Low Load and Low Sulphur Fuel Operation on MAN B&W Two Stroke Diesel Engines

Stig Baungaard Jakobsen

Marine Low Speed – Operation

Copenhagen

Recent Service Letters on Low Load Operation

Service Letter SL09-511/MTS

MAN Diesel

Action code: WHEN CONVENIENT

Low Load Operation

10% to 40% Engine Load

SL09-511/MTS
May 2009

Concerns
Owners and operators of MAN B&W two-stroke marine diesel engines.
Type: MC/MC-C and ME/ME-

Dear Sirs

Our Service Letter SL08-501 has triggered an interest for continuous running of MAN B&W engines below 40% engine load. This service letter outlines our recommendation for MC/MC-C and ME/ME-C engine

Service Letter SL08-501/SBE

MAN Diesel

Action code: WHEN CONVENIENT

Low Load Update

Down to 40% load

SL08-501/SBE
October 2008

Concerns
Owners and operators of MAN B&W two-stroke marine diesel engines.
Types: MC/MC-C and ME/ME-C

Summary
Long-term low load operation down to 40% load is generally feasible without any engine modifications.

Dear Sirs

Generally, MAN B&W MC/MC-C and ME/ME-C engines can operate down to 40% load without any engine modifications. As an example, a 24% speed reduction can cut a container vessel's fuel consumption per travelled nautical mile in half.

Low Load Operation
Service experience

Test on a 8K80MC-C engine with Slide Valves

- Test duration: 3 days on 10% Load
- No engine load up

Conclusion

No significant change in fouling condition of exhaust gas ways

Low Load Operation
Service experience

Inspection after 1 day test

Inspection before test

Inspection after 3 day test

Low Load Operation
Service experience

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Inspection before test

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Low Load Operation
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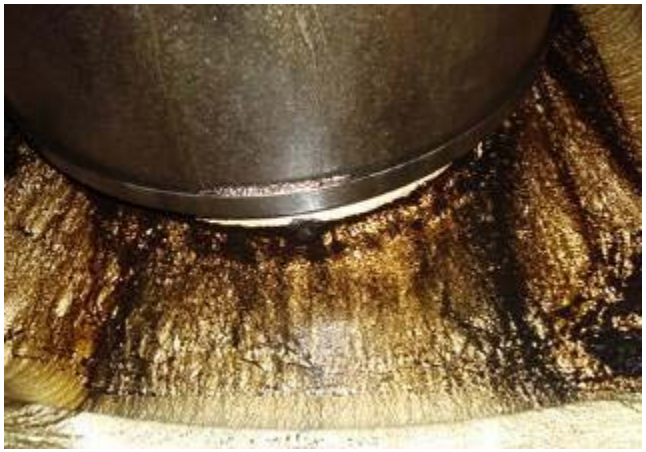

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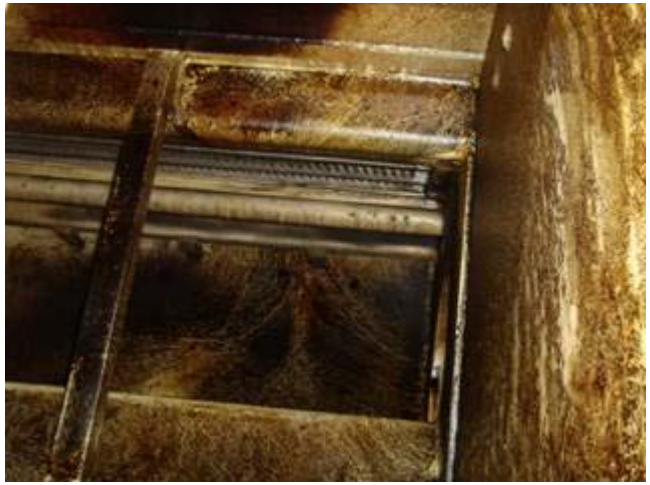
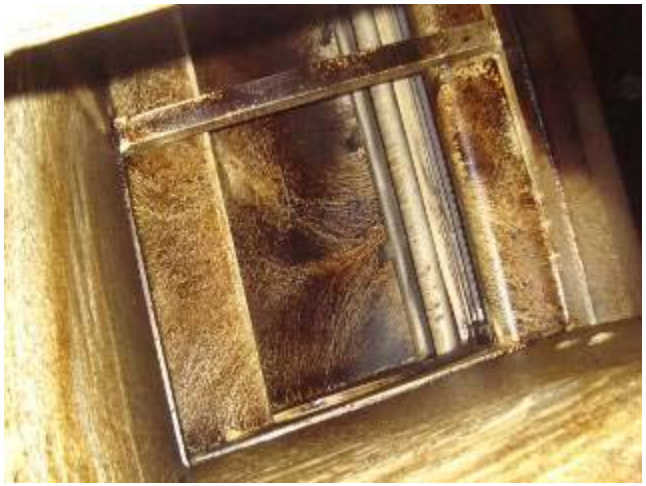
Low Load Operation
Service experience

Inspection after 1 day test



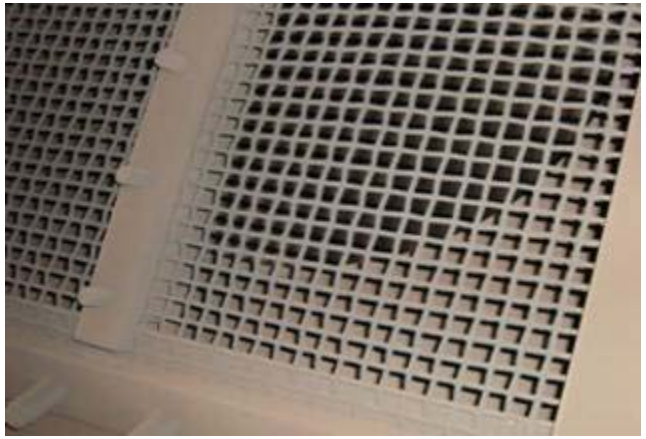
Inspection before test



Inspection after 3 day test

Low Load Operation
Service experience

Inspection after 1 day test



Inspection before test

Inspection after 3 day test

Low Load Operation
Service experience

Inspection after 1 day test

Inspection before test

Inspection after 3 day test

Low Load Operation - General Service experience

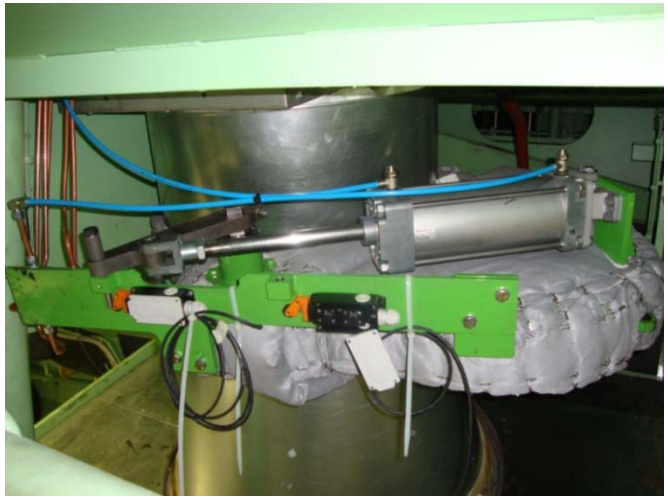
Feedback from vessels:

- Increased fouling in scavenge air receiver small
- Slide fuel valve retrofit recommended
- Cylinder oil feed rate too high → Alpha Lubricator retrofit
- Increased maintenance on auxiliary blowers → extra blower onboard
- Increased heat load on the exhaust valve spindles. Experienced in few cases related to T/C performance during low load. (30 – 40 % load)
- Exhaust gas boiler condition more or less the same
- Exhaust gas receiver condition more or less the same

Generally positive feed back on low load service and much better than expected

Low Load Operation
T/C Cut-Out: Service Experience

T/C Cut Out Valve (Compressor side)



Low Load Operation
T/C Cut-Out: Service Experience

T/C Cut Out Valve (Turbine side)

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Low Load Operation
T/C Cut-Out: Service Experience

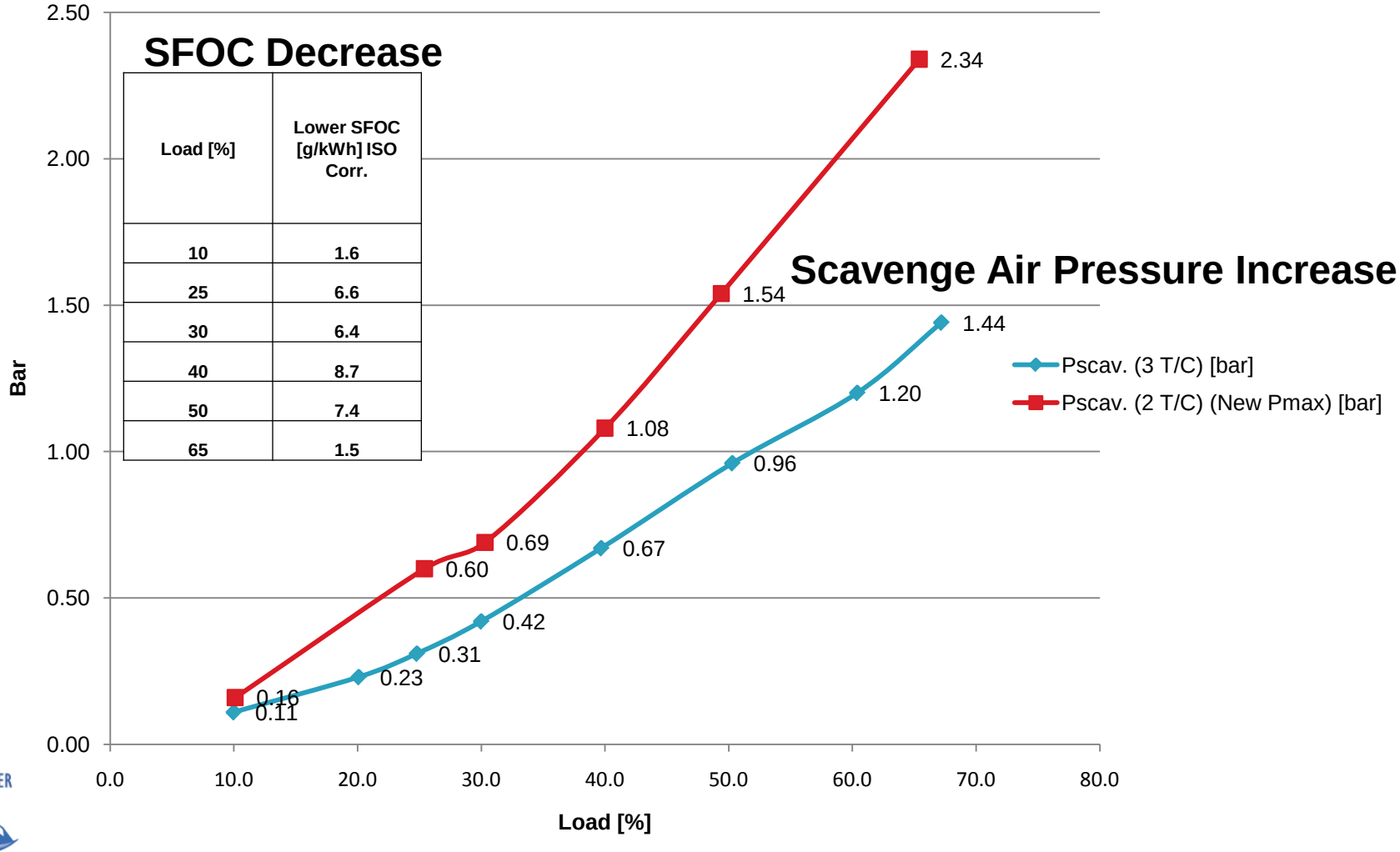
Operation of the T/C Cut-Out Valves

Indication of Valve Position

Local Operation Panel

Sealing Air for T/C

Low Load Operation
T/C Cut-Out: Service Experience



Low Load Operation – Increased Pscav
Service experience

T/C Cut-Out Feedback:

- IMO cycle value and type of engine limits potential fuel oil consumption benefit
- Bearing loads and torsional vibration issues must be checked
- Turbine out temperature can drop up to 30 degrees
- Air flow distribution in scavenge air receiver can appear uneven
- Typically 7-8 g/kWh reduction in SFOC between 25% and 50% engine load
- Low specific cylinder oil feed rate maintained at low load with increased Pscav (as opposed to the competitor)
- Stable cylinder condition maintained at low load with increased Pscav (as opposed to the competitor)

Generally positive feed back on low load service with increased Pscav

Low Load Operation – Increased Pscav
Service experience

MAN Diesel & Turbo

LS/OG/BMH/60094-2010

6 August 2010

To whom it may concern

MAN Diesel & Turbo hereby is pleased to confirm that the application of Swing gate T/C cut off technology sold by MAN Diesel & Turbo's PrimPrimeServ unit to the owner for low load efficiency enhancing will NOT impair the operation of the engine and therefore NOT call for any specific reservations in the guarantees for the engines given by the manufacturing licensees of MAN engines as well as MAN Diesel & Turbo towards the owner.

MAN Diesel & Turbo

Ole Groene
Senior Vice President

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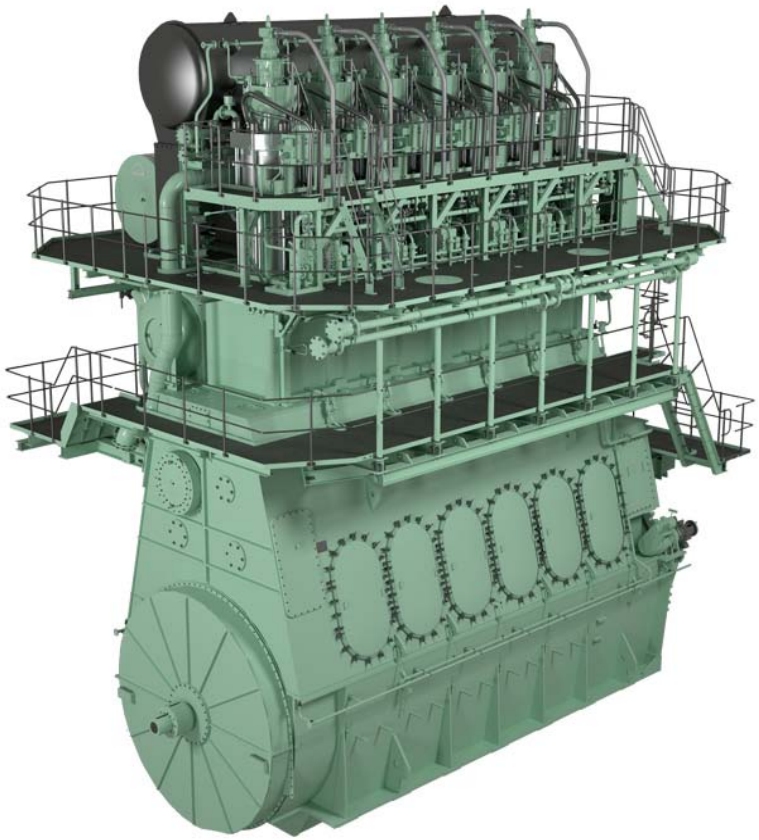
Low Sulphur Fuel Operation

2010

Fuels for MAN B&W 2-Stroke Engines

MAN B&W two-stroke engines can operate on:

- MGO
- MDO
- Low S HFO
- High S HFO
- Biofuel separate fuel spec.



The fuel should be in accordance with:

- ISO8217
- CIMAC recommendation 21

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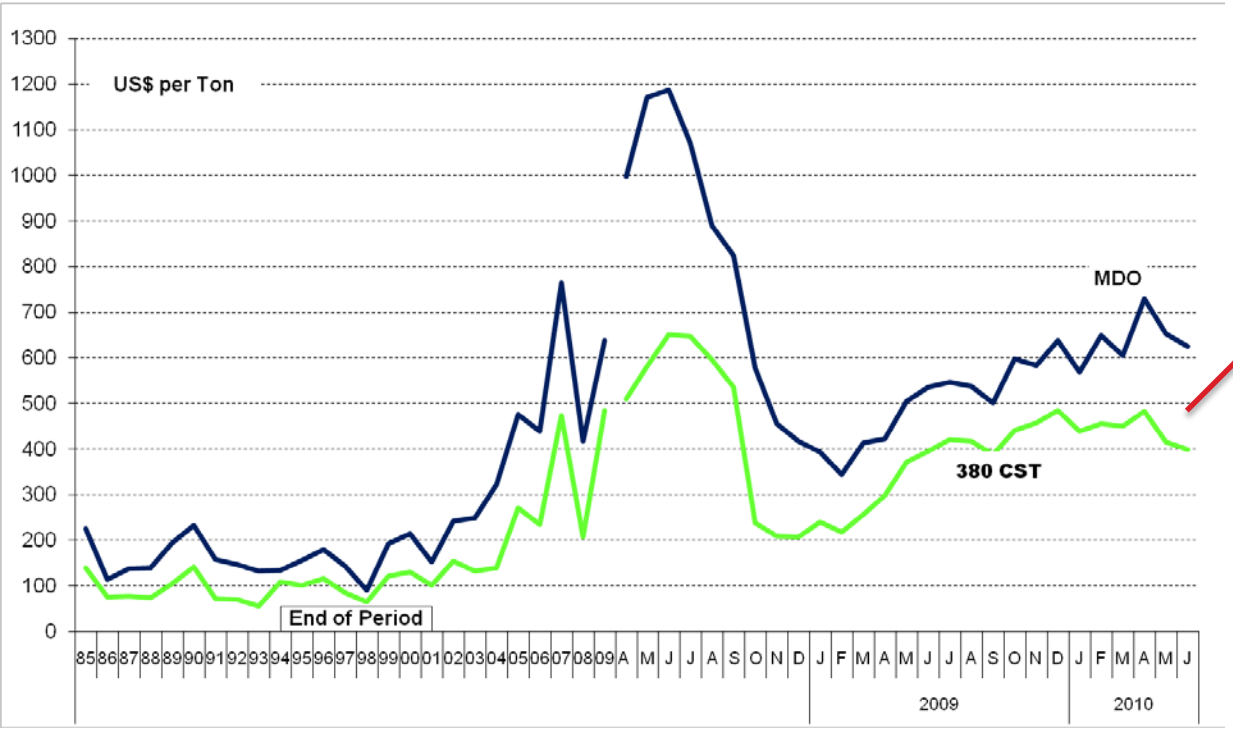
SOx Scrubbers because of:
Cost Difference - HFO vs. Distillates



Leads to more focus on abatement technology such as wet scrubbers

Low Sulphur Fuel Issues:

- Catfines in Low Sulphur HFO
- Cylinder Lubrication on Low Sulphur Fuels
- ”Design-handles” in Relation to Low Sulphur Fuel Operation
- Viscosity Issues
- Slow Burning Characteristics of Low Sulphur Fuels
- Abatement Technologies
- Gas burning 2-Stroke Engines: ME-GI

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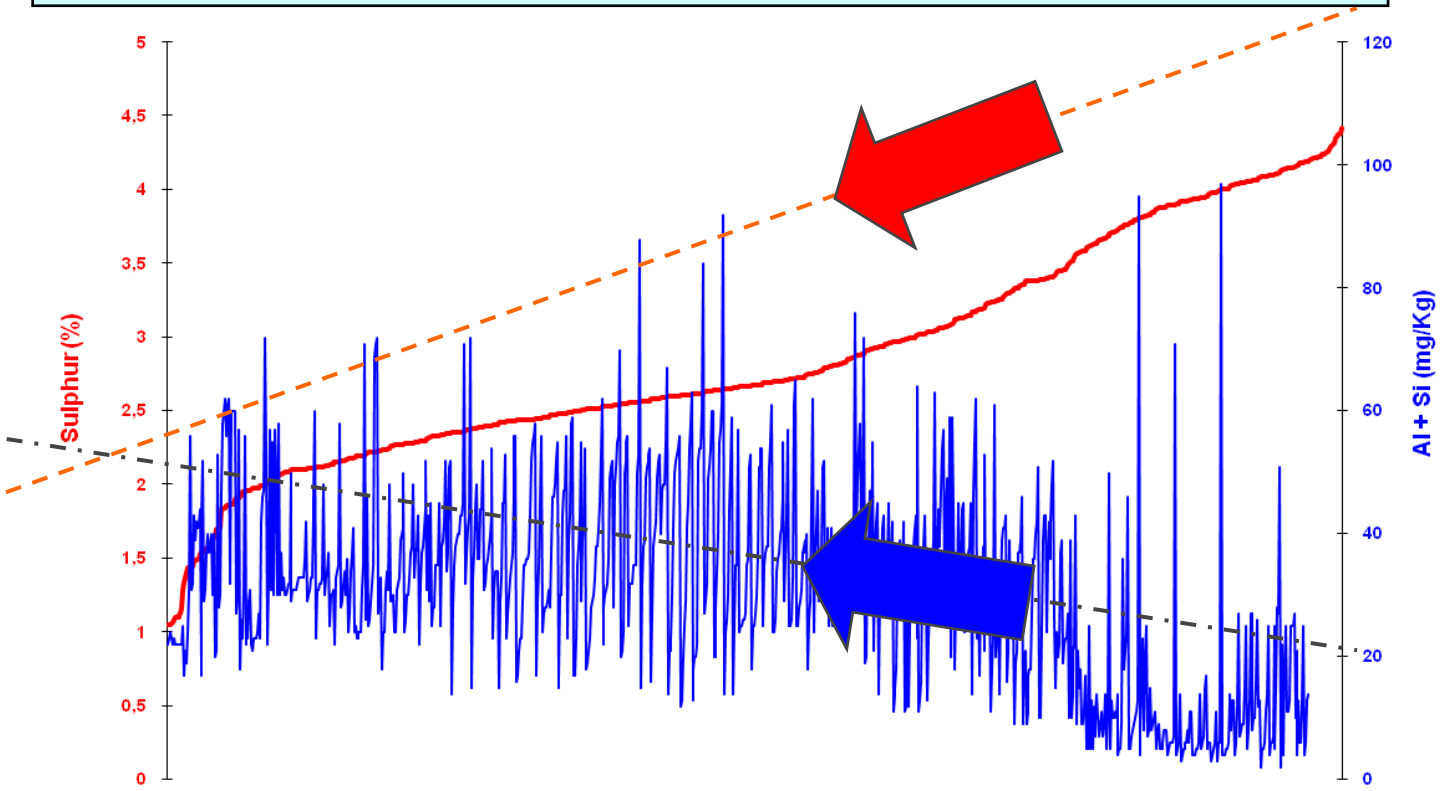
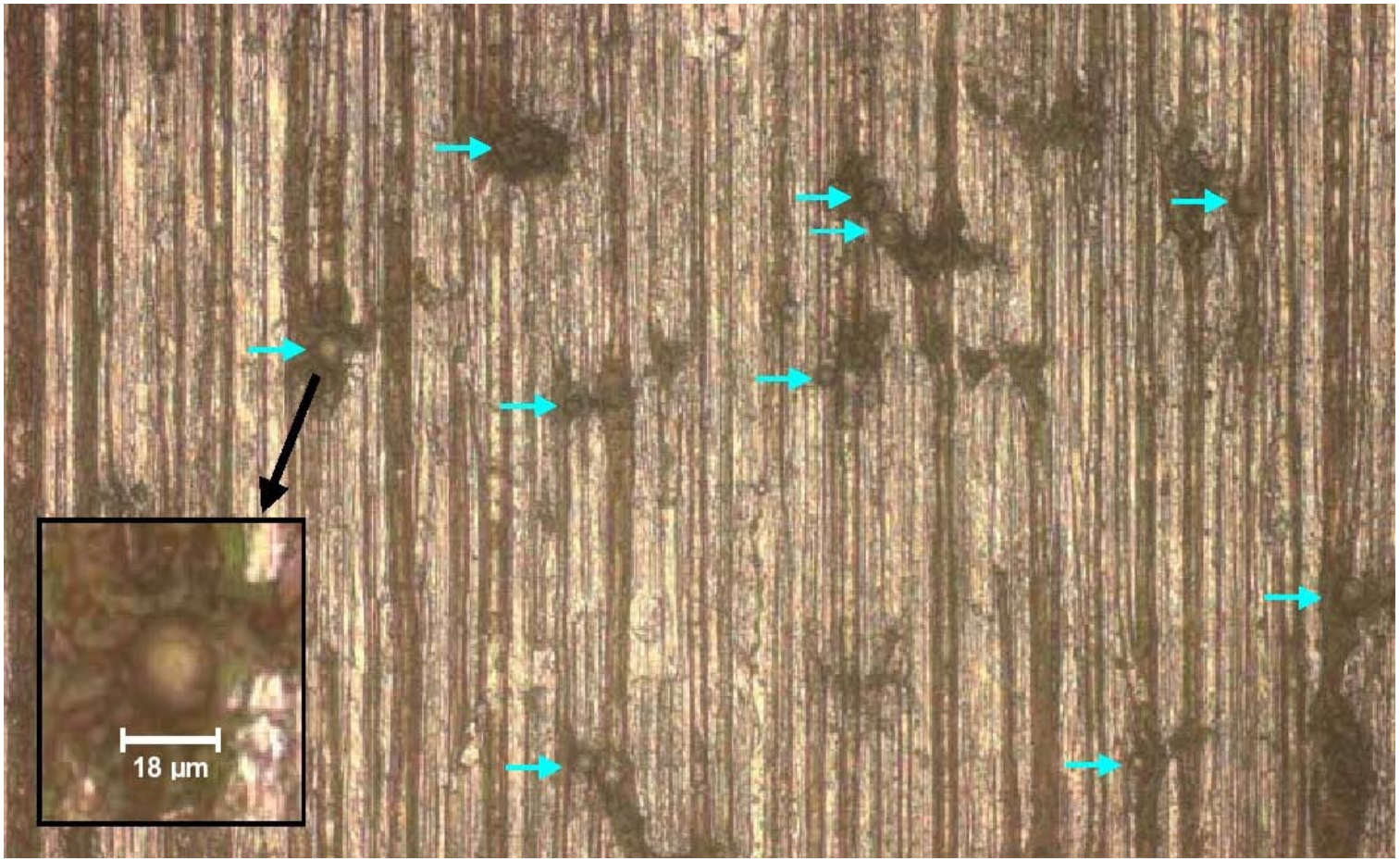
Challenges of Low-sulphur HFO - Catfines

A reduction of the low-sulphur content in HFO has seen a corresponding increase in the abrasives content

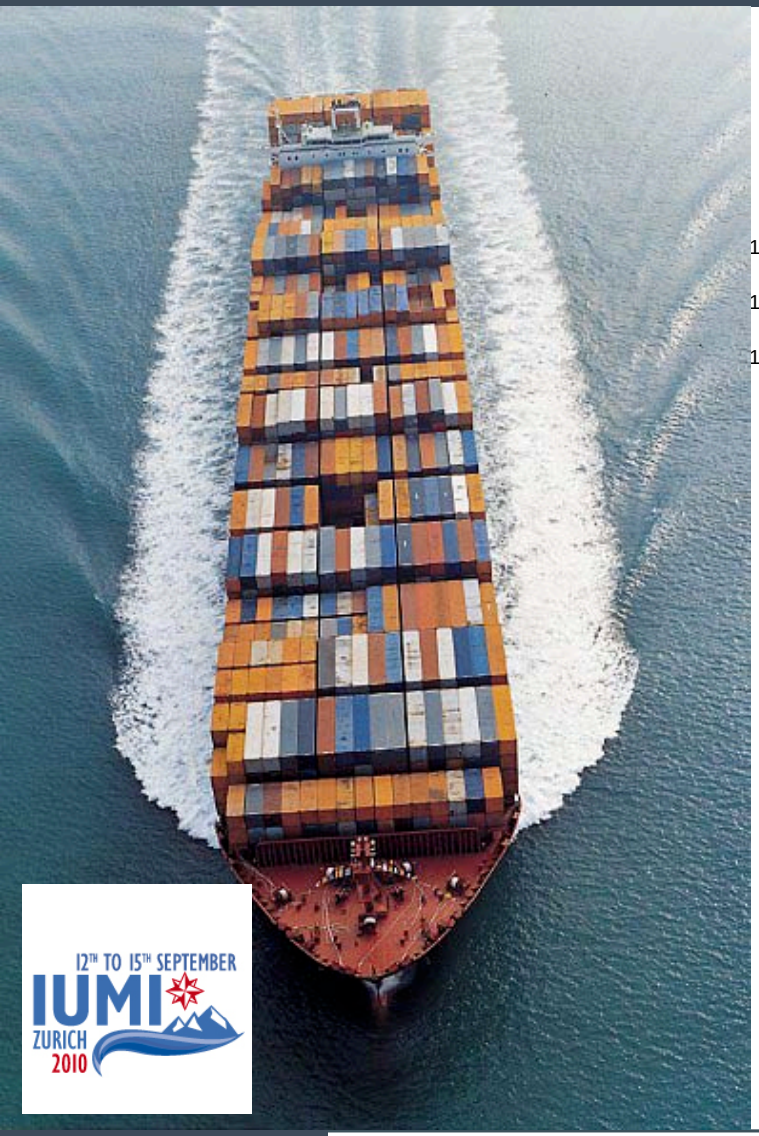


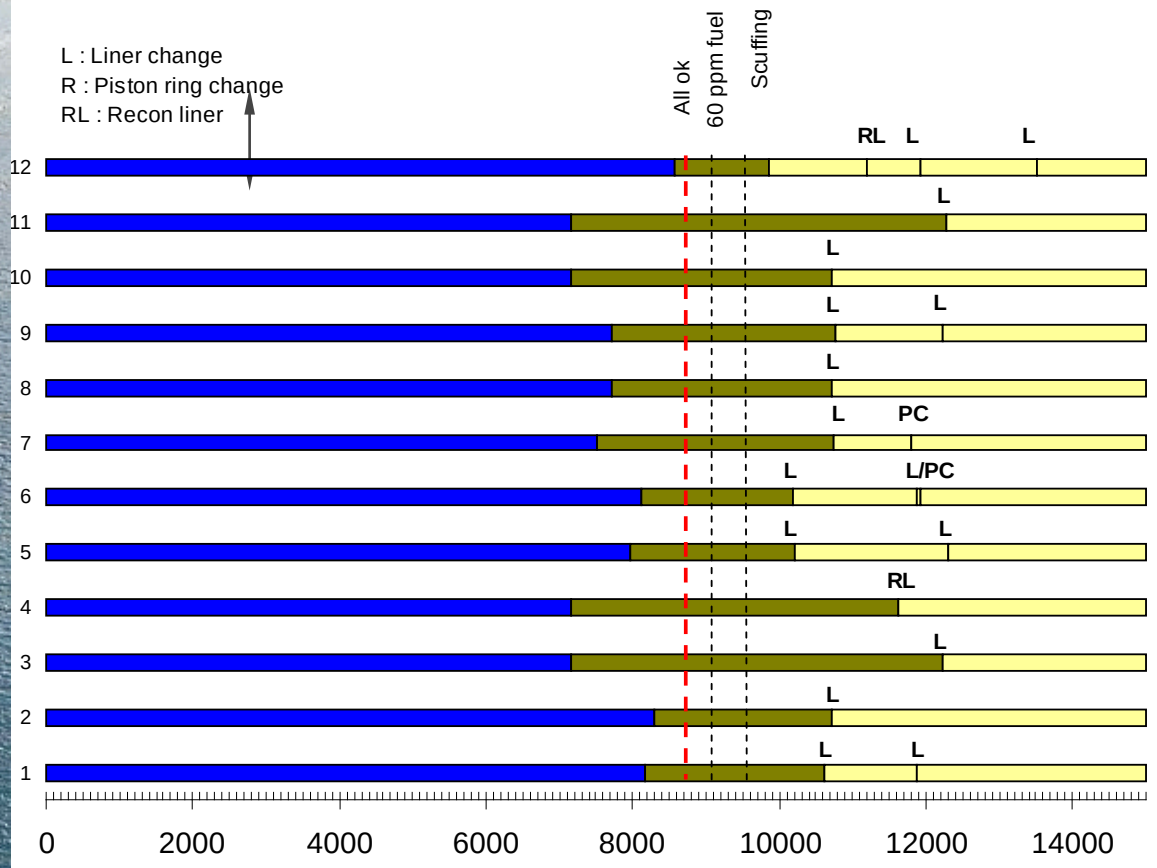
Source: DNVPS database of 1,012 analysis results (from 1 October – 10 November 2007)

Cat fines in piston ring running surface



Cylinder Condition, abrasive wear





Cylinder Condition, abrasive wear

12K98MC, Singapore 24th April 2004, 9545 hours

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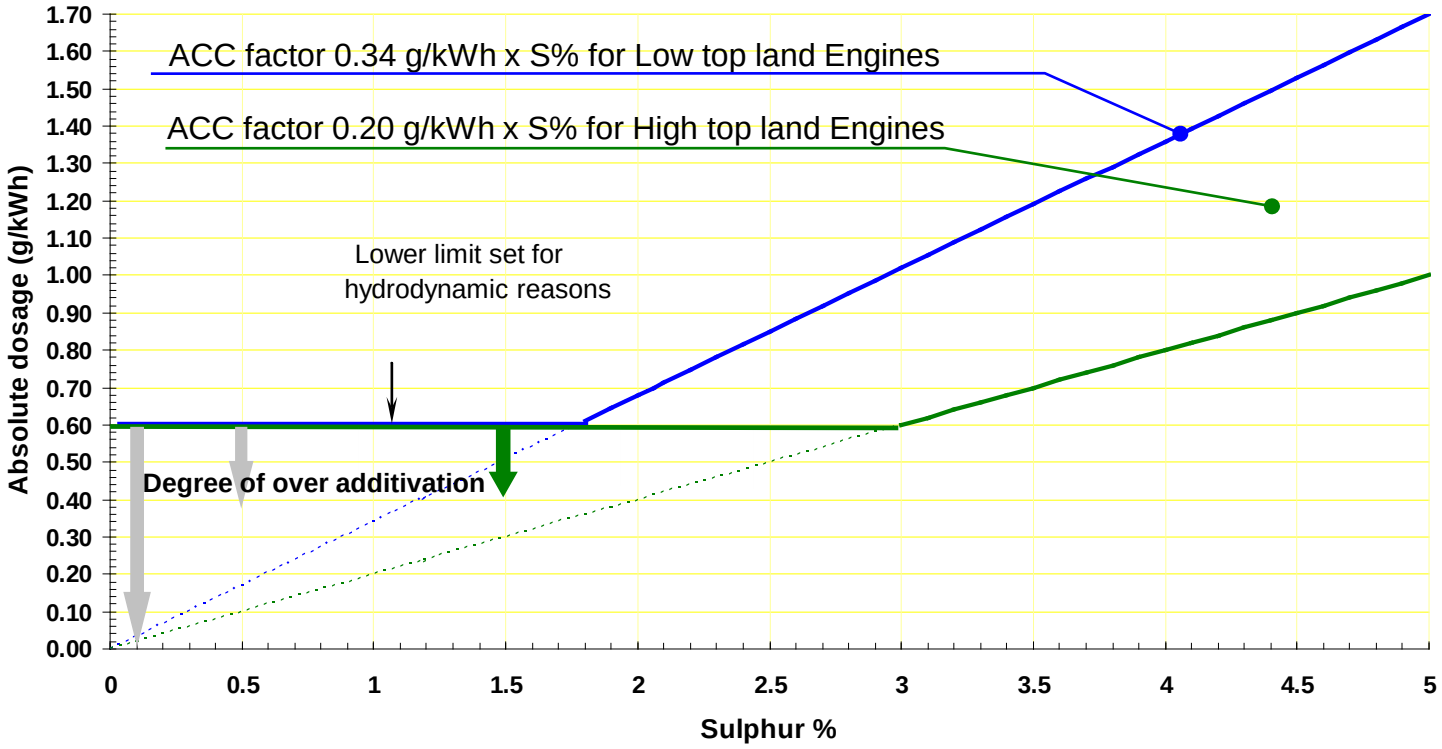
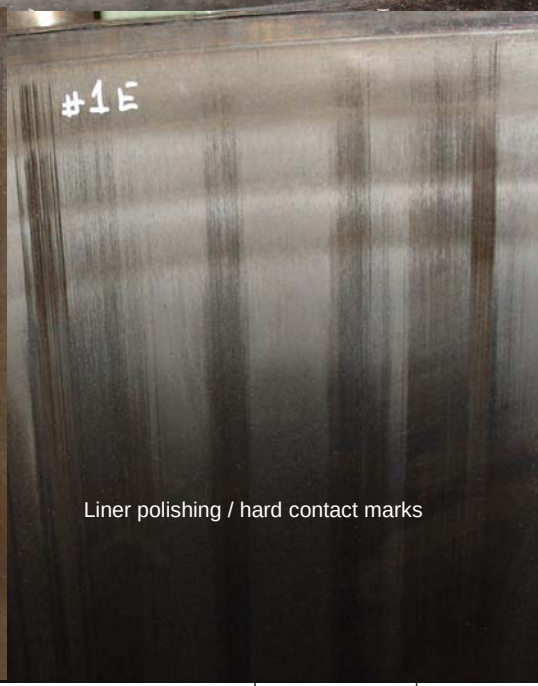
Low Sulphur Fuel Operation



Low Sulphur Fuel Operation

How does over-aditivation harm the cylinder condition?

- Over-aditivation lead to mechanical- and chemical bore polish
- Bore polish lead to micro-seizures and latent risk of scuffing
- However, this negative influence from over-aditivation is time based. Over-aditivation may be accepted in 1 – 2 weeks.
- Running more then 1 - 2 weeks in SECA area, it is recommended to change to a lower BN cylinder oil (BN40 – 50 cylinder oil)



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Cylinder Liner Surface

‘Open’ graphite structure with good tribological abilities

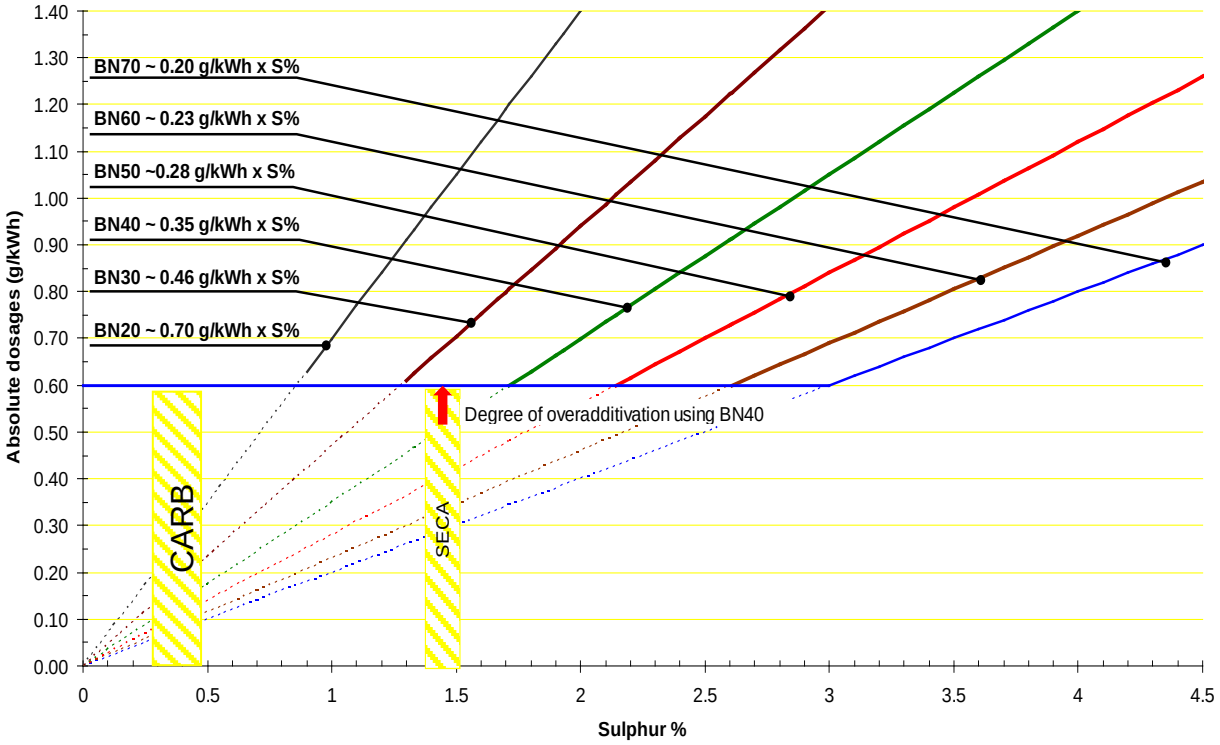
1.6 mm

‘Closed’ graphite structure with reduced tribological abilities

1.6 mm

Low Sulphur Fuel Operation

New ACC Cylinder Lubrication, feed rate factor as function of BN



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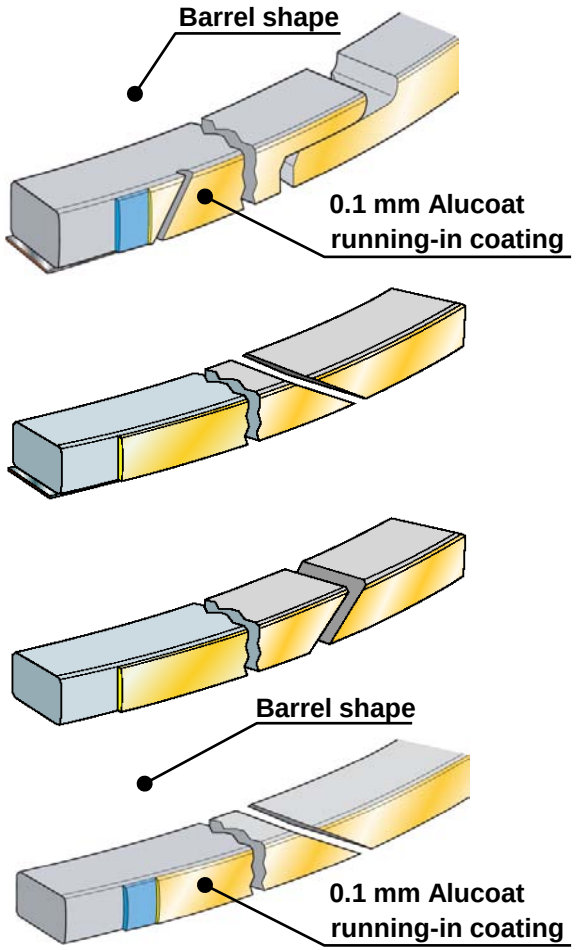
Low Sulphur Fuel Operation

1st ring:
Cl-grooves: CPR E4-180
Base material : Vermicular cast, CV1
Hard coating: 0.5mm Cermet (PM2)
Run-in coating: 0.1mm Alucoat
Bottom face: Chrome plating

2nd ring:
Left cut
Base material : Grey cast, CF5
Run-in coating: 0.3mm Alucoat
Bottom face: Chrome plating

3rd ring:
Right cut
Base material : Grey cast, CF5
Run-in coating: 0.3mm Alucoat

4th ring:
Left cut
Base material : Grey cast, CF5
Hard coating: 0.3mm Cermet (PM2) Run-in coating: 0.1mm



Low Sulphur Fuel Operation

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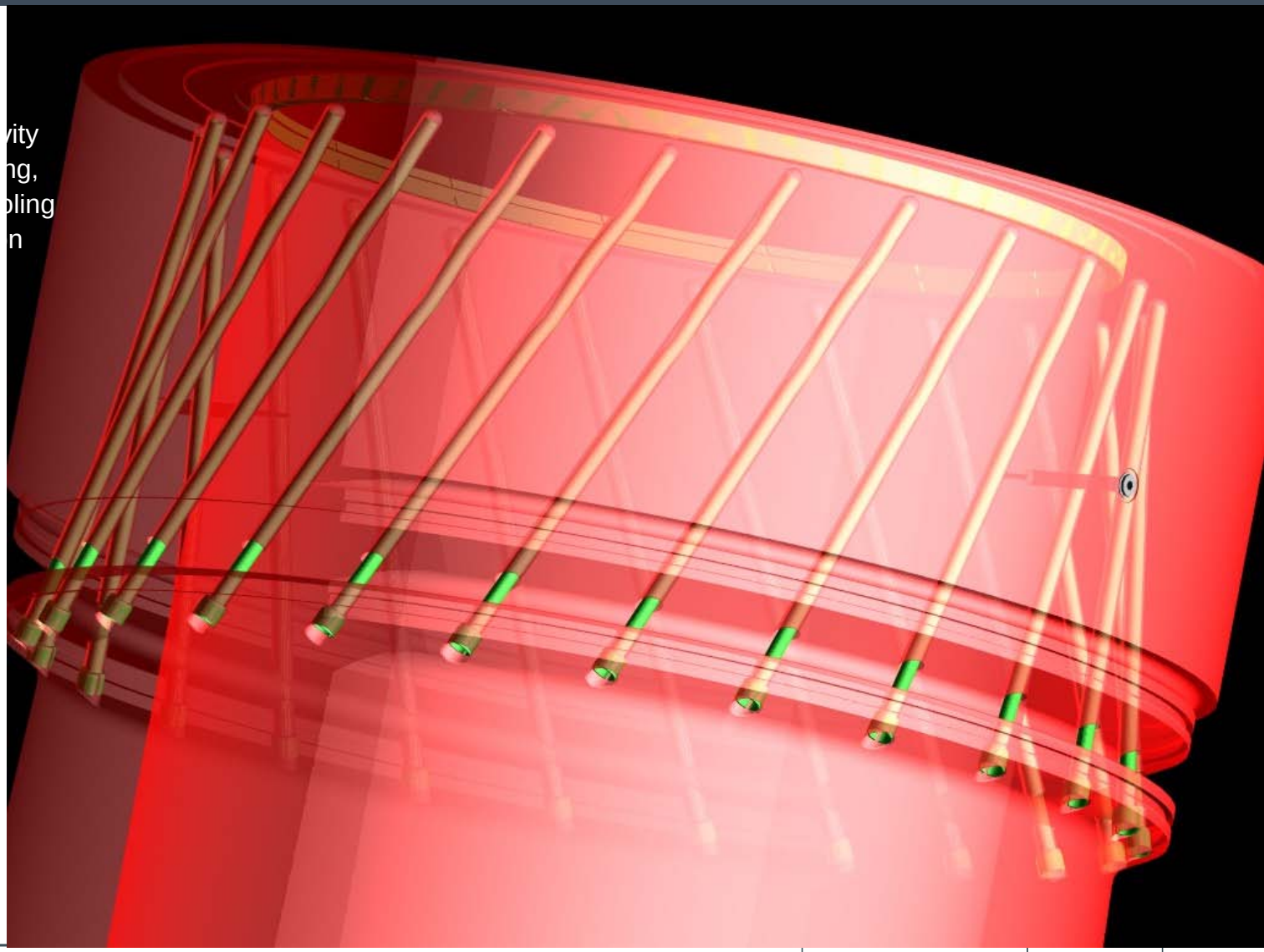

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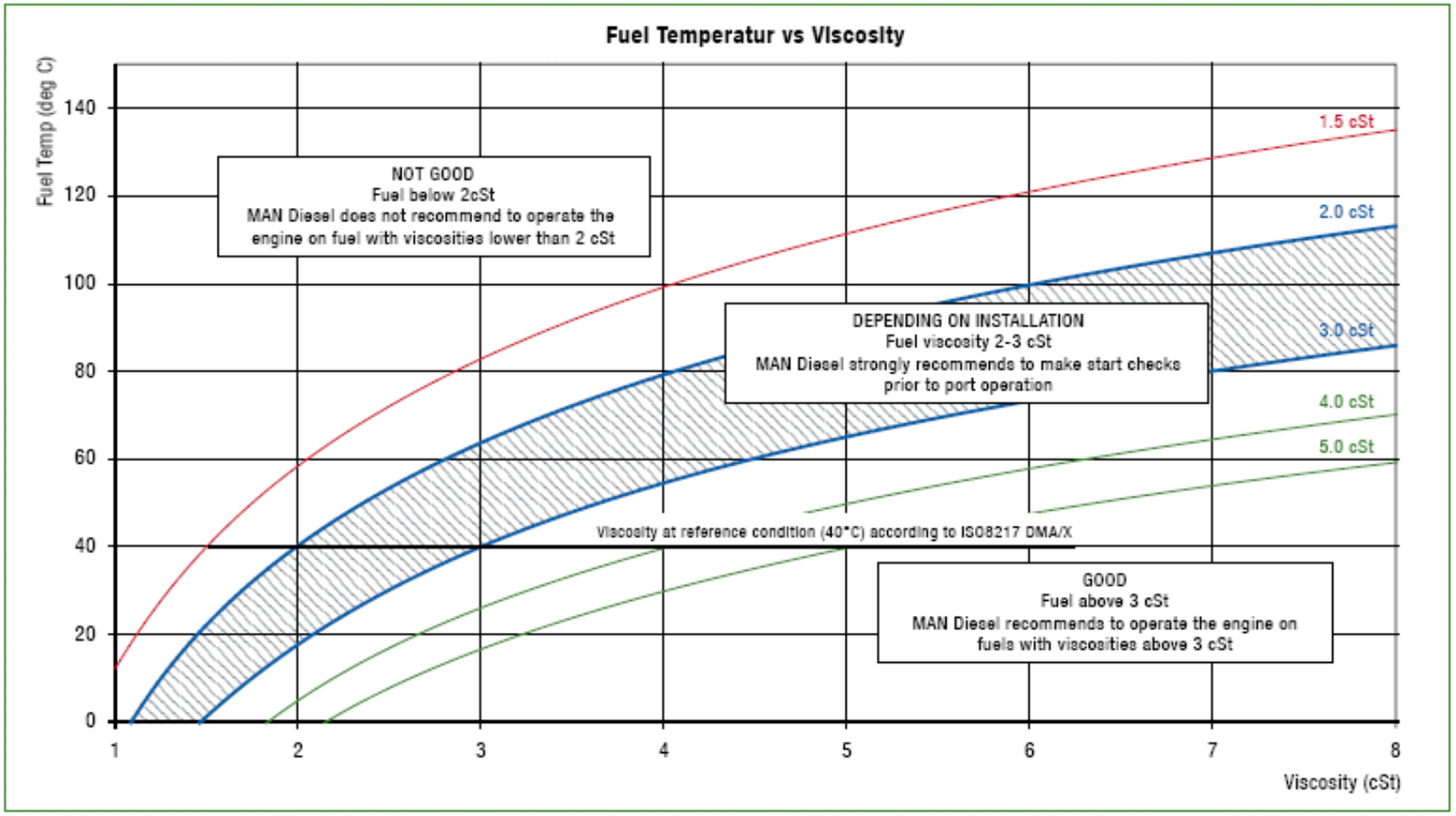
Marine Fuels



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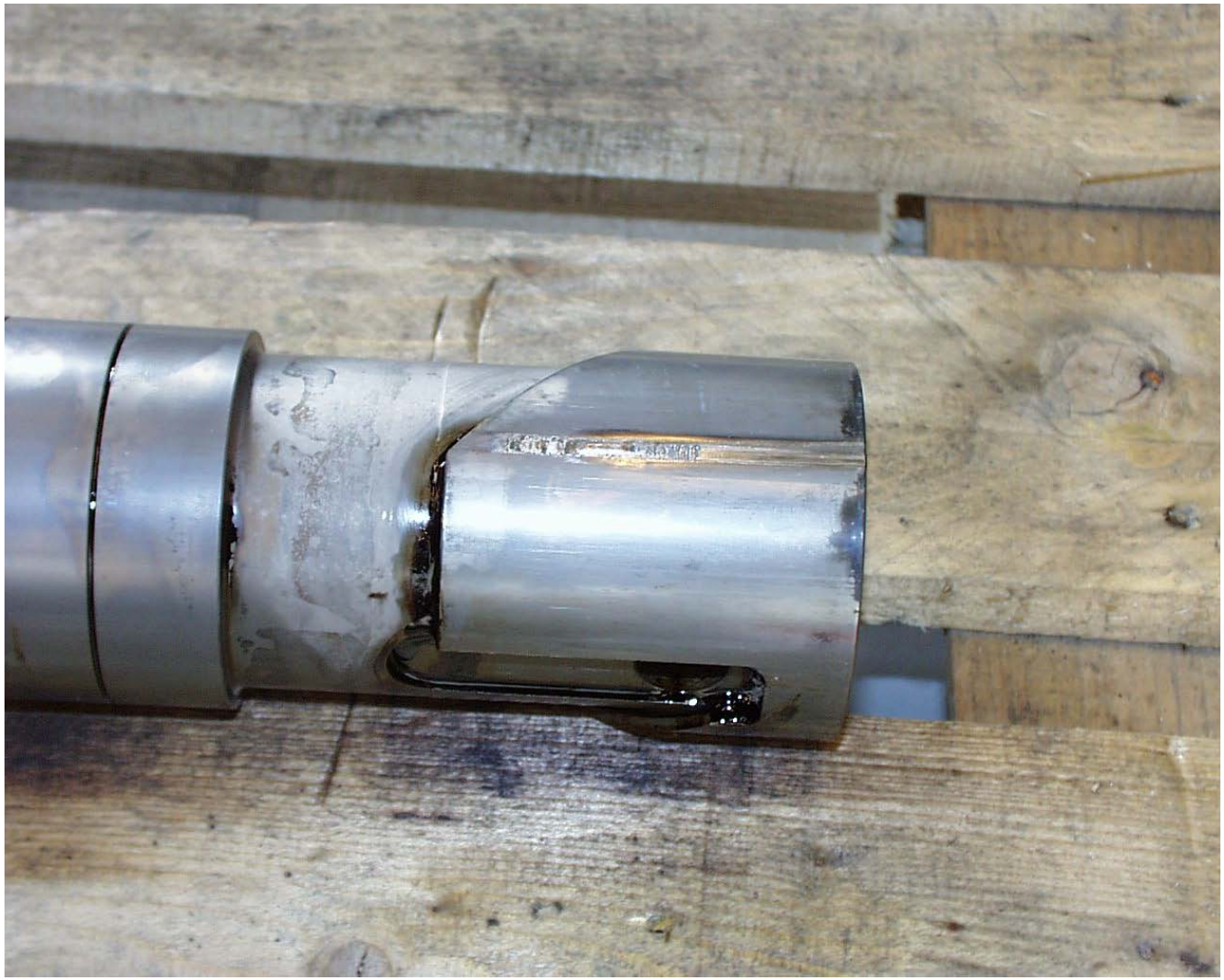
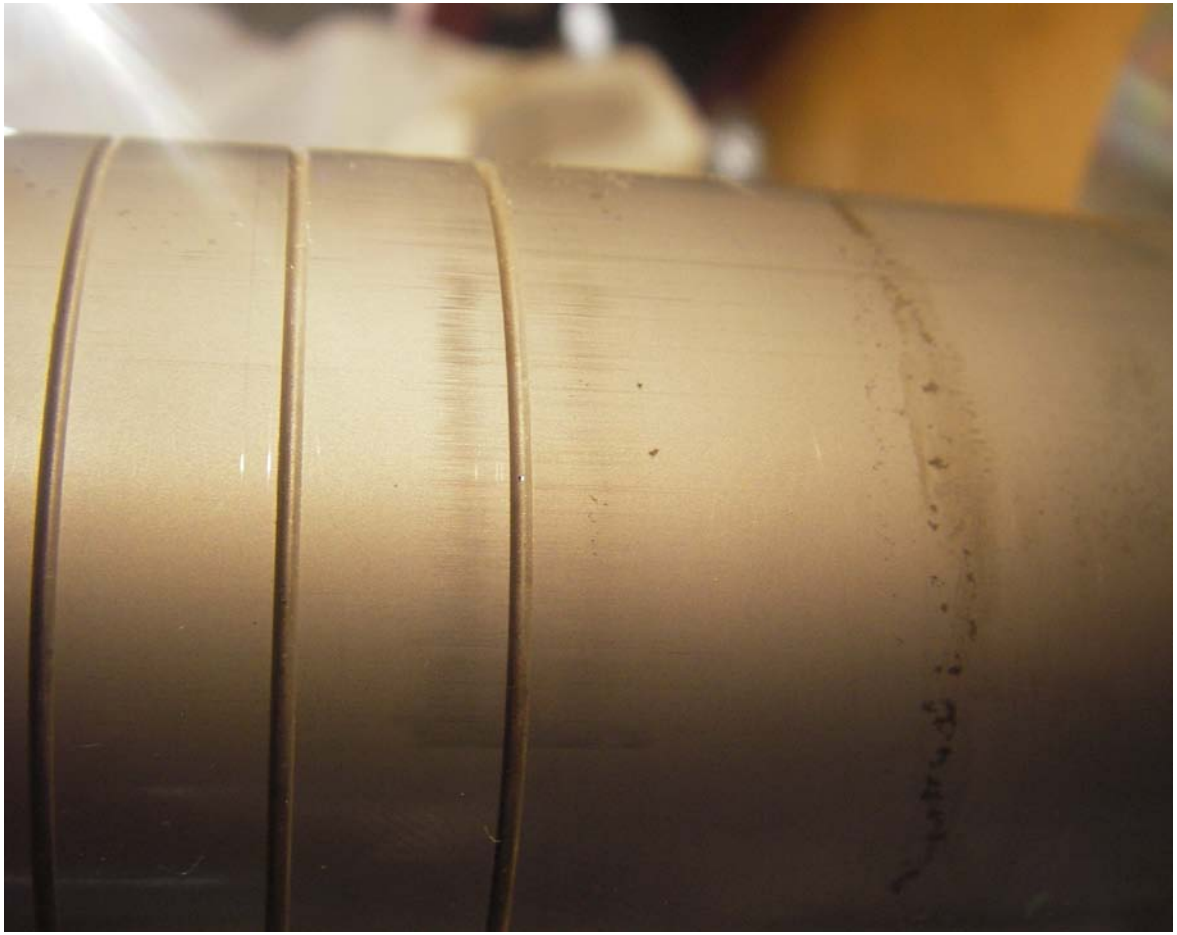
Damage to Fuel Pump Plunger



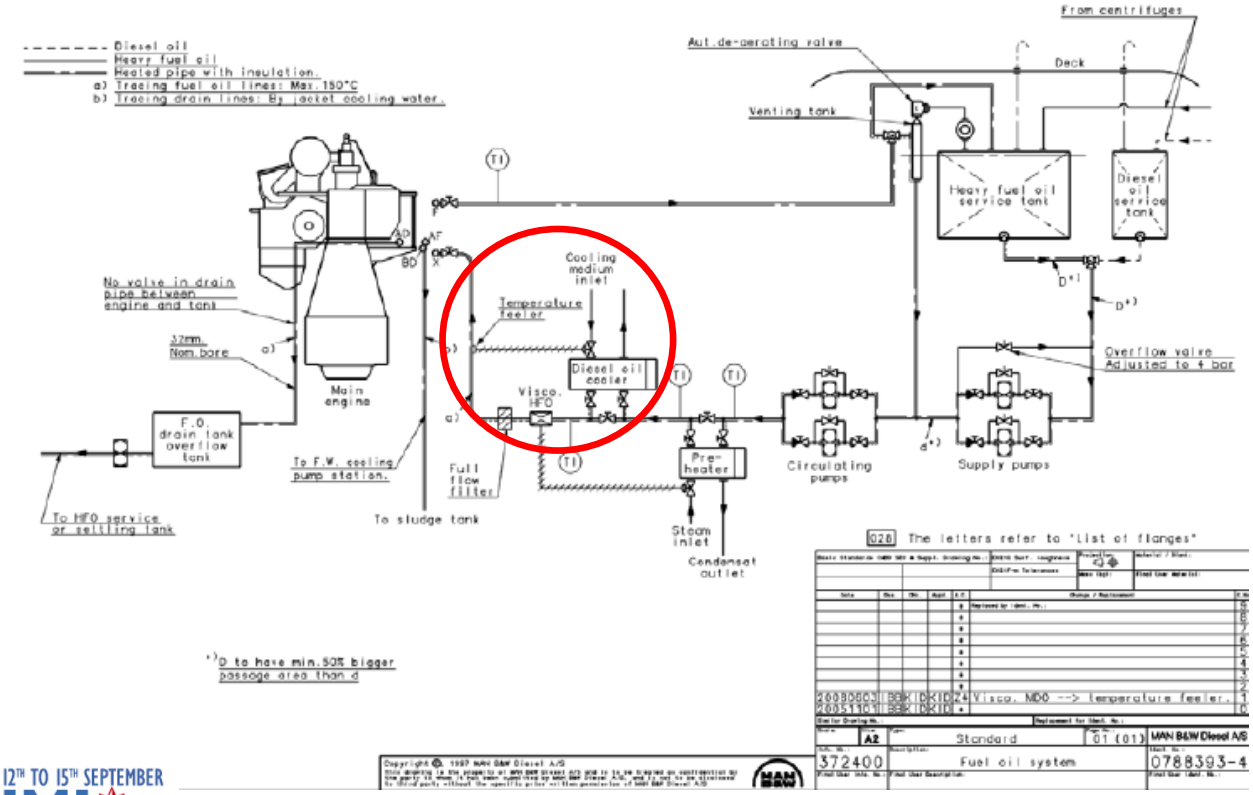
Lubricity test (ME test rig)

- After 60^0C, 1.4 cSt:



Low Sulphur Fuel Operation

Diesel Oil Cooling System:



Engine Type	**6S60MC-C7**
IMO-NOx compliant	Tier 1
Engine Power	13560 kW
SFOC (Tropical ambient condition)	173.2 g/kWh
Fuel oil consumption (110% Engine load)	2.64 m³/h
MGO temperature in service tank	45 °C
MGO temperature return from engine	30 °C
MGO temperature required for 2 cSt	15 °C
MGO density at 15 °C	890.0kg/m³
Specific heat capacity of MGO	2.0 kJ/kg °C
Capacity of supply pump	3.40 m³/h
Capacity of circulation pump	6.90 m³/h
MGO flow return from engine	4.26 m³/h
MGO cooler heat dissipation	122 kW
MGO flow to cooler	6.90 m³/h
MGO temperature to cooler	36 °C
Cooling medium flow to MGO cooler	
Cooling medium temperature inlet to MGO cooler	11 °C

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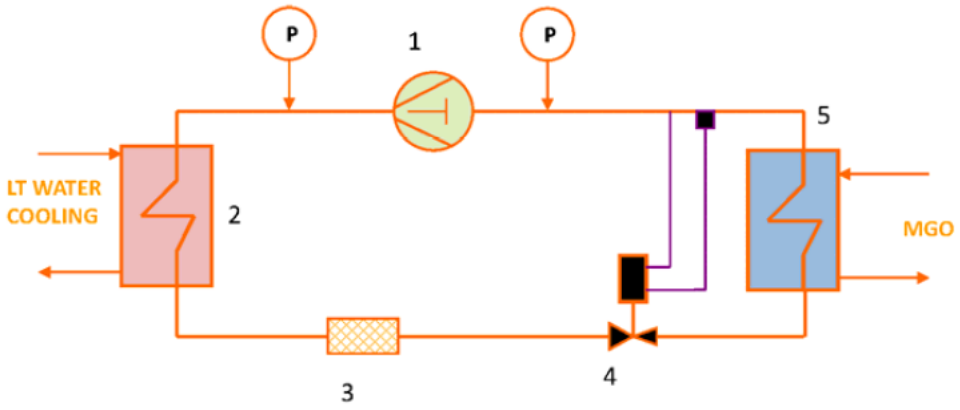
Low Sulphur Fuel Operation

Chiller – Cooling of MGO



1	Compressor
2	Condenser
3	Strainer
4	Thermal Expansion Valve
5	Evaporator

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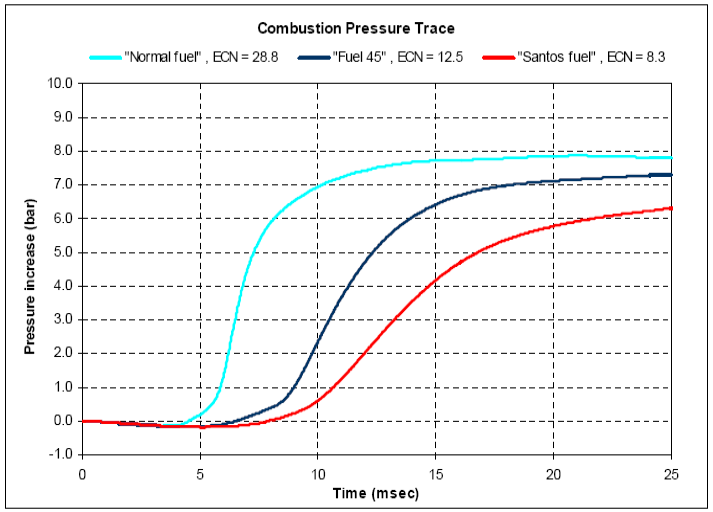
FIA - 100 FCA

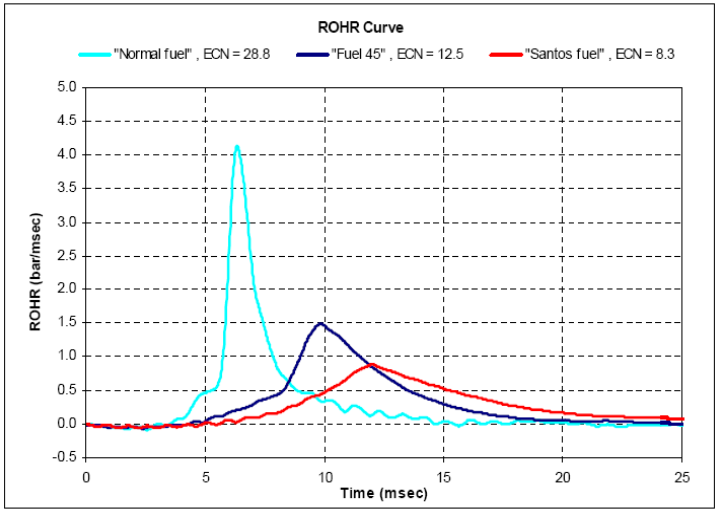
Constant volume spray combustion chamber:

- **Tinit = 800K,**
- **Pinit = 45bar**

Pressure trace



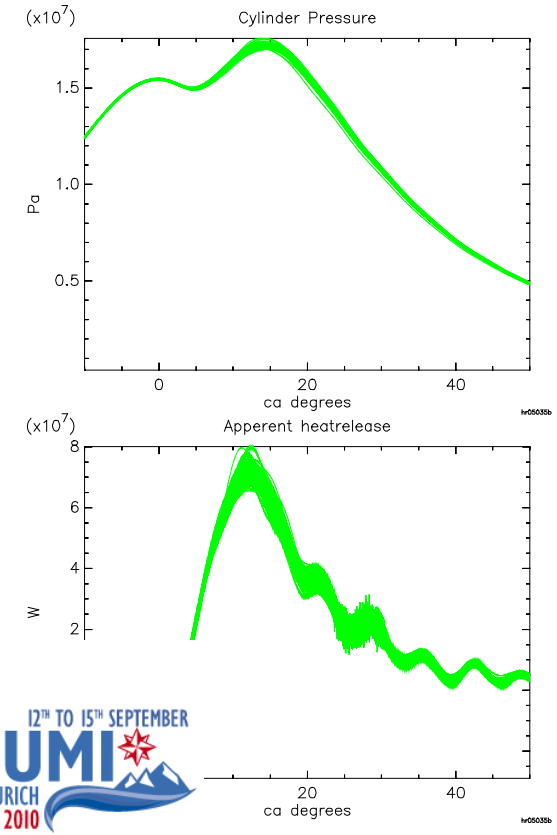
Heat release rate



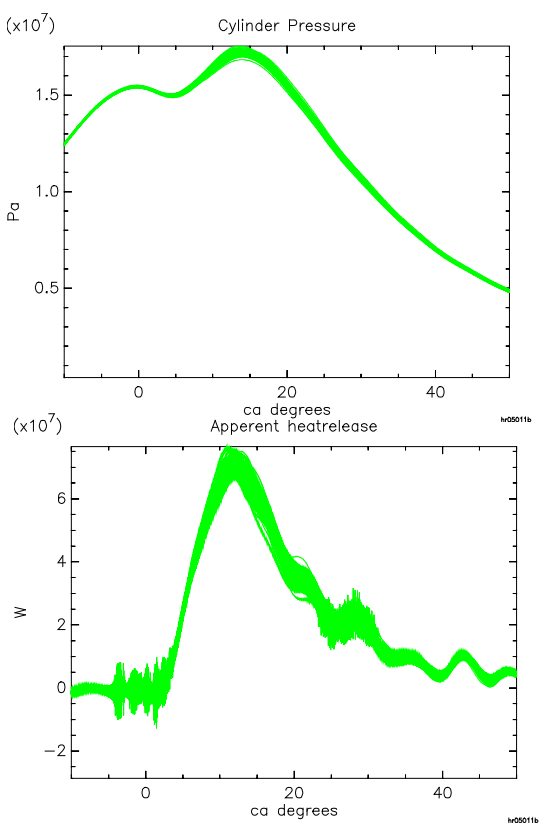
Measurement of ignition delay on the 4T50MX test engine

Direct comparison of fuels, 100 % engine load

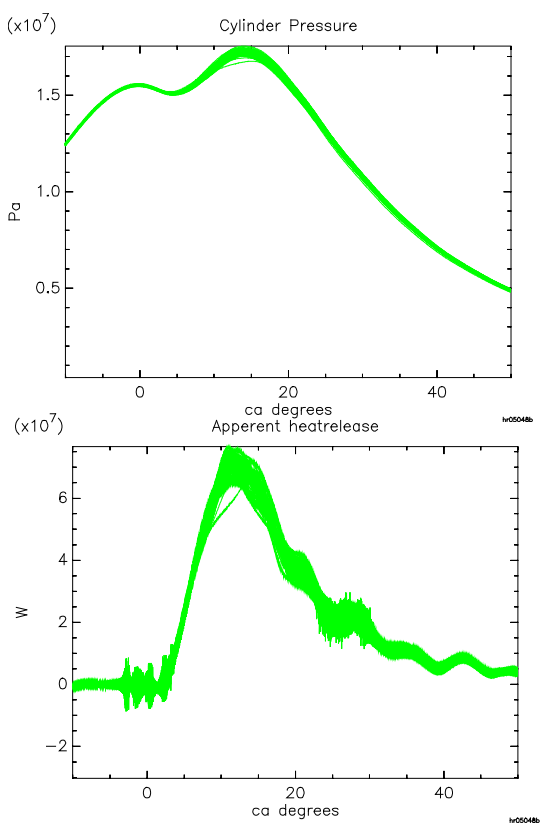
Diesel



HFO



Santos



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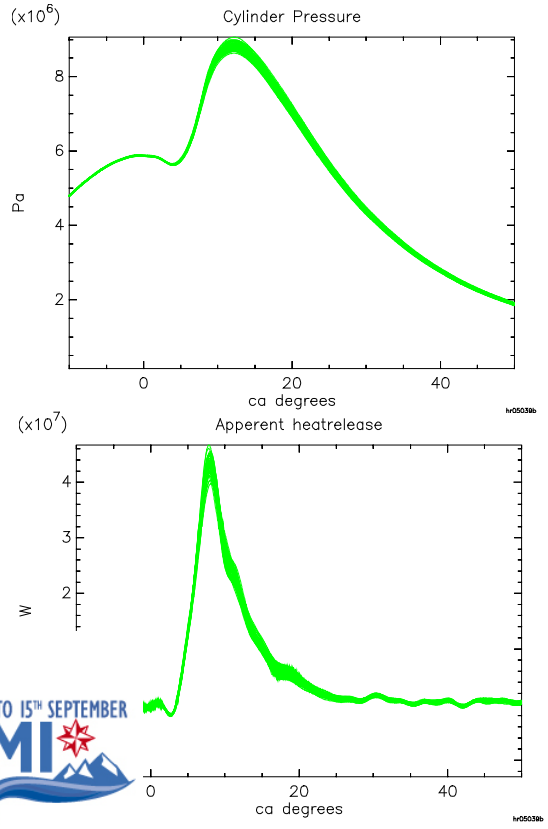
Measurement of ignition delay on the 4T50MX test engine

Direct comparison of fuels, 25 % engine load

Diesel



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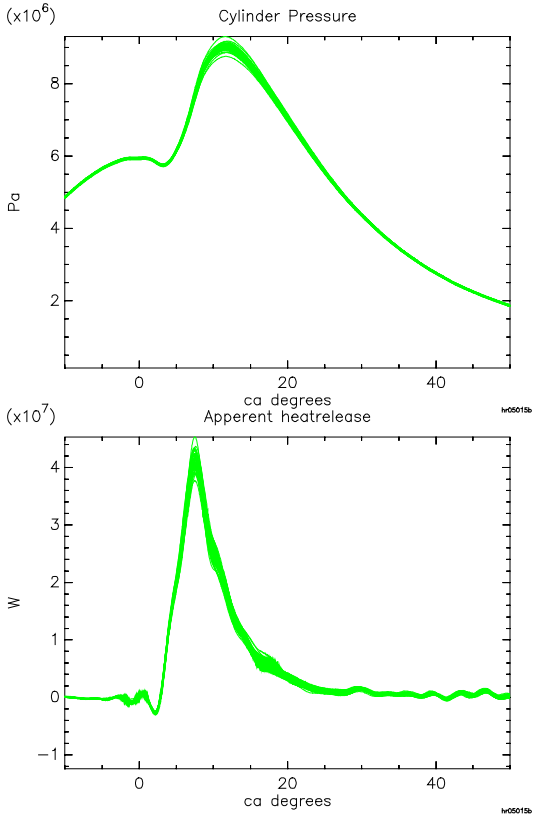

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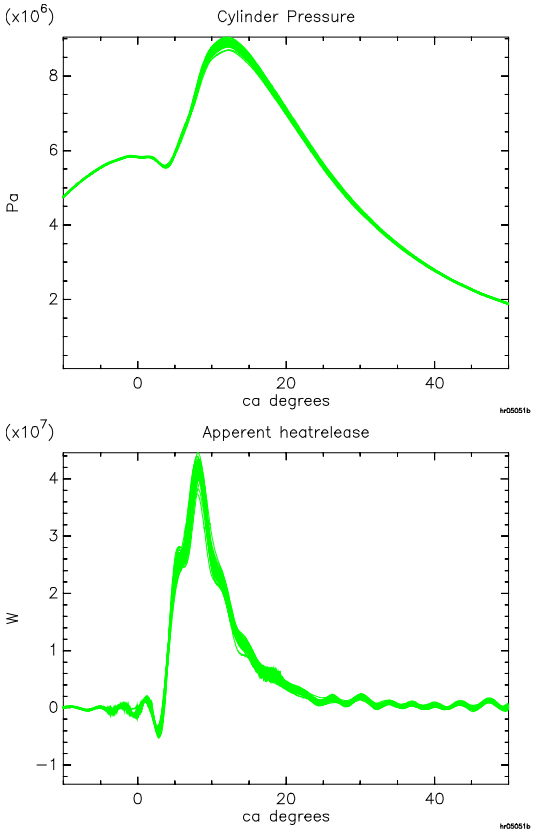

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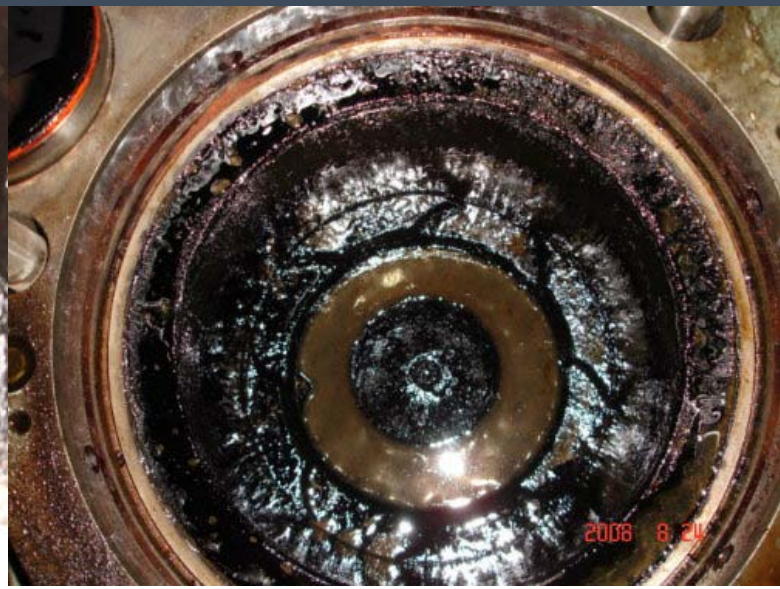
Low Sulphur Fuel Operation



Dear Sirs,

re MV “M… D…"

we received some bad fuel in Oakland /CA . Please see attached analysis reports and comments of DNVPS.

Our vessel is equipped with MAN B&W 9K90MC-C MK6 and with four Aux Eng. 9L28/32H.

Main engine runs so far without any problems, but Aux engines had broken exhaust valves and push rods.

Do you have any official restriction to use this type of fuel (in a way to claim the fuel and to run the aux eng on MDO)?

You assistance in this matter is very welcome. Thanks in advance.

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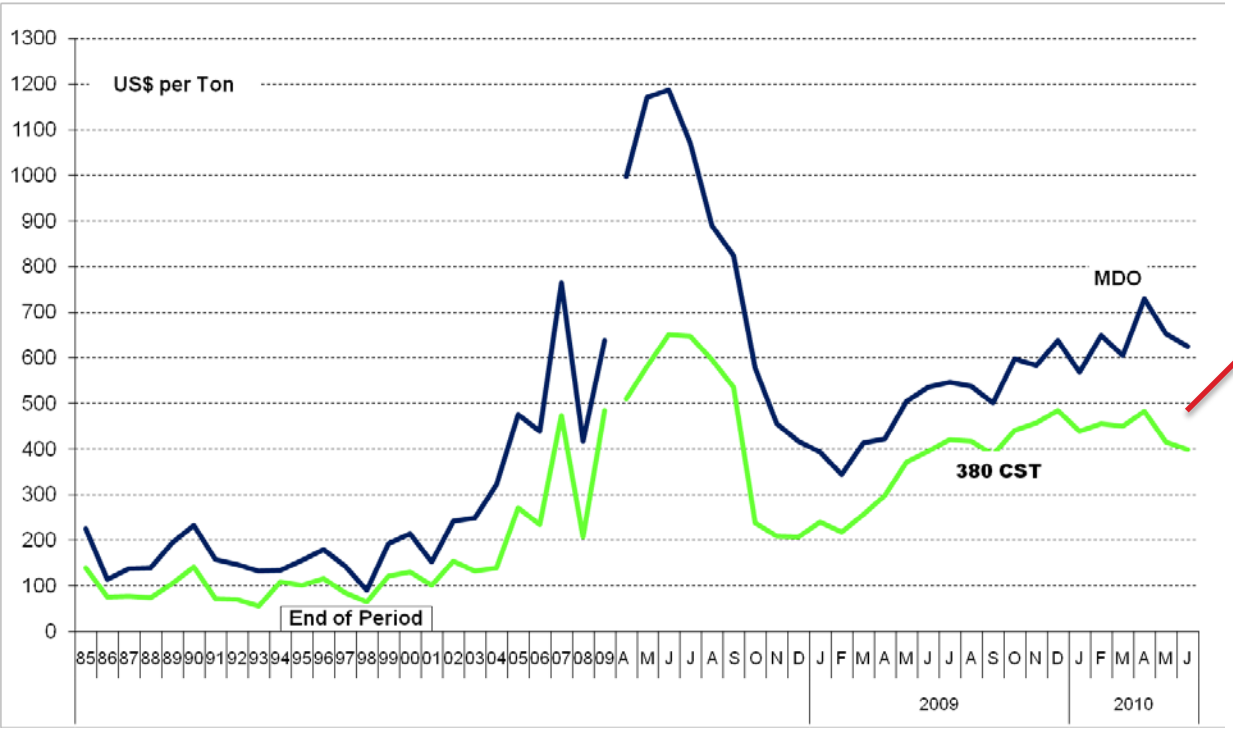
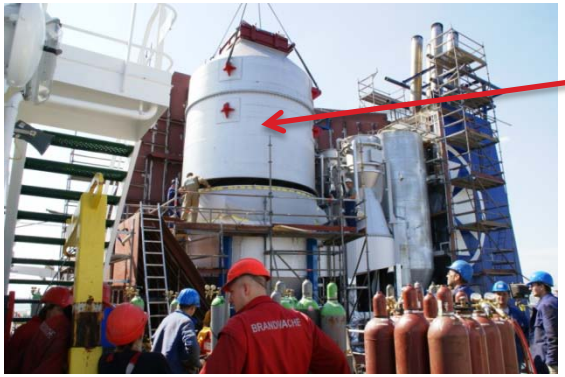
SOx Scrubbers because of:
Cost Difference - HFO vs. Distillates

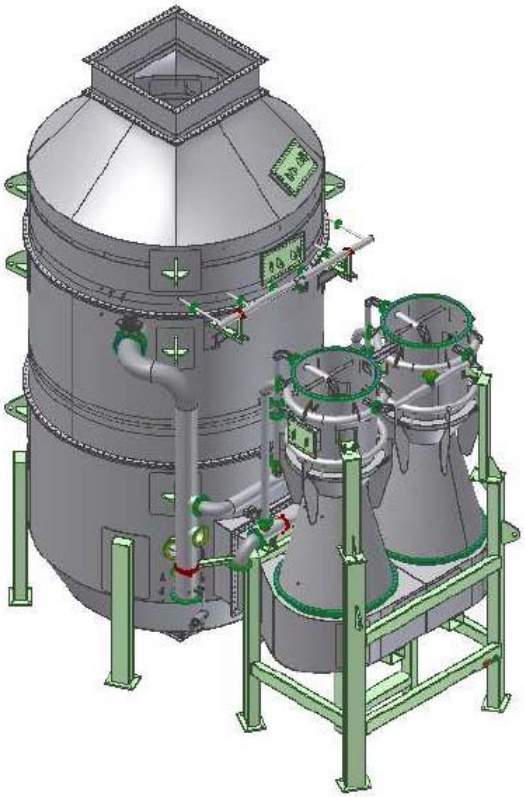


Leads to more focus on abatement technology such as wet scrubbers

SOx Scrubber Technology:
M/V Tor Ficaria: 9L60MC-C (20 MW)

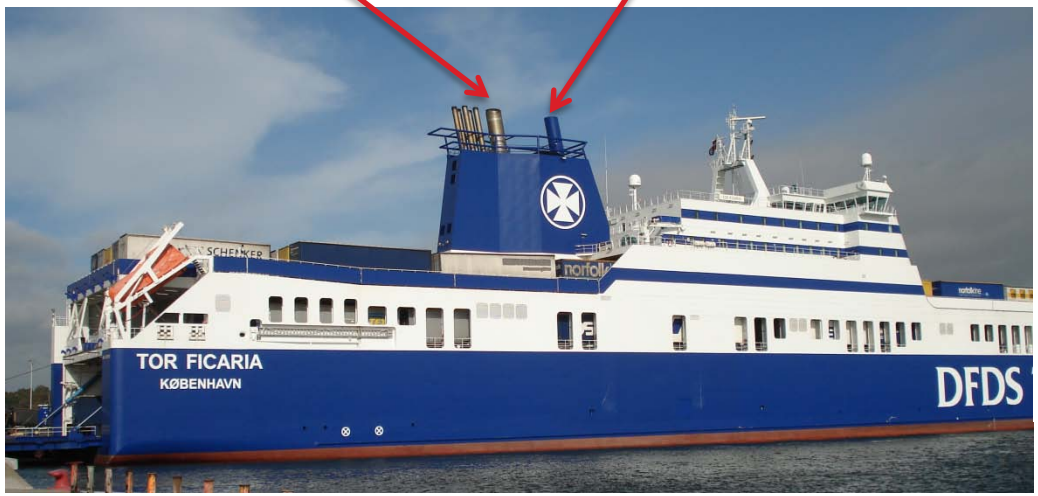


Scrubber during installation



Old Exhaust Pipe

Scrubber Exhaust Pipe



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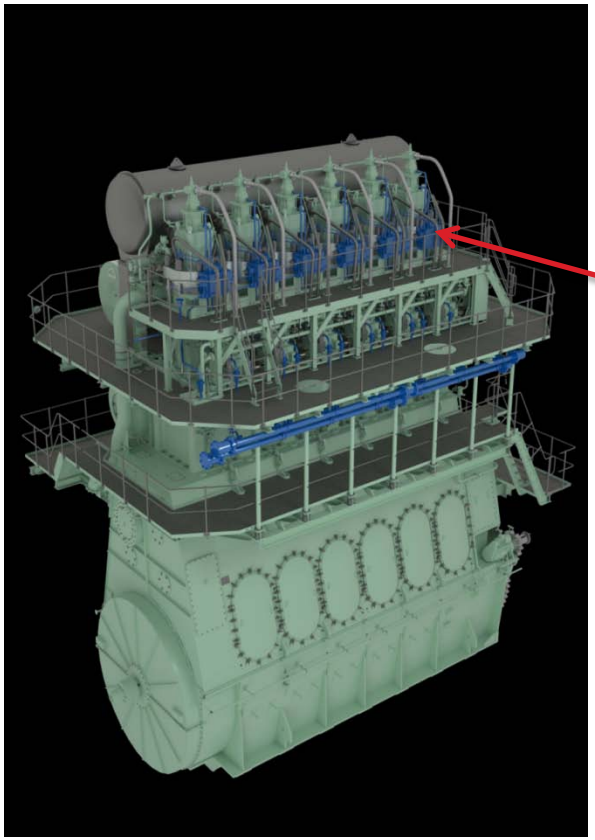
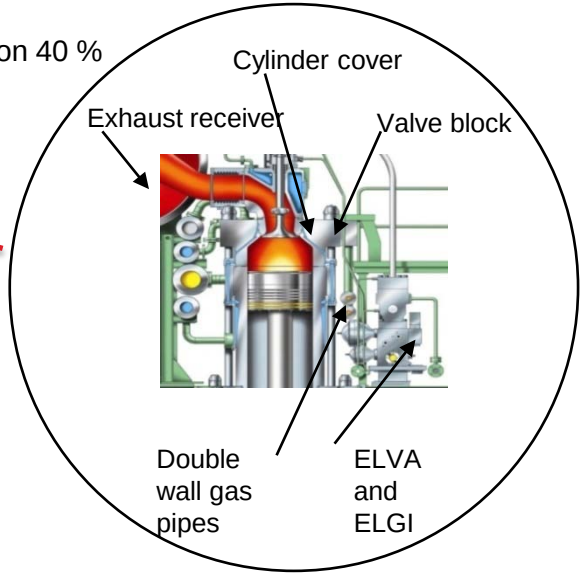
Low Sulphur Fuel Issues:

- Catfines in Low Sulphur HFO
- Cylinder Lubrication on Low Sulphur Fuels
- ”Design-handles” in Relation to Low Sulphur Fuel Operation
- Viscosity Issues
- Slow Burning Characteristics of Low Sulphur Fuels
- Abatement Technologies
- **Gas burning 2-Stroke Engines: ME-GI**

MAN B&W ME-GI Engines Powered by NG, HFO, MDO and LPG



CO_2 reduction 20 %
NO_X reduction 15 %
SO_X reduction 90 %
Particulate matter reduction 40 %



Simple modifications enable two-stroke gas injection

Proven engine design
· High fuel efficiency 50%
· High fuel flexibility
· High reliability

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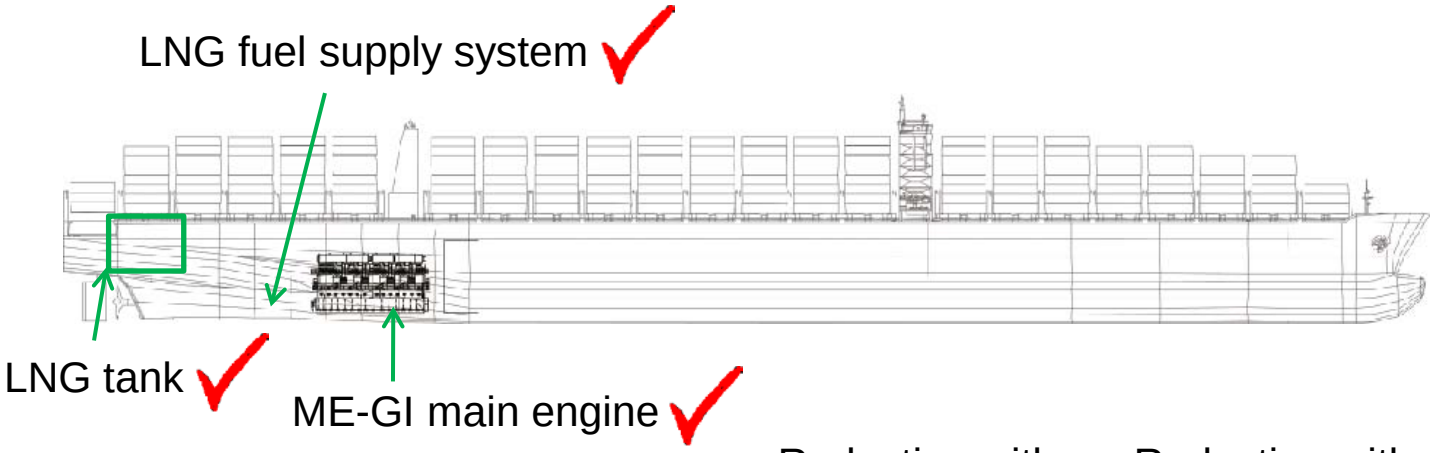
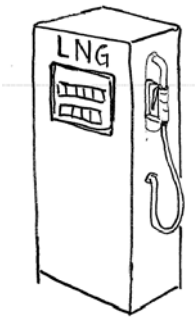
Alternative Fuel for Container Ships
ME-GI Engine for LNG





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	Reduction with ME-GI	Reduction with ME-GI + WHR	Reduction with ME-GI + WHR + EGR
CO_2 (gram per tonne mile)	23%	32%	31%
NO_x (gram per tonne mile)	13%	13%	80%
SO_x (gram per tonne mile)	92%	92%	94%
Particulate matter (mg per m^3)	37%	37%	48%

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Thank you very much for your attention

Stig Baungaard Jakobsen
Marine Low Speed, Operation

MAN Diesel
powering the world