OPTIMIZING OPERATING COST FOR CONTROLLING SO_X EMISSION

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ABSTRACT: As a result of the restrictions laid down by international conventions that determine the proportion of exhaust gas emissions from ships, increased the cost of fuel to ship owners. These costs could be retrieved by way of increasing the freight rates. However, that would have an adverse effect on their competitive position compared with other modes of transport, which made it necessary to install the exhaust gas treatment system to help ship owners. This paper studies the potential of using exhaust gas treatment system onboard of an ongoing ship. The exhaust gas treatment system supposed to be installed in the engine room. The power requirement is calculated. Money saved by using exhaust gas treatment was calculated. The study showed the uses of the exhaust gas treatment reduce the cost of fuel.

1 ***Keywords:*** emission control area, exhaust gas cleaner, investment.

1 INTRODUCTION

As emission limits become more stringent, compliance becomes more challenging and costly. There are a number of compliance options, each of which has different technical and operational challenges.

To meet reduced SOx emission limits, ships can operate on low-sulphur residual and distillate fuels, and in the longer term alternatives such as LNG (liquefied natural gas), biofuels, DME (dimethyl ether) and methanol may provide solutions. The alternative to these options are exhaust gas treatment systems (EGTS) known as SO_x scrubbers, which clean the exhaust gas to reduce SO_x emissions to a level that is equivalent to the required fuel sulphur content. This offers the flexibility to either operate on low-sulphur fuels or to use higher sulphur fuels.

The choice of strategy for compliance with sulfur dioxide emission requirements is causing frustration and confusion as owners weigh up the pros and cons of exhaust cleaning solutions against fuel switches. And rightly so: the introduction of SOx cleaning technology is a paradoxical problem. On the one hand, there is a potentially very favorable economic solution with a pay-back time of between one and two years in special cases. On the other hand, there are the unknown risks that accompany the introduction of new technology; what if it doesn’t work as intended.

This paper provides a study of the economic possibilities for the installation of exhaust gas treatment system on container ships operating on a regular route between the Arabian Gulf and the North Sea by the study of the actual consumptions of the fuel during the area with the conversion of fuel sulfur lowest

2 AIR POLLUTION REGULATIONS AND CONTROLS

International, regional, national and local instruments regulate emissions of SO_x, NOx and particulate matter from ships. In response to greater concern about air quality the extent and complexity of regulation have increased while emissions limits have become tougher. Annex VI of the IMO MARPOL Convention applies to all ships trading internationally and has been used as the basis for many other regional, national and local regulations(1).

Once the lowest limits for SO_x and NOx come into force, the exhaust emission limits for ships engaged in international trade will still be higher than the current limits for emissions from land-based industry, land-based transportation and air freight, when considered on the basis of sulphur content of fuel consumed or an engine's NO_x emissions in g/kWh. However, when considered on the basis of unit of emission per unit of transport work delivered (e.g. SO_x per teu·km) the emissions of ships will be lower than other forms of transportation due to shipping's significantly higher transport efficiency(2).

2-1 MARPOL Annex VI

MARPOL Annex VI regulates the emissions from ships engaged in international trade and regulations 4, 13 and 14 are particularly relevant.

2-1-1 Regulation 14

Regulation 14 places limits on the sulphur content of fuel to restrict SO_x and particulate matter emissions, and is applicable to all ships in service. The regulation specifies different limits for operating inside and outside an Emission Control Area for SO_x (ECA-SO_x) and these follow a stepped reduction over time, as shown in Figure 1.

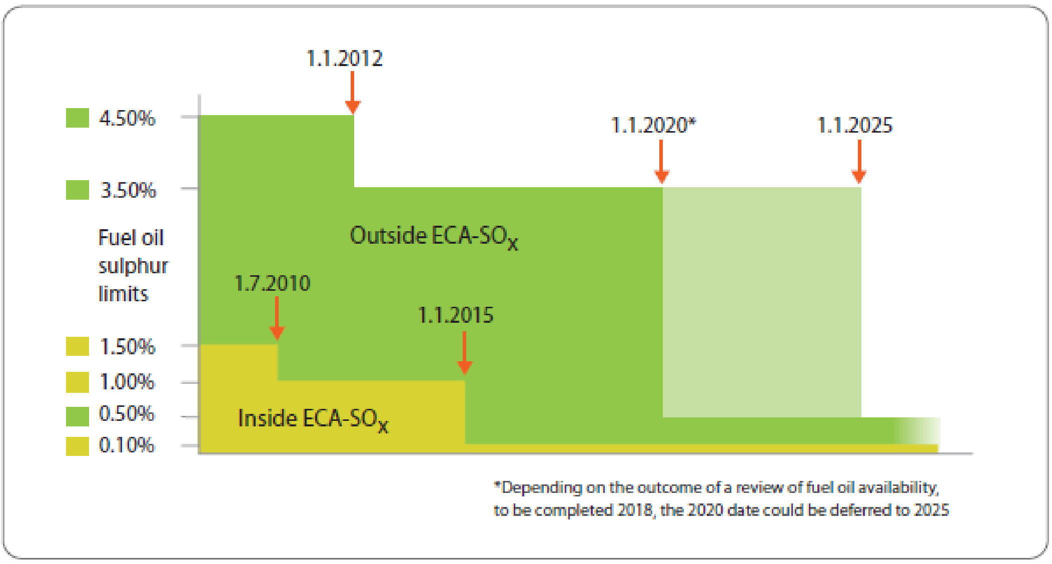

Fig 1 The MARPOL Annex VI fuel oil sulphur limits(1)

Two ECA-SO_x – the Baltic and the North Sea (which includes the English Channel) – are currently in effect and well established. From 1 August, 2012, a third – the North American ECA-SO_x – will enter into effect, while a fourth – the US Caribbean ECA-SO_x – is intended to enter into effect in January 2014.

2-1-2 Regulation 4

Regulation 4 allows flag administrations to approve alternative means of compliance that are at least as effective in terms of emissions reduction as the prescribed sulphur limits. This means that a ship may operate using a fuel with a sulphur content higher than that allowed by regulation 14 as long as an approved SO_x scrubber can reduce the SO_x emissions to a level that is equivalent to, or lower than, the emissions produced by compliant fuel. If a SO_x scrubber is fitted, it must be approved and verified as compliant in accordance with the IMO Exhaust Gas Cleaning Systems Guidelines (MEPC 184(59) – 2009 Guidelines for Exhaust Gas Cleaning Systems [3].

The Guidelines specify two testing, survey, certification and verification schemes: • Scheme A – initial approval and certification of performance followed by in-service continuous monitoring of operating parameters plus daily spot checks of the SO_2/CO_2 emission ratio; and • Scheme B – continuous monitoring of SO_2/CO_2

In either case any wash water discharged to sea must also be continuously monitored. Appendix B1 contains more detailed information on these Guidelines.

3 EXHAUST GAS CLEANING SYSTEM USE

The IMO and EPA both recognize Exhaust Gas Cleaning Systems (EGCS) as acceptable alternatives to low sulfur fuels

Compliance with IMO sulfur reduction requirements options are detailed in the Guidelines and termed Scheme A – Type Approval, and Scheme B – Continuous Emissions Monitoring (CEM). The Scheme A approach demands a significant testing and approval process resulting in a Type Approval. The Scheme B approach requires the use of sophisticated emissions monitoring equipment. Such a monitoring system however, although to perhaps a somewhat lower standard, will still be required for Scheme A systems[4].

EPA provides guidance in its Vessel General Permit program regarding wash water requirements, and follows the IMO Guidelines. However, the EPA has instituted a particulate matter testing program for Category 3 engines, and may in the future define PM requirements related to the use of EGCS.

The sulphur limits apply to both new buildings and existing vessels. Essentially, ship operators can choose between switching to significantly more expensive, low-sulphur fuels (LSFO or distillates) or installing a desulphurization plant (scrubber) that removes SO_x from exhaust gas[5].

3-1 Wet SO_x scrubbers

Hybrid system (see figure 2) can be operated in either open loop mode (sea water circuit) or closed loop mode (fresh water circuit). This provides the flexibility to operate in closed loop mode (including zero discharge mode) where the water alkalinity is insufficient or where there is sensitivity to, or regulation of, wash water discharge, and in open loop mode without consuming sodium hydroxide at all other times [1].

The arrangement offers advantages in that sodium hydroxide is only used when necessary, reducing handling and storage and associated costs. Fresh water consumption is also reduced.

Hybrid scrubbers are, however, more complex than open loop or closed loop SO_x scrubbers.

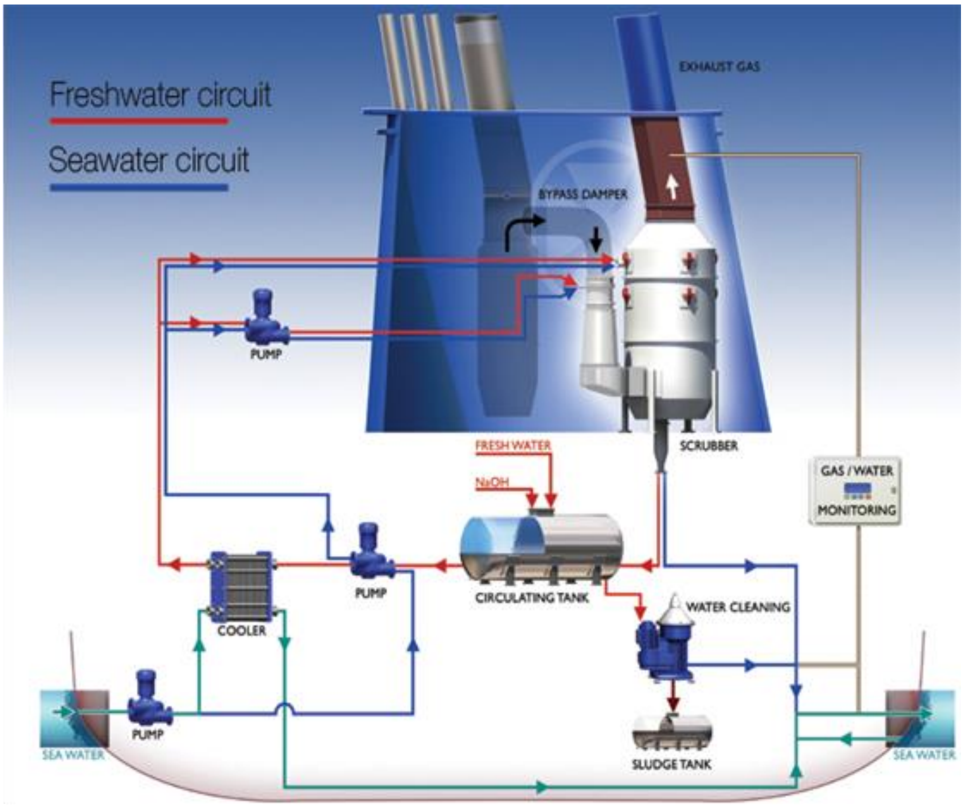

Fig 2 Hybrid system [6]

The cost of the EGCS consists of equipment cost, installation cost and operating cost. Table 1 shows the average prices of the EGCS [1][7],

Table (1) . System prices

Item	Cost
EGCS unit	100 $ /kW
Installation	30% of EGCS
Operating	10 $ /MW .h
Allowances	10% of EGCS

4 CASE STUDY

The ship in the study has the below properties as shown in Table 2. The engine room contains one main engine with the properties shown in Table 3. The ship working between the gulf and the North Sea &the consumption of low sulphur fuel in ECA about 880mt in the rout (during the period in ECA) . The engine working in economical speed at 77 rpm (18knote) and power 40000 KW (company instructions).

Table (2). Properties of ship

Type	Built	L*B	Dwt	GT	TEU
Container ship	2012 /Apr	366m*48m	145236.7	141077	13500

Table (3). Specifications of main engine

Model	power	R.P.M	Speed
Doosan MAN B&W12K98ME7	71,770kW	97	27 knote

The total cost for fixed EGCS on board the ship in case study shows in table (4)

table (4). total cost for unit EGCS

Operating power	Cost for EGCS	Operation cost/ 10 year	Total
Economical load	(Unit installation +allowances) *power	Operating*power*time	∑
40000 kW	140$ * 40000 = 5600000 $	10*4*(24*8*6*10)= 460800$	60000800 $

5 RETURN OF INVESTMENT

The different price between the heavy fuel high sulphur and low sulphur (distillate cost different) is ranged between 250$ to 500$ in the last period (255$ in dec 2013). In this search have fig 3 show the return investment time for different change of price 250$, 500$, 750$, 1000$.

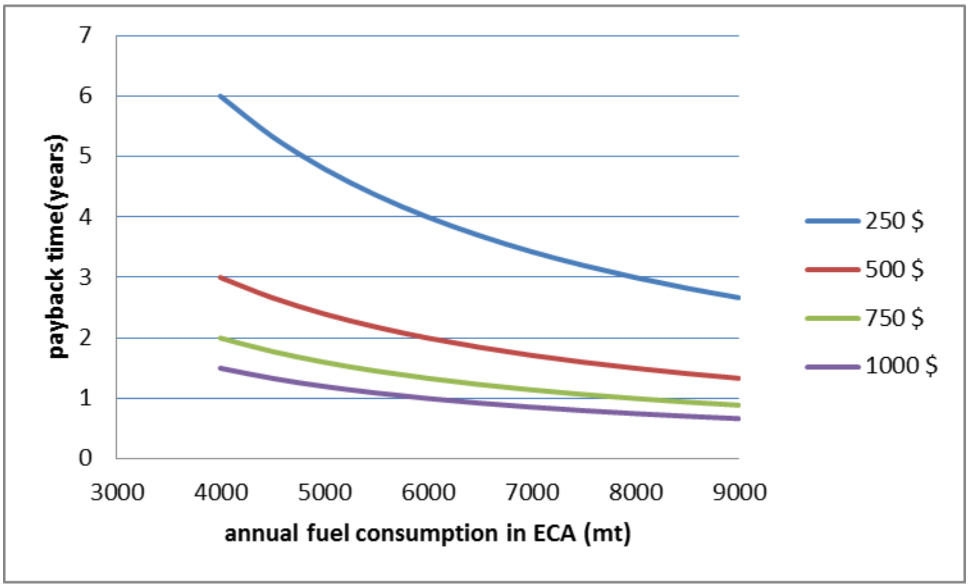

Fig 3 Return on investment

6 ANALATICAL STUDY

- According to increase the demand of low sluphur fuel oil in the ECA, The price different between fuel oil high sulphur and fuel oil low sulphur increases too. By fixing the EGCS on board ships can be saving money.
- In this time with the installation of EGCS in our case study, we can return the investment in about 4.5 years.
- Fig 3 shows the increases of price different bet fuel oil high sulphur &fuel oil low sulphur leads to decrease the payback time.

7 CONCLUSIONS

- This paper studied the potential of using exhaust gas cleaner system onboard of ships. Simple curve was introduced to calculate the return on investment in different change of price for heavy fuel high &low sulphur.
- For the ship under the study, fitting exhaust gas cleaner system in economic power 44000kW with operating cost 10 $/MW.h can return of investment in 4.5 years.
- In 2015 distillate fuel will become scarce because of increase the demand created by the ECA requirements.
- The installation for EGCS on board ship working in ECA is very important to reduce the operating cost for ship

8 RECOMMENDATION

- Study how to reduce the initial cost of the exhaust gas treatment plants to increase the revenues of the ship owners.
- Study how to make the Middle East a zone of cleaning air.

9 ACKNOWLEDGMENTS

Head of training engineering department sea training institute Arab Academy for Science, Technology and Maritime Transport (AASTMT. Alexandria, Egypt).

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