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EuDA INFORMATION PAPER: REDUCTION OF SO_x EMISSIONS FOR DREDGING VESSELS

ABSTRACT

Air pollution from ships causes a cumulative effect that contributes to the overall air quality problems on a local scale, particularly in coastal zones, and most of these airborne pollutants are produced when burning fuel oil. To focus on possible legislative or technical concerns of the European dredging companies with regards to the sulphur legislation and to review potential solutions, a workshop was organised by the European Dredging Association (EuDA) in April 2013. Besides dredging experts, the workshop also gathered industry representatives from the ship owners, engine manufacturers and providers of exhaust gas cleaning solutions as well as from the oil refinery and distribution sector. In this article, EuDA presents a summary of the findings of the workshop – including the legislative background, the technological or methodological options to comply with the legal requirements and finally setting forth on the most realistic option available at present.

INTRODUCTION

Air pollution from ships causes a cumulative effect that contributes to the overall air quality problems on a local scale, particularly in coastal zones in the case of sulphur oxides (SO_x), nitrogen oxides (NOx), Particulate Matter (PM), and on a global scale with CO_2 emissions contributing to climate change. Most of these airborne pollutants are produced when burning fuel oil.

On April 23, 2013 the European Dredging Association (EuDA) organised a workshop focussing on possible legislative or technical concerns of the European dredging companies regarding the sulphur legislation on special areas worldwide, with a particular focus on European waters, and reviewing the solutions available today.

The workshop gathered a group of industry representatives and experts from the dredgers, the ship owners, engine manufacturers and providers of exhaust gas cleaning solutions as well as from the oil refinery and distribution sector. It attempted to answer to the following questions:

- Are there still pending legal issues for the Dredgers (relative to emissions)?
- Are there technical issues with engines and/ or scrubbers for SO_x compliance?
- How about NO_x compliance?
- How about compliant fuel availability?
- Is LNG a realistic option for Dredgers? If so, under what conditions?

This article presents a summary of the findings of the workshop starting with the legislative background, then following with the technological or methodological options to comply with the legal requirements. It concludes with the most realistic option available today.

Above: A dredging vessel sailing near Riga, Latvia, which is in the SO_x Emission Control Areas of Europe – the Baltic Sea, the North Sea and English Channel. As of January 1, 2015, all ships including dredgers working in these waters, will have to comply with stricter requirements.

SO_x LEGISLATIVE BACKGROUND

The reference legislative body for the shipping industry is the International Maritime Organization (IMO). Beside navigation and safety issues, the IMO legislation also covers all environmental regulatory aspects linked to shipping, including the emission of airborne pollutants (as confirmed recently by United Nations Framework Convention on Climate Change - UNFCCC). The issue of controlling air pollution from ships was already discussed when adopting the MARPOL Convention in 1973. However, no IMO legislation on reducing sulphur emissions was adopted until decades later (i.e., these are the Protocols to the Convention on Long-range Transboundary Air Pollution in 1985 and 1994).

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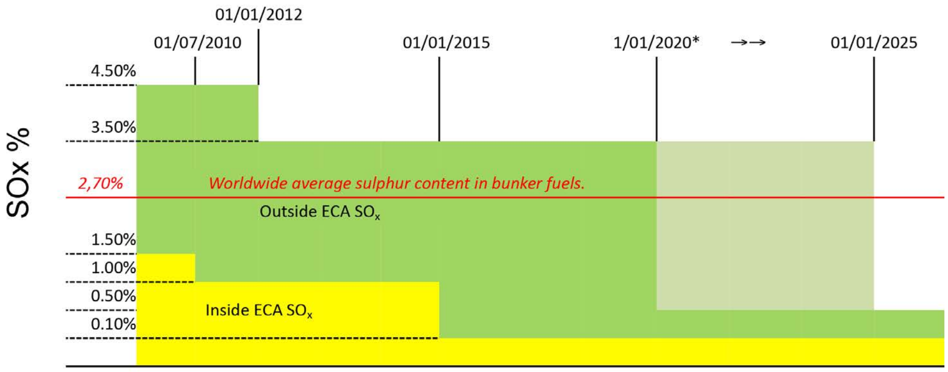

Depending on the outcome of a review, to be concluded in 2018 (could be deferred to 1 January 2025)

Figure 1. Sulphur limits evolution 2010-2020/25.

When MARPOL Annex VI (see box) was adopted in 1997, limits were set for the main air pollutants contained in ships' exhaust gas, including sulphur oxides (SO_x) and nitrous oxides (NO_x). It also regulated emissions of ozone-depleting substances, of volatile organic compounds from tankers and shipboard incineration. These limits were to be revised in 2005 and were finally adopted in October 2008 by the Marine Environment Protection Committee (MEPC58). The revised MARPOL Annex VI, in force globally since July 2010, sets a progressive reduction in emissions of SO_x, NO_x and Particulate Matter (PM) and also introduced Emission Control Areas (ECAs) where stricter limits are implemented for those air pollutants. These fuel oil sulphur limits (expressed in terms of % m/m – by weight) are subject to a series of step changes over the years as described in Figure 1.

As a consequence, most ships sailing both outside and inside these SECAs will need to choose to operate on only SECA-compliant fuel or on different fuel oils complying with the respective limits (in and out of the SECA). Sailing on SECA-compliant fuel at all times is in principle possible but costly: Operators will face an average mark-up of about 30% with regards to non-SECA-compliant fuel (Figure 2).

REGULATION 14 ON SULPHUR OXIDES (SO_X)

Regulation 14 of the MARPOL Annex VI provides both the limit values and the means to comply. The IMO regulation recognises that besides solely sailing on SECA-compliant fuel, there are other means by which equivalent levels of SO_x and PM emission control, both outside and inside SECA, could be achieved. These may be divided into:

- methods termed primary, in which the formation of the *pollutant is avoided* or
- methods termed secondary, in which the *pollutant is formed but subsequently removed* to some degree prior to discharge of the exhaust gas stream to the atmosphere.

Therefore, the options within an IMO special area are either to use SECA-compliant fuel or to remove the excess pollutants from the exhaust gases. Outside a SECA, equivalent options (0.5% sulphur content) will also have to be implemented by 2020 (or 2025).
The European Commission is also legislating on the sulphur content of marine fuels but largely follows the IMO rules. Following the revision of the MARPOL Annex VI, the Commission has had to amend accordingly its so-called 'Sulphur Directive'. However, the European 'Sulphur Directive' implements the provisions of IMO Annex VI with:

1) stricter deadlines (latest by 2020) and
2) some additional requirements for passenger ships sailing outside SECA zones (same sulphur limits as inside SECA).

PRIMARY METHODS FOR SULPHUR EMISSION CONTROL

When trying to reduce the emission of air pollutants, one usual starting point would be to make more and more efficient use of the

MARPOL ANNEX VI - REGULATION 14 ON SULPHUR OXIDES (SO_X)

Annex VI Regulations for the Prevention of Air Pollution from Ships established general fuel oil sulphur limits as well as more stringent restrictions on sulphur emissions in certain protected areas, the SO_x Emission Control Areas (SECAs) (see Table I).

SO_x and Particulate Matter emission restrictions apply to all fuel oil, combustion equipment and devices onboard and therefore include both main and all auxiliary engines together with items such boilers and inert gas generators. These restrictions divide between those applicable inside SECA established to limit the emission of SOx and Particulate Matter and those applicable outside SECA. These restrictions are primarily achieved by limiting the maximum sulphur content of the fuel oils as loaded, bunkered, and subsequently used onboard.

Figure 2. Maintenance dredging at Warrenpoint Harbour, Northern Ireland. Although the Irish Sea is not yet part of European SECAs, at some point all European waters including the Mediterranean Sea and Black Sea will probably become SECA (SO_x) / NECA (NO_x)/.

Table I. Annex VI Emission Control Areas

Special Areas	adopted #	into Force	in Effect from
Baltic Sea area (SO_x)	26 Sept 1997	19 May 2005	19 May 2006
North Sea area (SO_x)	22 July 2005	22 Nov 2006	22 Nov 2007
North American area (SO_x, and NO_x and PM)	26 Mar 2010	1 Aug 2011	1 Aug 2012
United States Caribbean Sea area (SO_x, NOx and PM)	26 July 2011	1 Jan 2013	1 Jan 2014

fuel. Historically in the dredging sector, the operations' efficiency improved on average by 7.5% per decade and in particular for trailing suction hopper dredgers (THSDs) (Figure 3). Nevertheless, additional measures need to be taken to achieve the ambitious targets set by legislators worldwide.

The primary methods – avoiding the formation of the pollutants – as considered by IMO include switching to cleaner fuel oils. These are usually found in the more refined products such as the distillates. Indeed the combustion in the main engines follows the rule that "what comes in must come out". Therefore, in order to avoid the formation of the pollutant, the main possible solutions include:

- *Permanent switching* to compliant fuel (inside and outside SECA)
  a. more refined marine gasoil (MGO)
  b. marine diesel oil (MDO)
  c. LNG

- *Temporary switching* between different fuel types to comply with the emissions standards (only when inside ECA): This means technology operating on multiple liquid and/or on gaseous fuels, allowing for the seamless switch over from non-SECA fuel (heavy fuel oil, HFO) to SECA-compliant fuel (LNG, MGO or MDO) and vice versa.

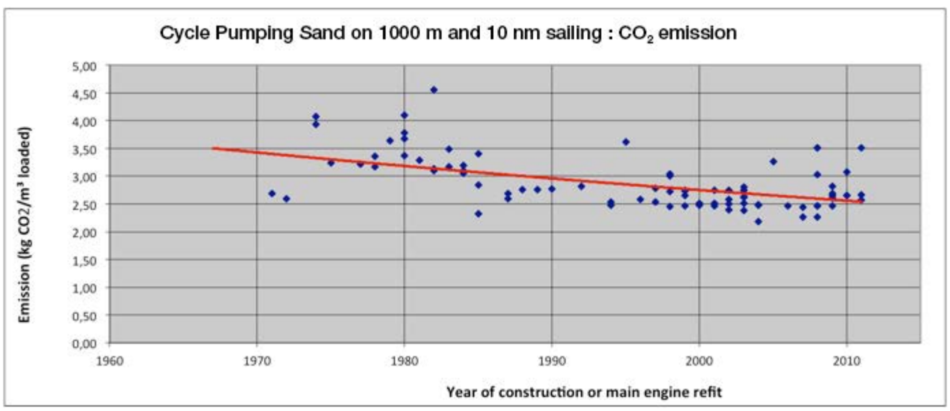

Figure 3. Efficiency improvement for Trailing Suction Hopper Dredgers.

Technological solutions

As far as the engine manufacturers are concerned, the technological solutions for full compliance to the IMO sulphur regulation exist for ships sailing through or working within SECAs. The solutions include the use of compliant fuel or the installation of scrubbers. For the use of compliant fuel, the engines may need some adaptation and the specifications need to be upgraded because (non-ECA compliant) heavy fuel (HFO) has a higher calorific value generating more power per metric volume of fuel than (compliant) medium gasoil or diesel oil (MGO or MDO). These solutions can be applied to both new-builts or existing ships (retrofit).

Technical viewpoint

From a technical point of view, the engine manufacturers agreed that owing to the strong variations in power demand for the dredging cycle and the current absence of appropriate regulations (e.g., class rules for portable LNG tanks on deck), LNG or dual fuel engines are probably not the most suitable options for dredgers.

Economic viewpoint

From an economic point of view, the decision is much more complicated for the existing fleet than for the new-built ships: the operating time spent in and out of a SECA affects the period needed to recover the investment (payback period) and, together with the age of the vessel and the state of recovery of past investments, this determines the economic feasibility of the considered solution for SECA compliance.

The payback period of the investment for a new-built also depends on the operating time spent inside a SECA (which is a small fraction of their time for most of the internationally operating dredgers). Moreover, the benefit of switching fuel will greatly depend on the highly volatile *price differential between cheaper non-SECA fuel and more expensive SECA compliant fuel* (at the bunkering sites) and on the general worldwide availability of the different fuel types for which investments have been made.

Policy-making viewpoint

From a policy making point of view, *the best solution should deal in a holistic manner with* *the various issues at stake (SO_x, NO_x, PM, ...).* This is typically the case when LNG would be used: indeed, SO_x and PM emissions are quasi nonexistent while NO_x emissions are strongly reduced and CO_2 emissions are reduced by 20% (see Figure 4).

Through programmes such as the Trans-European Transport Network (TEN-T) and the Connecting Europe Facility (CEF), Europe is stimulating infrastructure development for distribution of LNG in the TEN-T core network of ports. However these initiatives still have to be implemented. As far as the dredging companies are concerned, their technical versatility to cope with projects demand has resulted in vessels' geographical working areas needing to be as flexible and large as possible, therefore worldwide. This imposes on these dredging companies the prerequisite that the choice of fuel should not become a limiting factor: *i.e., internationally operating dredging companies need to use a fuel available worldwide* (Figure 5).

Fuel availability will also depend on the investment decisions of the oil refiners and distributors for which about US$ 30 bn have been identified. Even so, to satisfy the current fuel consumption for shipping in the European SECAs with compliant fuel, an extra US$ 21 bn need to be invested. This is probably never going to happen in a saturated and receding market such as Europe, competing for investments against the BRIC (Brazil, Russia, India, China) countries.

To date, the most realistic (technical and economic) solution for dredgers operating in a SECA, with regards to primary methods of SO_x compliance (0.1%), would be to run on Marine Diesel Oil (MDO).

SECONDARY METHODS FOR SULPHUR EMISSION CONTROL

The secondary methods – removing the pollutant from the exhaust gas – as considered by IMO include dry and wet (sea / fresh water) scrubbers. For some of these the IMO Guidelines, Classification Societies rules and certification are already in place.

Technological solutions

As far as the scrubber manufacturers are concerned, the technological solutions for full compliance to the IMO sulphur regulation exist for ships sailing through or working within SECAs. Scrubbers can be installed on both new-builts or on existing ships (retrofit). However for the dredging vessels, the suppliers anticipated some specific issues, such as quality of intake water, deck and engine room space, height of installations, engine load variations, which would need to be solved in a joint effort with the dredging companies for effective performance of the scrubbers and SECA compliance.

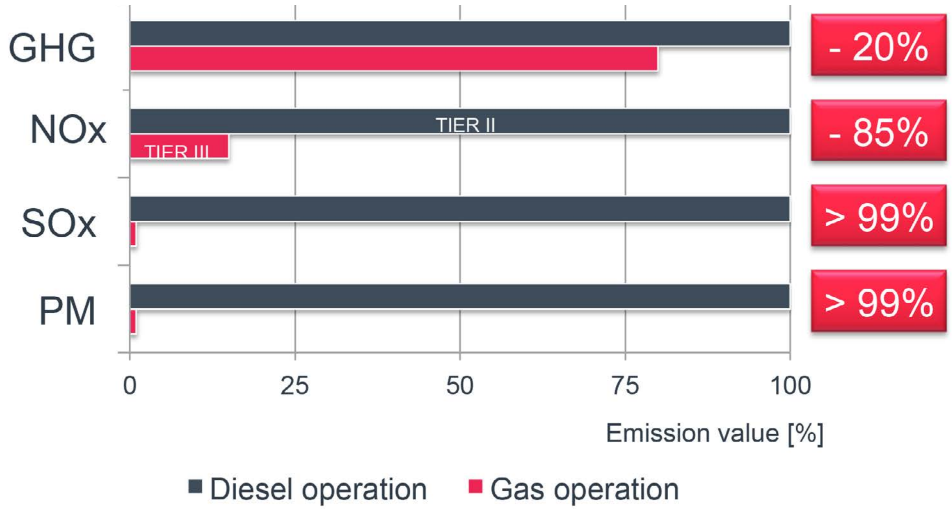

Figure 4. Air Emissions Reduction, Gas vs Diesel operations. Gas mode offers IMO compliant operation without any additional after treatment technology.

Technical viewpoint

From a technical point of view, these "existing" solutions have NOT yet been developed for all ship types or for large engine load variations: a development period of up to two years can be necessary (Figure 6).

Moreover, according to the ship owners' own experiences, the level maturity ("proven technology") is not as high as the manufacturers claim and the size of the equipment to be installed is huge (not compatible with existing installations on dredgers).

Their current experience remains limited and problems have been reported with regards to:

- the actual performance of the scrubber itself (raising doubts about actual compliance),
- its negative impact on fuel consumption (increase of fuel consumption owing to the weight of the scrubber and sometimes to its interaction with the engine),
- its high cost (particularly in retrofitting),
- its residues and waste management.

Figure 5. An added factor when considering fuel and emissions is that dredging vessels work all over the world and often 24/7. Refuelling is an important issue.

Figure 6. A fallpipe vessel (FVP) being used for subsea rock installation in Norway. Dredging vessels come in a variety of types which may require different fuel solutions.

For the dredgers, the retrofitting of such systems can also create new issues such as concerns about the stability of the ship as a result of the size and weight of the equipment to be placed onboard.

Economic viewpoint

From an economic point of view, the decision is complicated for the existing fleet by the following facts:

- investments need to be paid back (payback period),
- operational efficiency is negatively affected by increase of weight and loss of cargo space (payload) and tank space (fuel capacity).

The payback period for the new-builts and existing ships depends on the operating time spent inside a SECA (which is a small fraction of their time for most of the dredgers).

Moreover, as a consequence of these factual elements, the investors will be reluctant to provide the necessary financing. For the dredging companies, these issues are even more critical as they compete on the global open market, including SECAs, where increase of costs or reduction of productivity can become deciding factors for the tendering project owners.

NO_x emissions reducing technologies

The possible NO_x emissions reducing technologies include Engine adjustments, Exhaust Gas Recirculation-EGR, Humid Air Motors-HAM/ Direct Water Injection-DWI, Selective Catalytic Reduction-SCR. In general, these technologies are not as demanding as their sulphur equivalent and can be combined. However the NO_x implementation date appears to be shifting (from 2016 to 2021) and until the IMO delivers a clear message with a clear deadline, investment decisions in such technology are difficult to make and particularly for the existing fleet.

CONCLUSIONS

The main issues for the dredgers to comply with the stricter sulphur emission limits inside SECA, are linked to their design and use:

- the space and weight of dredging vessels are optimised (including accommodations, equipment and cargo haul);
- their economic added value is measured in tonnes of transported material;
- their engine loads vary widely; and
- their geographical versatility is an absolute must.

When considering the technological options:

- all solutions (scrubbers; LNG engines / dual fuel) require a lot of space and add significant weight to the ship (sometimes causing concerns about stability);
- they require availability of compliant fuel in or near SECAs (dredging equipment must work worldwide);
- current economic evaluation is based on (quasi-)permanent operations in a SECA (for return on investment; payback);
- they ignore payback on previous investment (e.g., in HFO installations);
- the various retrofit options are still too expensive, not fully mature and not yet optimised for dredging vessels (e.g., with regards to engine load variations);
- they also require extra logistics for reagent and waste management which are not available worldwide (i.e., in all areas where dredging vessels operate).

The decision for the dredgers on which technological solutions to choose is rigged with uncertainty as it will depend on decisions by other players:

- which fuel type(s), in which quantities and at what price will the refiners and distributors provide?
- will the technology suppliers produce mature, compact, cheap installations and suitable for large load variations?
- will the dredger companies' clients agree to pay more for a "greener" service?
- will the countries / contracting parties to the Convention opt for a legislative exemption for dredging?

Two further points: To date, the most realistic (technical and economical) solution for the dredgers operating in a SECA (0.1% of sulphur), would be to run on Marine Diesel Oil (MDO). Though sustainable solutions are the only option, no inexpensive solution exists.