ABSTRACT: The environment still is exposed on degradation caused by industries activities. Fortunately for the environment, the international community (IMO, EU, HELCOM) agreed to reduce emissions of some pollutants. These requirements are being implemented gradually and will have full force in 2015 and 2016. On the other hand that situation is a big challenge for a shipping industry to meet these requirements, especially on ECA (emission control area). One option is to use LNG as a fuel. This paper describe the LNG situation on Baltic Sea, and aims of project “MarTech LNG” as well. “MarTech LNG” is one of projects, which support the LNG solutions for south Baltic Sea region.
TECHNOLOGICAL SOLUTIONS

The review of existing engine technology and its development indicates that currently only three solutions are in accordance with SOx regulations. If shipowners wish to continue sailing on Baltic Sea after 2015 they have to choose (DMA 2012):

- low sulphur fuel,
- an exhaust gas scrubber,
- LNG fuel (liquefied natural gas).

The first solution require only minor modifications on vessel fuel systems. The content of sulphur in a fuel like MDO (marine diesel oil) and MGO (marine gas oil) can be below 0.1%. The main disadvantage such a choice is limited availability of low sulphur fuel is that rising demand is expected to increase its price uncertainty.

The second solution requires installation of an exhaust gas scrubber to remove sulphur from the engine exhaust gas by using chemicals or seawater. This technology require significant modifications on ship systems. Additional tanks, pipes, pumps, and a water treatment system. The sulphur-rich sludge produced is categorized as special waste, to be disposed of at dedicated facilities. Moreover, scrubbers increase the power consumption, thereby increasing its CO$_2$ emissions.

The third solution is using LNG (liquefied natural gas) as a fuel. Natural gas is the cleanest form of fossil fuels available, and when fuelling a ship with LNG no additional abatement measures are required in order to meet the ECA requirements. However, an LNG-fuelled ship requires purpose-built or modified engines and a sophisticated system of special fuel tanks, a vapouriser, and double insulated piping. Available space for cylindrical LNG fuel tanks on board ships has been a key challenge, but new hull integrated tanks are expected to simplify this issue.

For new ships delivered after 1 January 2016, exhaust gas purification by Selective Catalytic Reduction (SCR) or LNG fuel are the only two currently available abatement measures to meet Tier III requirements.

BENEFITS OF USING LNG

LNG means liquefied natural gas. The natural gas is temporarily converted to liquid form at -163 Celsius, under atmospheric pressure. It takes up 600 times less space than as a gas, therefore it is more efficient for storage and transport. LNG is currently tested as a fuel on more than 20 vessels sailing on Norwegian waters.

In addition LNG is clean not only in aspect of exhaust gases, but also in case of spill. LNG does not cause environmental disaster because in such a case it will evaporate quite fast. The main hazard in case of LNG spill, are frostbites due to extremely low temperature (Starosta 2007).

Taking account above mentioned three solution it should be said, that LNG is the best alternative in aspect of economic and environmental impact to Baltic Sea.

3.1 Environmental impact

LNG as a fuel has the lowest emission of all three pollutants NOx, SOx, and particles, as well as the greenhouse gas CO$_2$ (GHG). SOx and particles are reduced by close to 100% (Figures 2 and 4), NOx emissions close to 85–90% (Figure 3), and net GHG emissions by 15–20% (Figure 5).

Pollutant emissions for a typical, cargo Baltic Sea vessel is shown below (DNV). The typical cargo vessel was determined as follows:

- Gross tonnage: 2700,
- Power of main engine: 3300 kW,
- Yearly sailing hours: 5250.

Low sulphur fuel means a fuel contains maximum 0.1% sulphur, and conventional fuel contains 1% sulphur (according to 01.07.2010 status).

Figure 2. SOx emission of different fuel solutions for typical Baltic Sea cargo vessel (DNV 2010)

Figure 3. NOx emission of different fuel solutions for typical Baltic Sea cargo vessel (DNV 2010)
3.2 Economic benefits

Nowadays the LNG trade market is large and flexible. The forecast developed by U.S. Energy Information Administration (EIA) in 2008 are optimistic and indicates an expanding gap between conventional fuel and LNG (Figure 6).

The cost of a new vessel equipped with LNG propulsion is higher about 10-20% than conventional vessel with similar gross tonnage. The additional cost is mainly due to the sophisticated LNG storage tanks, the fuel piping system and in some cases a slightly larger ship. Based on experience from ships built, the additional investment cost for the LNG fuelled typical Baltic Sea cargo vessel has been estimated to about 4 million USD. Estimated cost of scrubber installation should be around 1 million USD. Taking these assumptions into account and forecasting price of marine gas oil (MGO) in 20 years perspective the lowest exploitation cost are in case of LNG vessel (Figure 8).

The exploitation costs analysis indicates that fueling LNG is cheaper even in comparison to HFO, and differences between MGO option is up to 12 million USD.

4 STATUS OF LNG INFRASTRUCTURE ON BALTIC SEA

In order to enable navigation of vessels using LNG as a fuel, a grid of bunker stations is required. An average period between bunkering for the LNG
vessels today is about one week, and vessels should have possibilities to obtain LNG in one of the ports during their trips. Currently there is no LNG infrastructure on Baltic Sea (figure 9).

The number of import terminals is not enough to provide a supply of LNG for every route on Baltic Sea. They should operate rather as a hub of LNG and distribute it to small scale bunker stations.

In case of decision about building new import terminal, it belongs to government in order to securing energy independence of given country, but decisions about building small scale LNG terminals or bunker stations, depend on market. Currently there is no LNG bunker stations on Baltic because there are a small number of LNG powered vessels, and lack such vessels is a result of lack of bunker stations. It seems correct that at least at the beginning, the bunker stations should also have a political support.

MarTech LNG – “Marine Competence, Technology and Knowledge Transfer for LNG in the South Baltic Sea Region (SBSR) is one of the projects which aims are dissemination of LNG technology by exchanging experiences, knowledge and competencies within SBSR. The project supports the activities related to LNG technology, promotes LNG as a green energy and the cleanest marine fuel. Main idea of the project is to create a better access to technology and knowledge on LNG related business activities to build up a better competences and specialization among the SBSR maritime business supply chain. The main idea will be achieved by realize following aims:

- Develop the LNG related competences for the Maritime industries in SBSR
- Foster LNG targeted scientific research
- Create LNG supply/value chain in SBSR

5 SUMMARY

LNG is one of the best solution for Baltic region to protect environment against pollution caused by conventional fuels. Now is the time for owners to decide which solution to choose to be in compliance with the MARPOL Convention. They will choose LNG, if on Baltic Sea the LNG infrastructure will exist. Unfortunately it seems that without political support, building infrastructure may be difficult or even impossible.

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