Global Leader

SOx SCRUBBER

SHIPBUILDING DIVISION

18th OCTOBER, 2019

HYUNDAI HEAVY INDUSTRIES

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HYUNDAI HEAVY INDUSTRIES

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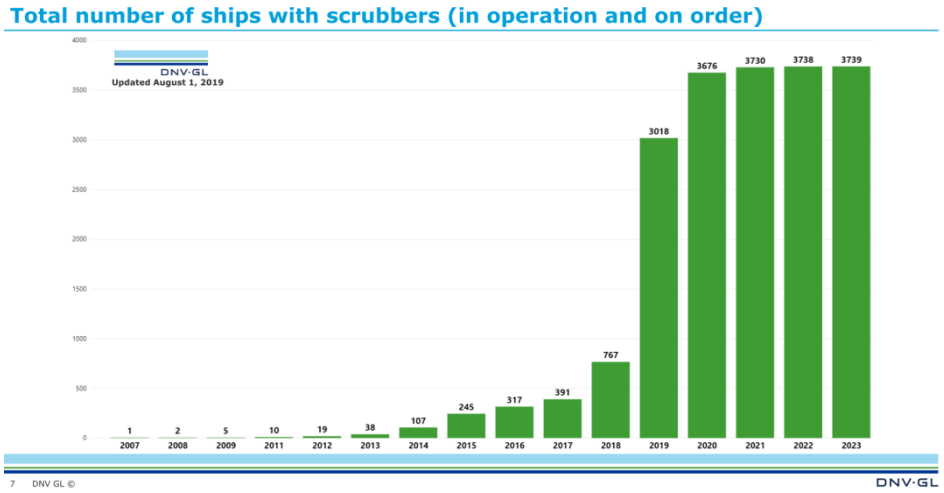
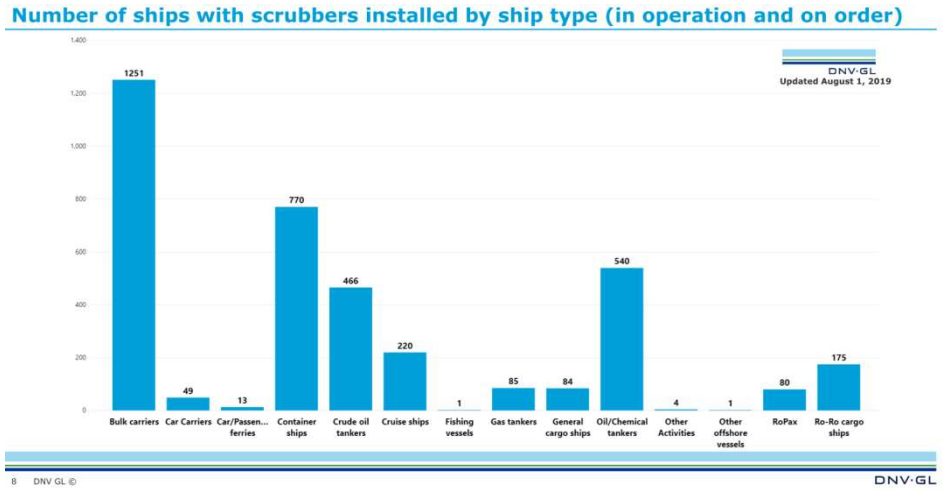
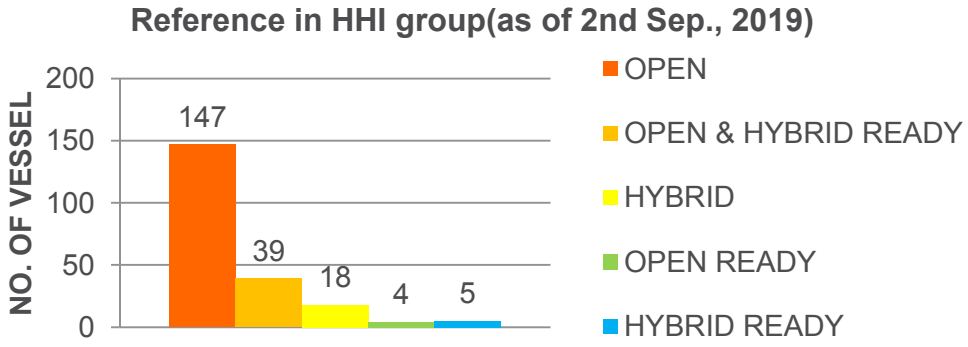
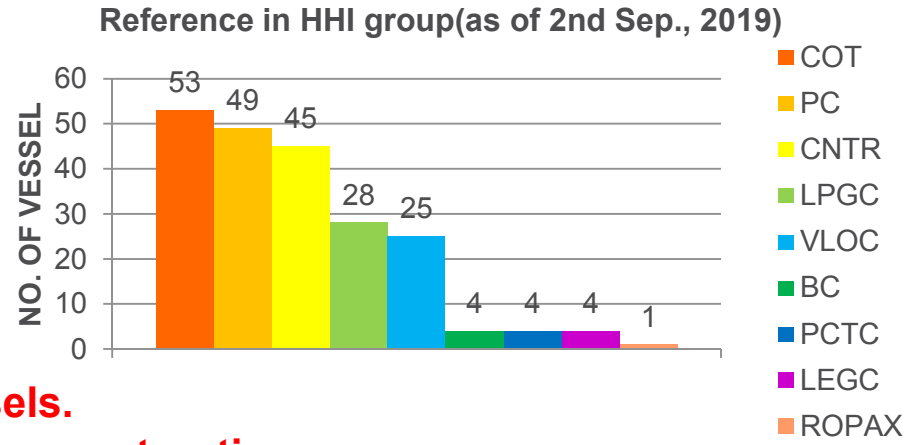
1. TREND

HYUNDAI HEAVY INDUSTRIES









SOx scrubbers have been installed for 213 vessels.
88 vessels were delivered. 125 vessels are under construction.
The SOx scrubber is applied for about 80% vessel for conventional fuel vessel.

2. SOx SCRUBBER TYPE

❖ OPEN LOOP vs. HYBRID TYPE

Type	Open loop	Hybrid
Mode	Open only	Open + Closed loop
Water treatment system	X	O

❖ BYPASS vs. INLINE TYPE

Type	Bypass	Inline
Bypass line	O	X
Packing	O	X
Elec. power consumption	-	Higher
Exh. gas pipe arrangement	Complicated	-
Installation	Larger footprint -	- Higher space

3. ASPECTS TO CONSIDER

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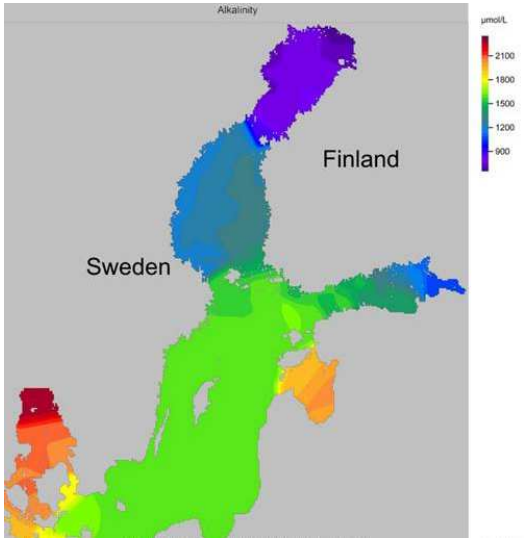
❖ SOx SCRUBBER OPERATION LIMITATION



- Discharge inhibited area(very limited at the moment)
  - Sulphur compliant fuel operation
  - Closed loop mode operation
    (Hybrid type scrubber to be installed)

- Low alkalinity area of S.W.
  - Design S.W. alkalinity
    : Normally 2,200 or 2,300 µmol/litre
  - Performance is reduced in the lower S.W. alkalinity area than design value(it depends on maker's standard).

- Strict pH control area
  - US-VGP area : pH at discharge ≥ 6 (IMO rule : pH at 4m discharge ≥ 6.5)
  - Additional provision(NaOH dosing system, Additional S.W. pump) to be required for open loop scrubber or hybrid type scrubber to be considered.

3. ASPECTS TO CONSIDER

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❖ INSTALLATION SPACE

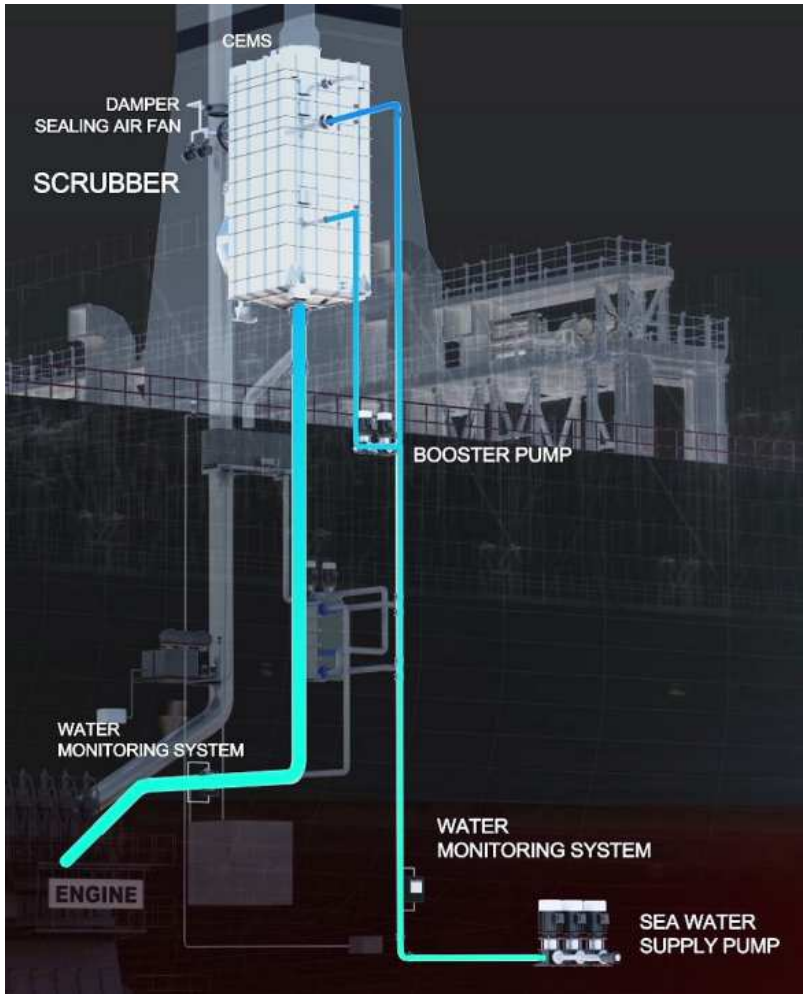
	Dimension	Weight
VLCC	4.2m(W) x 7.5m(L) x 11.5m(H)	26 ton
15K CNTR	5.4m(W) x 10.5m(L) x 13.1m(H)	45 ton

→ Anchor, anchor chain, windlass capacity may be increased due to enlarged funnel size.

❖ ADDITIONAL ELECTRIC CONSUMPTION

	Elec. consumption at sea going condition(Open loop)
VLCC	280 kW
15K CNTR	670 kW

→ Generator capacity to be increased or two(2) generators to be operated at sea going condition.



3. ASPECTS TO CONSIDER

❖ ADDITIONAL FUEL OIL CONSUMPTION

	50%	75%	100%
Main engine	-	+0.1 g/kWh	+0.45 g/kWh
Generator engine	+3 g/kWh	+2 g/kWh	+1 g/kWh

❖ CORROSION (due to sulphuric acid)

- Overboard pipe : GRP(GRE or GRVE)
- Exh. gas pipe inside : Special painting or 254 SMO / Duplex stainless steel
- Ship side discharge piece : Special painting or GRP lining.
- Overboard discharge surrounding : Special painting
- Valve inside : Duplex stainless steel

❖ ENGINE MODIFICATION

- T/C matching to be checked due to the increase of exh. gas line backpressure.
- EIAPP certificate(NOx technical file) to be updated in case T/C matching is required.

❖ NaOH BUNKERING (in case of hybrid type)

- NaOH(Caustic soda, neutralizer) bunkering onshore may be limited according to onshore bunkering facility. Offshore bunkering using barge or etc. to be considered.

4. TEST

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❖ TEST METHOD

- Scheme A : demonstrated by parameter check, daily spot check is recommended. (No CEMS required in principle)
- Scheme B (Almost all vessel) : demonstrated by continuous exhaust gas monitoring on board

❖ TEST PROCEDURE

- Shop test : Not available
- Onboard test (Function test only)
  - Installation inspection
  - Pre-commissioning check (Function test)
- Sea trial (Performance test)

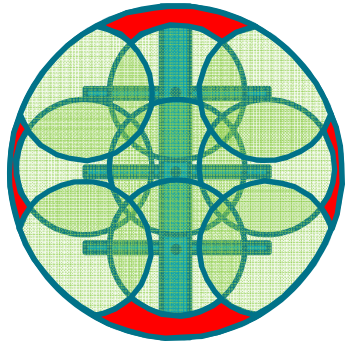
5. LESSON & LEARN

❖ Performance fail

- Insufficient packing quantity
- Insufficient water flow
- Improper water spray nozzle arrangement and number
- In case of boiler application, the sufficient water flow to be considered due to low air/fuel ratio.
- No specific EGCS design criteria / only required value

Trial & error method for performance verification during sea trial only

→ **Big burden for both ship owner and ship builder**



The method to be established to verify the performance before sea trial.

5. LESSON & LEARN

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- Safety
  - Engine failure due to water flooding in SOx scrubber
- Engineering capability
  - Insufficient engineering man power
  - Insufficient experience (in marine industry)
  - Unreliable CFD performance analysis
- Equipment delivery delay
  - Insufficient manufacturing capacity
  - Insufficient engineering capacity
- Poor quality control
  - Welding defect
  - Malfunction of equipment(e.g. gas analyzer)

Proven design model to be considered.

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THANK YOU
Q & A