“Use of scrubbers to comply with 0.50%S”

IMO 2020 & Alternative Fuels Symposium

17th & 18th October 2019, IMO HQ, Albert Embankment, London

Don Gregory, Director EGCSA

Topics

- 2020 Routes to Compliance & Benefits
- Scrubber Facts
- Wash water Environmental Impact Assessment
- EGCS & Future Maritime Air Quality Ambitions

Background & Membership

EGCSA
exhaust gas cleaning systems association

- Inaugurated in 2008
- Represents >90% of EGCS suppliers globally
- Associate membership of sub suppliers
- Share knowledge on the health environmental, technical & commercial realities of EGCS technologies
- Assure Ethical Compliance Code of Conduct of the EGCS Association

Benefits of 2020 compliance

USE OF 0.50%S FUELS

- Reduced emissions of SOx – Some 24Mt/annum (2.7%S - 250Mt HSFO)
- Reduction in secondary particulates – Sulphate formed post stack in the atmosphere
- Reduction in acid rain
- Lowers contribution lung & cardiovascular disease

USE OF EXHAUST GAS CLEANING SYSTEMS

- Exceeds the regulatory SOx reductions ambitions – DFDS example

FICARIA SEAWAYS

10 years of scrubber operation

56000 hours ME running hours
150000 ts. of fuel

SOx emissions with compliant fuel
1721 ts
SOx emission using scrubber
29 ts.

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Health Benefits

- Health effects include lung and cardiovascular disease
- “Particulate Matter from Both Heavy Fuel Oil and Diesel Fuel Shipping Emissions Show Strong Biological Effects on Human Lung Cells at Realistic and Comparable In Vitro Exposure Conditions”

Ship engine emissions are important with regard to lung and cardiovascular diseases especially in coastal regions worldwide. Known cellular responses to combustion particles include oxidative stress and inflammatory signalling. To provide a molecular link between the chemical and physical characteristics of ship emission particles and the cellular responses they elicit and to identify potentially harmful fractions in shipping emission aerosols. Through an air-liquid interface exposure system, **we exposed human lung cells under realistic in vitro conditions to exhaust fumes from a ship engine running on either common heavy fuel oil (HFO) or cleaner-burning diesel fuel (DF).** Advanced chemical analyses of the exhaust aerosols were combined with transcriptional, proteomic and metabolomic profiling including isotope labelling methods to characterise the lung cell responses. The HFO emissions contained high concentrations of toxic compounds such as metals and polycyclic aromatic hydrocarbon, and were higher in particle mass. These compounds were lower in DF emissions, which in turn had higher concentrations of elemental carbon ("soot"). Common cellular reactions included cellular stress responses and endocytosis. **Reactions to HFO emissions were dominated by oxidative stress and inflammatory responses, whereas DF emissions induced generally a broader biological response than HFO emissions and affected essential cellular pathways such as energy metabolism, protein synthesis, and chromatin modification.** Despite a lower content of known toxic compounds, combustion particles from the clean shipping fuel **DF influenced several essential pathways of lung cell metabolism more strongly than particles from the unrefined fuel HFO**. This might be attributable to a higher soot content in DF. Thus the role of diesel soot, which is a known carcinogen in acute air pollution-induced health effects should be further investigated. For the use of HFO and DF we recommend a reduction of carbonaceous soot in the ship emissions by implementation of filtration devices.

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Refinery CO_2 emissions

"The production of fuels with lower Sulphur will lead to increased CO_2 emissions from the refining industry. Making use of on-board scrubbers will result in lower overall CO2 emission versus desulphurisation of fuels in refineries"

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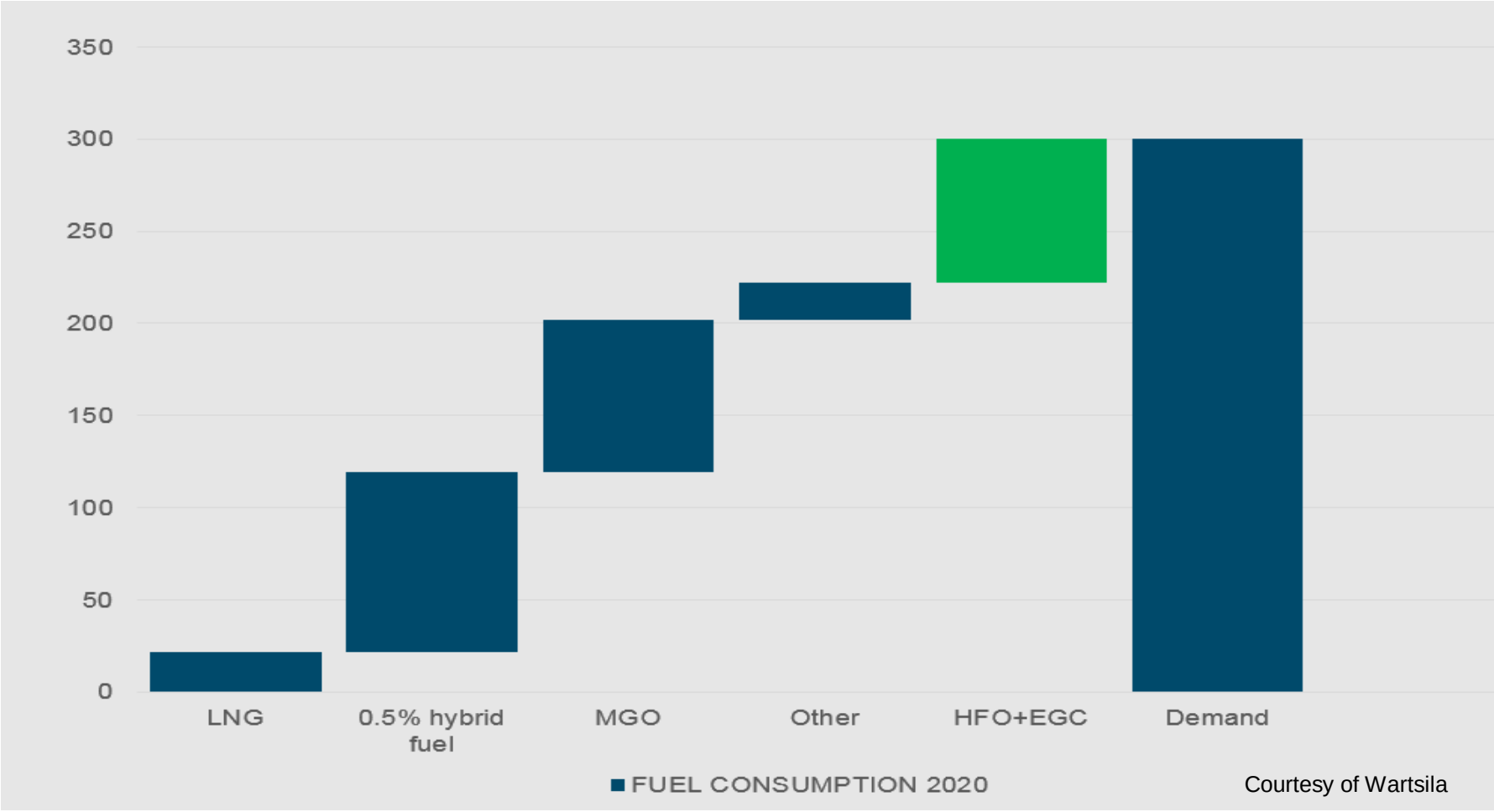

- The number of ships with EGCS installed will exceed 4,000 during 2020
- Ships installing EGCS have large installed power and/or operate at full power
- These ships represents about 7% of the global fleet
- But represent 15% of global fleet annual fuel consumption
- Scrubber installed vessels are unlikely to be involved in compliance avoidance

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- Scheme B requires continuous performance monitoring & recording of compliance

Historical use of scrubbers

LAND BASED SYSTEMS

- Globally since the 1960s over 30 power stations and refineries have adopted sea water scrubbing to remove SO_2 and other emissions
  - One of the earliest applications of scrubbing – Battersea Power Station on the river Thames
  - Periodic inspections over up to 40 years have not identified significant short or long term affects
  - Total installed power scrubbed has exceeded 100GW
  - Countries include China, Norway, UK, Malaysia, USA…
  - The current fleet with installed scrubbers is estimated to be around 80GW (but operated at <50% power)

TANKER INERT GAS SYSTEMS

- Following several explosions inert gas systems were widely adopted in the 1970s. Crude oil tankers scrubbers clean the exhaust gases from steam boilers prior to use as a blanket of inert gas in the headspace above the crude oil
- Port of Rotterdam is the main sea borne import location for northern Europe. Despite inert gas scrubbing over the 24/365 for the last 60 years there is no detectable evidence of any impact on sediments in the discharge locations

Seawater Flue Gas Desulphurisation – (SWFGD)

- Pioneer in SWFGD with 1st installation in 1968
- 50+ GW in Power alone
- Proven experience with 1,000 MW unit
- Unique packed tower design
- No reagent and no by-product, with superior restoration quality of discharged seawater

Reduce Cost of Electricity

- Lower power consumption resulting from packed tower design
- No additional cost for reagent and end-product disposal
- Lower maintenance cost

Lower Environmental Footprint

- > 98% SO2 removal demonstrated
- Up to 4.5% Sulphur in Heavy Fuel Oil (HFO)

Increase Flexibility & Reliability

- Largest fuel flexibility, including coal, HFO and industrial flue gas
- Robust design without nozzles, leading to high reliability

NO.1 in SWFGD with ~60% of installed base globally

ALSTOM

EGCS – Definitions

OPEN LOOP SCRUBBER

- Utilises the natural alkalinity of sea water to neutralise acid formed from scrubbing SO_2. The wash water is appropriately processed before returning to the sea in accordance with IMO discharge limits

CLOSED LOOP SCRUBBER

- Utilises an alkali reagent such as Caustic Soda or Magnesium Hydroxide to neutralise acid formed from scrubbing SO_2. Typically the wash water flow rate is lower than open loop scrubbers as the reagent provides a more concentrated alkalinity. The circulated wash water is treated to ensure that the 0.5% bleed-off water returned to the sea is in accordance with IMO discharge limits. For short periods the bleed-off can be stored on board if a suitable holding tank is installed

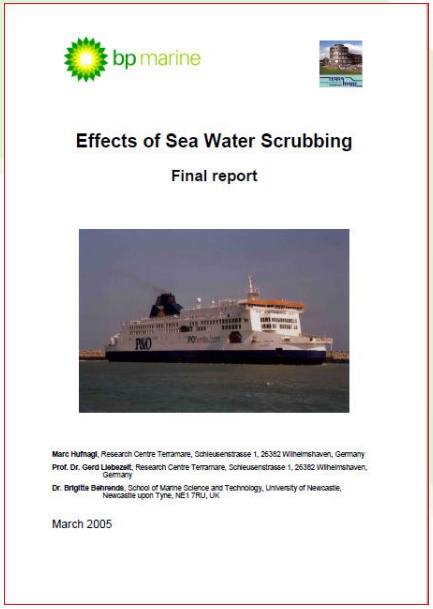
HYBRID SCRUBBER

- Can operate as an Open Loop or Closed Loop scrubber

Wash Water EIA

DISCHARGES TO WATER

- 1991 M/S Kronprins Harald serving the Oslo - Kiel route. Environment impact considered the marine organism exposure time negligible considering very low concentration
- BP Marine study published in March 2005
  - Literature review of discharges to marine environment
  - Component analysis
  - Bio assays
  - MAM PEC model
- Danish EPA study in 2012
  - Evaluated wash water samples from scrubber in service in North Europe
  - Detailed chemical analysis
  - Overall impact of the measured discharge applied to shipping density scenario
- Japanese study published February 2019
  - Shore-side engine & scrubber installation utilising sea water from Tokyo Bay
  - Detailed analysis of wash water
  - Concluded discharge well below levels considered harmful


bp marine

Effects of Sea Water Scrubbing

Final report

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Wash Water EIA cont'd

DISCHARGES TO WATER

- Numerous discharge water sampling studies
  - EGCSA 22 ships in northern Europe
  - Carnival Cruise >80 vessels throughout fleet
  - Scientific study on 5 ships funded by German Environment Agency
  - US EPA General Vessel Permit discharge analysis submissions
  - Ship-owner discharge water analysis submissions to Flag State
- Strict discharge limits which are monitored & continuously recorded on all wet scrubber systems

EGCS – The Future

- With the current known technology it is unlikely that heat engines will be displaced for main propulsion in the next 20 years
- Alternative fuels may provide the targeted zero GHG emissions for new buildings launched in 2030
- All alternative fuels have emissions and may need exhaust gas cleaning
- Reducing or elimination Black Carbon emission will require exhaust gas aftertreatment
- Future emissions regulations will almost certainly include ultra-fine particulate
- Scrubbers are evolving to assist in meeting Tier III NOx emissions

THANK-YOU

For a wealth of materials on EGCS please visit our website at

www.egcsa.com