
CSSC
沪东重机有限公司
HUDONG HEAVY MACHINERY CO.,LTD.
2 Stroke Engine
new technology
Zhang Zhen Shan
Senior engineer
Low speed engine
R&D Center_HHM

Topic

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NOx emission control

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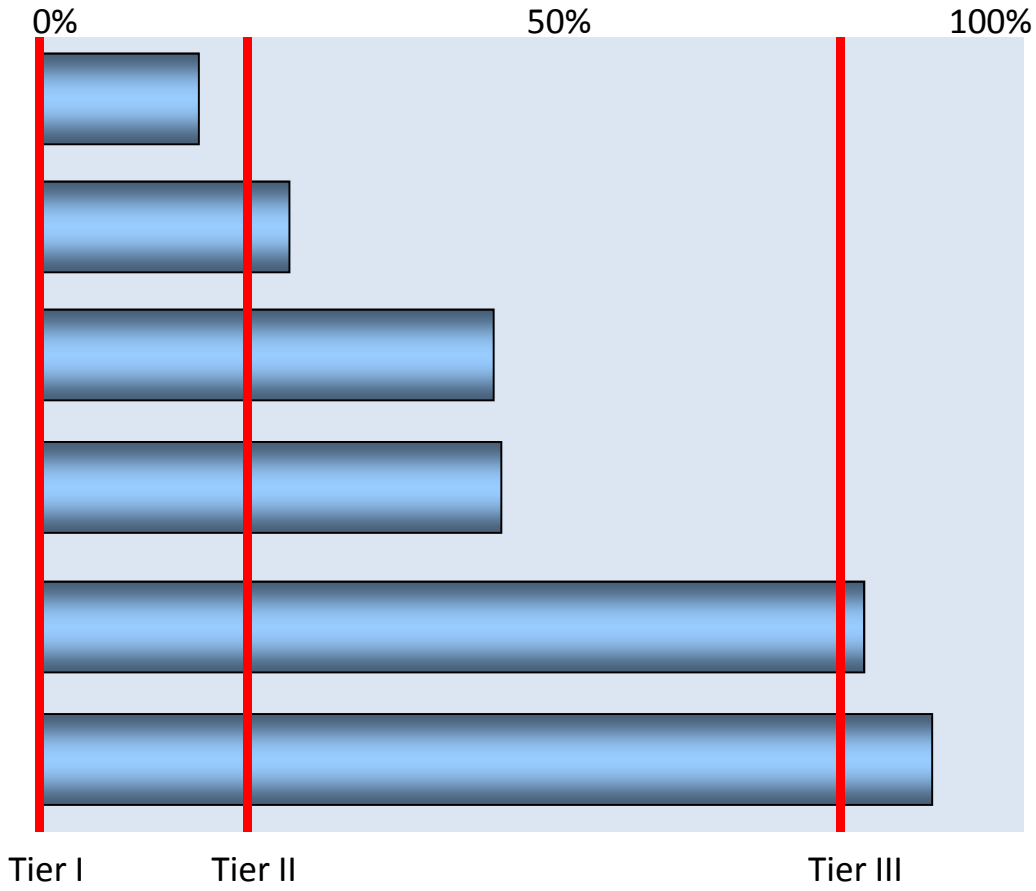
Diesel engine NOx reducing technology

Technology	Effect of Reduction
engine optimize tuning	
Miller cycle	
Scavenge Air Moisturizing	
Fuel Water emulsification	
EGR	
SCR	



NOx emission control

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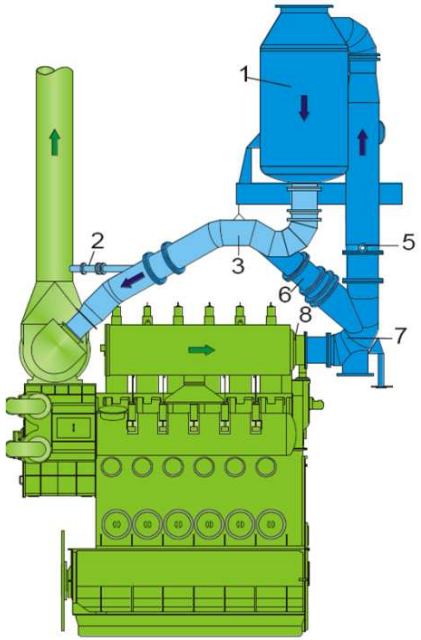
Solutions

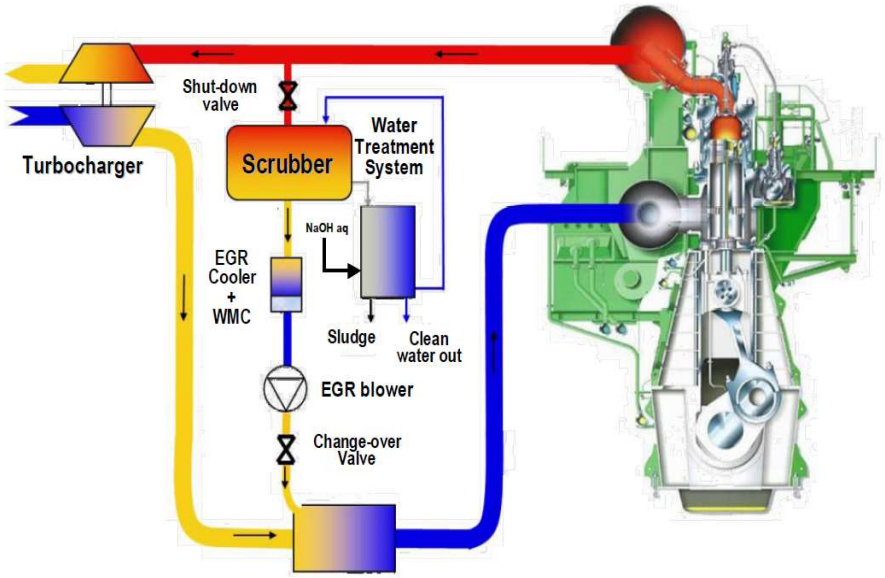
SCR

After treatment

EGR

Production control





SCR

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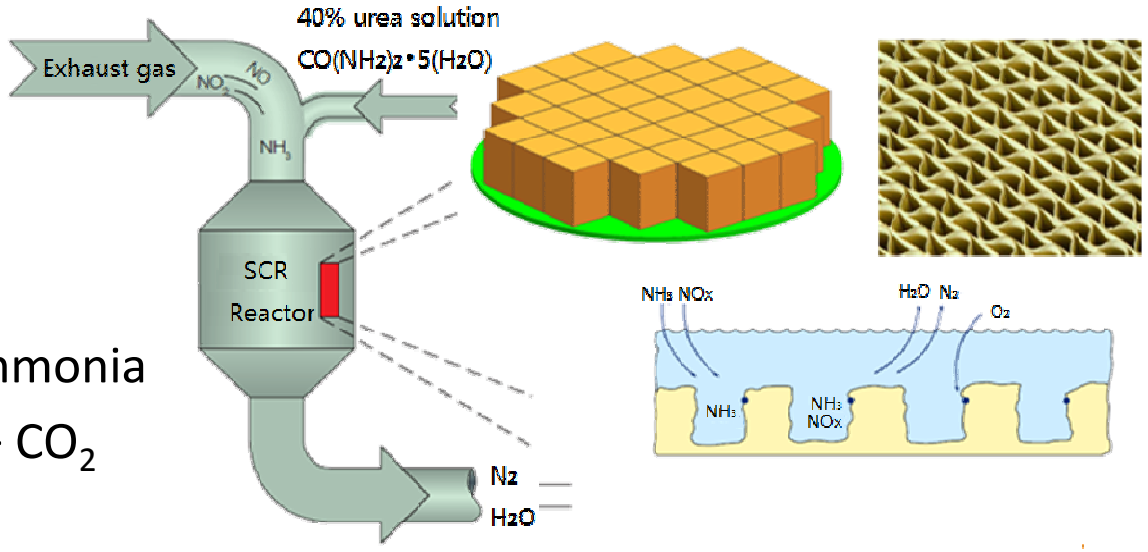
Selective Catalytic Reduction

SCR working principle



1. Urea solution mixed to Gas
   - $CO(NH_2)_2 + H_2O$
2. Urea solution change to ammonia
   - $CO(NH_2)_2 + H_2O \rightarrow NH_3 + CO_2$
3. Redox reaction
   - $NH_3 + NOx + O_2 \rightarrow N_2 + H_2O$

SCR

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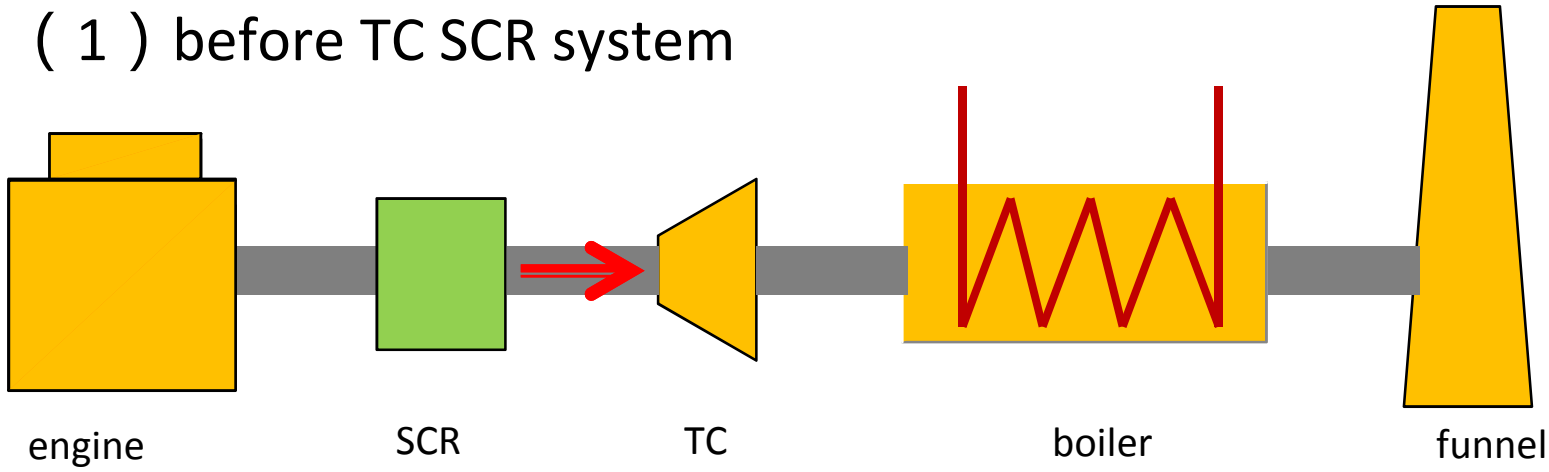
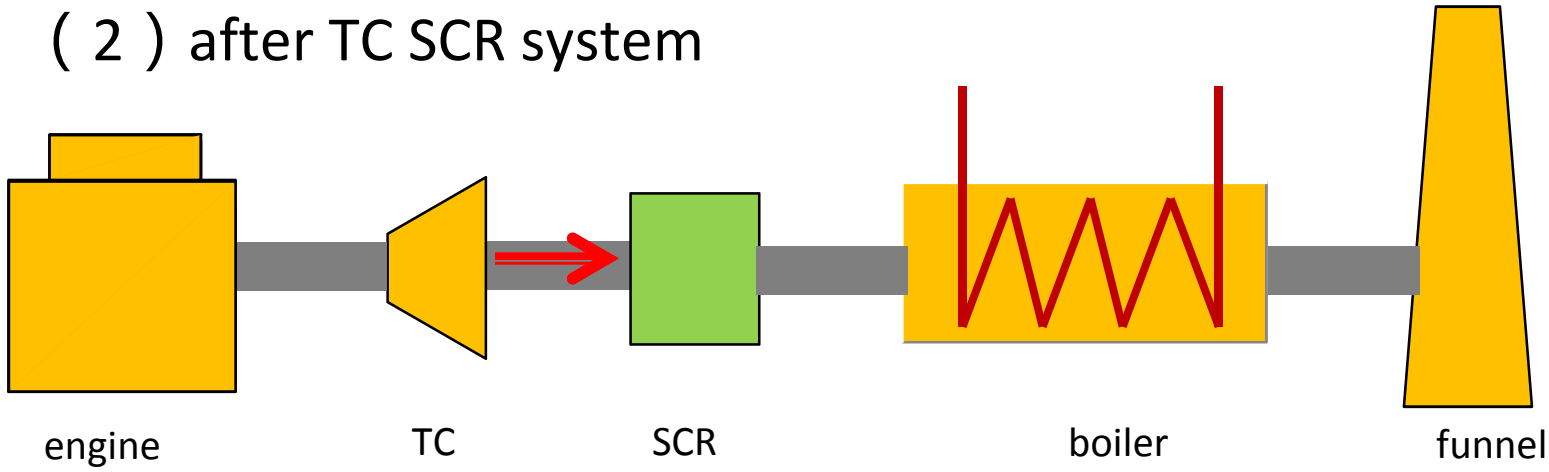
（1）before TC SCR system



（2）after TC SCR system



SCR

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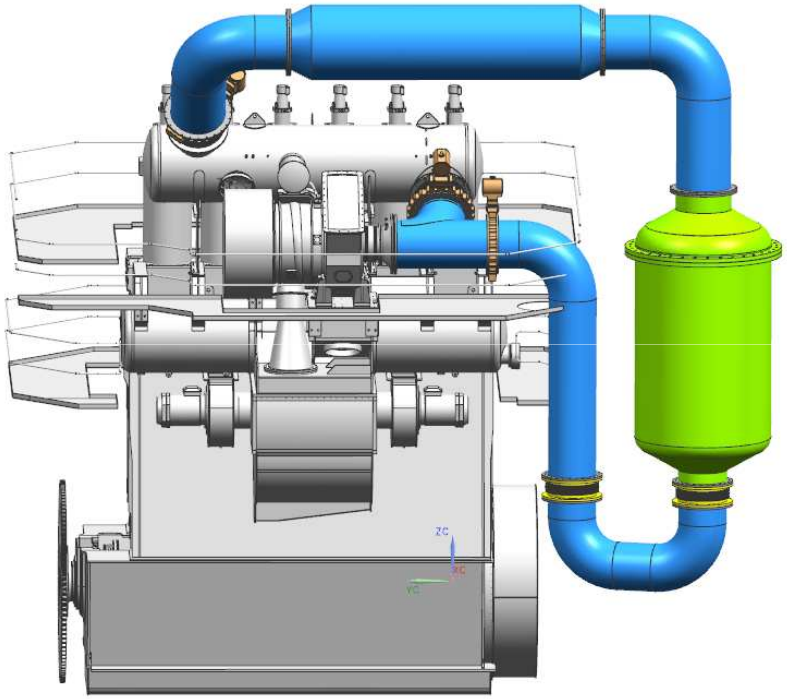
（1）before TC SCR system

- SCR reactor between TC and exhaust gas receiver.
- High temperature high pressure gas.
- Catalytic operation T>300℃.
- Sulphur oil can be used.



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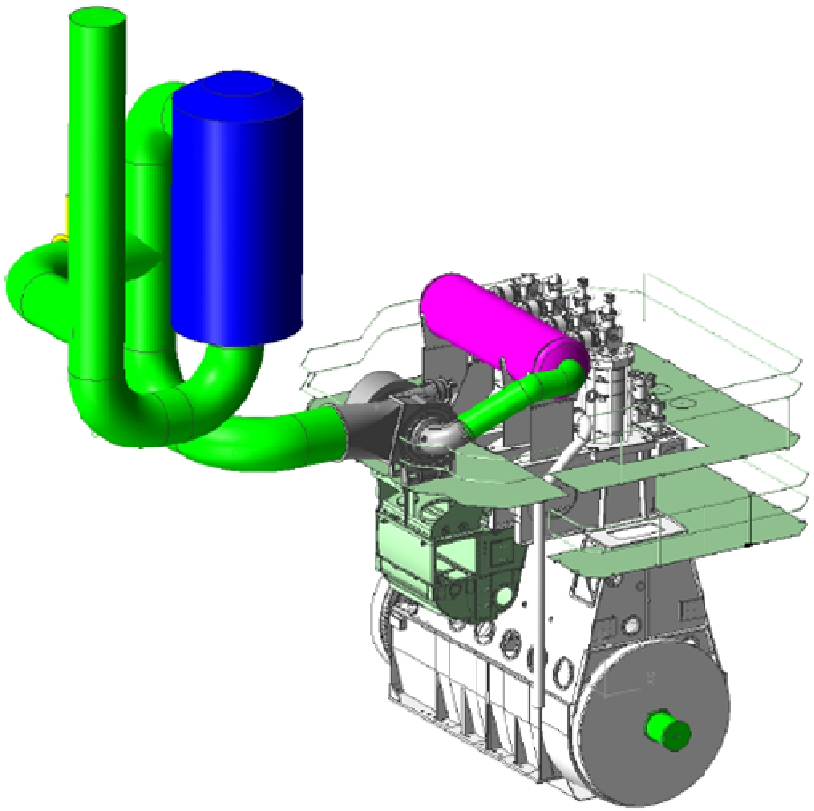
（2）after TC SCR system

- SCR reactor after TC.
- Low temperature Low pressure gas.
- Catalytic operation T<300℃.
- Sulphur oil can not be used.
- No influence on engine design but larger.



HHM-SCR

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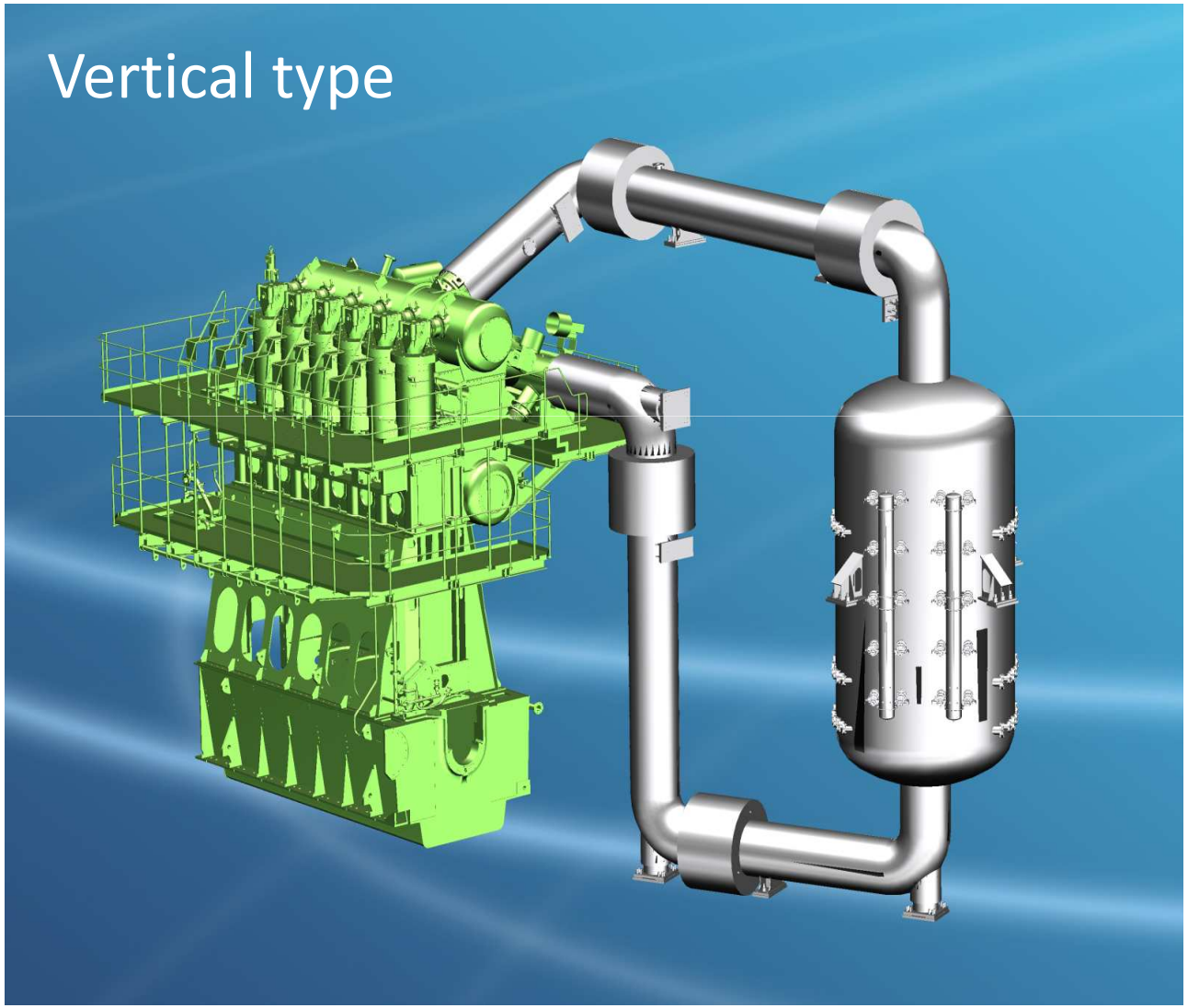

HHM-SCR

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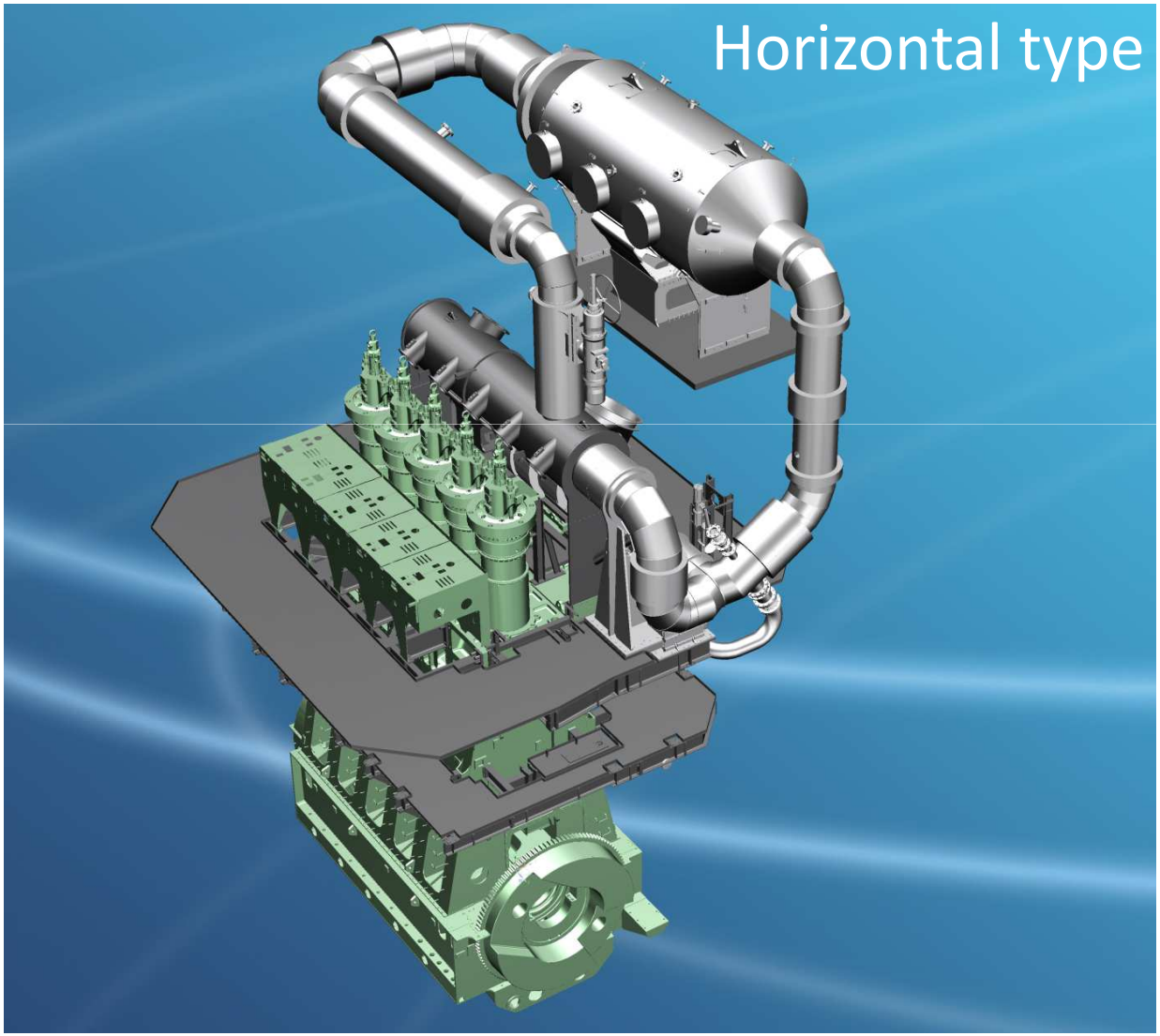

HHM-SCR

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Low speed engine SCR system specification

parameter	unit	value
SCR by-pass，fulfills Tier II	g/kW.h	≤ 14.4
SCR operation, fulfills Tier III	g/kW.h	≤ 3.4
SCR system pressure loss*	mbar	< 50
Ammonia slip	ppm	< 10
Urea solution thickness by weight	%	40
Suited fuel		HFO，MGO，MDO，GAS，……

*pressure loss within the range of the engine allowed.

HHM-SCR

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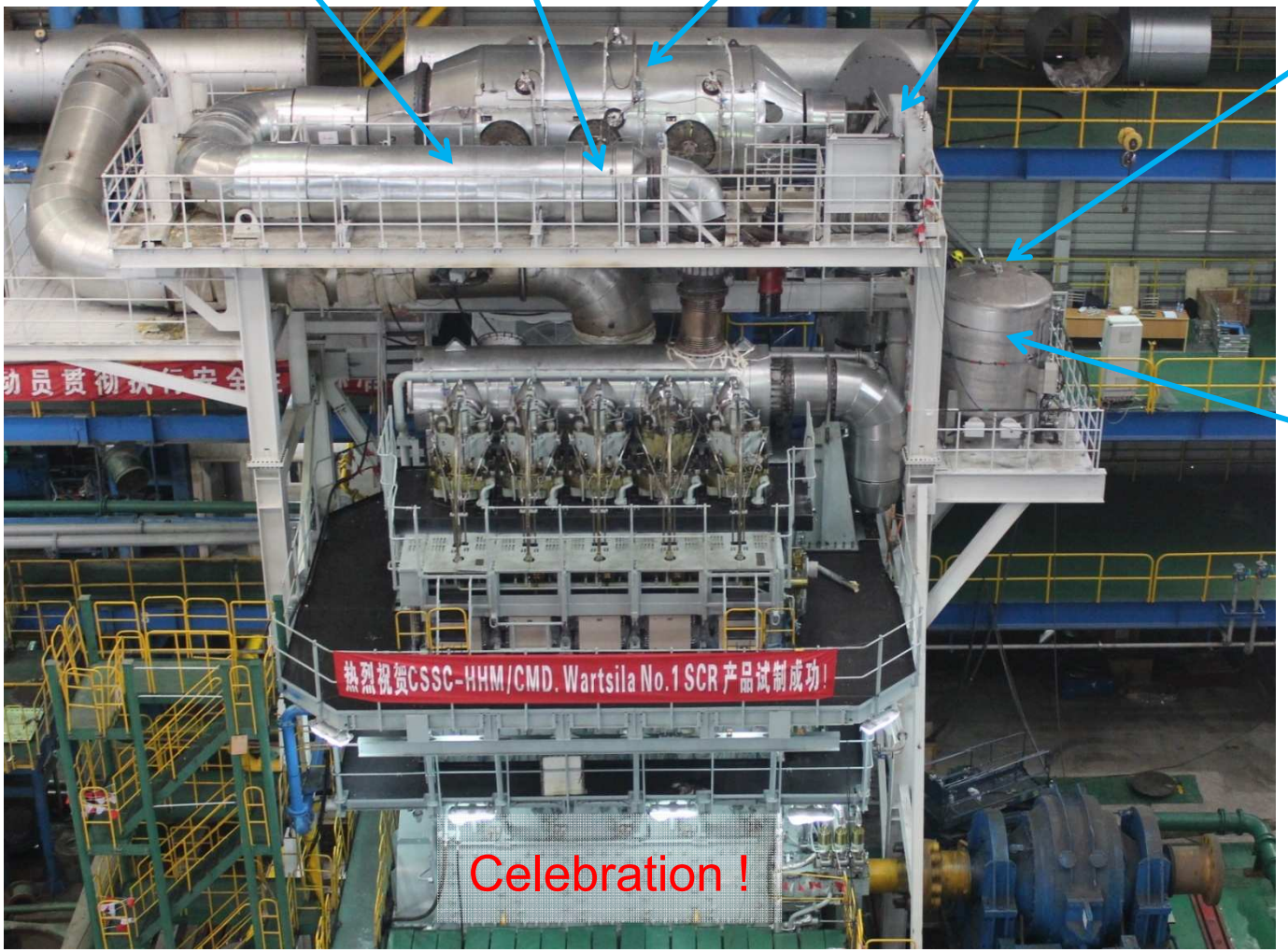
SCR parts designed according to engine room arrangement



HHM-SCR

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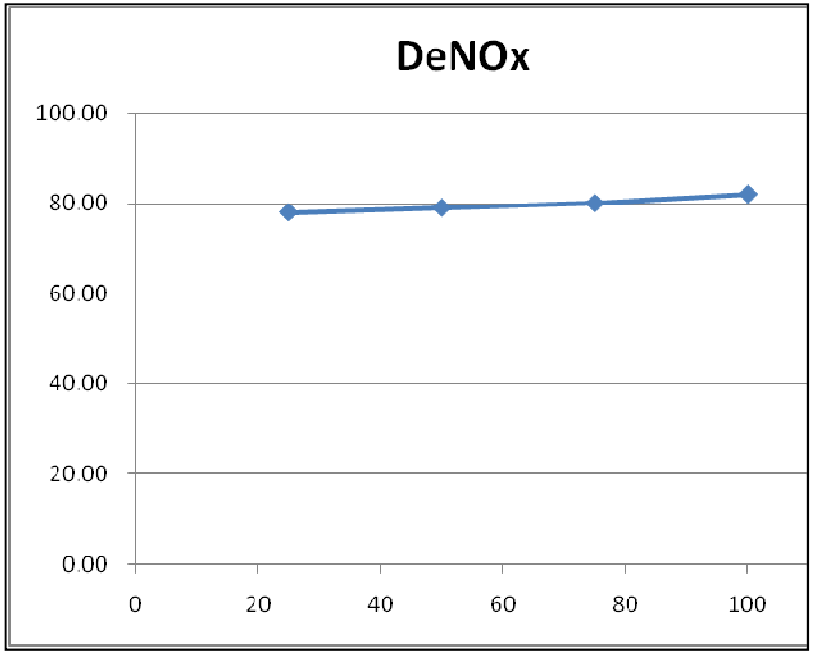
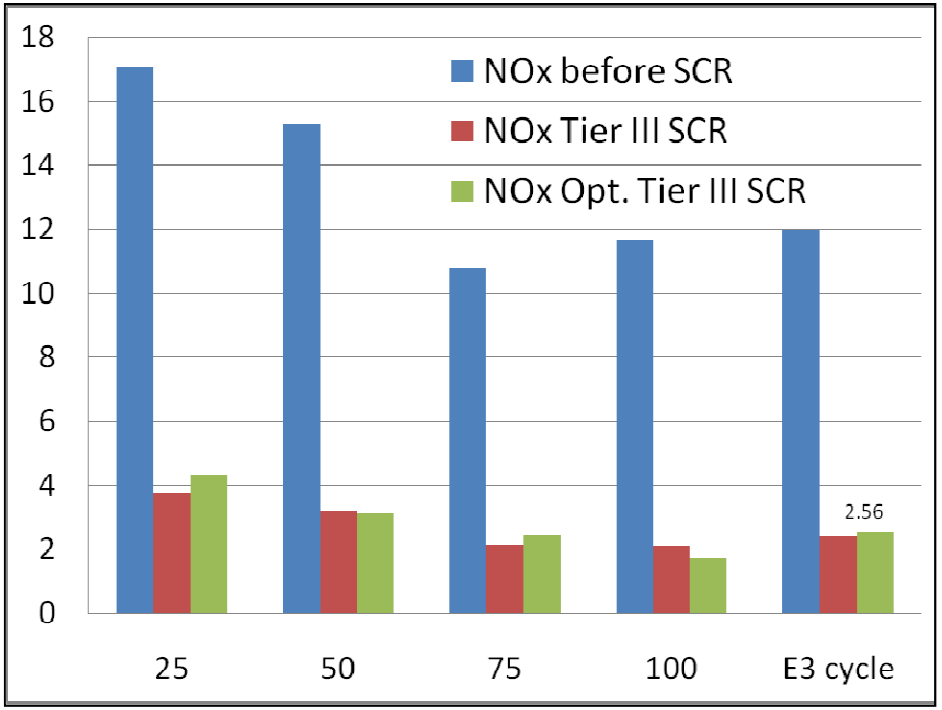
E3 cycle emission test report:

- NOx reduction setting = 78%
- NOx reduction rate = 79%
- E3 cycle NOx emission= 2.56 g/kWh
- E3 single point ≤5.1 g/kWh

Tier III: 3.4g/kWh, Single point 3.4x1.5g/kWh





HHM-SCR

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- HHM-SCR test conclusion:
  - ✓ NOx emission fulfill the requirement of Tier III .
  - ✓ SCR optimized can decrease SFOC.
  - ✓ Engine control and SCR control system are steady.
  - ✓ SCR operation well in Engine Low load.
  - ✓ Urea solution pump station、 dust blowing system、 valves operation well.
- HHM-SCR system can be official supplied since 2015.

HHM-SCR selection

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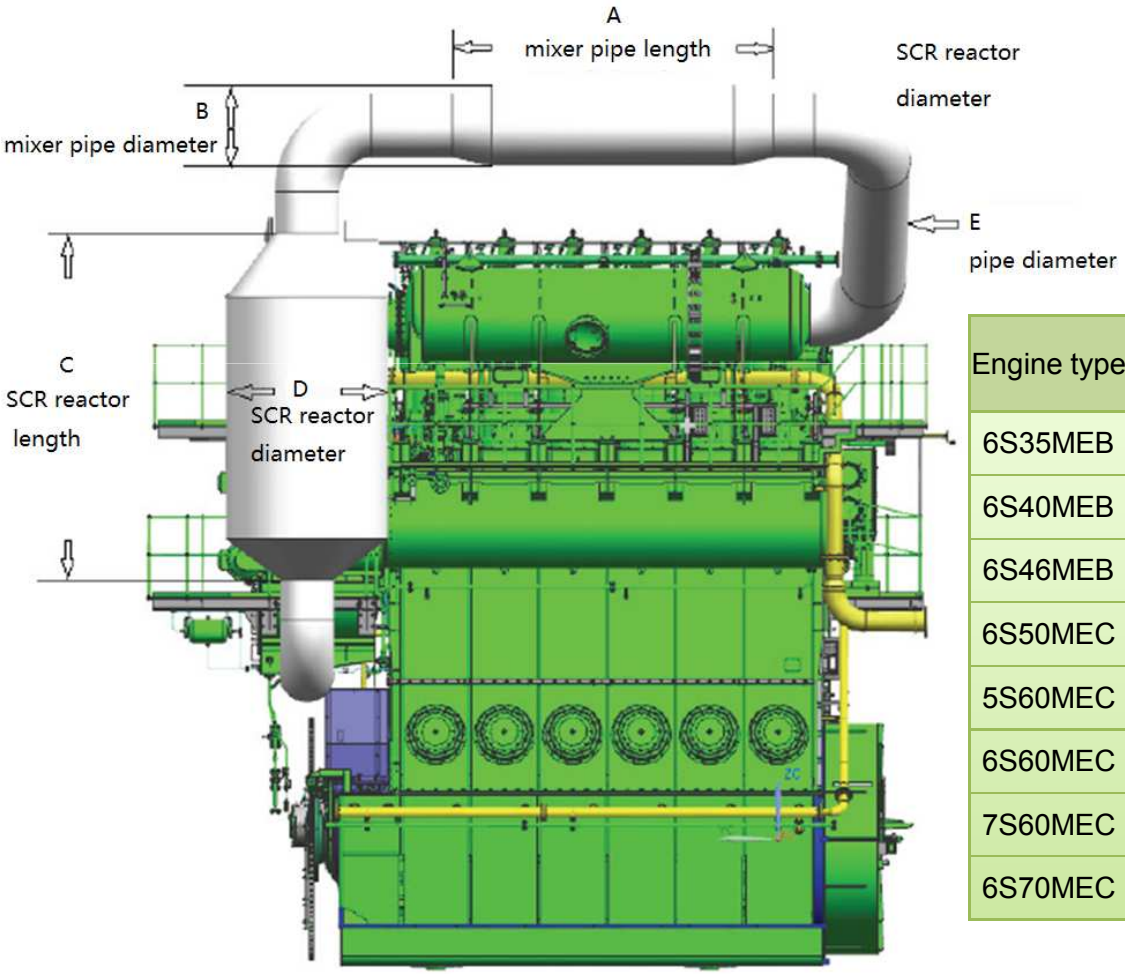
MAN engine SCR selection



Engine type	Power (kW)	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
6S35MEB	5220	3500	900	3500	1600	600
6S40MEB	6810	3800	900	3500	1720	700
6S46MEB	8280	4000	1000	3500	1900	800
6S50MEC	9960	4200	1000	4000	2200	800
5S60MEC	11900	4500	1200	4500	2350	900
6S60MEC	14280	4700	1200	4500	2500	1000
7S60MEC	16660	5000	1500	5200	2800	1200
6S70MEC	19620	5500	1800	6000	3150	1500

HHM-SCR selection

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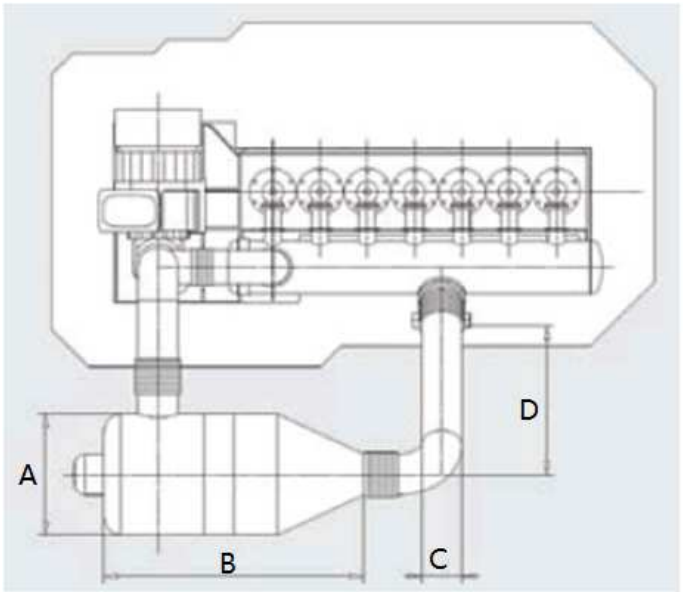
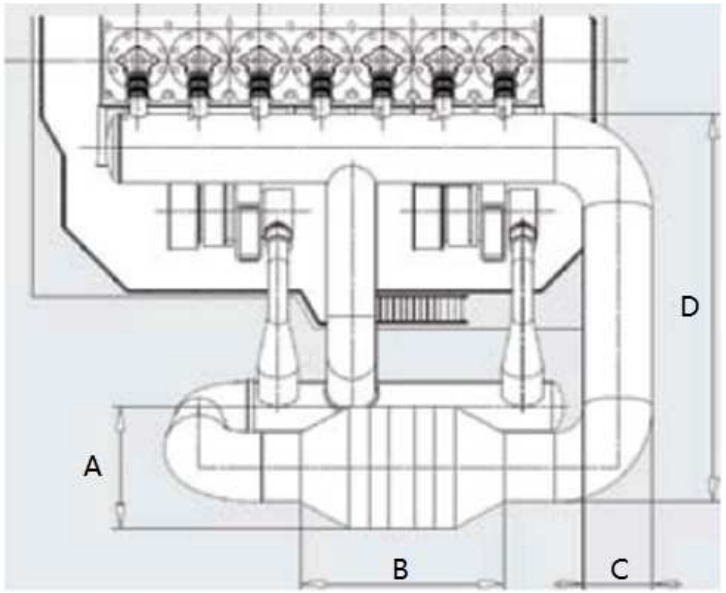
Wärtsilä engine SCR selection：

Engine type	Power (kW)	SCR diameter A (mm)	SCR length B(mm)	mixer diameter C(mm)	mixer length D(mm)
6RT-flex50D	10470	1900	4200	900	4700
7RT-flex50D	15820	2200	4000	1100	5200
8RT-flex50D	25040	2700	4800	1400	6100
9RT-flex50D	31640	3000	5000	1700	6600





EGR

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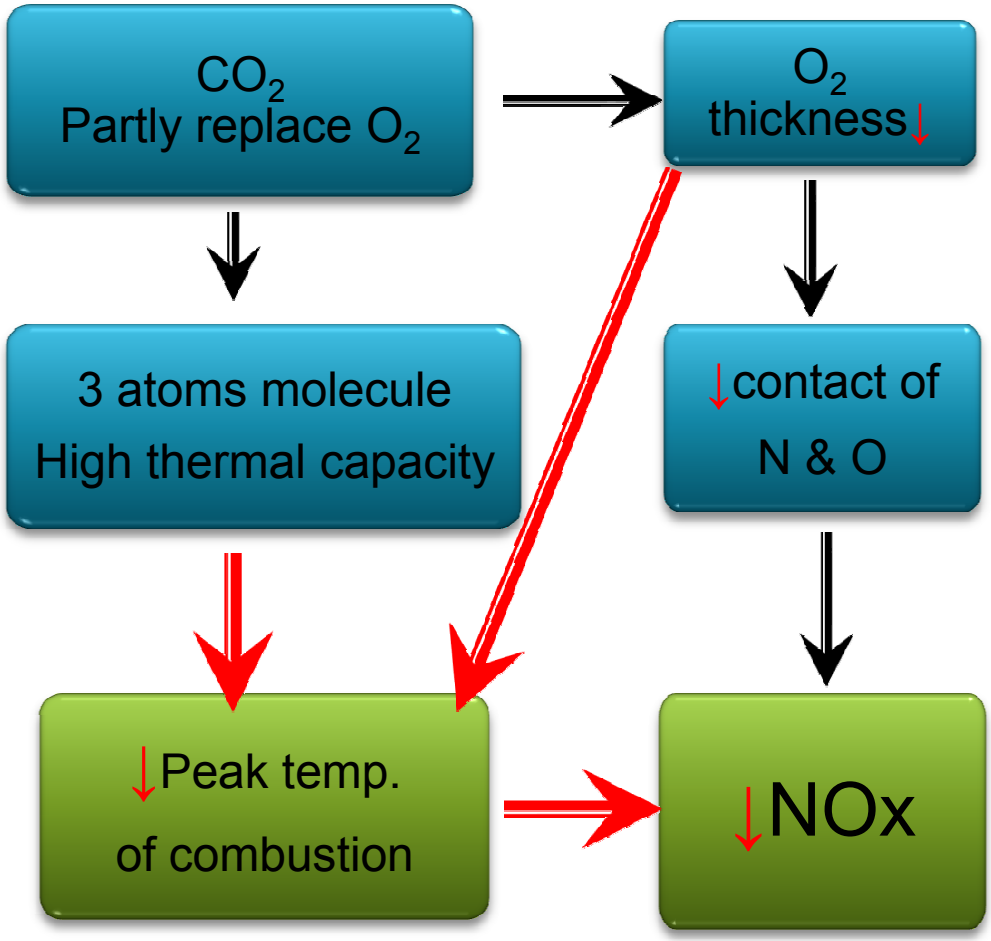
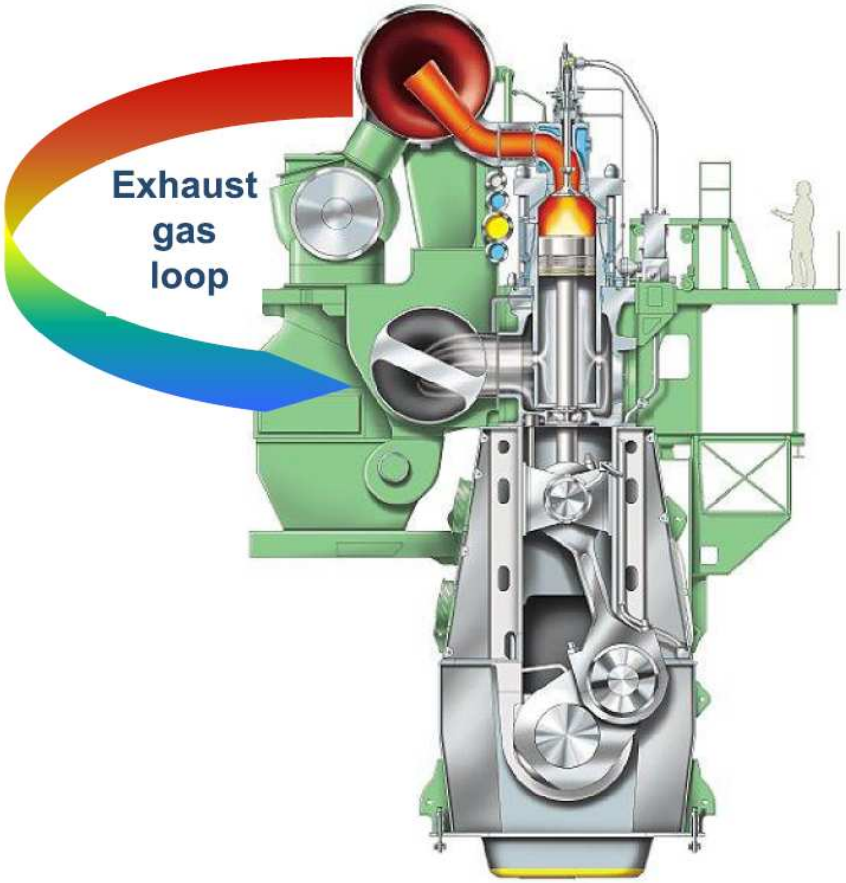
Exhaust Gas Recirculation





EGR

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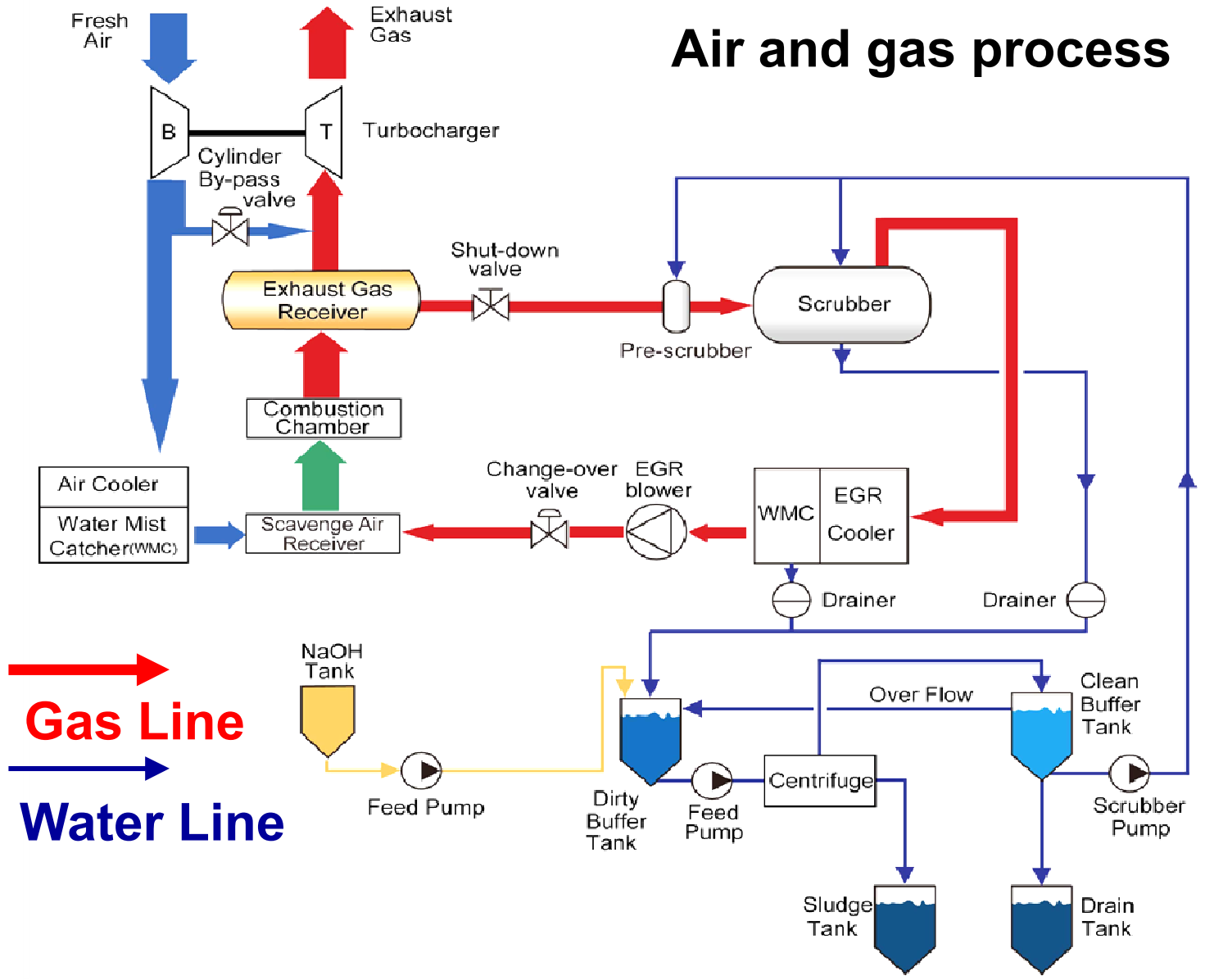
Air and gas process



EGR matching

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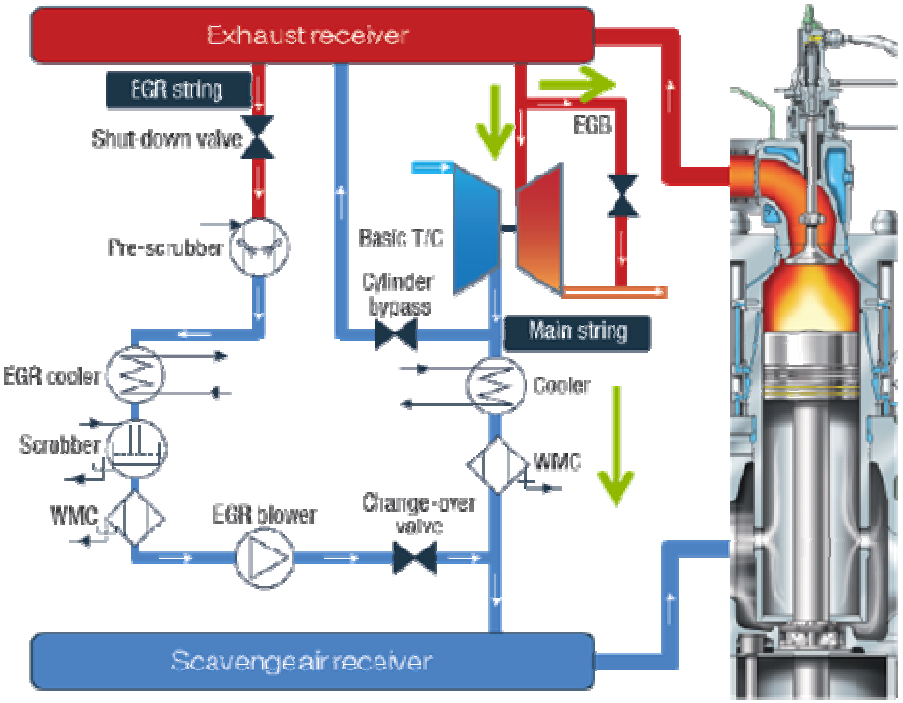
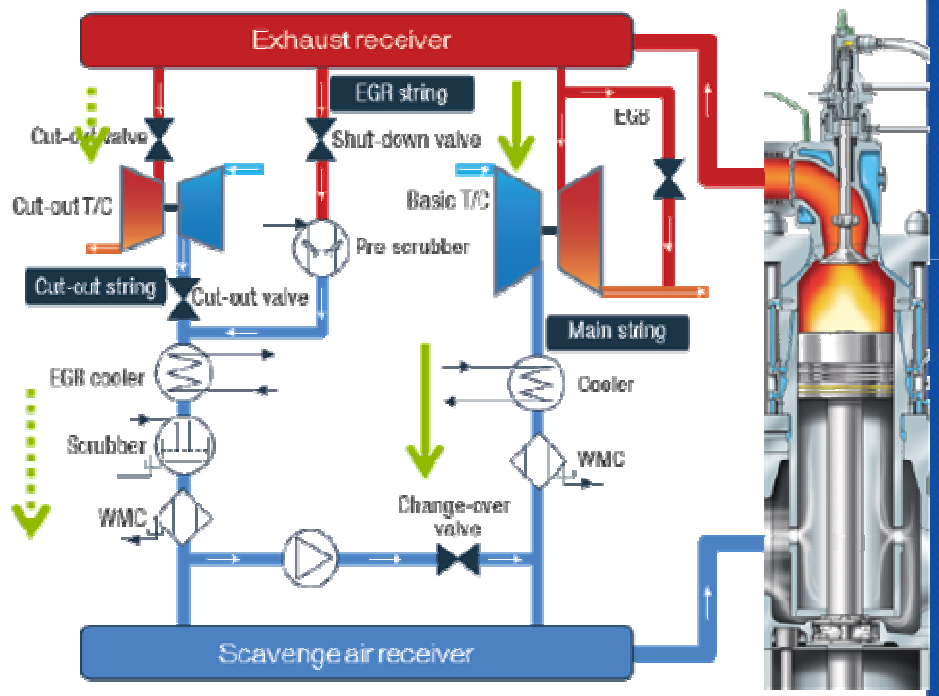
EGR – By-pass matching



No EGR

EGR – Cut out matching



Solutions depends on engine design

Similar performance

TC cut out / EGB → Low/part load optimised Tier 2

EGR matching

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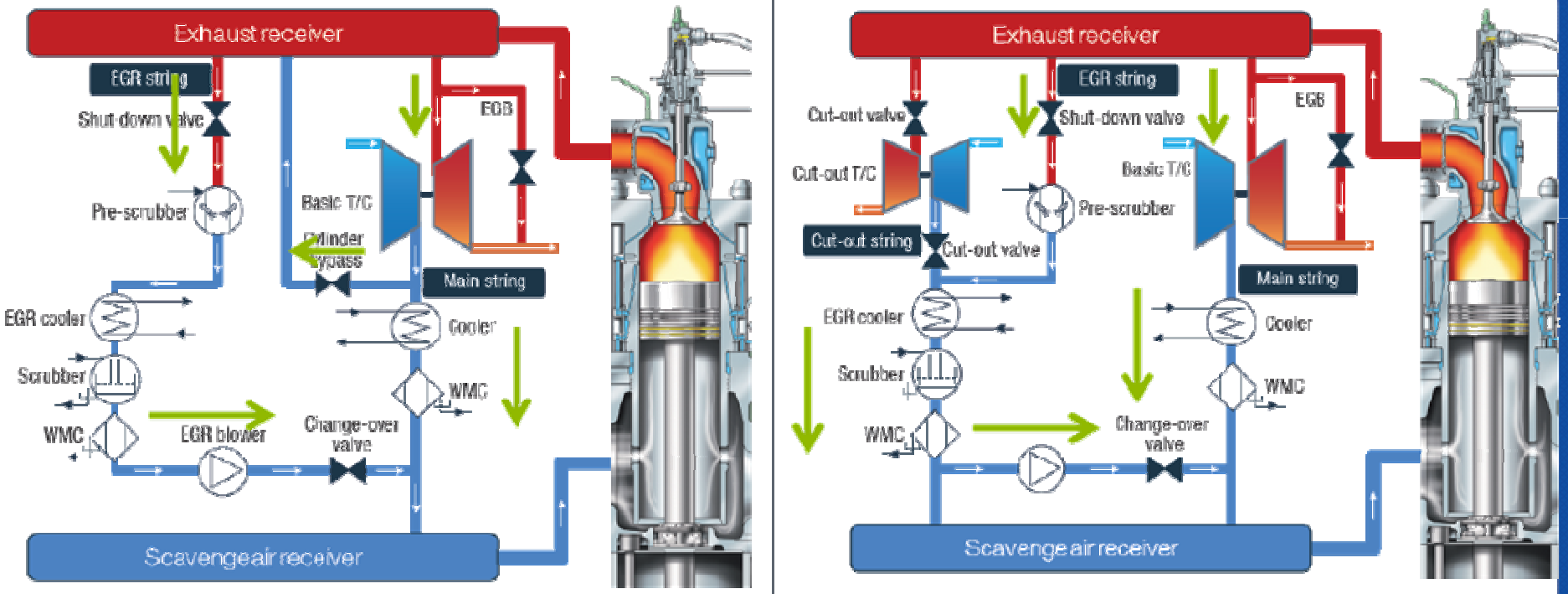
EGR – By-pass matching

EGR

EGR – Cut out matching



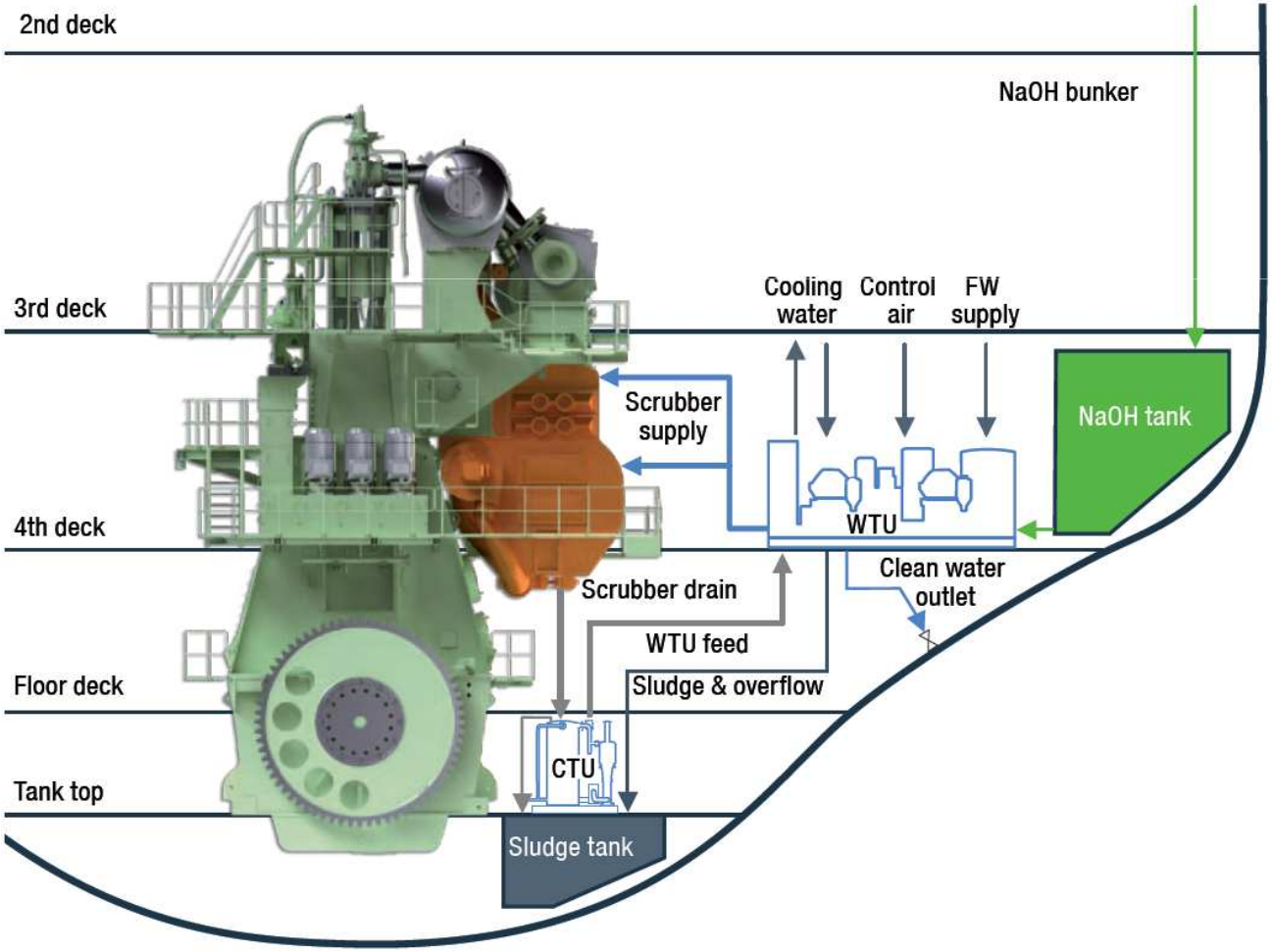
Solutions depends on engine design

Similar performance

TC cut out / EGB → Low/part load optimised Tier 2

EGR system

- EGR and its control system integrated in engine.
- WTU/CTU/tank in engine room.



Summary

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SCR ？ EGR ？

	SCR	EGR
Space	larger	smaller
First cost	lower	higher
Operation in ECA	Urea consumption	Higher SFOC NaOH consumption
Operation out of ECA	normal	Lower SFOC
Operation time in ECA	Long time high consumption	
Engine load power	High load high consumption	

Topic

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WHR back ground

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◆ How to decrease EEDI

- ✓ Propulsion power must be reduced
- ✓ Ship speed is consequently lowered
- ✓ Ship size or number increased
- ✓ lowering of ship speed
- ✓ derating of engines
- ✓ optimisation of the hull
- ✓ optimisation of the propeller
- ✓ Coating
- ✓ ……

✓ **Use of WHR:**
Reduce or without generator engine;
Supply working steam / driving power
Supply warm water for crew life;

WHR

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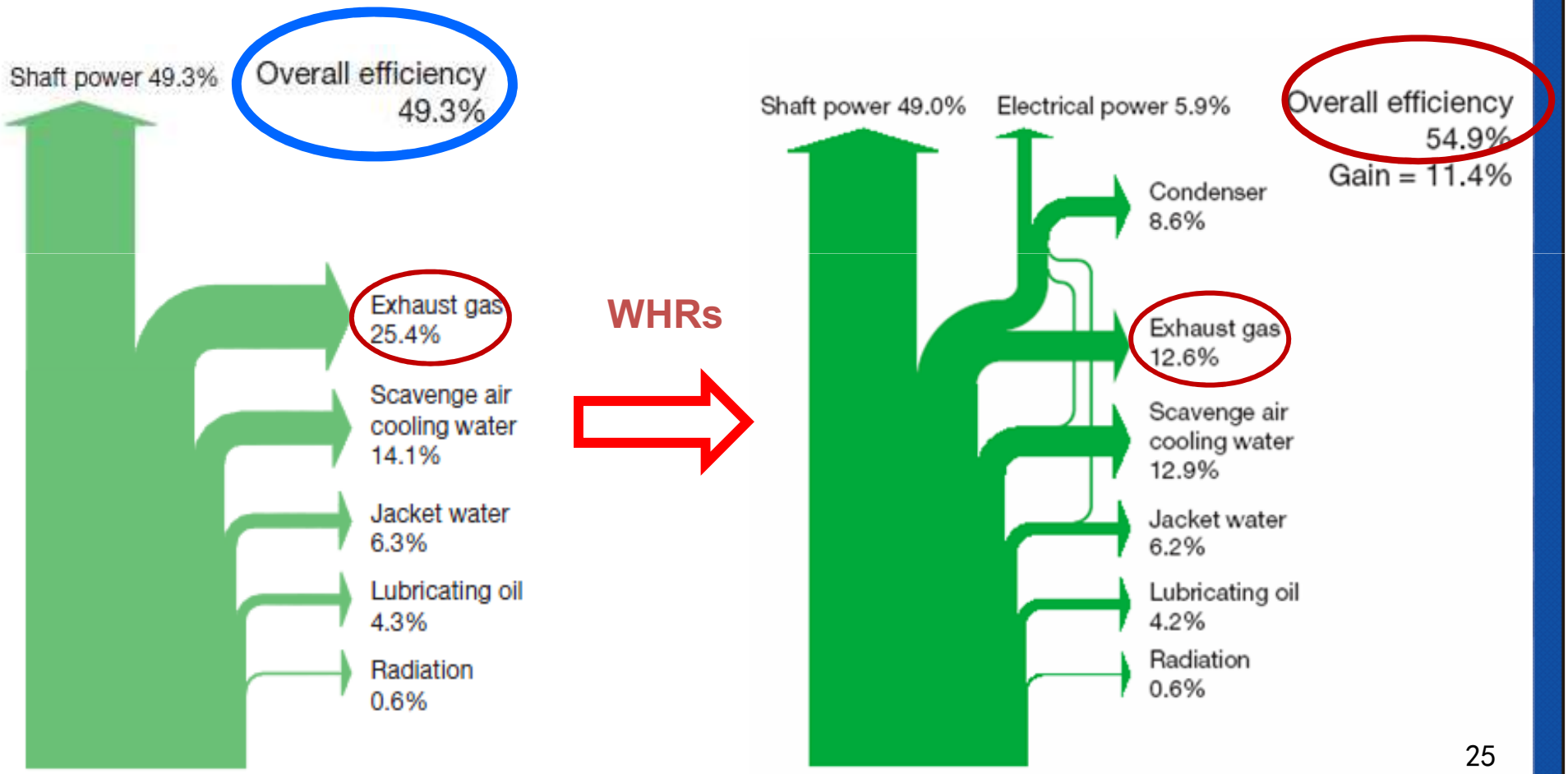
WASTE HEAT RECOVERY SYSTEM



CSSC-WHR

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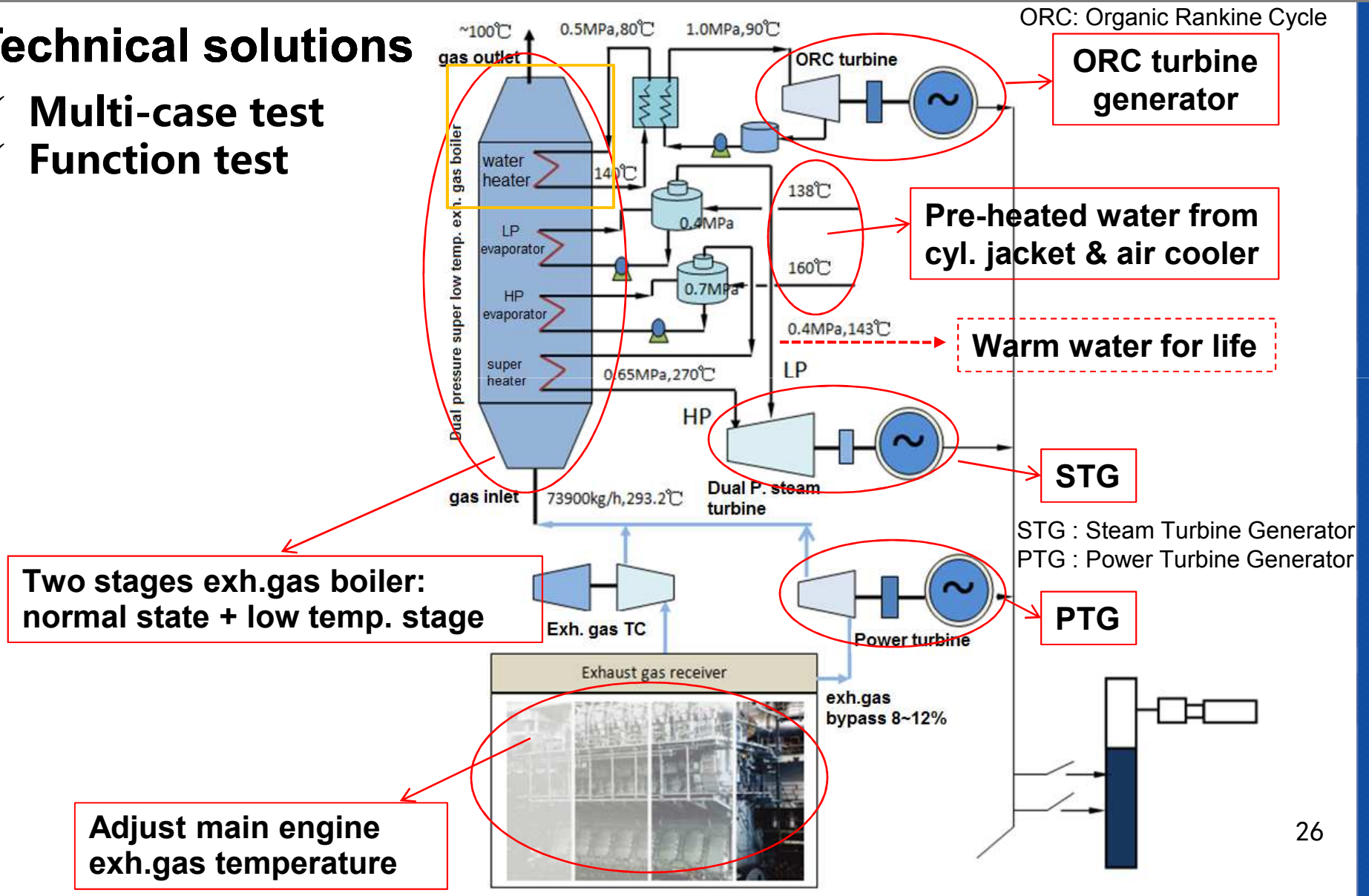
Technical solutions

- ✓ Multi-case test
- ✓ Function test

ORC: Organic Rankine Cycle



CSSC-WHR

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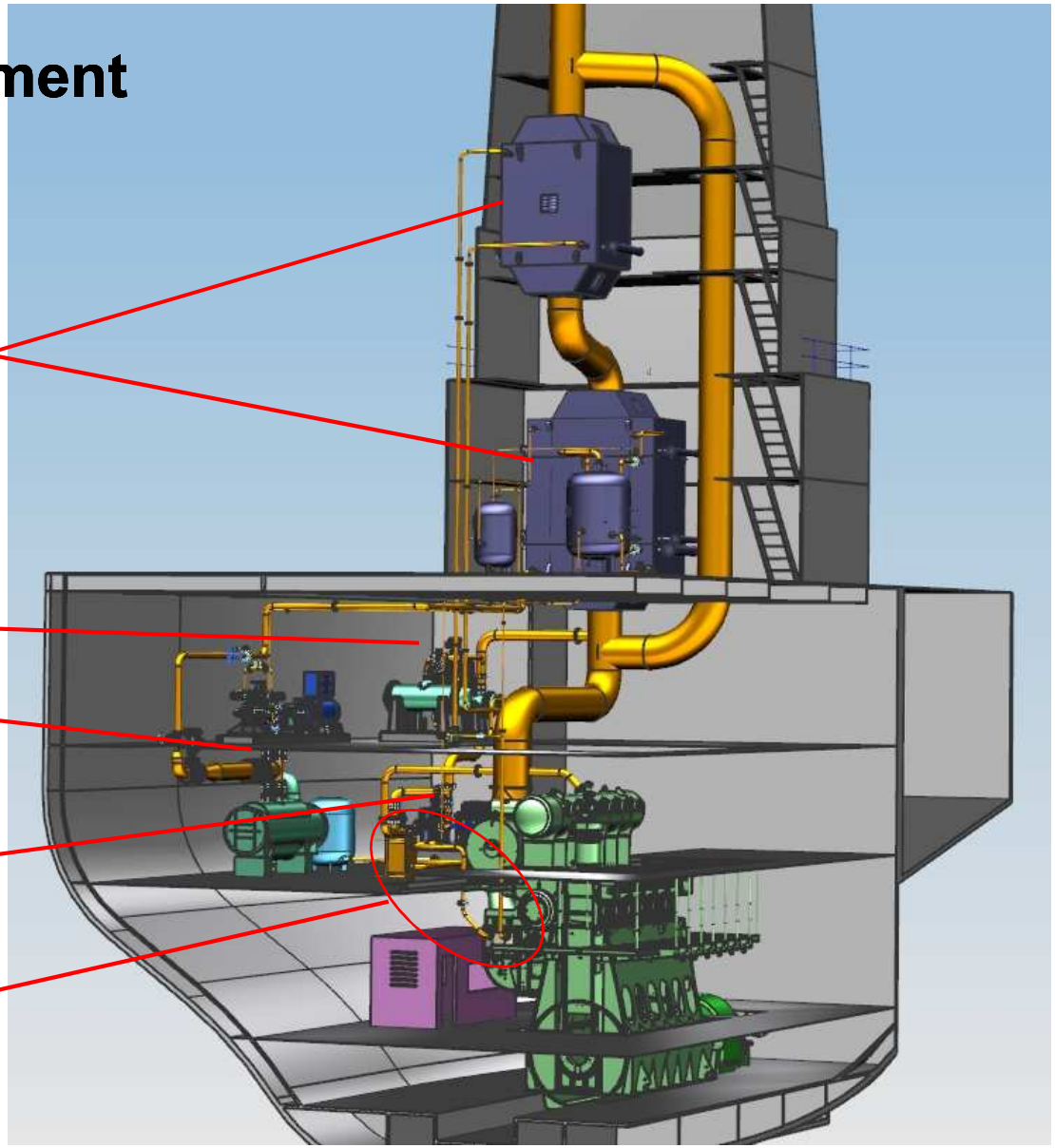
Test system arrangement (concept)



CSSC-WHR

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Engine power (kW)	Recommended system
<10,000	ORC
<15,000	PTG or ORC
<25,000	PTG or STG
>25,000	PTG and STG

WHR system recover power rate	
	%@M/E SMCR
ORC	2~3
PTG	3~5
Single P-STG	4~7
Dual P-STG	6~9
Dual P-STG+PTG	9~12

invest return

- ✓ **first cost**
- ✓ **reduced generator engines**
- ✓ **fuel price**
- ✓ **Sailing time per year**
- ✓ **Ship speed**
- ✓ **maintenance cost**

CSSC-WHR

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- CSSC-WHR system test will be finished in Dec.2015;
- Design WHR system according your M/E and engine room;
- Localize parts of WHR system save first cost;

Topic

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Dual fuel engine

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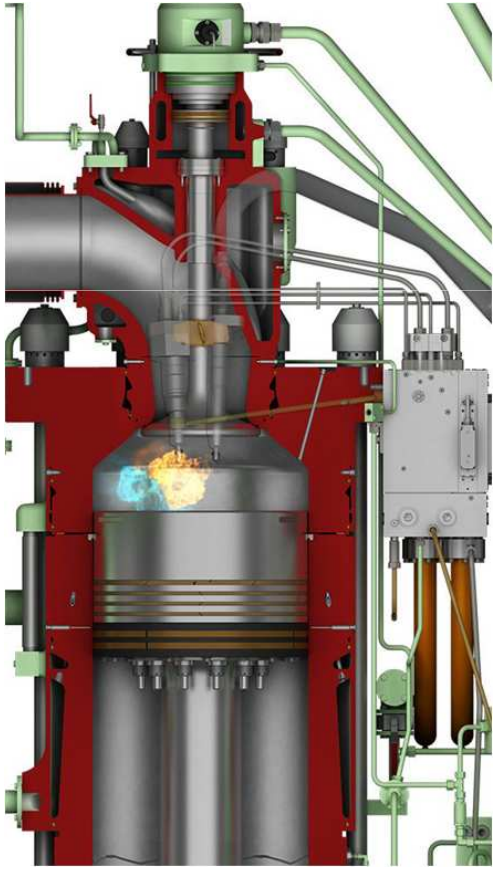
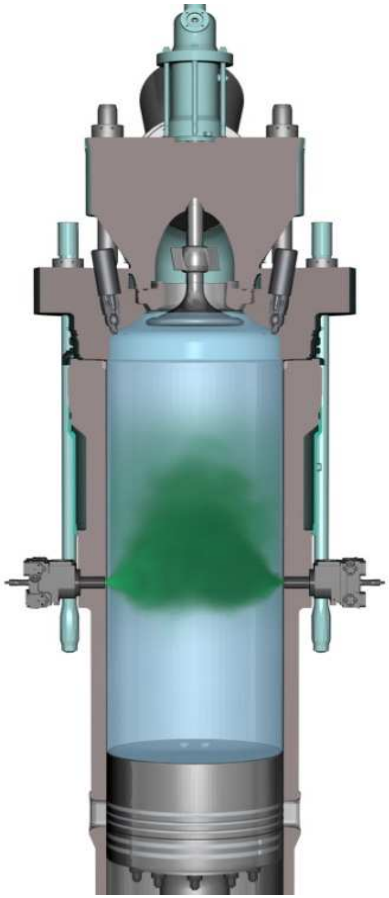
ME-GI



W-DF



ME-GI engine principle

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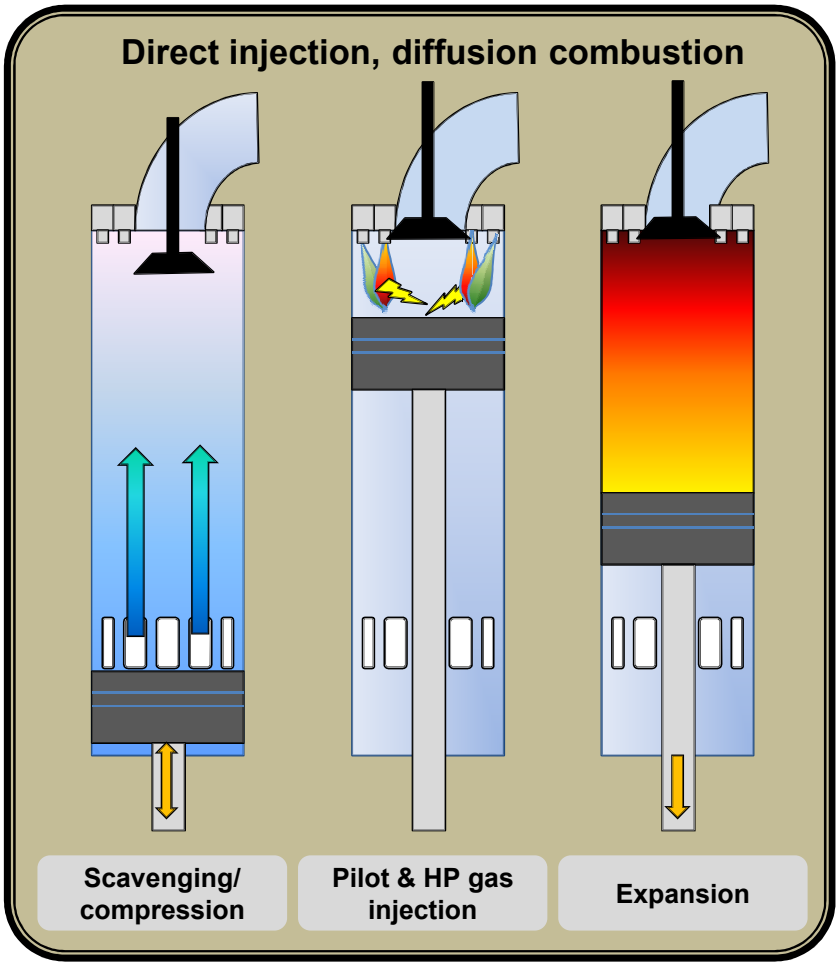
ME-GI = ME + GI

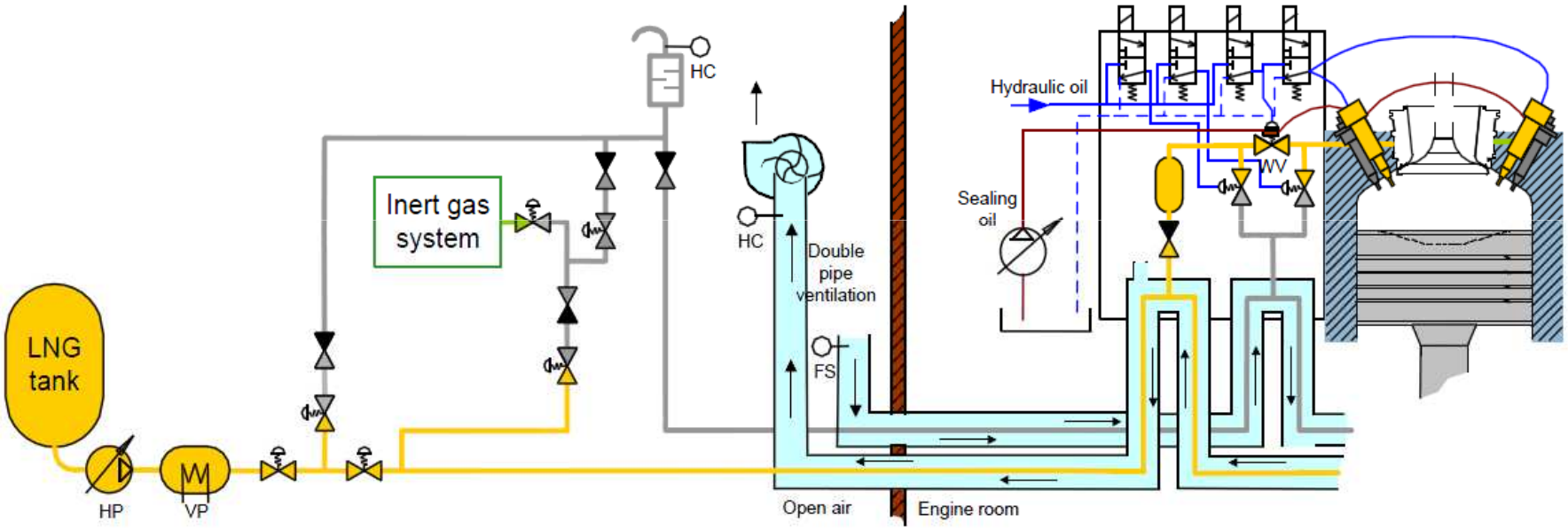


Rudolf C. Karl Diesel

- ✓Diesel process
- ✓Gas Injection close to TDC.

  P=300 bar, T=45 ± 10 ℃
  LCV ≥ 38MJ/Nm^3
- ✓Min. pilot ignition oil 3%
- ✓Requires SCR or EGR to meet Tier III NOx emission.

ME-GI engine system



W-DF engine principle

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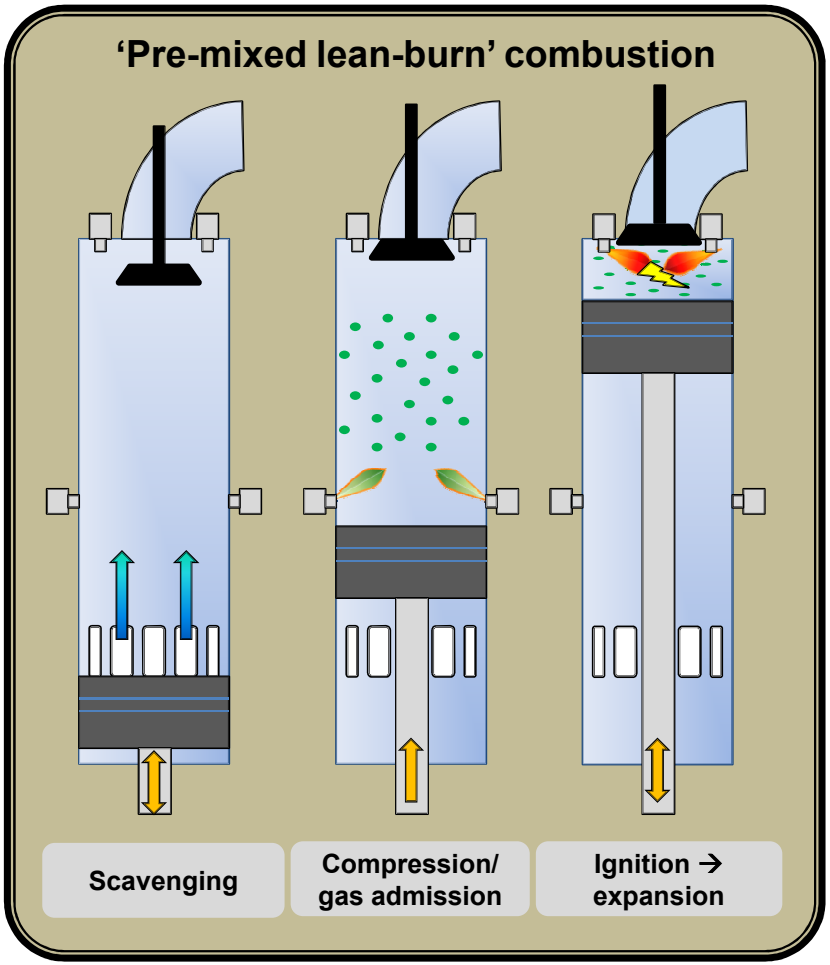
DF = Dual Fuel



Nikolaus August Otto

- Otto cycle
- Gas admission at 'mid stroke'

  P<16 bar, T=0~60℃
  LCV ≥ 28MJ/Nm^3
  MN ≥ 80

- Pilot ignition oil 1%
- NOx emission Fulfill Tier Ⅲ directly without SCR and EGR

W-DF engine system

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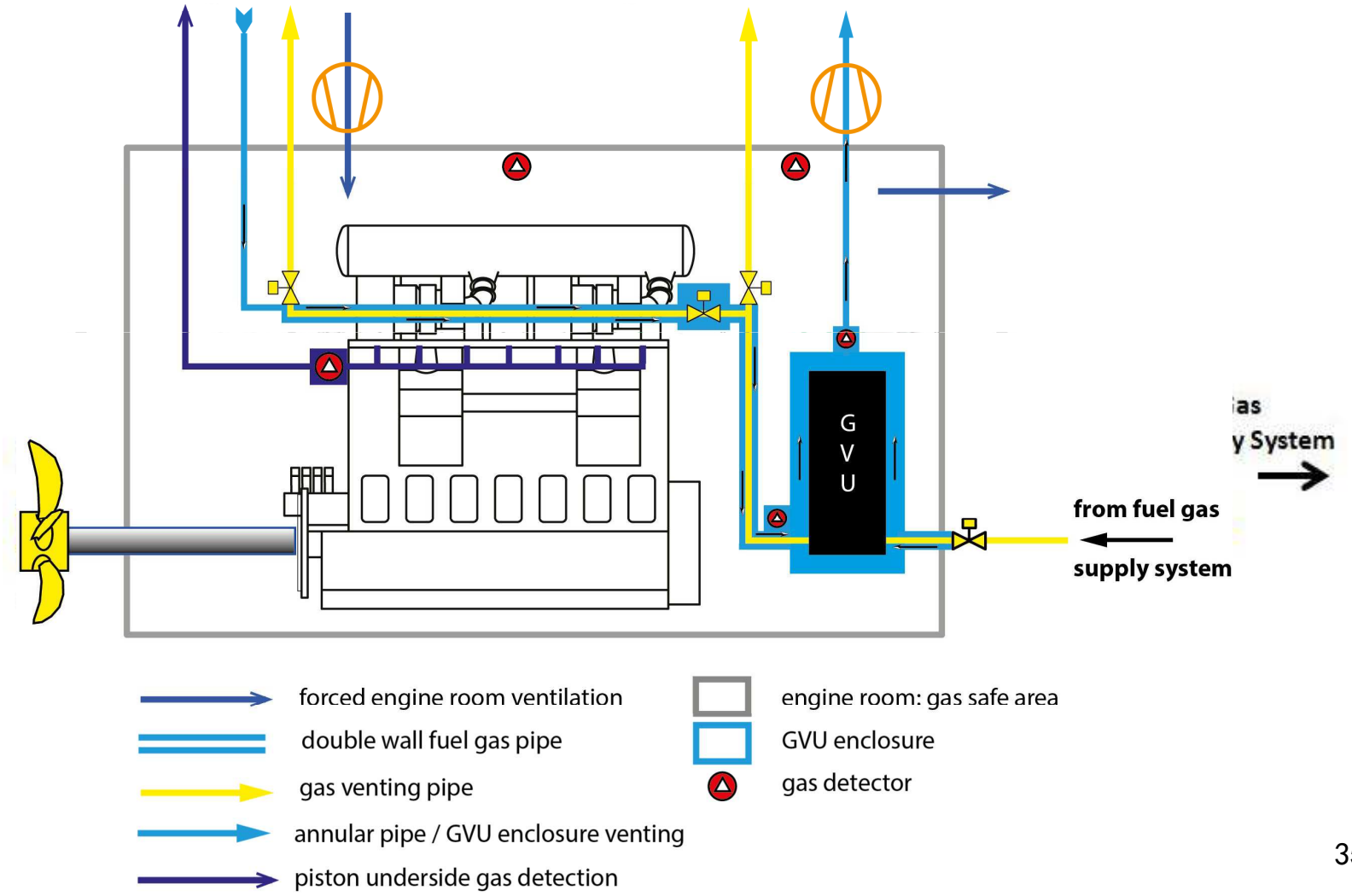
Prevent accumulation of gas in the engine room



Fuel Gas Supply System

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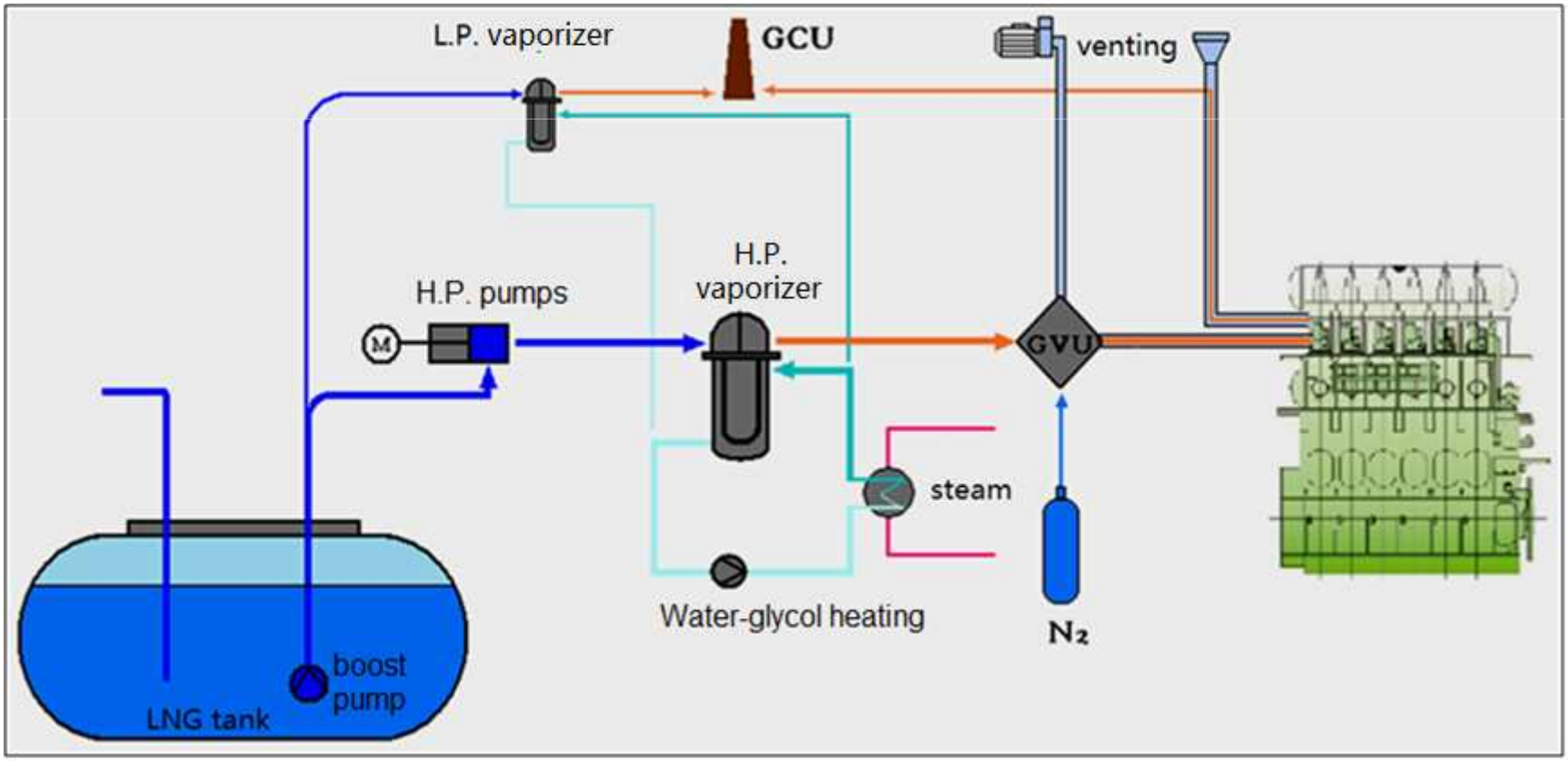
HHM-FGSS high pressure system

FGSS is important aux. system for Dural Fuel engine, main modules:

LNG storage tanks, LNG boost pumps, LNG HP pumps, HP vaporizer, heating circulation, valves unit, inert gas system, ventilation, distinguish and control system.



HHM-FGSS low pressure system

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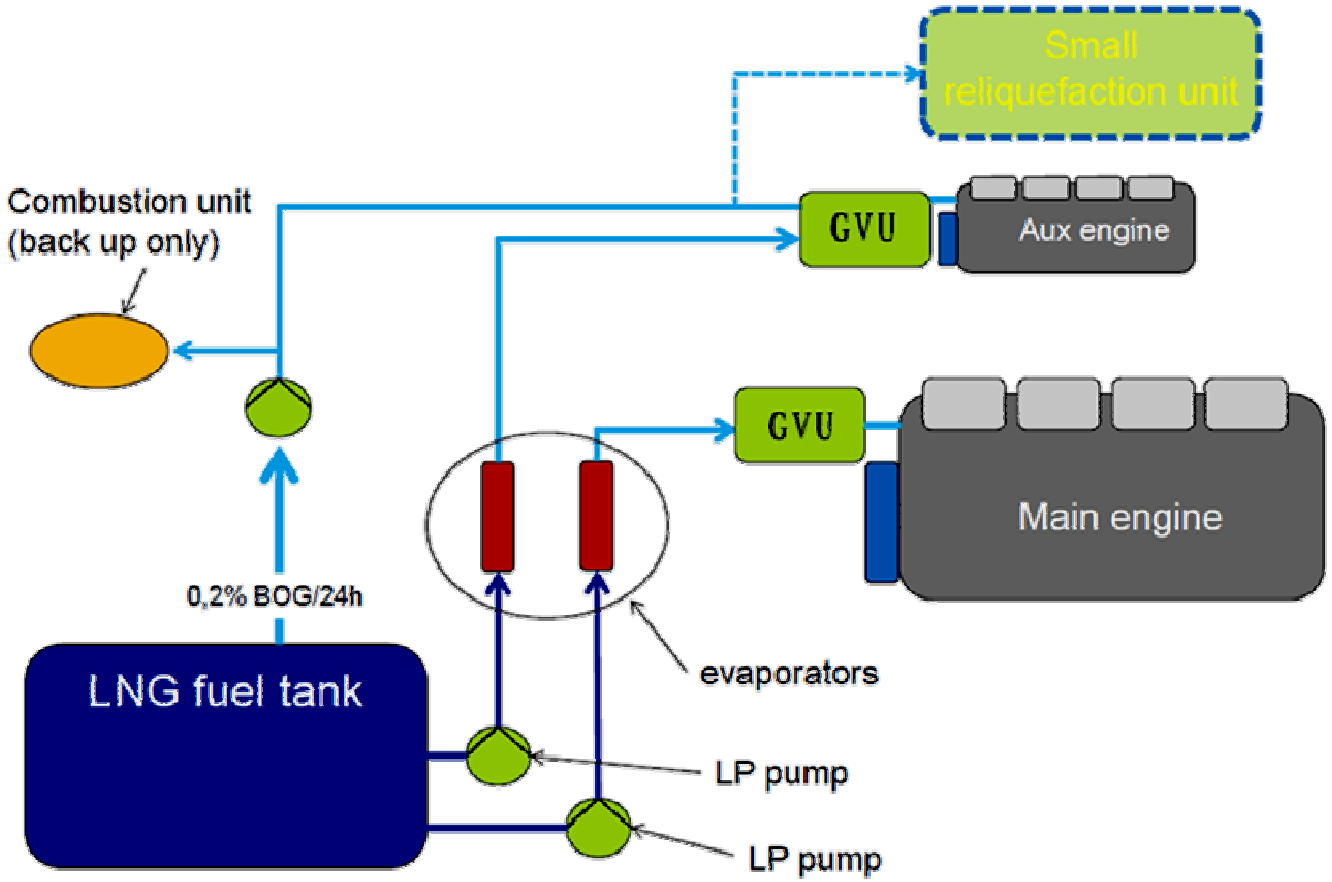
LP FGSS system： LP(16bar) vaporizer， no HP pumps.



FGSS modules

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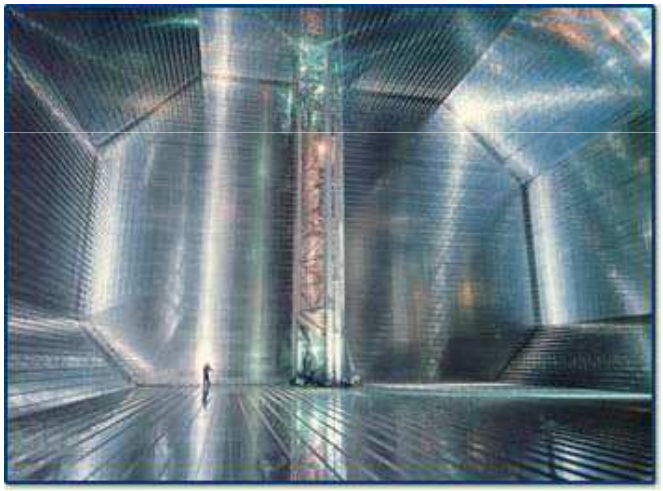
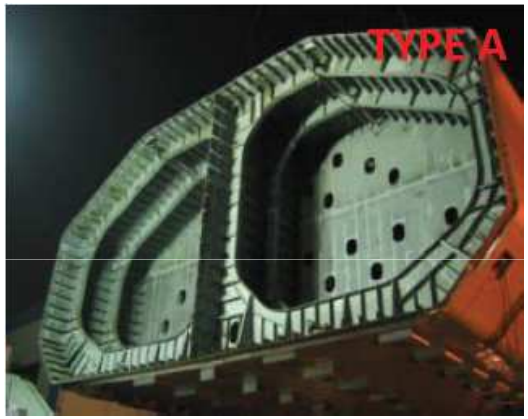
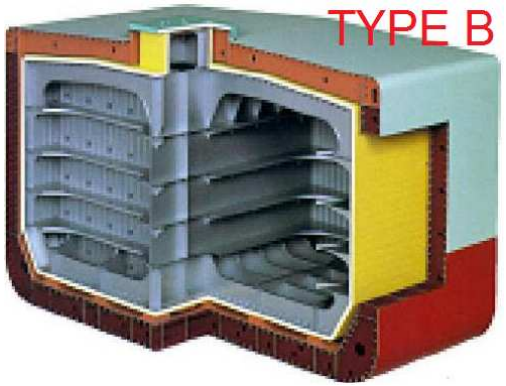
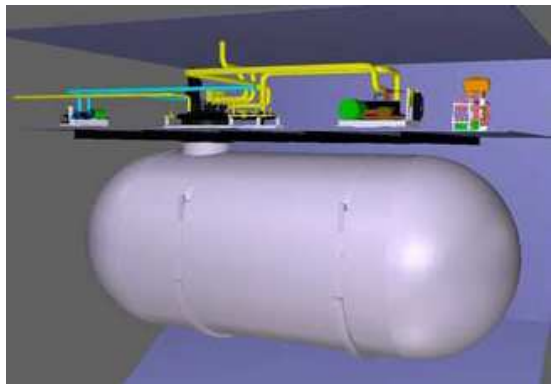
Membrane tank used for LNG carrier, type A/B/C for other ships usually.









FGSS modules

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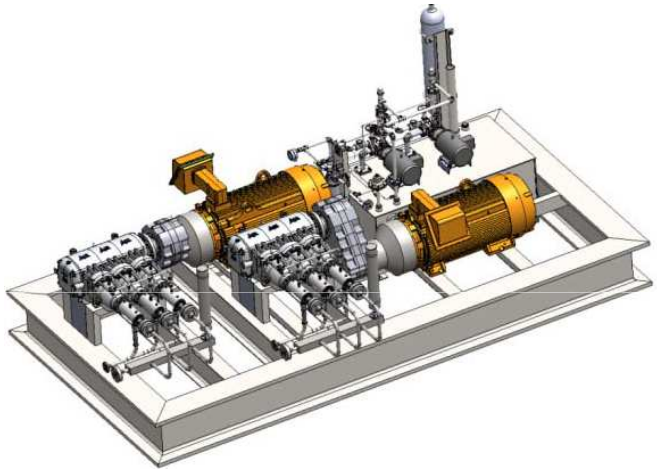
HP pumps unit



FGSS modules

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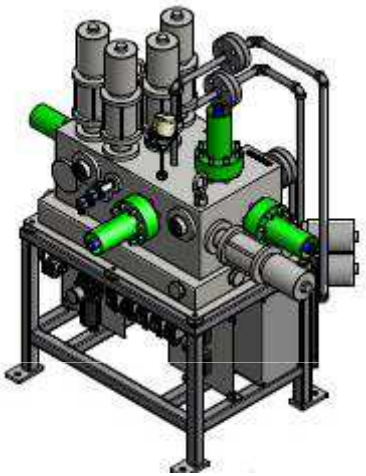
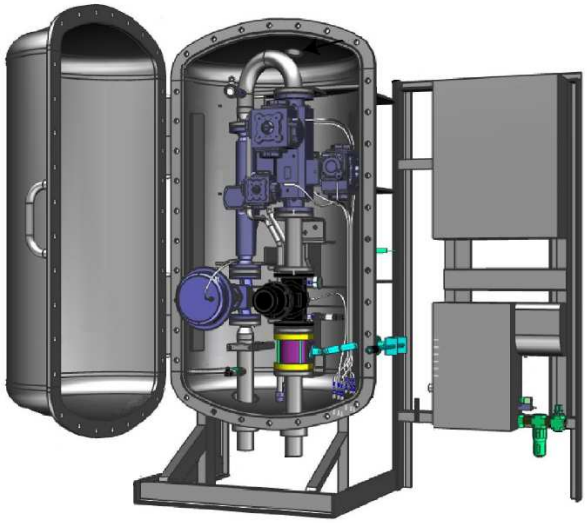
vaporizer

Valves unit





FGSS control system

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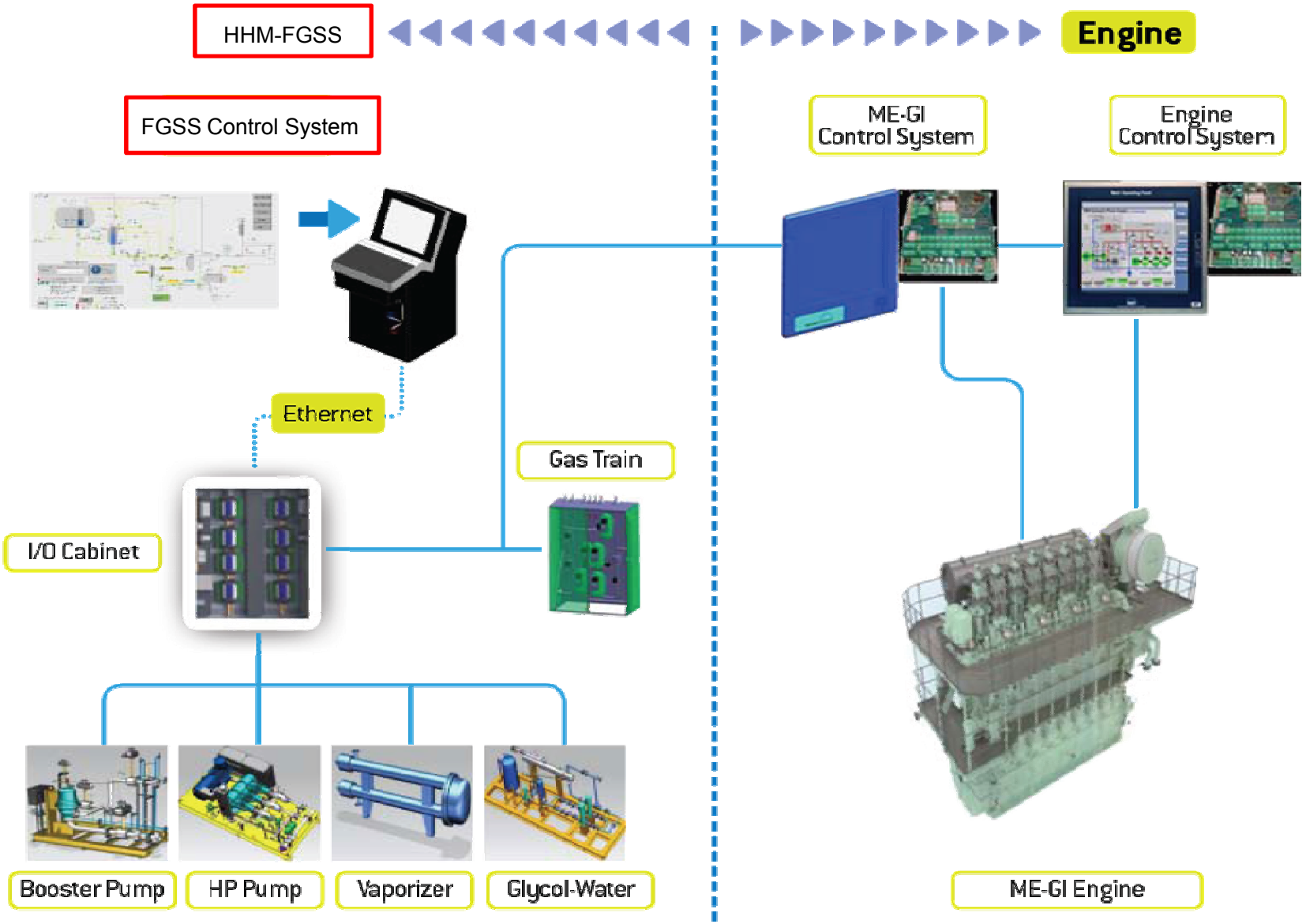

Summary

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Item	HP FGSS	LP FGSS
Working pressure	300 bar	16 bar
First cost	Very high	Normal
Delivery term	10~14 months	8~10 months
Space requirement	larger	smaller

HHM-FGSS

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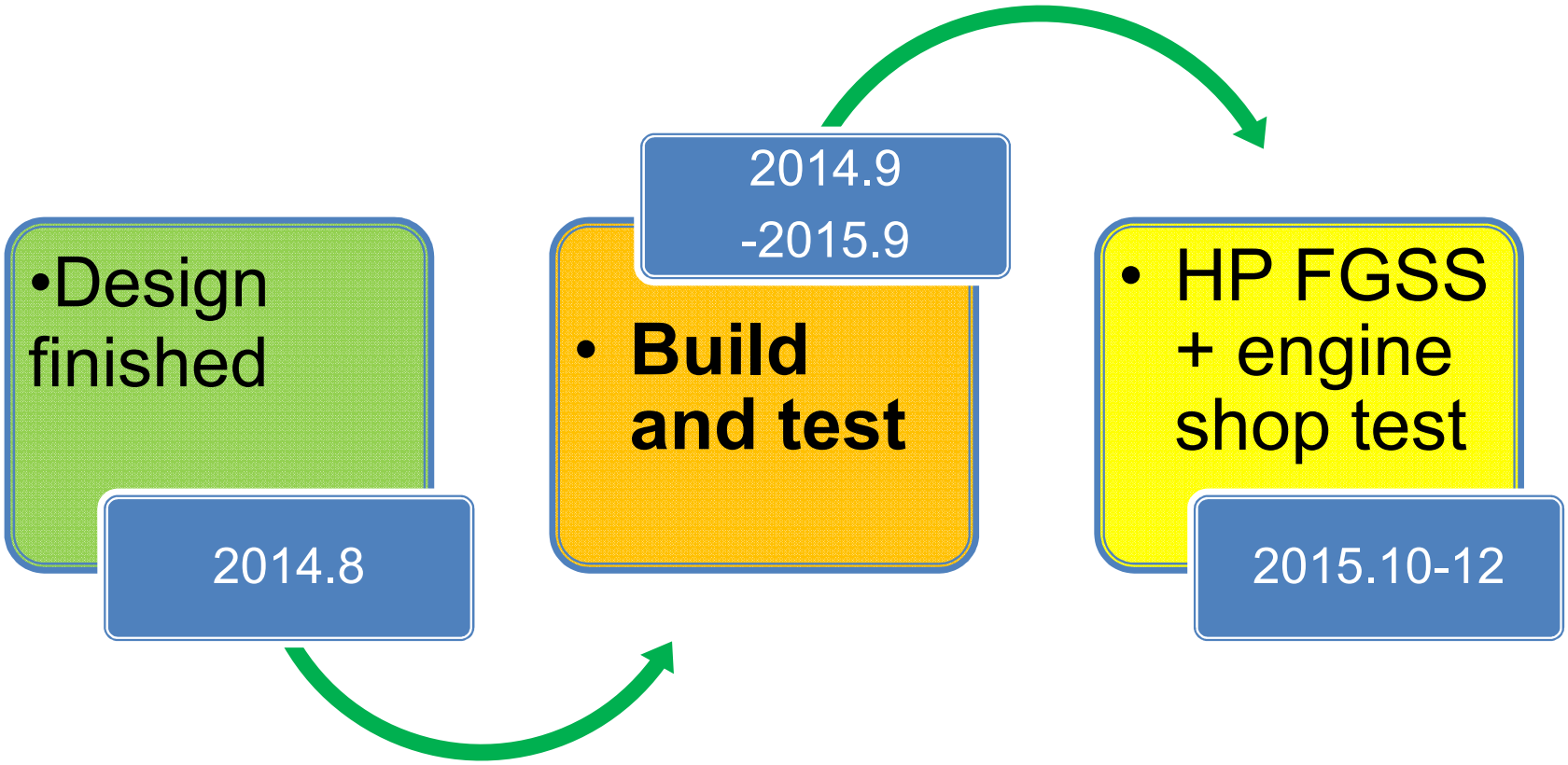

HHM-FGSS

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Capacity of shop FGSS

- ✓ firstly: HP-FGSS fulfill MAN 7G80ME-GI, up to 32,970kW;
- ✓ secondly: LP-FGSS fulfill Wärtsilä W8X72DF, up to 28,880kW;

Available for ship FGSS HP system and LP system.

- ✓ Engine + ship's FGSS shop test
- ✓ Training course for crew

If you have any question or any interested topic for our engines and new products, please don't hesitate to contact us.

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