低硫燃油的使用
Operation on Low Sulphur Fuels

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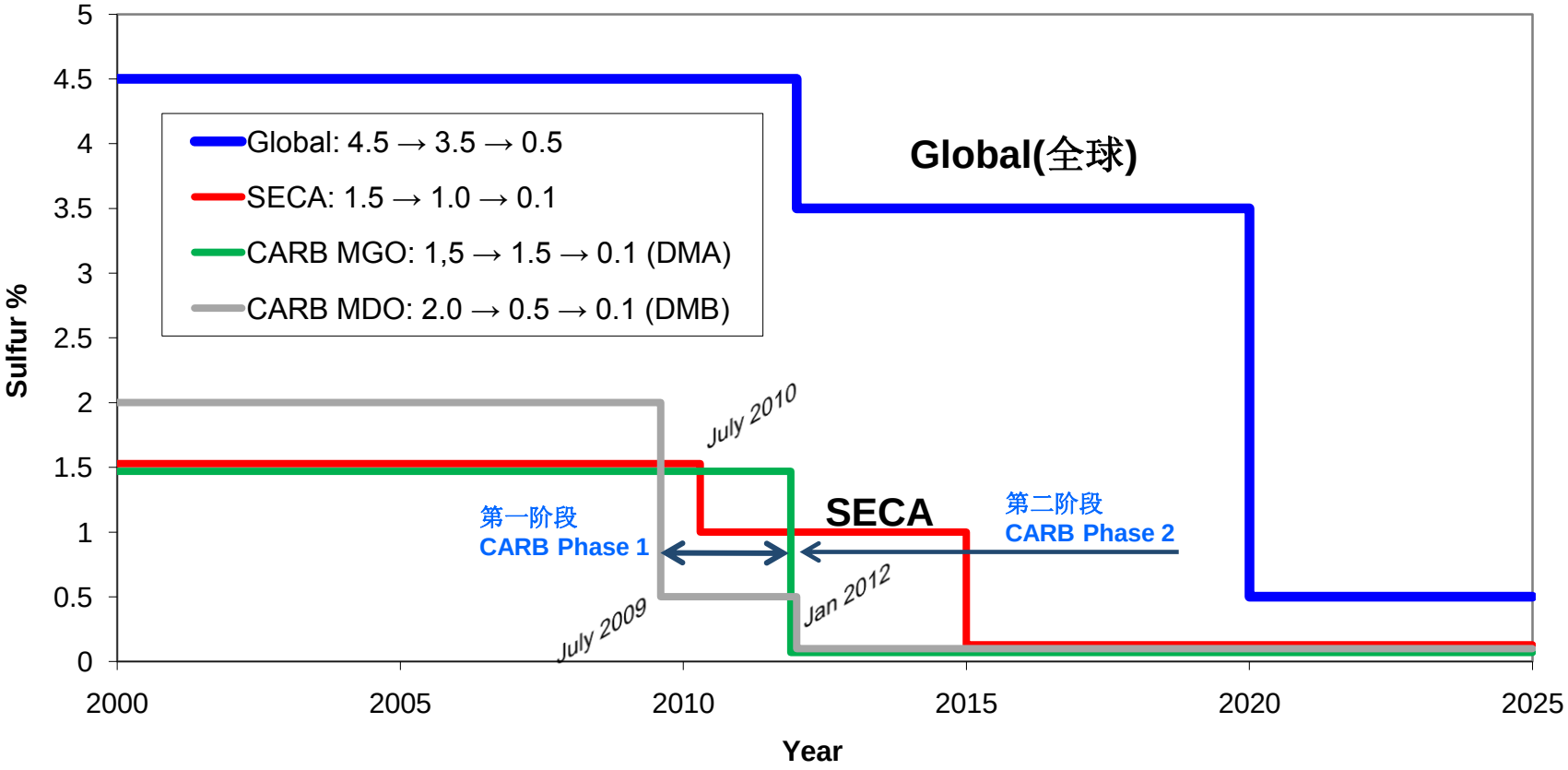
IMO和CARB燃油硫含量限值
IMO & CARB Fuel-Sulphur Content Limits



SECA: SOx Emission Control Area 硫化物排放受限区域

CARB: California Air Resource Board 加州空气资源委员会

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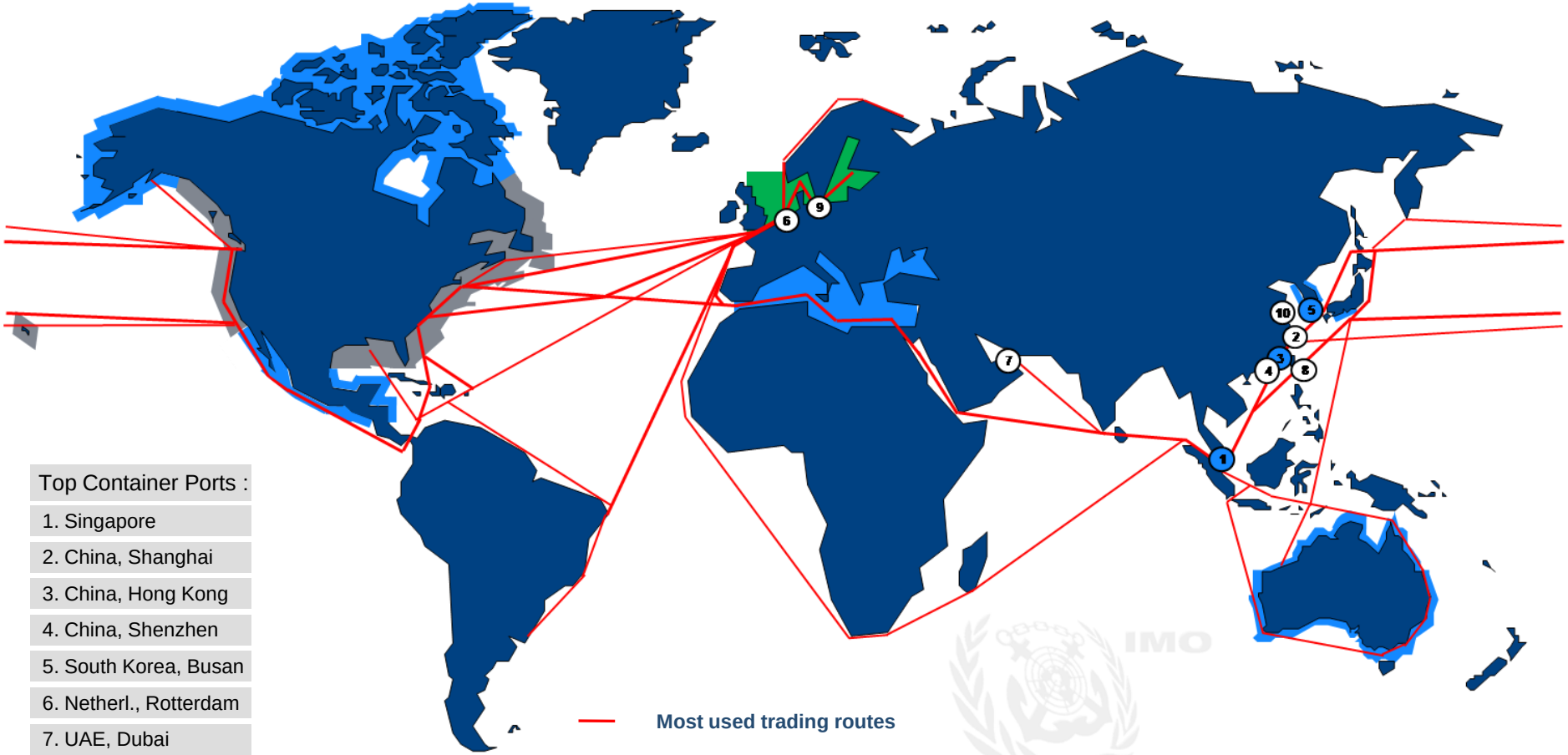
排放受限区域 - ECA
Emission Control Areas - ECA



Top Container Ports :

1. Singapore
2. China, Shanghai
3. China, Hong Kong
4. China, Shenzhen
5. South Korea, Busan
6. Netherl., Rotterdam
7. UAE, Dubai
8. Taiwan, Kaohsiung
9. Germany, Hamburg
10. China, Qingdao

现有ECA existing ECAs: Baltic Sea, North Sea

计划中ECA planned ECAs: Coasts of USA, Hawaii and Canada

讨论中ECA discussed ECAs: Coasts of Mexico, Coasts of Alaska and Great Lakes, Singapore, Hong Kong, Korea, Australia, Black Sea, Mediterranean Sea (2014), Tokyo Bay (in 2015)

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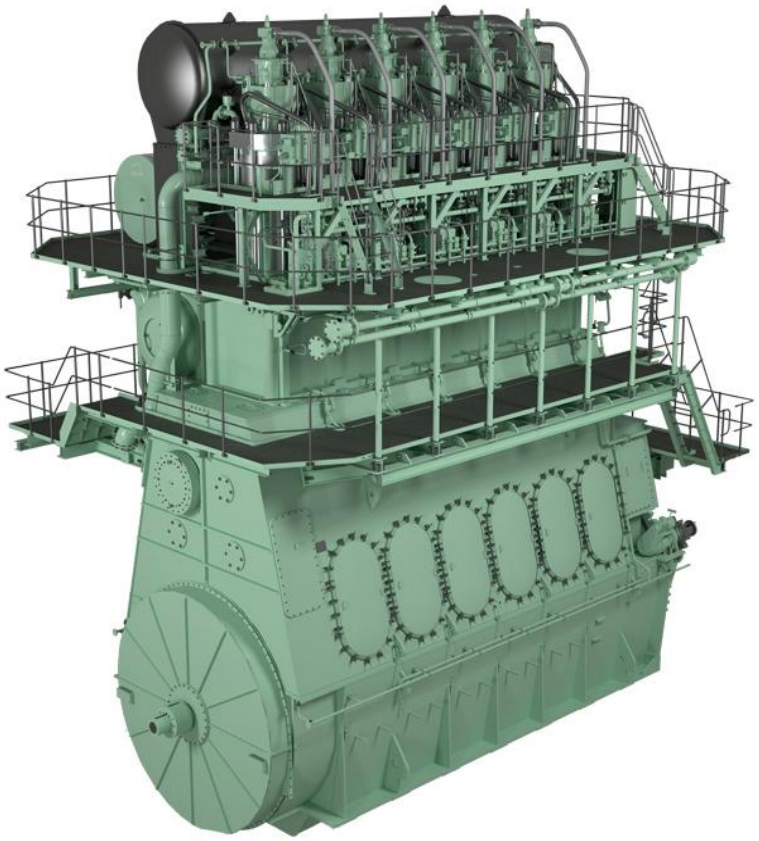
MAN B&W二冲程低速机使用的燃油
Fuels for MAN B&W two-Stroke Engines

MAN B&W二冲程低速机可以使用所有满足ISO8217:2010规格要求的燃油，包括馏分油，机器本身不需要任何修改。可使用燃油种类：

- MGO
- MDO
- 低硫重油
- 高硫重油
- 生物燃料

MAN B&W two-stroke egnines can operate on fuels fulfilling the ISO8217:2010 specification, including distillate fuels, without making modification to the engine itself：

- MGO
- MDO
- Low Sulphur HFO
- High Sulphur HFO
- Biofuel (separate fuel specificaiton)



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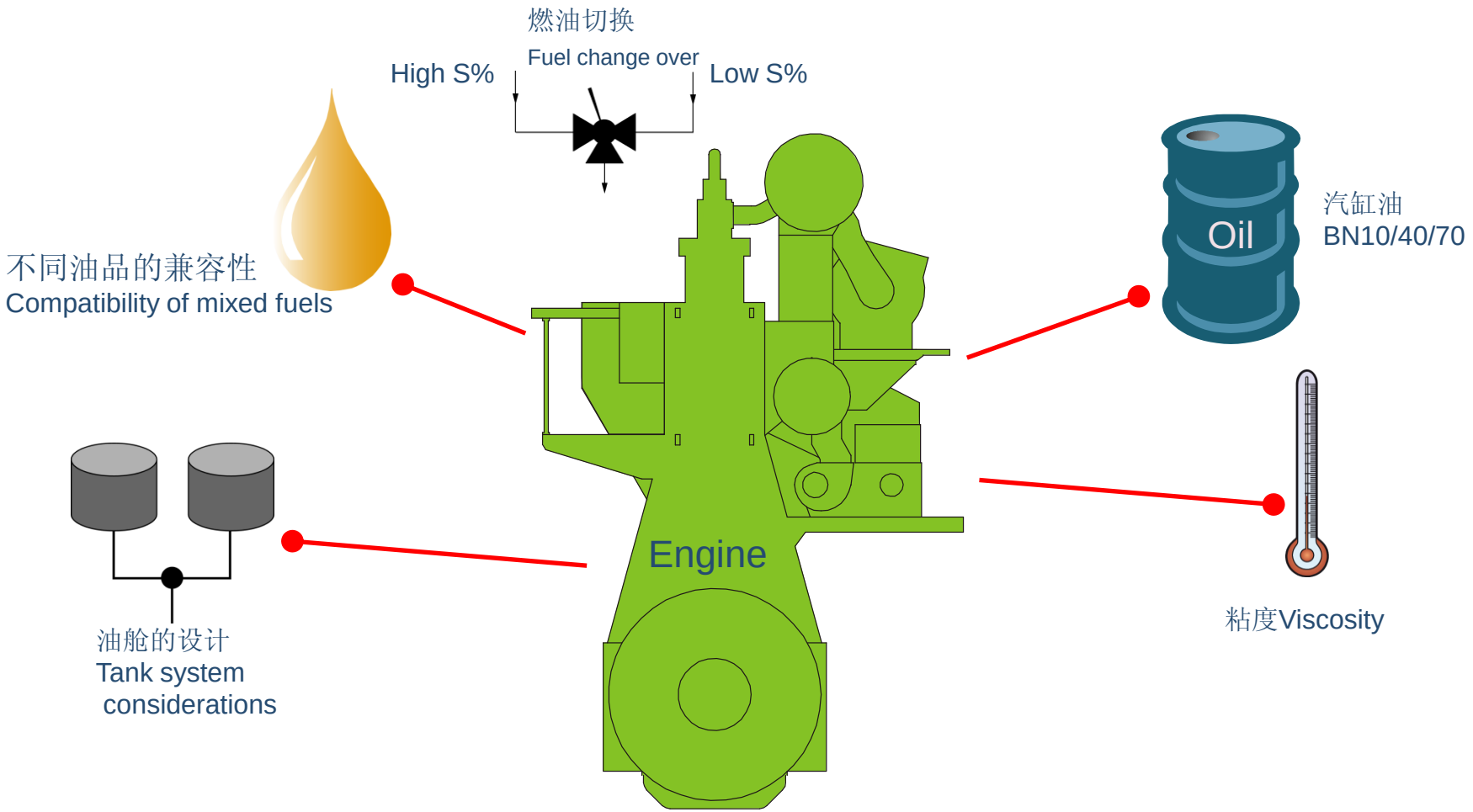
使用低硫油时需考虑的因素
Concerns of Low sulphur Fuel Operation



油品间的不兼容性
Incompatibility of Fuels

加油前，请检查油品间是否兼容

Check the compatibility between the fuels before bunkering

	Before separator	Bunker sample
Density @ 15C	**928.0**	**932.4**
Viscosity @ 50°C	**19.5**	**22.1**
Water	**0.2**	**<0.10**
MCR	**9**	**10**
Sulphur	**1.24**	**1.54**
TSP	**0.34**	**0.01**
Total sediment accelerated	**U/F**	**0.60**
Vanadium	**92**	**100**

Source: DNVPS

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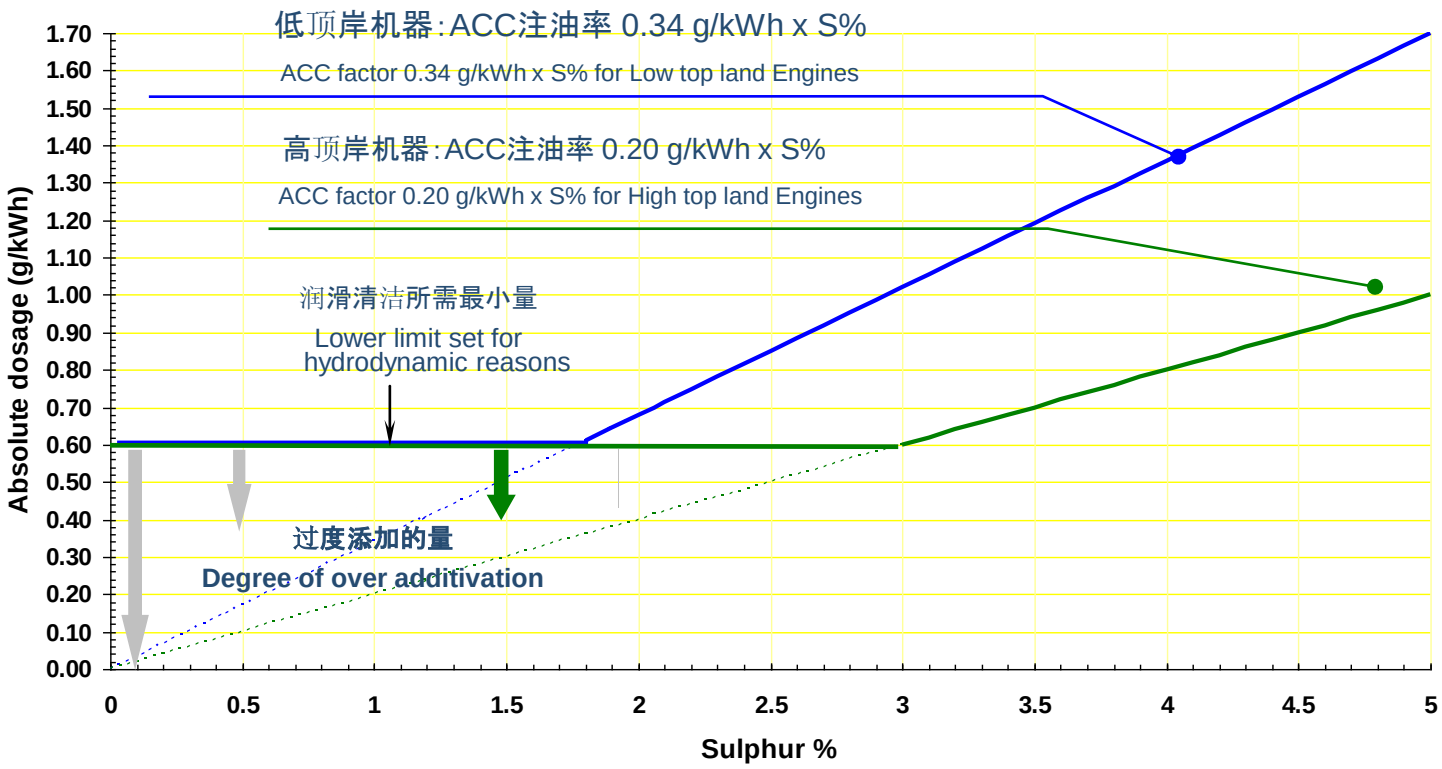
汽缸的润滑 (使用Alpha注油器)
Cylinder Lubrication with Alpha Lubricator



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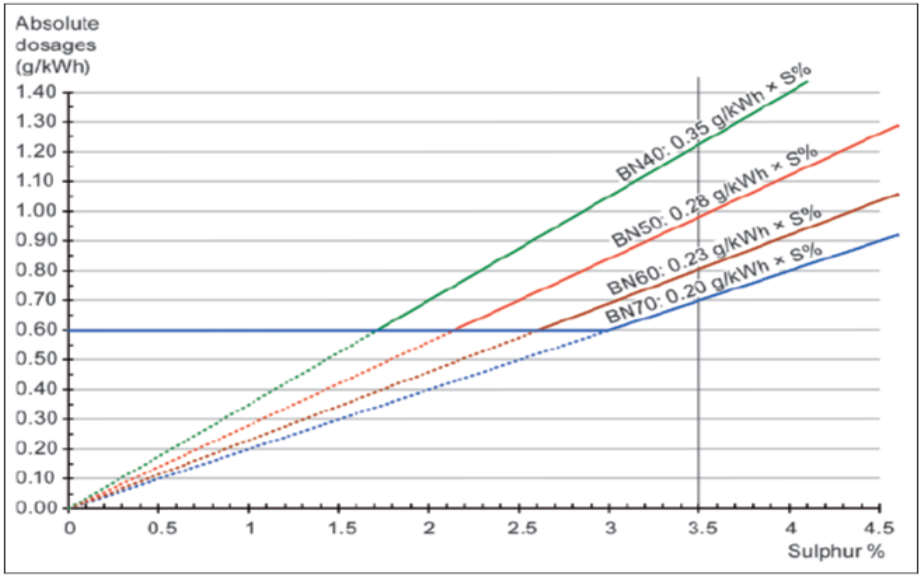
汽缸的润滑 (使用Alpha注油器)
Cylinder Lubrication with Alpha Lubricator

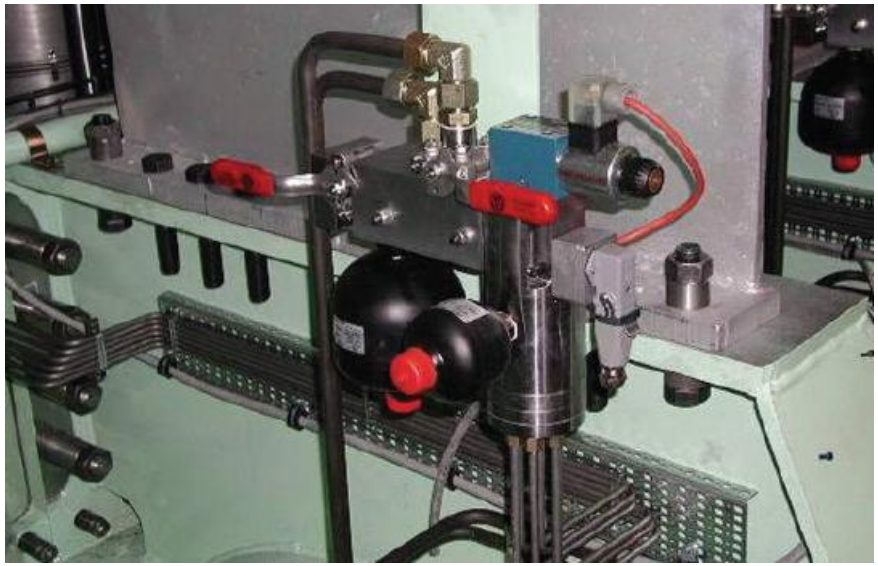
对于**高顶岸**机器，汽缸油与燃油含硫量之间的关系如下：
For **high topland** engines, the correlation between fuel sulphur level and cylinder oil can be shown as follows:

燃油含硫量 <1%： 建议使用BN40/50
只有当使用含硫量小于1%的燃油时间超过两个星期的情况下，从BN70切换为BN40/50.
燃油含硫量 1 – 1.5%： 使用BN40/50或BN70
燃油含硫量 >1.5%： 建议使用BN70

Fuel sulphur level <1%: BN40/50 recommended.
Changeover from BN70 to BN40/50 only when operating for more than two weeks on <1% sulphur
Fuel sulphur level 1 - 1.5%: BN40/50 and BN70 can be used.
Fuel sulphur level >1.5%: BN70 is recommended.

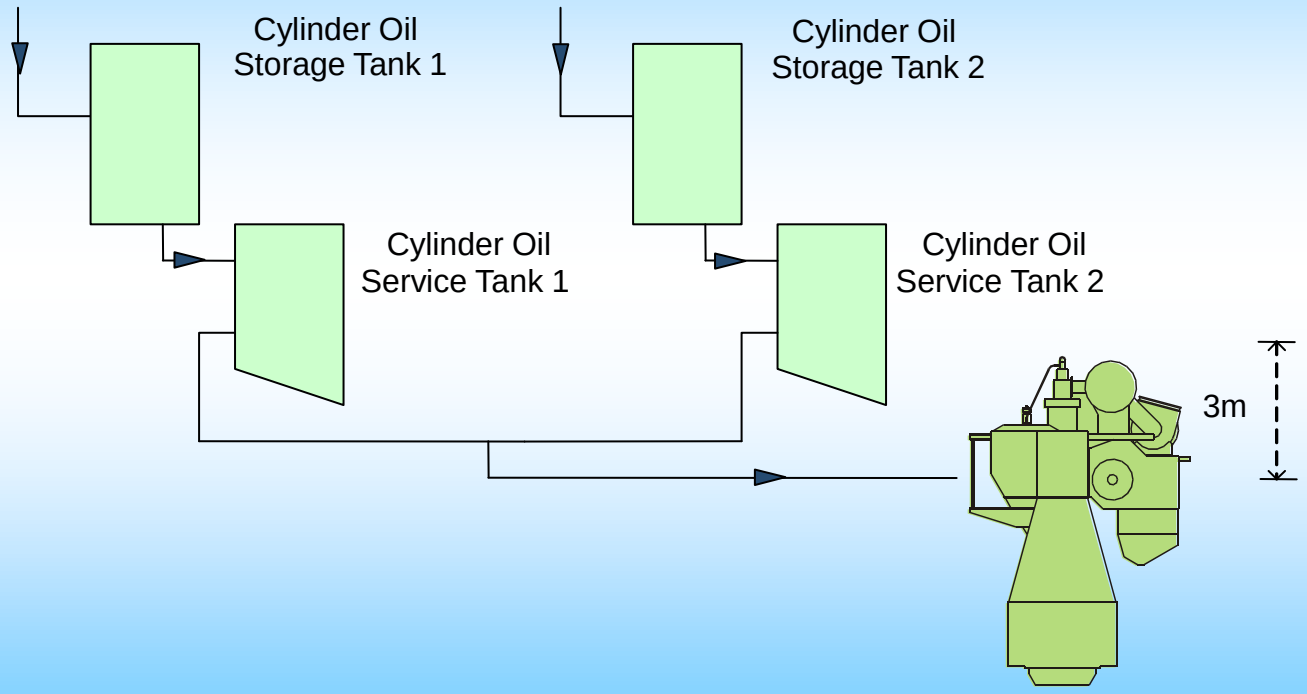
对于老式的**低顶岸**机器，长期使用BN70没有问题
Older **low topland** engines operating continuously on low sulphur fuels and with BN70 cylinder oil without problems





汽缸油柜设计
Cylinder Oil Tank

两套独立的汽缸油供给系统
Two Independent Cylinder Oil Systems



ISO 8217:2010 对馏分油的规定
Distillate Marine Fuels (ISO 8217:2010)

Charateristics	Unit	Limit	DMX	DMA	DMB	DMZ
Density at 15°C	kg/m³	max.	-	890	900	890
Viscosity at 40°C	mm²/s	min.	1.4	2.0	2.0	3.0
Viscosity at 40°C	mm²/s	max.	5.5	6.0	11.0	6.0
Flash point	°C	min.	43	60	60	60
Sulphur	%(m/m)	max.	1.00	1.50	2.00	1.50

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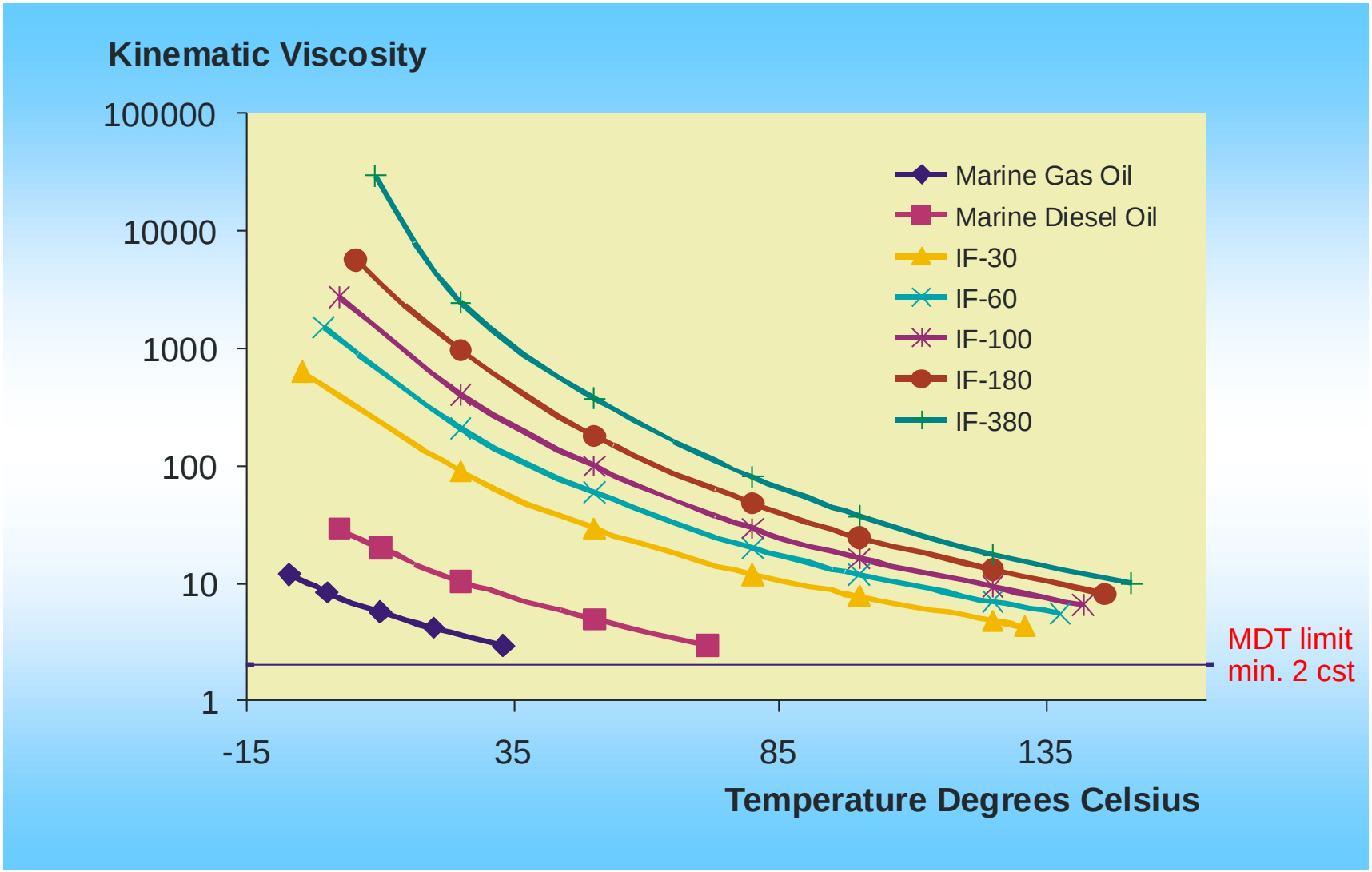
船用燃油的粘度
Viscosity of Marine Fuels



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燃油的粘度和润滑性
Viscosity and Lubricity of Fuels

粘 度
Viscosity

高压油泵的设计是基于在大多数时间里使用高粘度的重油
The engine fuel pump is designed for high viscosity heavy fuel operation the majority of its operation hours.

使用低粘度燃油时存在油泵过度磨损以及油压建立困难，**特别是在低负荷、启动以及低转速时**
The low viscosity challenges are the risk of excessive wear as well as the ability to keep proper injection pressure in the fuel pump - **especially during low load, start and low rpm.**

油泵磨损后，内部泄漏量加大，导致喷射压力不足，可能会造成主机无法启动
In worn pumps, the internal leakage can increase to a level where starting the engine is impossible because a proper injection pressure cannot be achieved.

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燃油的粘度和润滑性
Viscosity and Lubricity of Fuels

润滑性
Lubricity

MAN Diesel建议在使用含硫量低于0.05%的燃油前，检测燃油的润滑性
MAN Diesel recommends that, prior to using distillates fuels with less than 0.05% sulphur, the lubricity is tested.

独立的检测机构可以采用HFRR方法对燃油的润滑性进行检测
Lubricity can be tested by an HFRR (High-Frequency Reciprocating Rig) test (according to ISO12156-1) which can be performed by an independent lab.

根据ISO12156-1的规定，最大的磨痕直径不能超过520µm
According to ISO12156-1 the maximum wear scar diameter should not exceed 520µm.

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MAN Diesel的建议
MAN Diesel Recommendations

- 进机燃油粘度不能低于2 cSt，推荐 3 cSt
  Minimum Viscosity inlet engine 2 cSt

- 测试您的机器以及辅助系统的燃油敏感性
  Test your engine / external systems for fuel sensitivity

- 在进入敏感区域之前（如港口及其他拥挤区域），对机器进行正倒车启动实验
  Start ahead/astern checks are recommended before entering high-risk areas (e.g. ports and other congested areas)

- 如果需要，加装冷却器或冷冻机组
  If necessary, install cooler or Chiller

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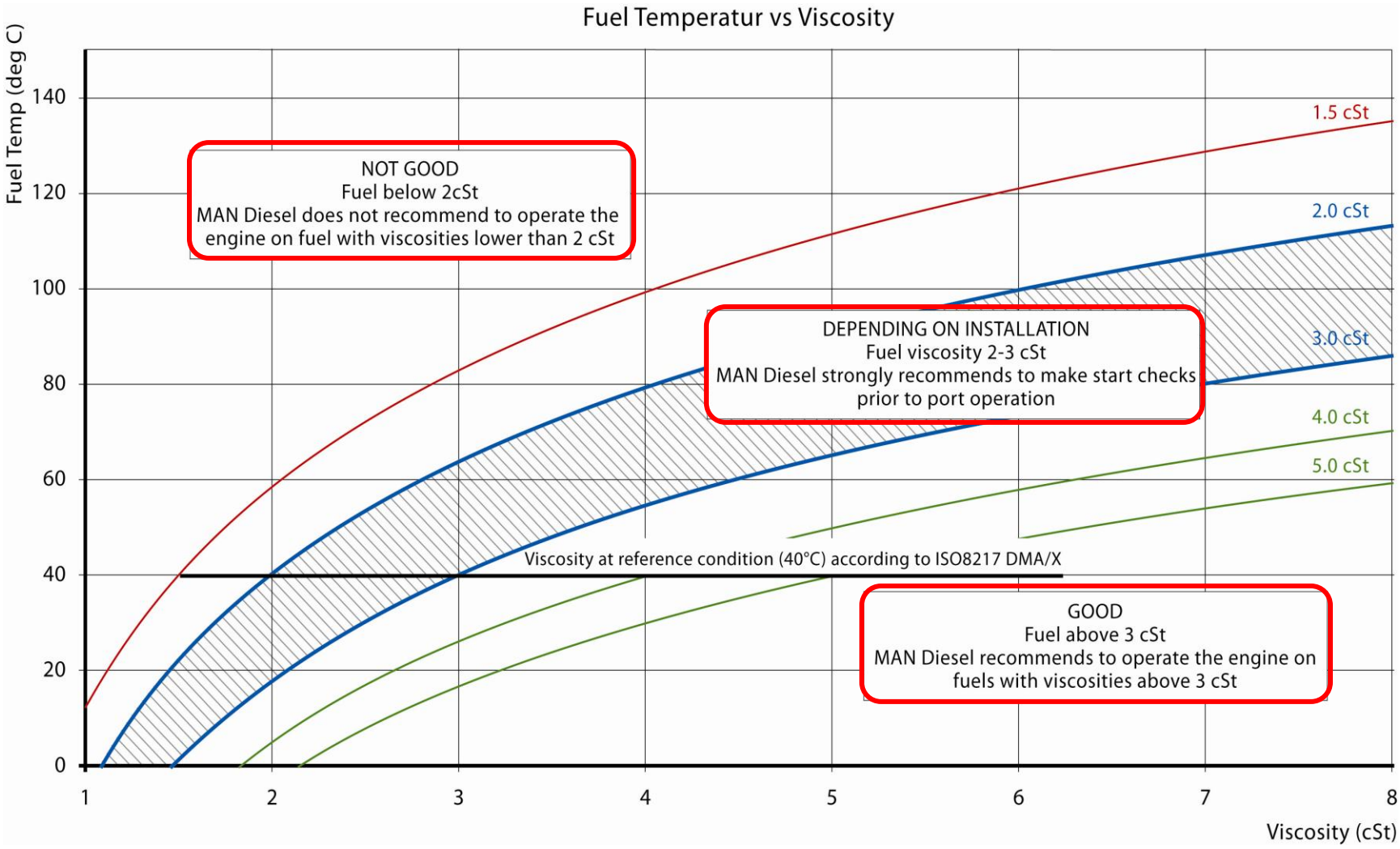
燃油温度与粘度之间的关系
Fuel Temperature vs Viscosity



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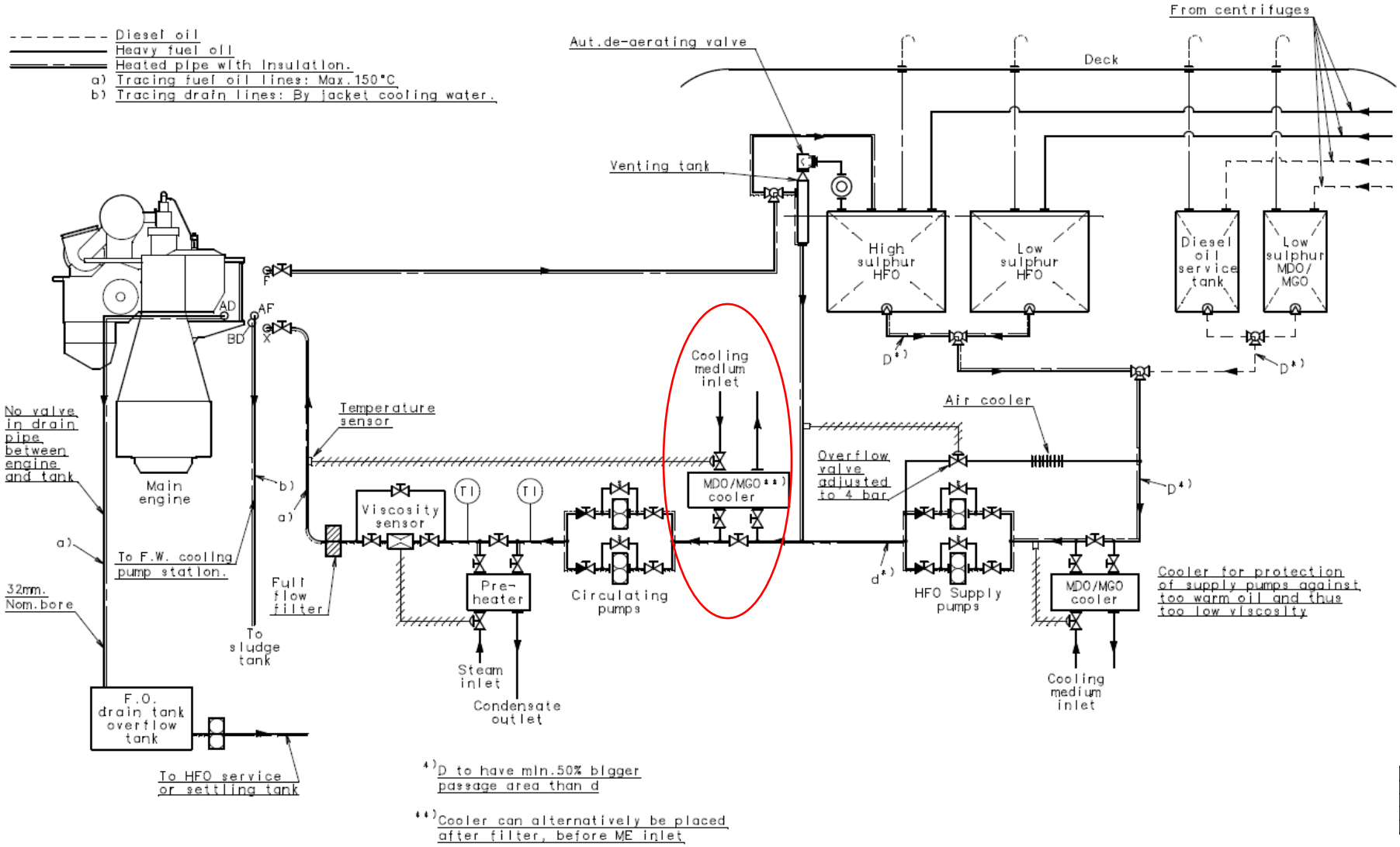
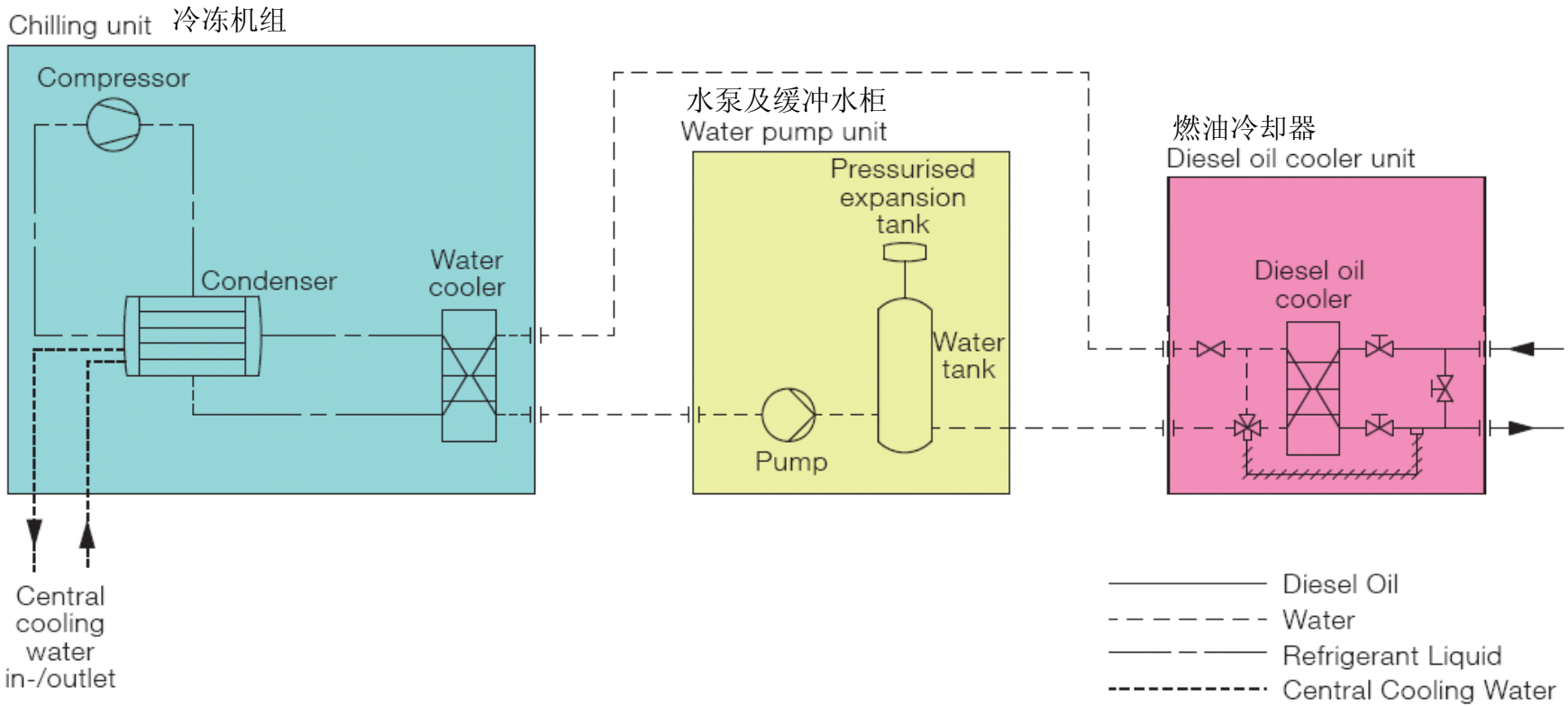
MDO/MGO冷却器
MDO/MGO Cooler



MDO/MGO冷冻机组
MDO/MGO Chilling Unit

对于粘度极低的馏分油，仅使用冷却器可能不够。在这种情况下，建议使用冷冻机组

For the lowest viscosity distillates, a cooler may not be enough to cool the fuel sufficiently. In such a case, it is recommended to install a so-called ‘chiller’.



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MDO/MGO与HFO切换
MDO/MGO and HFO Change-over

在MDO/MGO与HFO切换过程中需注意几点：
Two things to be kept under observation during MDO/MGO and HFO change-over are:

A. 进机燃油粘度不能低于2cSt，不能高于20cSt
The viscosity must not drop below 2 cSt and not exceed 20 cSt.

B. 进机燃油温度变化率不能超过2度/分钟
The rate of temperature change of the fuel inlet to the fuel pumps must not exceed 2°C/minute.

C. 在切换过程中，机器负荷控制在25 - 40%，以减小进机燃油温度的变化
The load during change-over should be 25-40% to ensure a slow change of the temperature

请参考MAN Diesel SL2009-515号通函
Please refer to MAN Diesel Service Letter SL2009-515

Service Letter SL09-515/CXR

MAN Diesel

Action code: WHEN CONVENIENT

Guidelines on Operation on Distillate Fuels

Low-viscosity fuels

SL09-515/CXR
September 2009

Concerns
Owners and operators of MAN B&W two-stroke diesel engines.

Summary
Guidelines on low viscosity fuel.
MAN Diesel recommends fuels with a viscosity of 2 cSt at engine inlet.

Dear Sirs:

With the introduction of new and tighter fuel sulphur content regulations by the EU and the California Air Resources Board, MAN B&W two-stroke engines will increasingly operate on distillate fuels, i.e. marine gas oil (MGO) and marine diesel oil (MDO) in such areas where required.

MAN B&W two-stroke engines are optimised to operate on heavy fuel. However, MGO/MDO fuels can be used when appropriate considerations are made to the following to ensure a safe and reliable performance, i.e.:

- the viscosity and lubricity of the fuel
- keeping a high fuel pump pressure
- the use of a cooler or chiller in an external fuel supply system
- other considerations, references for more information.

This service letter gives guidelines and recommendations on how to ensure a safe and reliable operation on low viscosity distillate fuels.

For any questions or inquiries regarding the recommendations in this service letter, please contact our Operation Department at the e-mail address: ie@manbw.com

Yours faithfully

Ole Green
Senior Vice President
Promotion and Sales

Kjeld Aabo
Director
Promotion and Customer Support

DIESEL switch for automatic change-over between HFO and MGO/MDO

自动切换 - DIESELswitch
Automatic Change-ovre by DIESEL*switch*

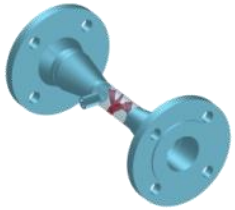
优点 **Advantages:**

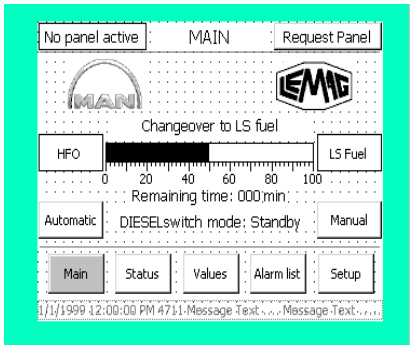
➢ 安全控制切换过程
Safety controlled change over process

减少由于温度急剧变化而导致的燃油喷射部件损坏
minimized risk of damaged fuel injection parts due to abrupt temperature changes

➢ 可以在全负荷下完成切换
Change over running at full load possible

无需为完成燃油切换而降低机器负荷
No need to run engine with lowest power for change over process





使用低硫油的挑战 – 残留的催化剂颗粒
Challenges of Low-sulphur HFO - Catfines

低硫油，尤其是SECA区域的低硫油，通常催化剂颗粒含量很高，易造成缸套、活塞环和油嘴等的过度磨损

Low sulphur fuels, especially SECA fuels, often has a high cat fines content，causing abrasive wear of liners，piston rings and fuel nozzles

确保船上的分油机处于良好的工作状态

Ensure the purifier on board are in good condition

重油中硫含量的降低意味着催化剂颗粒的增加

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

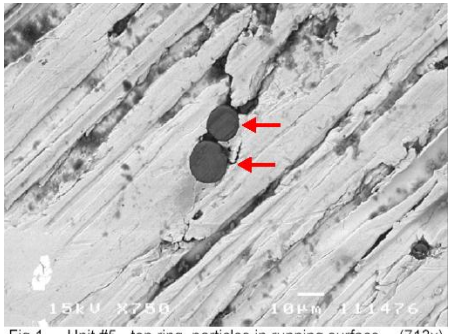
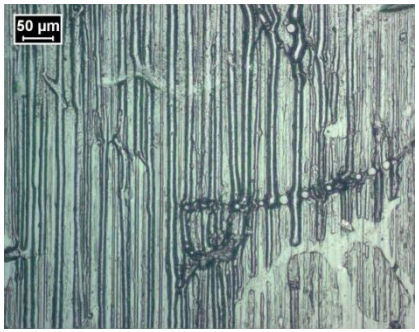
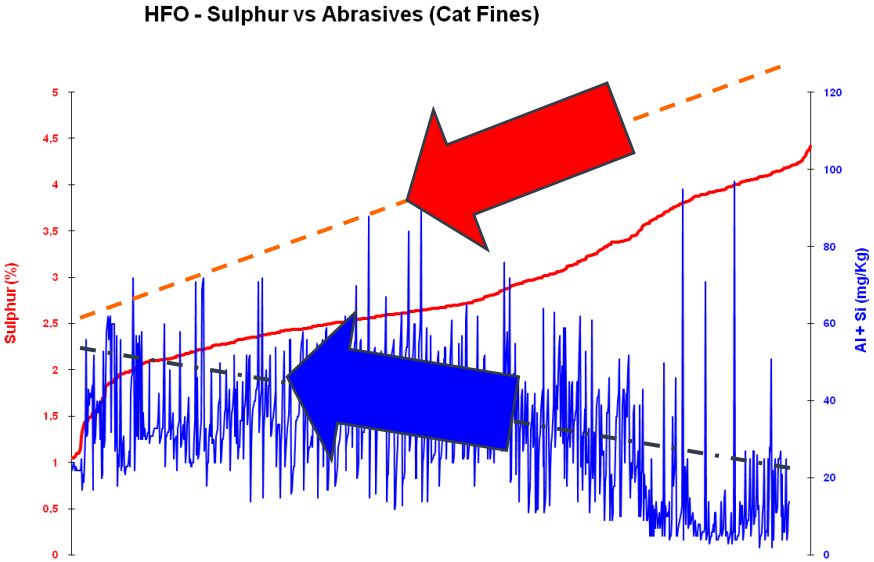


Fig.1 Unit #5 - top ring, particles in running surface (713x)



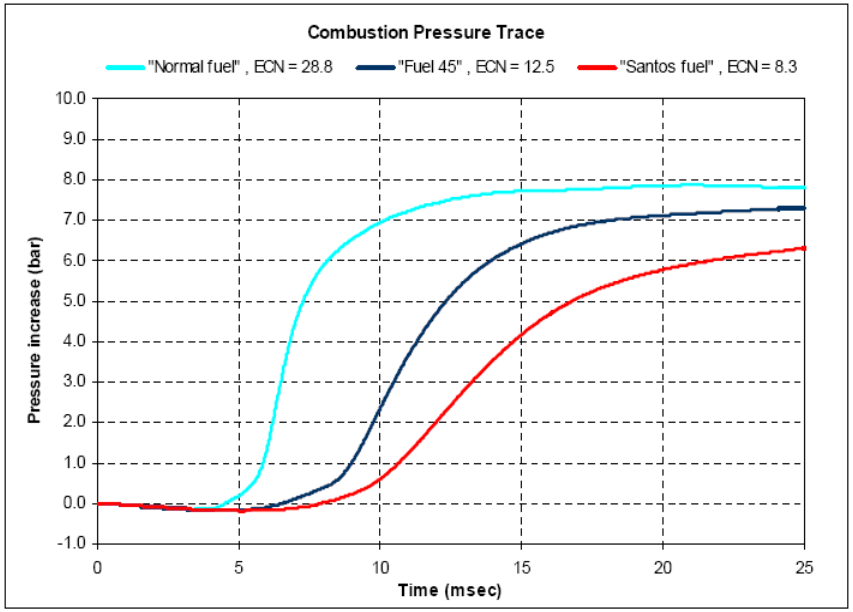


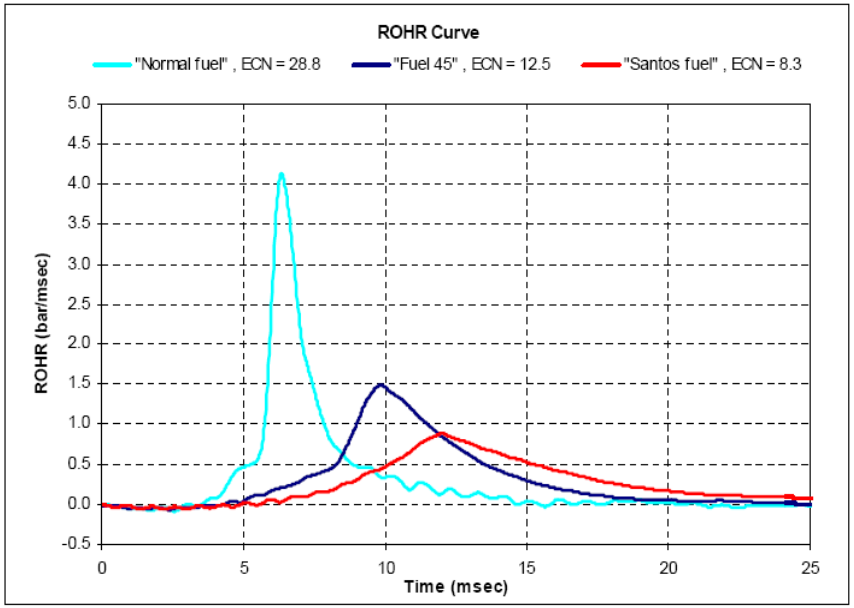
Source: DNVPS database of 1,012 analysis results (from 1 October – 10 November 2007)

低硫燃油的点火与燃烧特性
Ignition and Combustion Characteristics of Low Sulphur Fuels

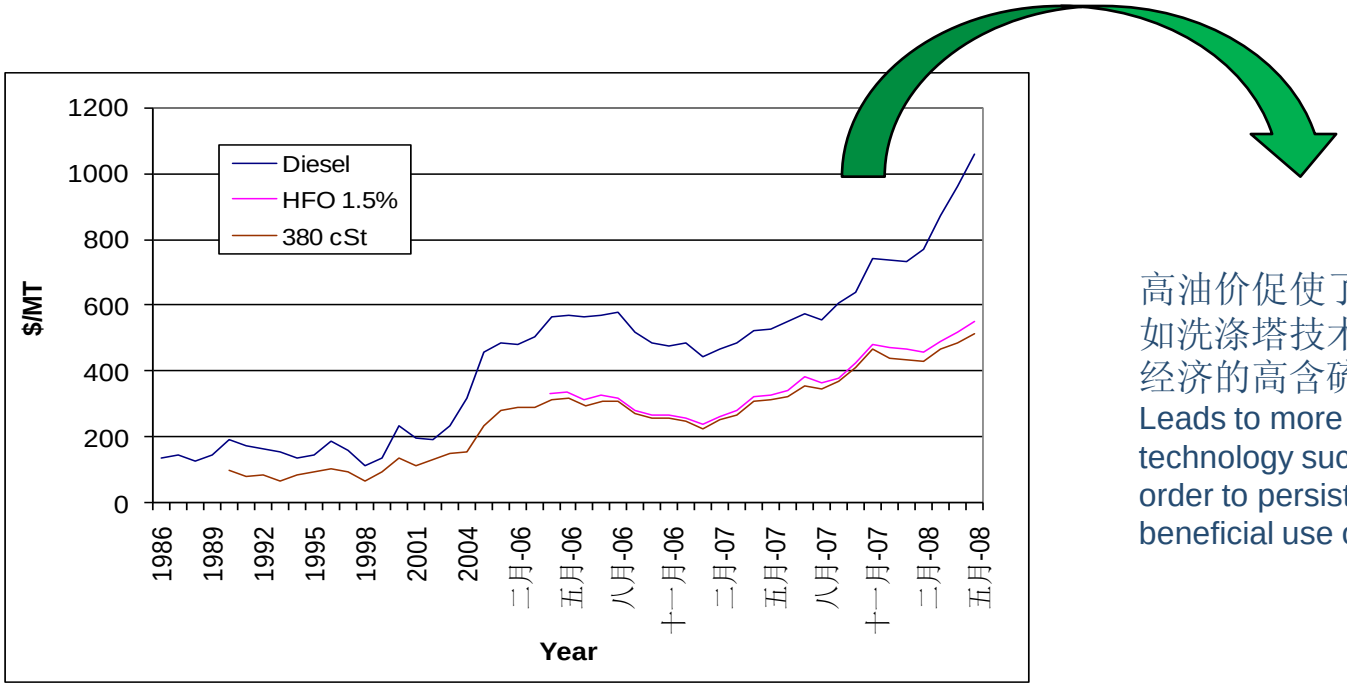
低硫燃油通常有慢燃特性，但是，慢燃特性、十六烷值以及FIA值，对于二冲程低速机都没有问题

Low sulphur fuels often has slow burning characteristic. However, the burning characteristic, the cetane number and the FIA number is not an issue on slow speed two stroke engines





洗涤塔
Scrubber



高油价促使了除硫装置的应用，如洗涤塔技术，这样就能使用更经济的高含硫量重油

Leads to more focus on abatement technology such as wet scrubbers – in order to persist with economical beneficial use of HFO with sulphur.

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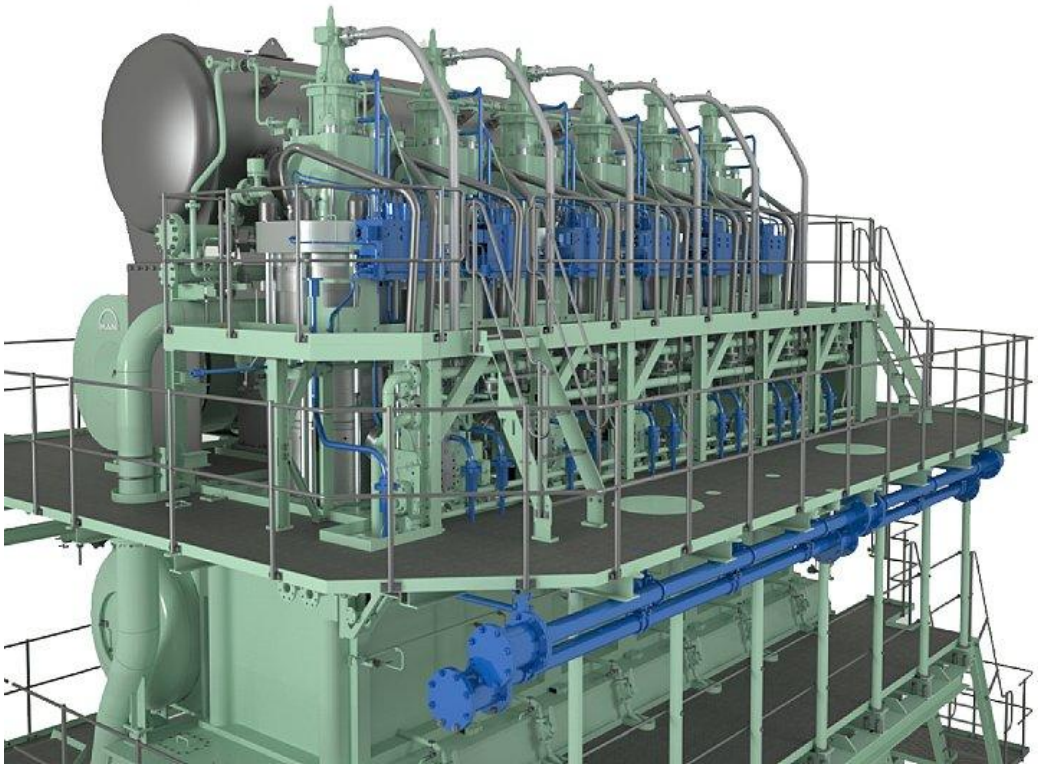
洗涤塔技术的发展与未来
Scrubber Technology Tests and future

Objectives	Participants	Scrubber	Goals	Test results	Ship test	Ship test
Development and test of scrubber for after-treatment	Clean Marine MAN Diesel		PM trapping: >90% SO_X removal: >67%	PM trapping: 35% 80% (salts add.) SO_X removal: 73% 95% (salts add.)	M.V. Banasol 7S50MC-C 9MW	
Development and test of scrubber for after-treatment	Aalborg Industries Alfa Laval DFDS MAN Diesel		PM trapping: >75% SO_X removal: >95%	PM trapping: 79% SO_X removal: 100% (NaOH)	Tor Ficaria 9L60MC-C 20MW	
Development and test of scrubber for after-treatment and EGR	APM MAN Diesel		PM trapping: >75% SO_X removal: >90%	PM trapping: 73% SO_X removal : 96% (NaOH)	Alexander 7S50MC 9MW	

MAN B&W ME-GI双燃料主机
MAN B&W ME-GI Dual Fuel Engine

使用天然气清洁燃料，减少排放：
CO_2 减少 20 %
NO_X 减少 15 %
SO_X 减少 90 %
颗粒物减少 40 %
LNG as fuel, lower emissions:
CO_2 reduction 20 %
NO_X reduction 15 %
SO_X reduction 90 %
Particulate matter reduction 40 %

通过简单的改造就可以使用双燃料
Simple modifications enable two-stroke gas injection



使用气体燃料所需添加的部件以蓝色标示
The add-on components are marked in blue color

联系方式

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