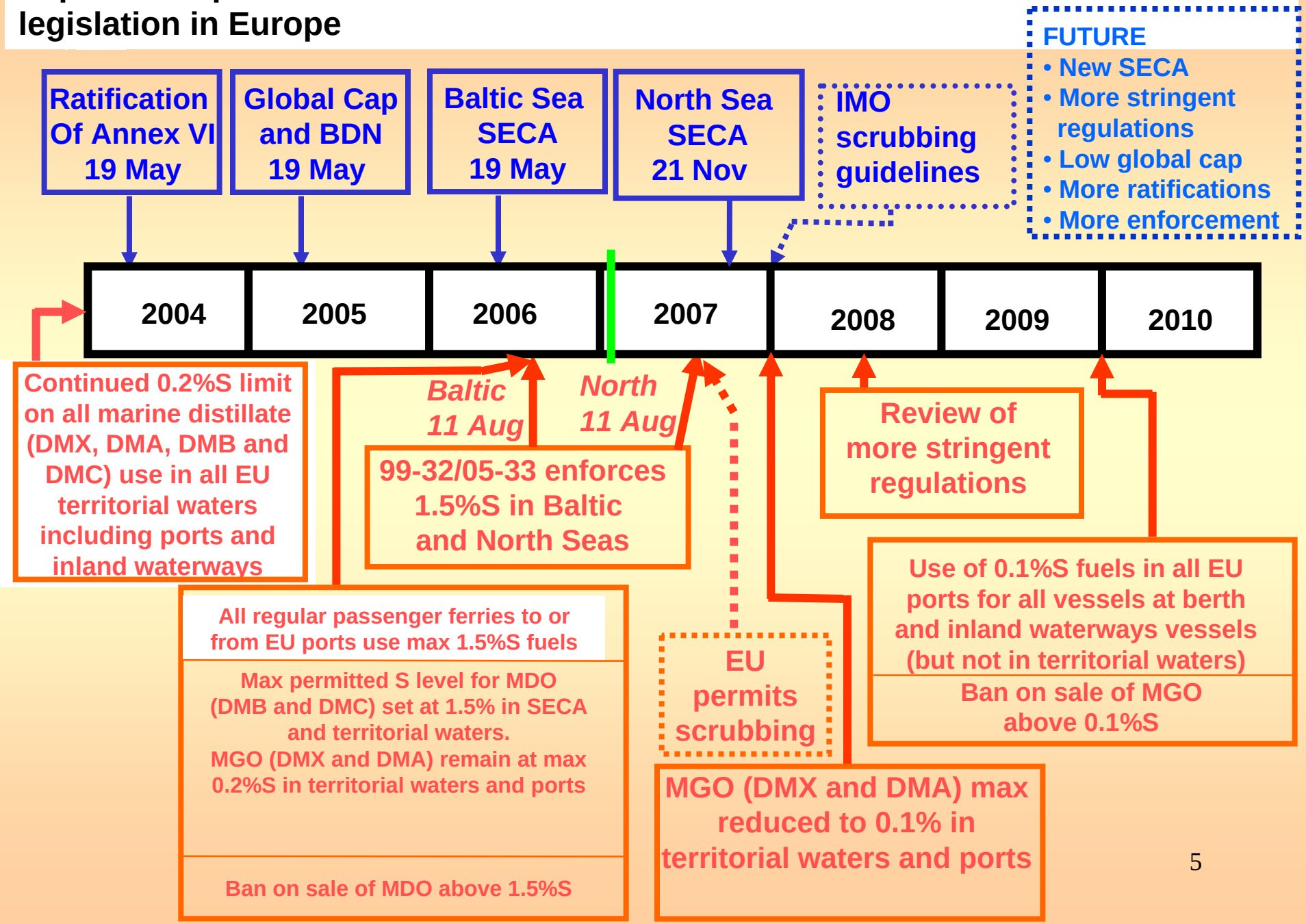
- A global sulphur limit of 4.5%S with proposals to reduce this limit

- Specification of 1.5%S in SOx Emission Control Areas (SECA)
  - Only the Baltic Sea is included in the Annex VI, but there is agreement that the North Sea will be implemented within a year later

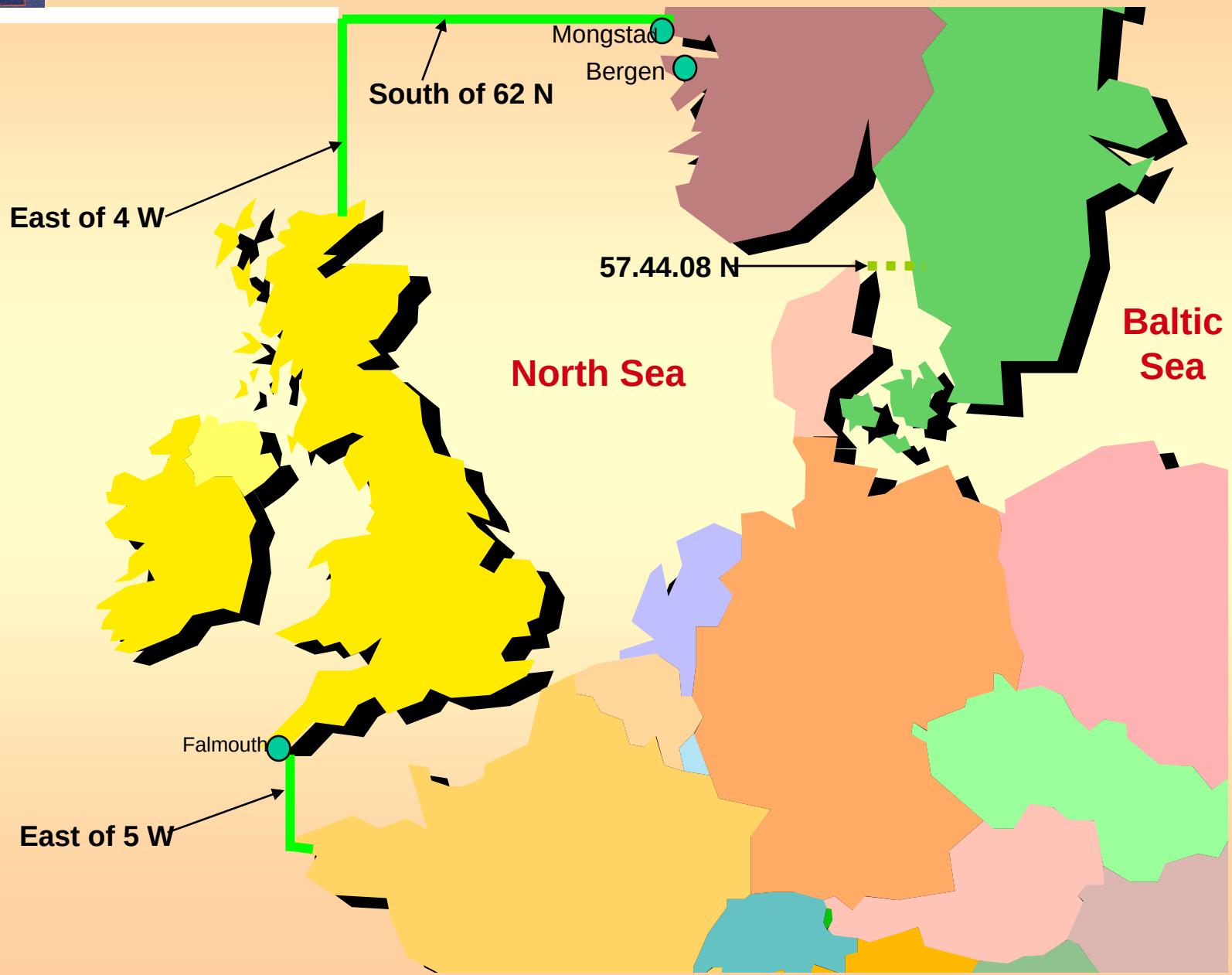
- Exhaust Gas Scrubbers are NOT excluded from use in a SECA and are specified to reduce emissions to 6.0 g SOx/kw hour which is equivalent of 1.5%S fuel – the details of the specification are currently being refined by IMO

- Issuance of Bunker Delivery Note (BDN) with every delivery
  - Copies of the BDN and fuel samples to be retained by the ship for one year and by the supplier the BDN for three
  - Compliance principally through Port State Authorities monitoring by review of the ship's log-book and reference BDN and fuel samples

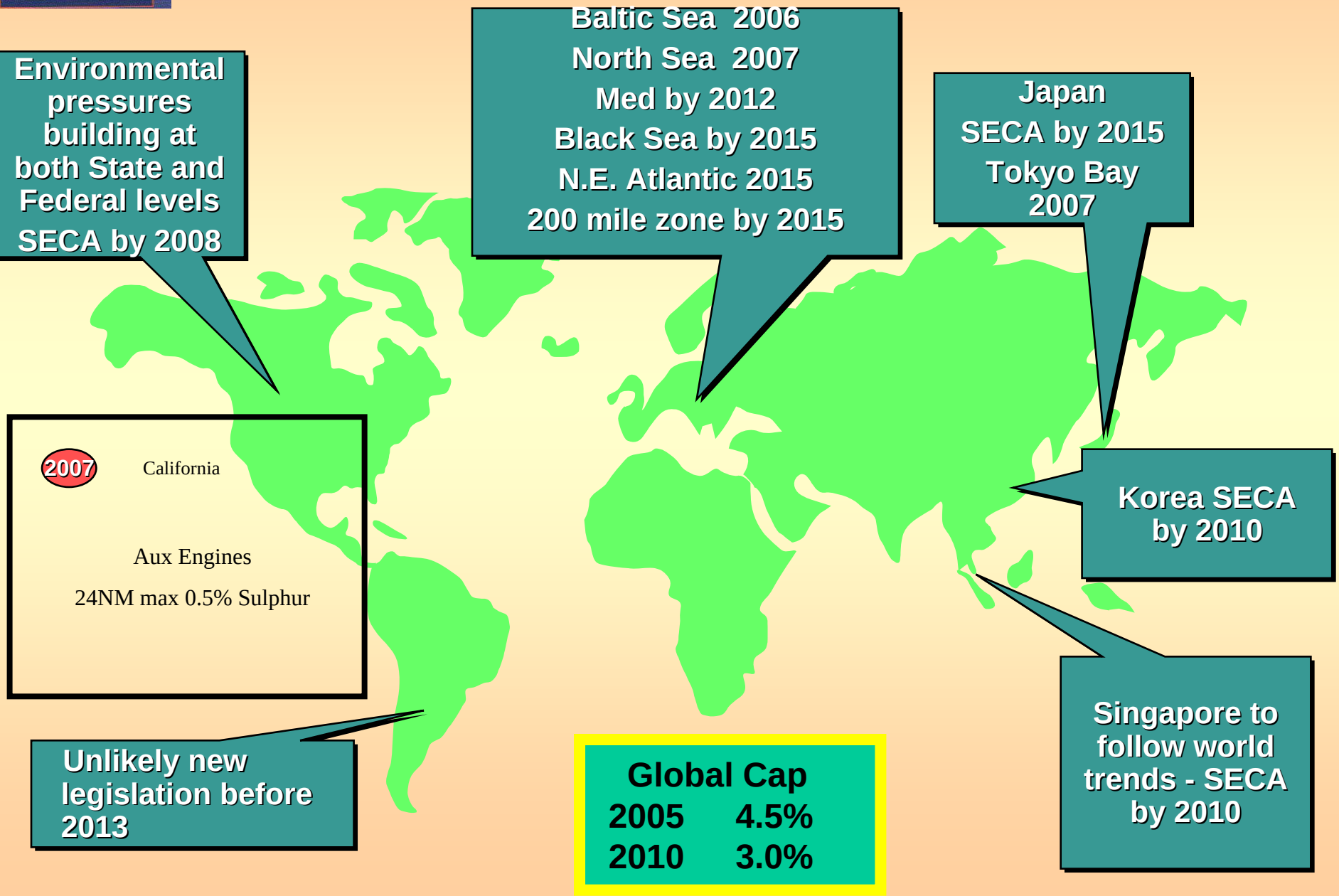
Expected implementation scenario for marine SOx emission reduction legislation in Europe



Definition of the SECA



Bunker legislation can only become more stringent – a possible scenario



EU Commission

- Pressure on IMO for action
- Mediterranean Sea – SECA
- North Atlantic SECA
- Lower Passenger vessels to 0.5% Sulphur
- Tax or charges for SOX & NOX contribution
- Shore Power
- If no action by IMO then EU regulations may be forced through.

Intertanko Position

- Paper to IMO proposing switch to Distillate fuel for consumption in all ships irrespective of vessel location.
- Claim would reduce SOX and Particulate Matter (PM)
- Some Owner support as reduced maintenance and higher energy
- Currently MDO twice the price of HFO
- Complete rethink of refinery economics
- Global supply network problems

IBIA response to Intertanko

- Would increase production of Greenhouse gas from refineries
- No current infrastructure in supply chain
- Refiners would need to convert residual fuel to coke- Huge refinery investment and many years needed.
- No need to reduce SOX on high seas
- Use alternatives such as Scrubbing, SECAS and Incentives in a more realistic approach.

2. Compliance with Regulations

The bunker delivery note is to contain the following

- Name and IMO number of the receiving ship
- Port
- Date of commencement of delivery
- Name, address and telephone number of the marine fuel oil supplier
- Product name(s)
- Quantity (metric tons)
- Density at 15^0C (kg/m^3) - fuel oil tested in accordance with ISO 3675
- Sulphur contents (% m/m) – Fuel oil tested in accordance with ISO 8754

A declaration signed and certified by the supplier's representative that the fuel oil supplied is in conformity with regulation 14 (1) or 4 (a) and regulation 18(1) of Annex VI

IMO claim that each stem must be individually tested as per the ISO tests

Compliance

- Vast majority of Suppliers issue Marpol samples
- Only Singapore complying with sampling location
- Many suppliers provide sulphur result as “less than 1.5% or 4.5%
- Suppliers not generally stating true density and sulphur content
- Demand in current SECA below expected indicating not full compliance by all ship owners
- Very little policing
- Some fuels have tested above 1.5% or 4.5% but precision of method causing some problems

Compliance

- If Supply is not compliant Captain/Chief Engineer must issue protest letter to Supplier and Port State Control (The ship's agent can arrange this)
- Protest if :-
- Bunker receipt is not fully compliant
- The supplier did not take a representative Marpol sample at the ship's receiving manifold

Compliance

- If the supplier does not issue a Marpol compliant sample – DO NOT TAKE YOUR OWN MARPOL SAMPLE
- Do take representative samples at your receiving manifold and use your Bunker Testing Service
- The best position is that the supplier agrees that all samples will be taken at your receiving manifold by continuous drip and that one of these will be the Marpol sample signed by the supplier and ship’s staff.

Compliance

To comply with SOX limits ships have a choice of burning low sulphur fuel oil in special areas

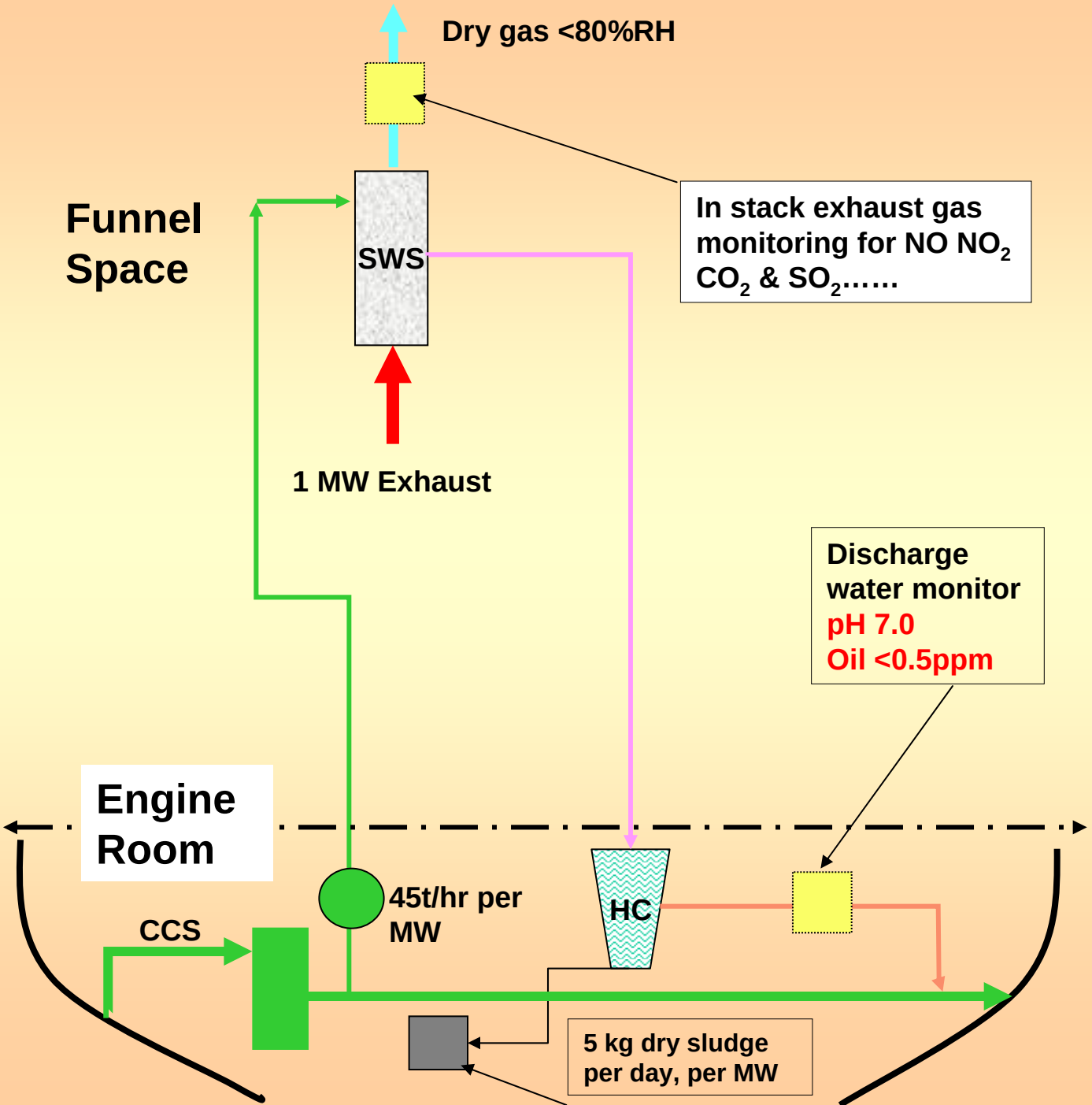
OR

Continue to use HSFO but use scrubbers to reduce the SOX

3. Status of Scrubbing Technology

First fully functional commercial installation

P&O Ferries - mv Pride of Kent


Dry gas <80%RH
Funnel Space
SWS
In stack exhaust gas monitoring for NO NO_2 CO_2 & SO_2……
1 MW Exhaust
Discharge water monitor
pH 7.0
Oil <0.5ppm
Engine Room
45t/hr per MW
HC
CCS
5 kg dry sludge per day, per MW

Scrubber Performance – real data from working unit

- SOx reduction > 99%
- NOx reduction < 5%
- Particulate reduction ~ 85% **********
- Within diesel engine backpressure envelope
- Water discharge already to IMO guidelines (from Environmental Impact Assessment by Terramare Inst + Newcastle University)
- Installed during normal drydock periods
- No unplanned stoppage since installation (five months trouble free operation)
- Zero crew intervention

Waste production

- The water treatment plant will typically produce approximately 20% of the vessels usual oily waste.
- This waste will go into the vessels normal oily waste sludge tank and will be disposed of in exactly the same manner.
- IMO already classifies this waste as “oily waste”
- It is **not** classed as hazardous waste

Design developments (Krystallon)

- Currently able to provide scrubbing to 11MW
- Commercial units now being installed
- Design being evaluated to 15 – 25MW
- Range 25MW to 50MW probably 2008
- Web based emissions monitoring

4. Implications of using LSFO - Technical

Switching from HSFO to LSFO

Best ship design would include:

* Designated LSFO primary storage tank (double bottom or wing tank)
* Two transfer pump systems (pumps and pipes) LSFO & HSFO
* Two settling tanks and two service tanks. HSFO & LSFO
* Common Purifier system
* This would permit switch over from HSFO to LSFO within one hour.

Switching from HSFO to LSFO

If you only have one service and settling tank!

- Consider how long it would take to consume the contents of the settling and service tank (HSFO) and replace with LSFO
- Remember you need to be using LSFO when you enter the SECA.
- This probably means that you need to start transfer of LSFO to the settling tank at least 48 hours before reaching the SECA

Switching from HSFO to LSFO

If you only have one service and settling tank!

- Some ships are allowing the settling tank to run down low before transfer of the LSFO
- This may be O.K. but do not allow the service tank to fall too low. Keep this full for safety reasons (Also a Classification issue)
- Remember that you may need to show the authorities your records to demonstrate that when the ship entered the SECA the engine was burning LSFO.
- Keep daily bunker tank contents records and keep the oil record book up to date.

Switching from HSFO to LSFO

Quality of LSFO

- Some LS Residual fuels (particularly those from South America and some from the U.K.) have been manufactured from LS Crude Oil and the viscosity and density may be similar to HSFO
- To keep up with the increasing demand for LS residual fuel suppliers need to take HS residual and low sulphur blend components and specially blend LSFO.
- If you have been using high viscosity Residual fuel 380-500cSt you may find that the LSFO has a much lower viscosity
- This should not present problems if your Viscometer is set to automatic.

Switching from HSFO to LSFO

Quality of LSFO

- Some Residual LSFO has been found to have poor ignition quality
- Sometimes the CCAI is found to be high (above 865) and this may indicate poor ignition and or slow combustion.
- Most large, slow speed engines are quite tolerant to fuels with poor ignition quality but if the same fuel is used in medium speed auxiliary engines problems may develop- High ring and liner wear.

Ignition Quality

- In General fuels with High density and low viscosity exhibit slow ignition properties
- CCAI is an indicator but not a perfect tool
- Some fuels have reasonable (low) CCAI but have poor ignition quality

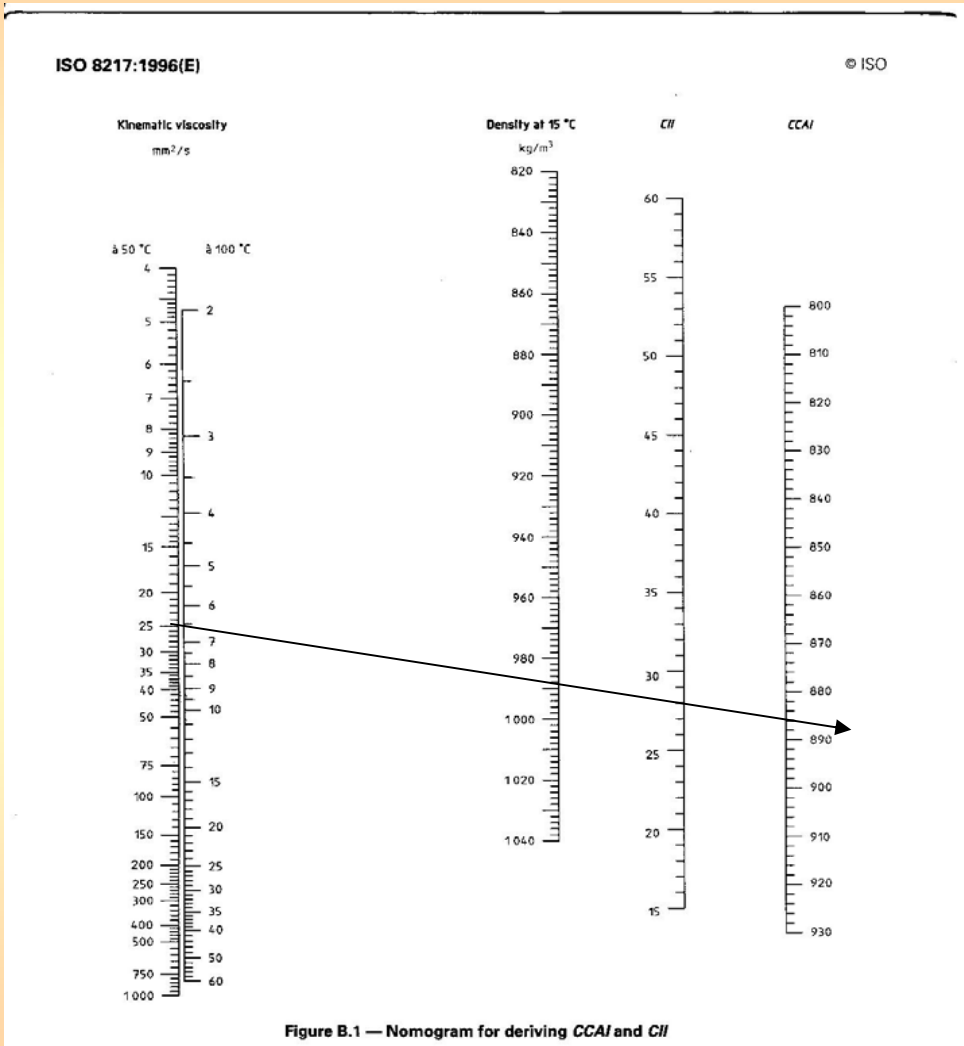


Figure B.1 — Nomogram for deriving *CCAI* and *CII*

CCAI

- Example :
- Fuel has density 991.0 & Viscosity 380cSt
- CCAI = 852 (good)
- Fuel has density 991.0 & Viscosity 180cSt
- CCAI = 860 (mod)
- Fuel has density 991.0 & Viscosity 100cSt
- CCAI = 867(poor)

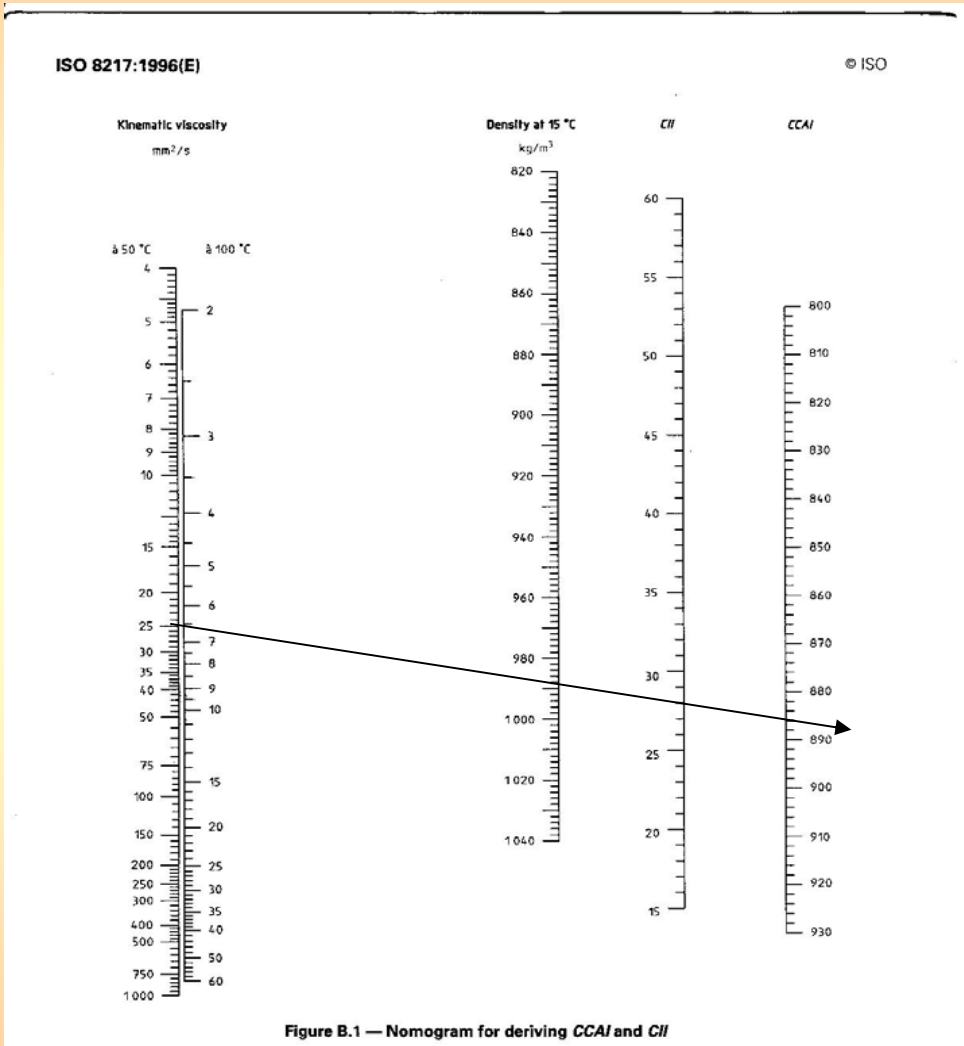
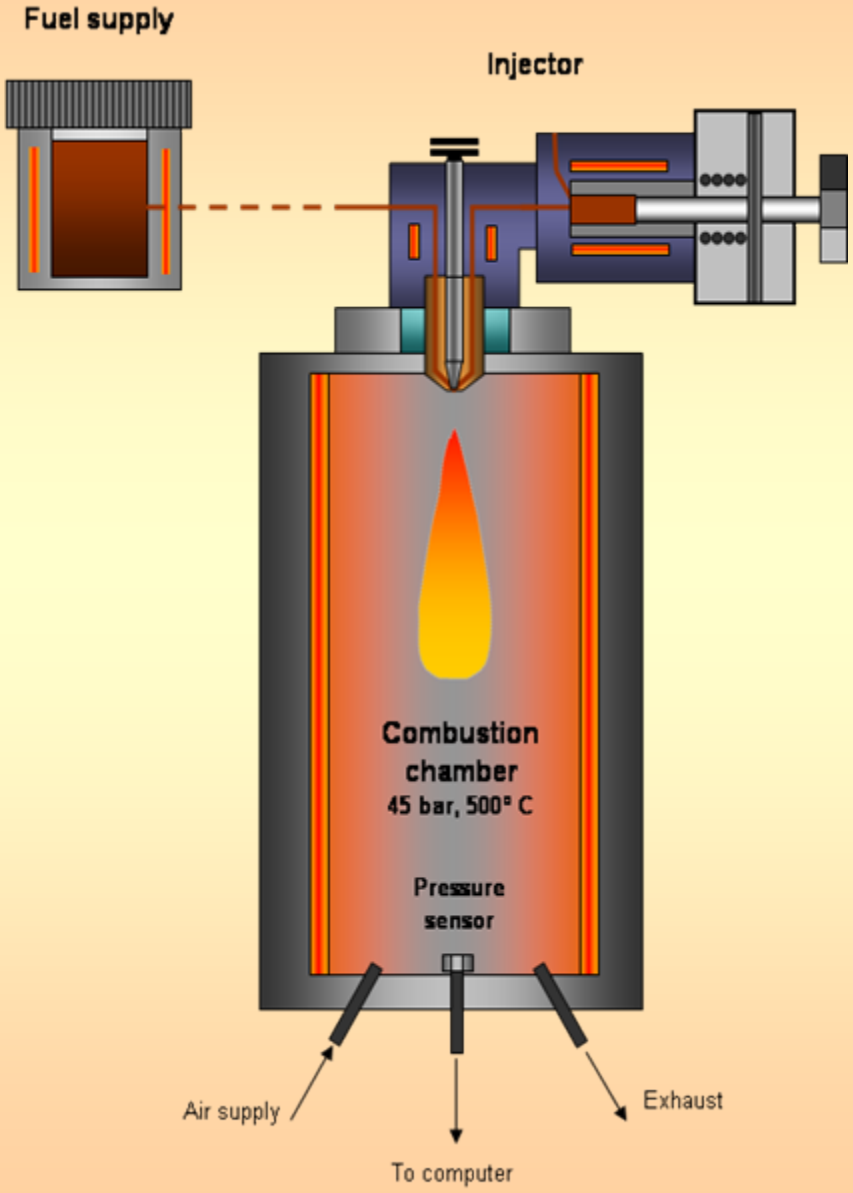


Figure B.1 — Nomogram for deriving *CCAI* and *CII*

FIA Analyser

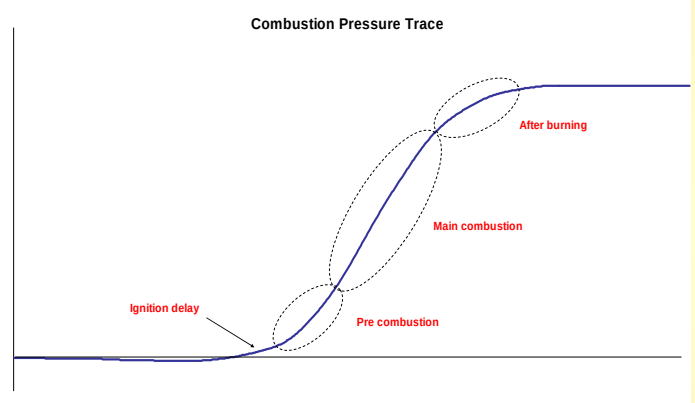
- Piece of Laboratory Kit
- Constant Volume combustion rig
- Simulates combustion
- Problem – No direct correlation to actual engine performance
- Recent arbitration accepted evidence based upon results.
- Now approved IP Test Method (IP 541. 2006)

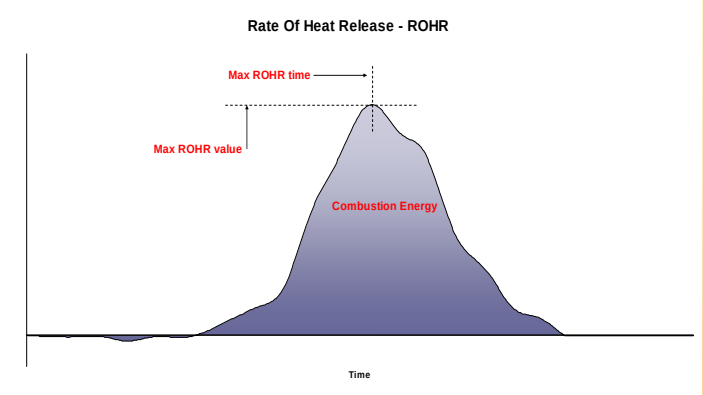
Working Principle



Output:

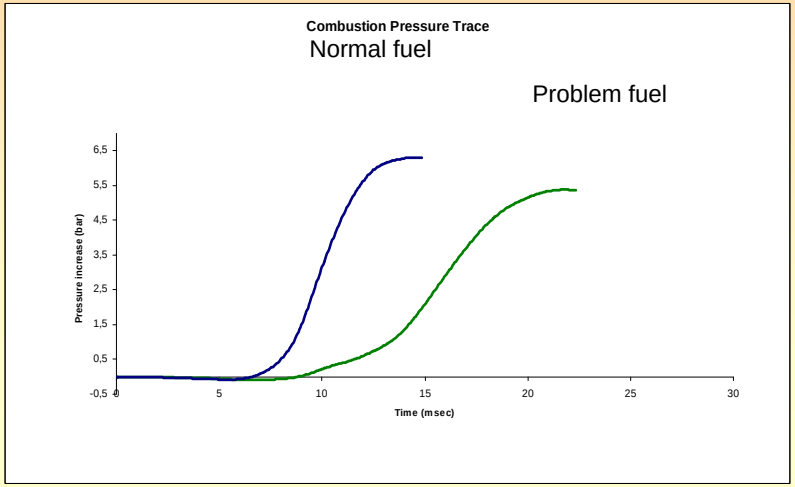
Parameters derived from Combustion Pressure Trace and Rate of Heat Release (ROHR)

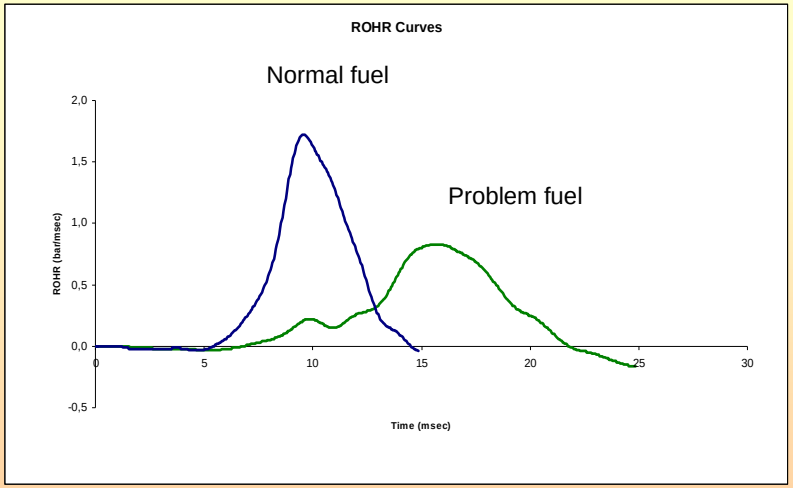




Case: Problem fuel

- Fuel properties according to ISO 8217
- Caused extensive problems for main engine
  - Reduced engine output
  - Heavy knocking at part load
  - Cylinder components needed replacement
- FIA testing shows
  - Bad ignition and combustion properties
  - Indication of dumb-bell fuel





Why use FIA ?

- If you experience engine knock or high ring and liner wear and the routine fuel testing shows everything is normal then ask your laboratory to test the Ignition and combustion quality by FIACN.
- Remenber that HSFO can also show poor ignition and combustion quality.
- Keep an eye open for fuels with lower than normal viscosity combined with high density.

Switching from HSFO to LSFO

Quality of LSFO

- Some Residual LSFO has been found to have poor stability
- This is as a result of the supplier using unsuitable blend components
- In some cases the normal tests did not reveal the problem and heavy sludge was generated in the purifiers
- Experience shows that additives do not help and de-bunkering may be the only solution
- Try running two purifiers in parallel with low throughput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Switching from HSFO to LSFO

Cylinder Lubrication

- Cylinder Lubricating Oil, for use in Slow Speed Diesel engines using Residual fuel contains an additive package designed to neutralize the corrosive tendency of the fuel due to the high sulphur content.
- The Total Base Number is guide to the alkalinity of the lubricating oil.
- When consuming HSFO it is normal to use a cylinder oil with a TBN of 70 and to follow the feed rate given in the engine maker's handbook.

Switching from HSFO to LSFO

Cylinder Lubrication

- Under normal operating conditions the engine cylinder liner will not be perfectly smooth and this is desirable as it allows the lubricant to adhere to the surface and thus provides better protection
- Some corrosion of the liner is therefore good!
- If the cylinder oil is too effective the liner becomes very smooth and lubrication is adversely affected and wear of rings and liners will take place
- Also if the additives in the lube oil are not depleted (by the acid in the fuel combustion) then these tend to deposit on piston rings and prevent proper movement resulting in wear and blow-by

Switching from HSFO to LSFO

Cylinder Lubrication

When using low sulphur fuels it becomes necessary to reduce the cylinder oil feed rate or even change the lubricant to a lower TBN.

Your engine manufacturer should give you guidance on the feed rate for cylinder oil to match the TBN

For most engines it is probably o.k. to use a high TBN oil and adjust the feed rate when the sulphur of the fuel is above 1%. Continued use of fuel with sulphur below 1% may require a switch to a lower TBN

There is a major advantage to careful lubricating oil consumption – Reduced operating costs!!