

20 Febbraio 2019

Confitarma

*Information Day
2020 Global Sulphur Cap*

**La scelta alternativa
The alternative choice**



**CARNIVAL
CORPORATION & PLC.**

Carnival and Ecospray Technologies

- Ecospray specializes in Research & Development, design and production of innovative technologies for gas cleaning in marine and industrial applications.
- Since 2013, Ecospray is part of Carnival Group.
- Ecospray solutions for the marine industry:
 - SOx removal (MARPOL 73/78 Annex VI) for cruise vessels and cargos, including ferries
 - NOx removal (TIER II & III) for commercial / navy vessels and superyachts
 - PM (particulate) filtration and CO removal for smaller ships and pleasure boats.

EGCS Performance & Features

Years of successful operations have provided lessons incorporated into the latest generation systems:

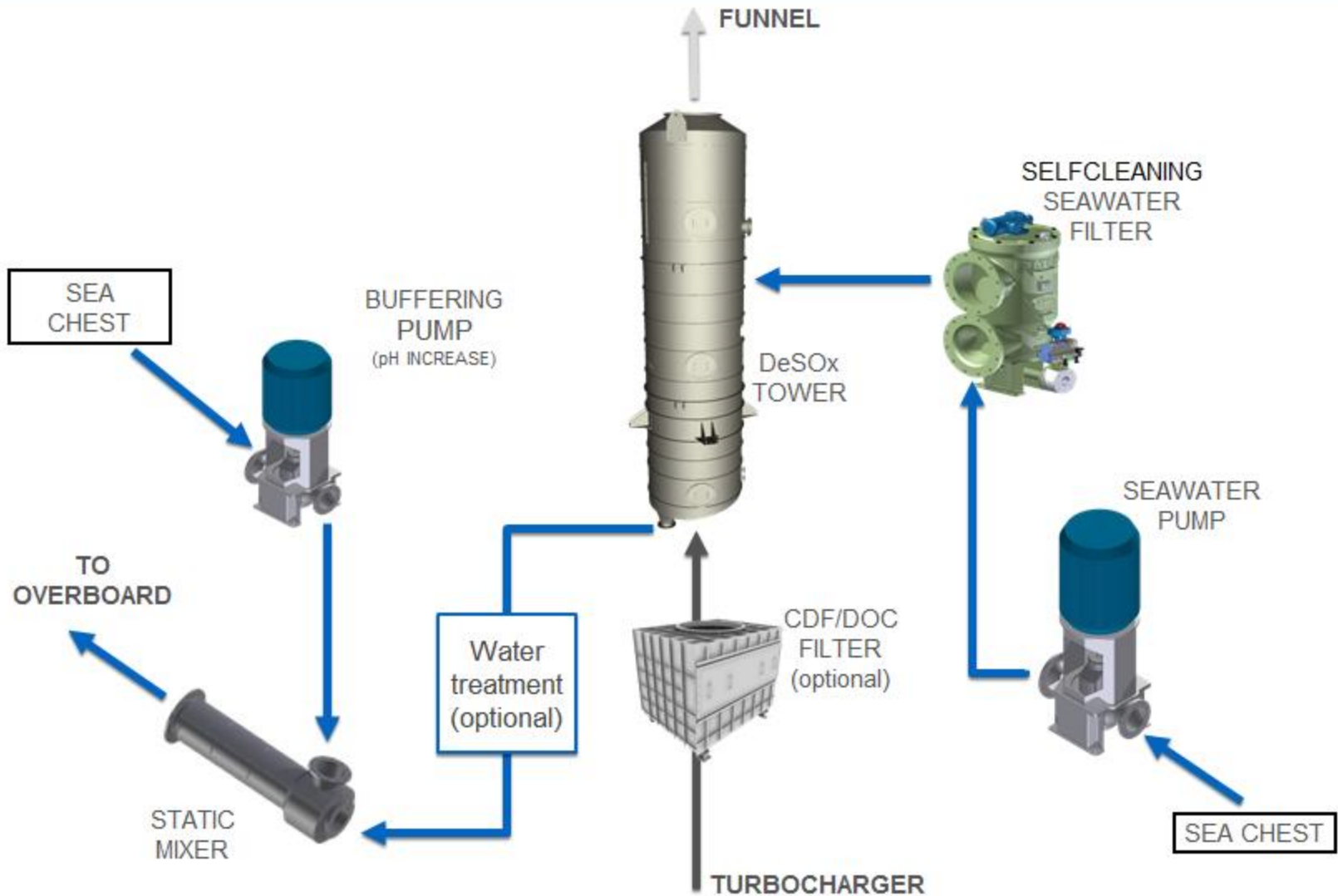
- Operates comfortably up to 3.5% sulfur fuel at high engine loads, even in lower alkalinity conditions (Alaska, Baltic Sea)
- Easily meets/exceeds all sulphur emission requirements
- Washwater meets all regulatory requirements and all major water discharge standards
- Compact size, replaces silencer with no resultant noise problems
- No bypass needed
- Typically installed in a 2-week dry-dock period
- Automated, easy operation for the vessel's crew

Ecospray references and portfolio

498	EGCS (cruise + commercial vessels)
254	SHIPS (cruise + commercial vessels)
240	Certified & operating EGCS (cruise + commercial vessels)
94	Certified & operating ships (cruise + commercial vessels)
258	EGCS systems on order (cruise + commercial vessels)
167	Ships on order (cruise + commercial vessels)
242	EGCS systems (commercial vessels)
171	SHIPS (commercial vessels)

70 % cruise
10 % ferries
20 % cargo
15 % cruise
12 % ferries
73 % cargo
Certified + on order

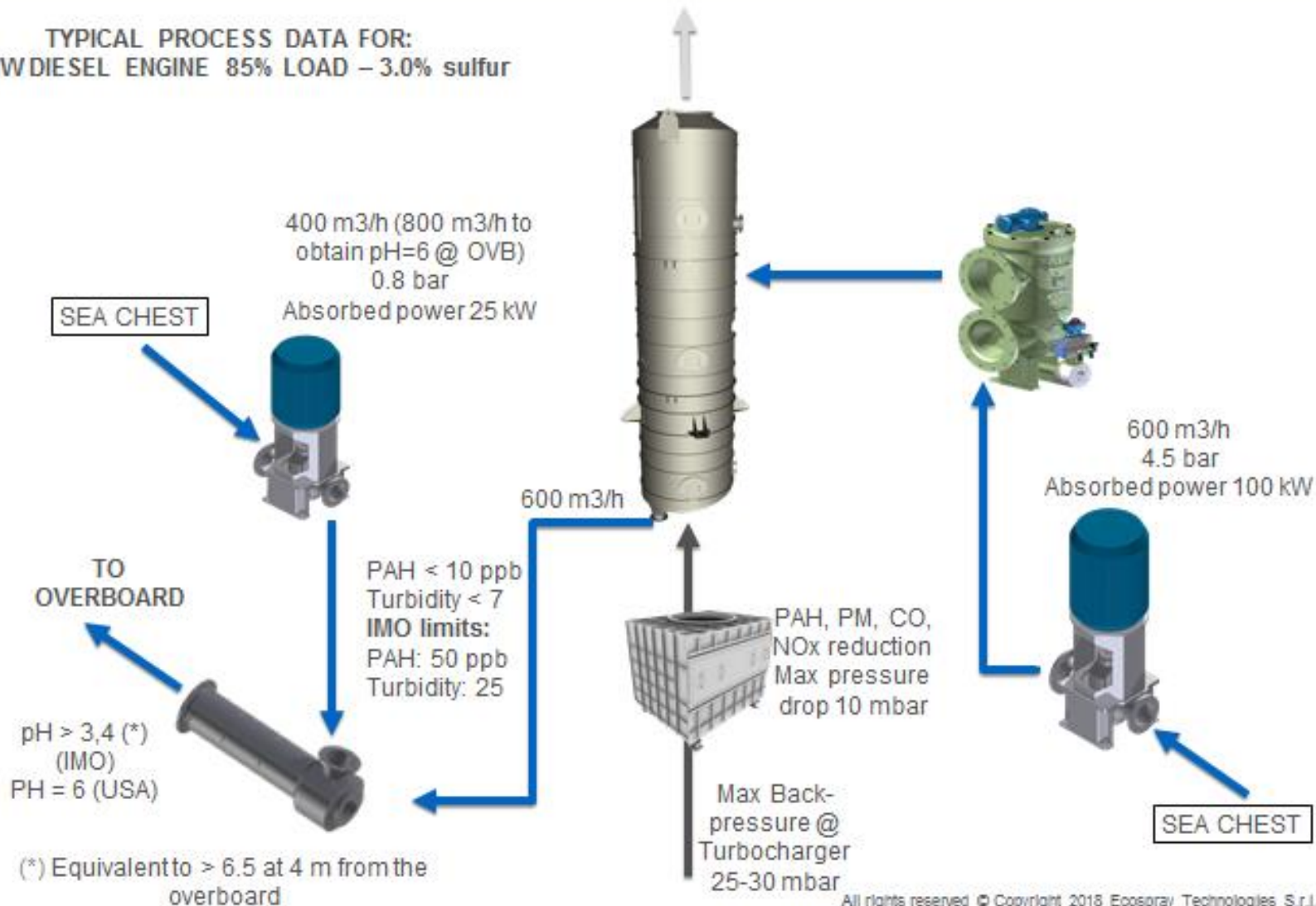
ECO-EGC™ OPEN LOOP



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ECO-EGC™ OPEN LOOP

TYPICAL PROCESS DATA FOR:
10 MW DIESEL ENGINE 85% LOAD – 3.0% sulfur

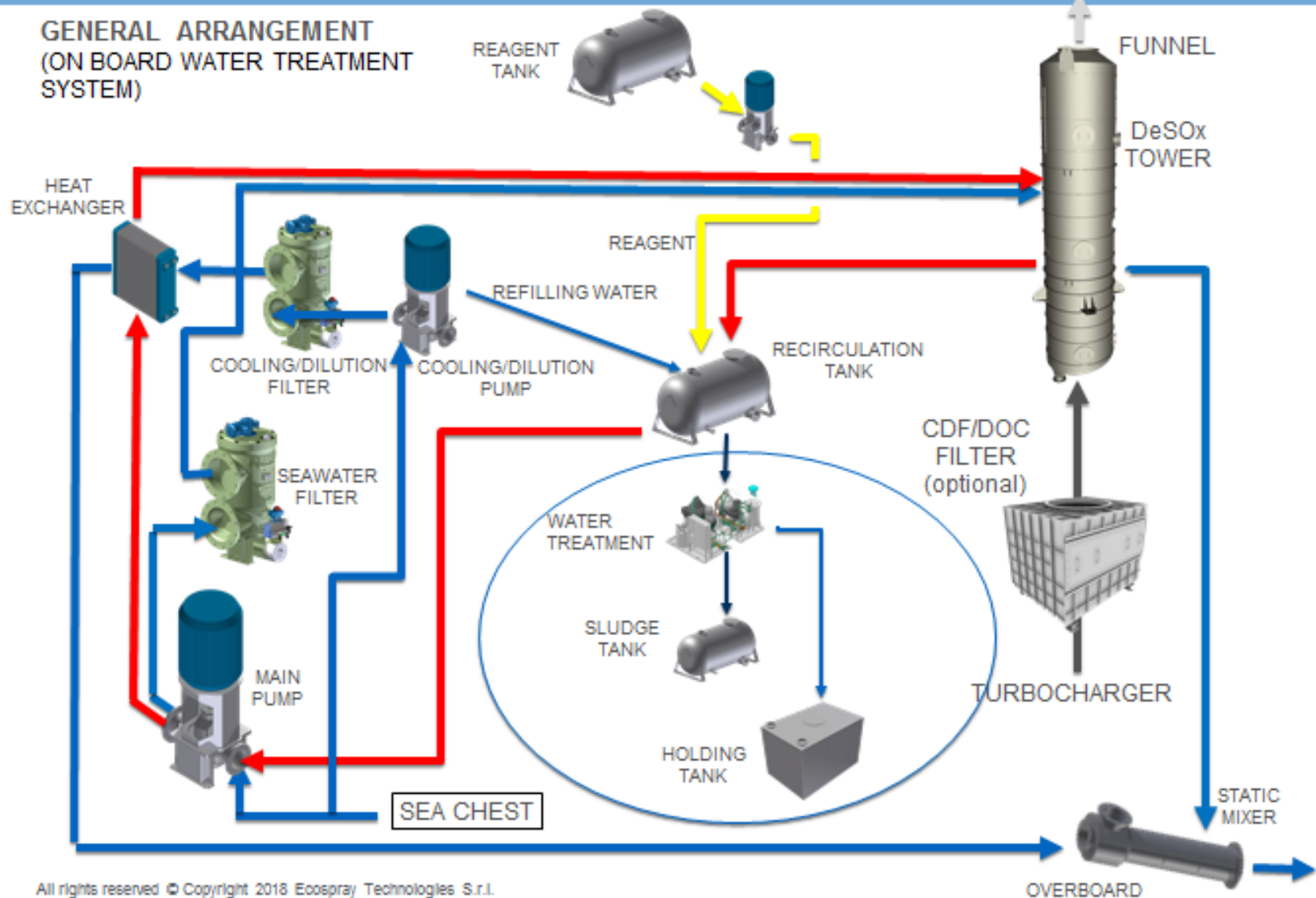


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ECO-EGC™ HYBRID

ECOSPRAY
TECHNOLOGIES

GENERAL ARRANGEMENT
(ON BOARD WATER TREATMENT
SYSTEM)

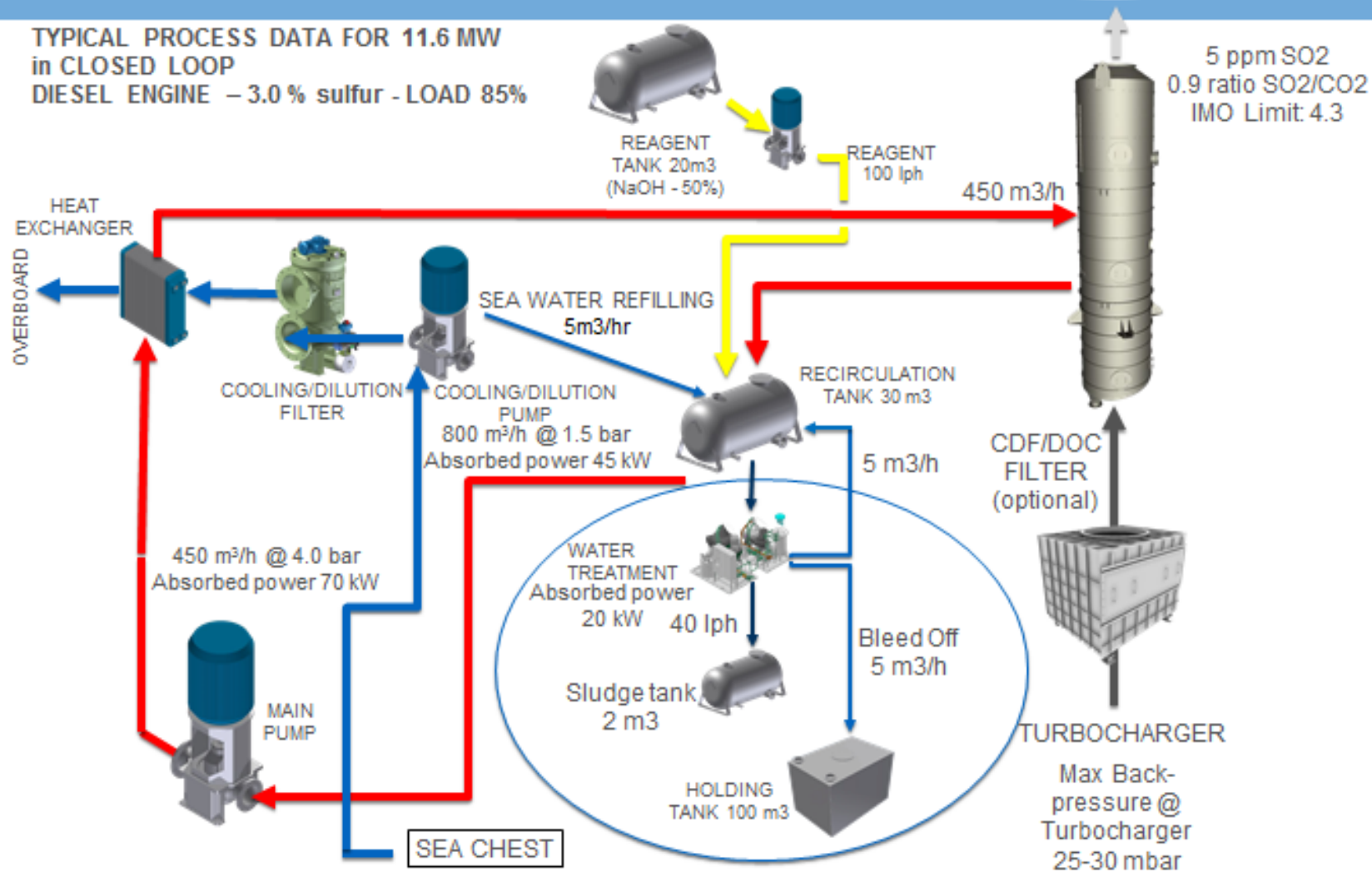


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ECO-EGC™ HYBRID

ECOSPRAY
TECHNOLOGIES

TYPICAL PROCESS DATA FOR 11.6 MW
in CLOSED LOOP
DIESEL ENGINE – 3.0 % sulfur - LOAD 85%



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Choosing your EGCS

The initial questions:

- Where is the ship trading?
- How often is the ship in port?
- How long is the ship in port?
- Power used during port stay, when moored?
 - Case 1: Ferry
 - Case 2: Cruise
 - Case 3: Container/Bulk Carrier

Choosing your EGCS: Example 1



Ro-Ro Pax Ferry

- Power Installed: 30 MW
- Engines/Gen to be equipped with scrubbers: 5 of 5 (4 towers)
- Average power used at sea: 18 MW
- Average power used in port: 4 MW
- 6 hours in port: daily



Cruise Vessel

- Power Installed: 64 MW
- DGs to be equipped with Scrubber: 4 out of 6
- Average power used during sailing: 30 MW
- Average power used in port: 8 MW
- 8 hours in port: 5-6 days/week

Choosing your EGCS: Example 2



Container/Bulk Carrier

- Power Installed: 25MW
- Engines/Aux to be equipped with scrubbers: 1 of 2
- Average power used during sailing: 18 MW
- Average power used in port: 2 MW
- 6 hours in port: 1-2 days/week

Option 1: Open loop

Open Loop Advantages:

- Least expensive option
- Easiest to install and maintain; relatively few components
- Simpler, affordable to operate

Considerations:

- Restrictions to open loop use currently in some ports (primarily EU)
- Consider frequency and length of port visits, size of port engine

Option 2: Hybrid-ready

Open Loop (Hybrid-ready) :

- Same advantages as Open Loop for cost, maintenance, installation
- Additional connections for future Hybrid are simple, minor cost
- As open loop before conversion, same simple, affordable operations

Considerations

- Potential additional future cost to convert to Hybrid (closed loop)
- Conversion to Hybrid can be done with the ship in-service.

Option 3: Hybrid

Hybrid (capable of either open or closed loop operations):

- More expensive to buy/install than Open Loop or Hybrid-Ready
- More challenging to install, additional space, equipment and tanks
- More complicated to operate, maintain; higher Opex due to chemicals

Considerations

- Close loop option provides ability to operate EGCS in most/all ports.
- Closed loop used primarily for ports; open loop for transits
- Consider frequency and length of port visits, and port engine size

Ecospray and 2020 Sulphur Cap

- Ecospray has delivered both, hybrid and open-loop, EGCS
- We have more than 200 registered installations of open-loop systems and have gathered experience in their deployment and performance
- Simple, reliable: open-loop EGCS is best choice for many owners to comply with 2020 sulphur cap requirements
- Ecospray also deployed more than 40 particulate filters and we believe interest will continue to expand in future.

Environmentals of Open-Loop EGCS

- Onboard exhaust emission studies indicate that HFO and Ecospray EGCS provide SAME or BETTER quality of air emission as use of MGO
- Third-party analysis of Carnival Corporation washwater sample database (>280 samples) shows washwater meets ALL REGULATORY and most other major point source and water quality standards, having NO ENVIRONMENTAL IMPACT

Some Open Loop options

Multiple inlet from Engine and AUX

Allows engine and auxiliary to operate with EGCS/HFO separately or together.

Wash-water filtration

Avoids potential for soot in the wash-water in port operations

Exhaust gas pre-filtration

Particulate (e.g. PAHs, CO) reduction in engine exhaust prior to EGCS.

Actors Involved in a EGCS retrofit project



EGCS
Maker

Installation
Engineering
Firm

Installer

Shipyard

Class /
Flag

Installation Engineering: Attention Points

- 3D-scan of vessel
- Ship survey & feasibility study
- Detailed engineering
- (installation supervision?)

Installation: attention points

- Close relationship with installation engineering firm
- Supply of components not provided by Maker or Yard
- Preparation work onboard and prefabrication ashore
- Installer and shipyard relationship
- Travelling teams for both pre- and post-Yard work
- Drydock versus wetdock
- In-service installation option

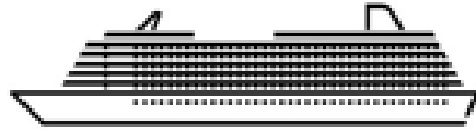
Considerations for successful retrofit

- Close gaps among Maker, Engineering Firm and Installer
- Early decisions obtain long-term benefits
- Owner-supply choices are not pure procurement exercises
- Maker decision likely predates installation location, therefore logistics is key

Some final thoughts

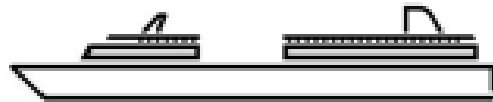
- Some makers still have availability in 2019-2020
- When possible, make deals at least one year in advance
- Reduce the number of players to maker, installer, yard
- ‘Turn-key’ deals are available: in Europe, Asia, Caribbean

Expected payback time



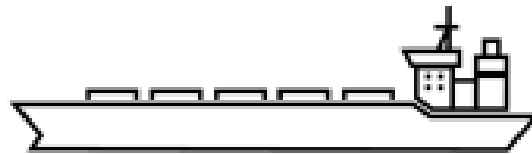
CRUISE VESSEL # 4 D/G 12 MW

< 2 YEARS



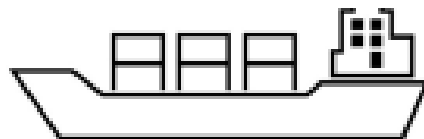
RO RO # 4 D/G 12 MW

< 2 YEARS



NEWCASTLEMAX BULK CARRIER

< 1.5 YEARS



CONTAINER 9000 TEU

< 1 YEAR