COMMERCIAL UTILIZATION OF ABATEMENT SYSTEMS

MARTIN BENTLEY
SO\textsubscript{X} Emission Control Areas

IMO ECAs – 0,1% from 2015
EU ports - 0,1% from 2010
EU passenger vessels - 1,5%, 0,5% from 2020
EU waters – 0,5% from 2020
IMO Worldwide – 0,5% from 2020/2025

New IMO ECAs?
New local regulations?

NO\textsubscript{x}?
PM?
CO?
European Sulphur Directive
How to minimise SO$_x$ – Alternatives

**FUEL SWITCH**  
Switch to low sulphur fuel in SECA  
- Flexible  
- Small investment  
- High operating cost  
- Fuel change over  
- Fuel availability  
- Lube oil TBN management

**CHANGE TO MGO**  
Run full time on Marine Gas Oil (MGO).  
- Convenient  
- No change over  
- High operating cost

**CONVERT TO LNG**  
Convert engines to run on gas (LNG).  
- A solution which also reduces NO$_x$ and particulates  
- Investment cost  
- LNG availability  
- ROI depends on fuel oil price spread

**ABATEMENT**  
Install an exhaust gas cleaning system (scrubber).  
- “Business as usual”  
- Lowest total lifecycle cost  
- Use everywhere  
- Easy operation  
- Energy efficient
Particulate Matter

Exhaust Gas Cleaning for PM removal

- The World Health Organisation estimates that PM is responsible for 865,000 premature deaths each year
- USEPA estimates that diesel PM will cause more than 21,000 premature deaths in 2010
- University of Hong Kong estimated 500 deaths per year in Hong Kong, from shipping emissions alone
- Lighter distillates give an estimated 85% reduction in PM, by mass, but no reduction in number of particles
- Smaller particles are more damaging and carry further.
- Scrubbers remove 85% of PM
Fuel prices (Rotterdam)

$\Delta = 140\text{–}700$/ton MGO–HFO

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Containerships VII SOx measurements

• Fuel sulphur content 1.84%.
• Measurement by accredited third party 2.12.2011.
Wärtsilä Inline Scrubber Open Loop

- Scrubbing water
- Reaction water
- Wash water
- Effluent
- Sludge

*Optional

Scrubber water Monitoring Module

pH, PAH, Turb, T

Wash water Monitoring Module

pH, PAH, Turb, T

Exhaust Gas Out

Deplume System*

Inline Scrubber

Reaction Water Pump*

Scrubbing Water Pump

Exhaust Gas In

Residence Tank

Wash Water Pump

Hydro-cyclone

Wash water Monitoring Module

pH, PAH, Turb, T

Sludge Tank

SOx, CO2,
Cost comparison for 25 years
Total engine power: 10 MW
Annual fuel consumption: 9800 ton/a
Annual average load: 69%
Interest rate for NPV calculations: 5.0%
Fuel price inflation rate: 4.8% (1980-2010 average)
Currency rate: 1.27 US$/€
NaOH 50%: 200€/ton

- **Case 1** HFO 428 US$/ton, MGO 649 US$/ton
- **Case 2** HFO 244 US$/ton, MGO 646 US$/ton
- **Case 3** HFO 580 US$/ton, MGO 1282 US$/ton

*System delivery cost (not including installation)*
Fuel prices are prices in Rotterdam
Case 1: 31.08.2010
Case 2: August 2008
Case 3: May 2008

Fuel prices are prices in Rotterdam
EXHAUST GAS CLEANING SYSTEMS - RETROFIT

WAY OF WORKING, REFERENCES, CAPABILITIES
Retrofit Aspects – general considerations

Retrofits require tailor-making.

Aspects to be considered:

• Space; design of exhaust gas funnel
• Ship stability
• Space available for tanks, pumps and water treatment unit(s)
• Power demand for the system
• Capacity of supplying water to the system
• Installation principle
SOx Scrubber – Retrofit Design Parameters

**Current configuration**
- Tank arrangement
- Existing fresh water capacity
- Noise attenuation
- Available space in stack
- Exhaust diameter
- Elevation
- Ship design layout

**Vessel operation and routes**
- Operation profile and consumption
- Number of hours in/out of SECA waters

**Equipment on board**
- Main engine(s)
- Auxiliary engines
- Boiler(s)
- Combustion gas flow
- Exhaust gas temperature throughout the load range
- Actual back pressure after engine

**Load profile vs. vessel itinerary**
- In port
- In manoeuvring
- At sea, high load / at sea, low load
- Other specifics, season loading…

**Ship stability**
- Stability check

**Water treatment:**
- Effluent discharge strategy (overboard / sloptank)
References

**Owner:** Containerships scrubber

**Vessel:** Containerships VII

**EGCS System:**
Retrofit
Operate Baltic and North Sea
Main stream scrubber
Freshwater closed loop system
Installation GL approved

**Installation:** August 2011

**Turn-key delivery:**
- Equipment, installation, piping, cabling
- Interfaces to existing systems
- Commissioning
- Performance guarantee
- Class approval, Certification, Documentation
- Customer training
CONTAINERSHIPS 7 EGC RETROFIT
In more detail

• Scope of supply
  – Wärtsilä Closed Loop Scrubber
  – CEMS*

• “Turn – key” project responsibility
  – Engineering, procurement, construction
  – Complete installation: scrubber room prefabrication and installation, equipment container prefabrication and installation, relocation of equipment, piping work, electrical and automation integration, etc…

• Modification to water treatment ongoing (root cause identified, modification tested for 1500 hrs with successful results, final modifications ongoing)

* CEMS = Continous Emission Monitoring System
References

Owner: American President Line

Vessel: APL England - Container vessel

EGC System:
Retrofit during dry-dock
Operate between America and Asia
1 x 8 MW 3 inlet scrubber for auxiliaries
Open loop system

Delivery equipment: January 2011

Ship in dock: February 2011

Performance:
98-99% SOx reduction
10-20% THC reduction
55-80% PM reduction
Space – Not an issue
- Scrubber at funnel top
- Tank on side of casing
- Pumps & Cyclones in ER

Challenges
- Piping
- Workmanship
- Materials
- Planning

Washwater discharge
Owner: Wilh. Wilhelmsen ASA

Vessel: MV Tarago

EGC System:
Retrofit during dry-dock
Operate Europe, America and Asia
1 x 25 MW 3 inlet scrubber for main engine and auxiliaries
1 x 6MW 1 inlet scrubber for auxiliaries in port
Hybrid system

Delivery equipment: Q4 2012

Ship in dock: Q1 2013

Performance:
Cleaning 3,5%S fuel down to 0,1,%S
Up to 85 % Particulate Removal
MV Tarago Retrofit

Space:
- Scrubbers
- Piping
- Tankage
- Pumps
- Bypass
- Pipe Routing
- Bunkering
## Wärtsilä reference list

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Reflections on fuel prices and attractiveness of solutions

- Global demand for distillates is likely to increase → Price of MGO is expected to increase while price of HFO will stay the same or even decrease
- Scrubbers demonstrated to work in marine environment
- Scrubbers allow for same bunkering and same engine operation as before
- European SECA now ratified, more SECAs can be expected
- Wärtsilä has the largest portfolio of marine scrubber solutions
- Wärtsilä scrubber solutions are fit for new buildings and retrofits, for any engine and boiler brands
- TIME IS RUNNING!