MAHARASHTRA ACADEMY OF NAVAL EDUCATION AND TRAINING

PRESENTS

A PAPER ON "GREEN SHIP TECHNOLOGIES"

PREPARED BY:-

1. CDT. **ANISH SEHGAL**
2. CDT. **RISHABH GAUTAM**

SEMESTER VIII

ABSTRACT

With more and more ships launched for commercial trade, marine environment concern has been at its peak among both ship makers and operators. The year 2011 has seen announcements of several projects that are specially designed to minimize pollution of the ocean from the shipping industry.

The Shipping Industry is leaving no stones unturned in order to contribute towards a greener marine environment. At both manufacturing and administrative levels, the maritime industry is taking advantage of the latest technologies to ensure that new ships contribute as low as possible to the global pollution.

With respect to airborne emission the aim of these technologies would be to provide new operational means to reduce emission as follows:

- 30 % reduction of CO_2 emissions.
- 90 % reduction of NO_x emissions.
- 90 % reduction of SO_x emissions.

The year 2012 is expected to be more environmental friendly and green shipping activities will be at its peak with launch of new ships technology.

INTRODUCTION

Almost 90 % of the world trade is carried by ship and for the vast majority of this trade there is little or no alternative to transport by ship. Ships are the most environmentally friendly form of transportation.

The shipping industry is the sixth-largest source of warming gases. Commercial vessels emitted 3 percent of the world's carbon in 2007, and that may increase to 18 percent by 2050 as global trade increases and fleets expand, as per the UN's International Maritime Organization reports.

Pollution from the ships is mainly in the form of sox and NOx, Carbon oxides, unburned hydrocarbons, volatile organic compounds and particulate matter. These have been proven to have a (-) ve impact on health & environment. Acidification from sulphur dioxide can be usually detrimental to the plants, animals, humans & aquatic life forms and there is a long term consequences of carbon dioxide on global warming. Marine diesel engines just like any other internal combustion machinery emit all of those harmful products.

The most significant challenge to our environment today is the preservation of the earth's atmosphere. IMO and the shipping community at large have been, and are continuing to work towards combating atmospheric pollution, as well as limiting or reducing emissions of greenhouse gases.In recent years, sustainability in a climate and an environmental perspective has become an issue of highest priority. This is an agenda that cannot and should not be ignored. Designing a Ship in present times has become a challenging task for now a ship has to be fully complied with new environmental rules and regulations. A few benchmark technologies have already been developed to reach the ultimate goal of building a "Green ship" which would not only comply with the new environmental rules and regulations but would also leave least possible carbon foot-prints. We'll be throwing light on 14 new technologies which if used together would result in ultimate "**Green Ship of the Future"**. They are as follows:

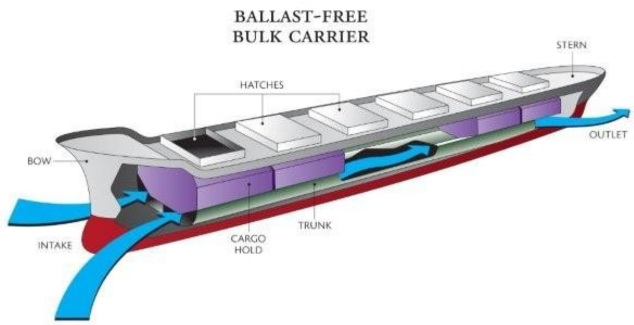
- No Ballast System
- LNG Fuel for Propulsion
- LNG Fuel for Auxiliary engine
- Exhaust Gas Scrubber System
- Advanced Rudder and Propeller System
- Speed Nozzle
- Hull Paint
- Waste Heat Recovery System
- Exhaust Gas Recirculation
- Water in Fuel
- Fuel and Solar Cell Propulsion
- Sandwich Plate Syatem (SPS)

No Ballast or Ballast free ship

The non ballast or ballast free ships are prototype of a greater paradigm, in accordance with the 1997 International Maritime Organization (IMO) ballast water management Guidelines A.868 (20) and the IMO ballast water convention that approaches ballast operation as the reduction of buoyancy, rather than summing up additional weight to help get the vessel to its required ballast drafts.

Why ballast free ships?

This is one promising design to block hitchhiking organisms and terminate the entire requirements for expensive sterilization equipment like costly filters, ultraviolet irradiation, chemical biocides and other technologies. It creates a constant flow of local seawater through a network of trunks, running from the bow to the stern, below the waterline, thus reducing the potential hauling of contaminated water across the ocean. Plus it could be one giant economic winner by affirming a saving of net capital-cost of about $540,000 per ship.



Features of ballast free ships

- **Ballast trunks:** Ship ballast tanks are replaced with longitudinal structural ballast trunks consisting of one centre tank, two intermediate tanks and two side tanks which surround the cargo hold below the ballast draft and are connected to an intake plenum and a discharge plenum near the bow and the stern respectively. These ballast trunks are swamped in the ballast circumstance to diminish the ship's buoyancy.

- **Hull Shape:** V-shaped hull minimises the resistance and optimises the propeller conditions in fully loaded and unloaded conditions by reducing the weighted sum of the wetted surface. In lightship condition it increases the draft from the normal 3-4 metres (with the bow and propeller almost out of the water) of a conventional 300k DWT VLCC.

- **CFD tools:** Computational Fluid Dynamics (CFD) compare the syrupy resistance of the new design with that of a more traditional design and assist in maximizing the pressure fields in the bow and stern area.

- **Propulsion:** The twin screw and optimum diameter propellers allow low draught aft in the unloaded condition and ensure high propulsive efficiency by overlapping propeller arrangement. Propulsion power is estimated on the basis of the resistance and propeller analyses.

- **Trim and heel:** Longitudinal bulkheads provide with moment equilibrium around the longitudinal centre line for all segregation alternatives and prevent large trims to occur during the cargo operations.

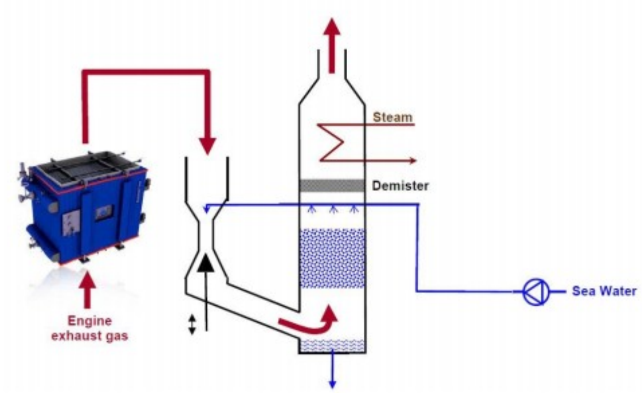
EXHAUST GAS SCRUBBER

The future international regulations regarding sulphur emissions from ships imply that low sulphur fuel should be used in the future;however, exhaust gas scrubbers are allowed as an alternative to actually lowering the fuel sulphur content.

Scrubbers can be used for washing the exhaust gas from the main engine and can, in principle, be compared to a large shower cabinet placed in the funnel of the ship. With Aalborg Industries' newly
developed scrubbing system, it is possible to reduce the sulphur emissions to a level as low as if low sulphur fuel oil was used. But because low sulphur fuel oil has a significantly higher cost price, it makes good financial sense to use scrubbers to clean off off the exhaust gas and thereby continue using heavy fuel oil.

The method:
The major environmental benefit from the scrubbing system developed is that both seawater and freshwater mixed with caustic soda can be used for the scrubbing. This makes the scrubbing process more environmentally safe than using chemicals to clean the exhaust gas of emissions. The scrubbing process in the Aalborg Industries system consists of three stages: At the first stage, the exhaust gas is cooled from approximately 350ºC to 160-180ºC in a conventional exhaust gas economizer that uses the extra heat in other parts of the system instead of just

wasting it. At the second stage, the exhaust gas is treated with a special ejector.



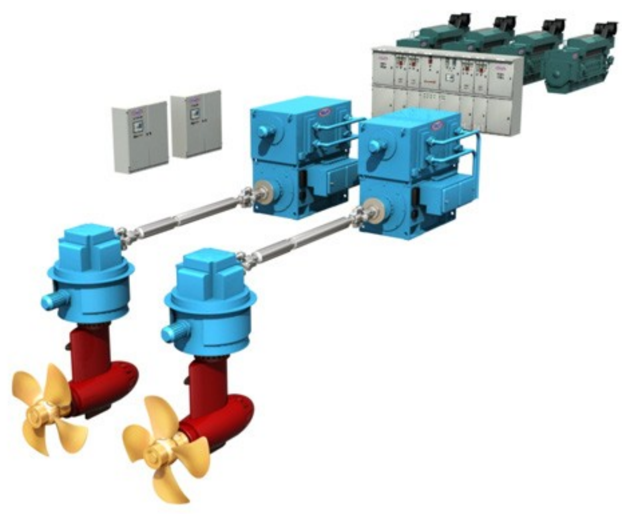
Scrubber system with sea water

Here the exhaust gas is further cooled by injection of water removing the majority of the soot particles. Finally, the exhaust gas is led through an absorption duct where the exhaust gas is sprayed with water and thus cleaned of the remaining sulphur dioxide. To prevent visible condensation and corrosion, the exhaust gas is subsequently reheated before being discharged through the funnel of the ship.

Emission reductions: CO_2 3% (compared to converting HFO to MGO in refineries)
Sox 98%
PM 80%

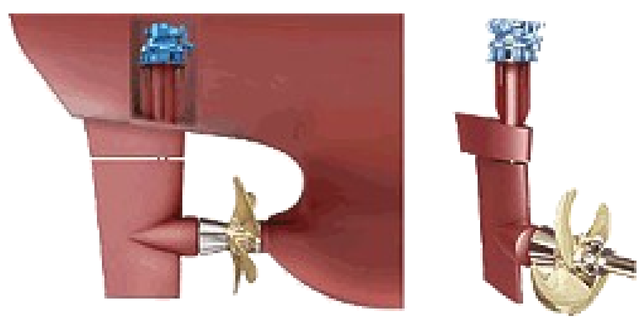
LNG FUEL FOR PROPULSION

Normally, the electrical power in harbour condition is supplied by using auxiliary engines running on heavy fuel or marine diesel. By using auxiliary engines running on LNG (liquefied natural gas) instead of conventional fuel, significant emission reductions can be achieved. Emission reductions in the magnitude of approximately 20% on CO2, approximately 35% on NOx and 100% on SOx are the potential of switching from diesel to LNG**.**



Advanced rudder and propeller system

A well-designed propeller and rudder system can save up to approximately 4% of the fuel oil consumption. Such a system could be a modern propeller combined with an asymmetric rudder and a so-called Costa Bulb.



With new propeller design methods modern propellers becomes more and more efficient. The Costa Bulb creates a smoother slipstream from the propeller to the rudder. With an asymmetric rudder, the rotational energy from the propeller is utilised more efficient compared to a conventional rudder.

Conventional design and construction together with simple installation means the payback time for the Promas concept can be surprisingly short. Other benefits include:

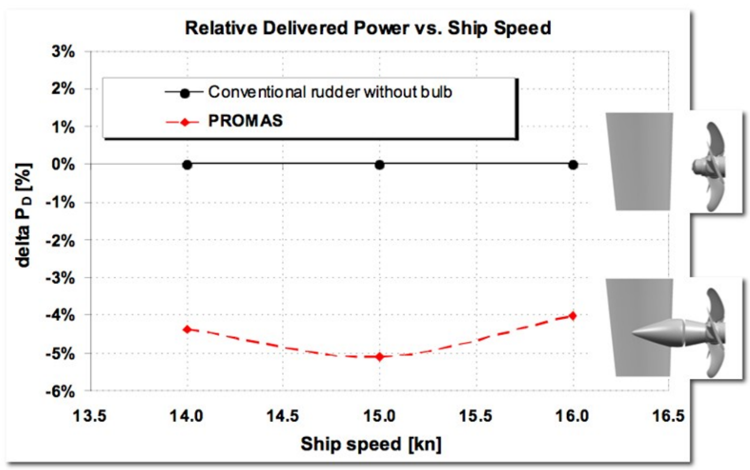
- Propeller and rudder are designed together as a single unit for optimum propulsive efficiency.
- Propulsive efficiency is increased by typically 3-6%.
- Improved low speed manoeuvrability.
- Improved possibility for low pressure pulse / low noise propeller designs.

- Simple and robust design.
- Almost as easy to install as a conventional propeller-rudder system.

The best results are achieved on blunt single screw vessels with a block coefficient of 0.75-0.85 and a design speed in the 14 to 16-knot range. Here the efficiency gain can be as much as 6-9% compared with conventional solutions.

For faster and slenderer single or twin screw vessels such as car carriers, efficiency improvements of 2-5% can be expected.

The diagram shows a test comparison for a medium size chemical tanker. A conventionally designed propeller and rudder is compared to the Promas system. The rudder blades are of the same size in both cases and the propellers are designed to be comparable from a pressure pulse point of view.



The reduction in power consumption recorded was 4-5% for a ship speed range of 14-16 knots. A small investment to improve propulsive efficiency during design will save money through out the vessels life.

Speed Nozzle

The principle, that the propeller thrust is relatively large compared to the mass flow through the propeller disc, meaning that a relatively high velocity increase of the flow is necessary, leading to a relatively high level of kinetic energy in the propeller wash. Propeller nozzles have been utilized for many years to overcome this type of problem, on tugs, trawlers and other vessels using relatively high power at low speed, and with a restricted propeller diameter, either due to space or RPM restrictions. For applications where the speed is slightly higher, such as a bulker, the nozzle is called a speed nozzle, but the principle is the same. The circulation around the nozzle's wing section is utilized to increase the contraction of the flow forward of the propeller, and in a corresponding manner divert the flow aft of the propeller, thus creating a flow pattern equivalent to the flow generated by a larger propeller. In practice this leads partly to the transfer of thrust from the propeller to the nozzle. The propeller design will of course have to be adapted

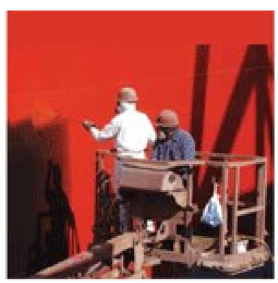
for, and optimized together with the nozzle.

Normally, nozzles are used to improve the bollard pull on tugs, supply vessels, fishing boats and many other vessels which need high pulling power at low speed.

This new kind of nozzle, called a speed nozzle, is developed to improve the propulsion power at service speed. Using the new speed nozzle concept has a saving potential of approximately 5%.

Hull Paint

The choice of the right hull paint is essential to keep the resistance at a minimum. Modern anti-fouling hull paint with a low water friction has a fuel saving potential in the region of 3 to 8%.



The reduction of emissions is proportional to the fuel savings. The present ship has conventional anti-fouling coating. By introducing of silicone type of hull coating (so-called 2nd generation), tests at FORCE have indicated up to a 2 % reduction on the frictional resistance of the hull. This means a total resistance reduction of abt. 1.5 %.

EXHAUST GAS RECIRCULATION:

Exhaust gas recirculation (EGR) is a method of modifying the inlet air to reduce NOx emissions at source, an approach widely and successfully used in automotive applications. Some of the exhaust gas is cooled and cleaned before recirculation to the scavenge air side. Its effect on NOx formation is partly due to a reduction of the oxygen concentration in the combustion zone, and partly due to the content of water and carbon dioxide in the exhaust gas. The higher molar heat capacities of water and carbon dioxide lower the peak combustion temperature, which, in turn, curbs the formation of NOx. EGR is a very efficient method of reducing NOx emissions (by 50–60 percent) without affecting the power output of the engine but has been considered more practical for engines burning cleaner bunkers such as low sulphur and low ash fuels, alcohol and gas. Engines operating on high sulphur fuel might invite corrosion of turbochargers, intercoolers and scavenging pipes.

WATER IN FUEL:

Water–fuel emulsions injected via the fuel valve achieve a significant reduction in NOx production. The influence varies with the engine type, but generally 1 per cent of water reduces NOx emissions by 1 per cent. Fuel water emulsion (FWE) methods mix the fuel with freshwater onboard the ship to form an emulsion suitable for injection into the combustion chamber. In the case of heavy fuel oil, up to 30 per cent water can be emulsified into the fuel, resulting in a NOx reduction of approximately 30 per cent.

WASTE HEAT RECOVERY SYSTEM:

When the exhaust gas leaves the engine, it has a very high heat potential. By utilizing this potential in an exhaust gas boiler, it is possible to recover a large part of the heat from the exhaust gas and to use it to generate steam. Waste heat recovery system consists of an exhaust gas boiler supplying steam to a steam turbine. The steam turbine is connected to a generator, and thereby the waste heat is recovered as electrical energy.

SOLAR PROPULSION:

The aim of solar power propulsion system is to reduce carbon dioxide emissions from the transportation of goods. Untill now, solar power systems have been limited to usage for the crews' onboard living areas , due to the very harsh environment that technological installations are exposed to onboard ships , including salt corrosion , vibrations and other factors .

ADVANTAGES:

- Less noise and vibrations .
- Do not pollute sea with oil.
- Nature friendly.
- No emission of Sox , Nox and Co2.
- Use only free solar energy and saves non renewable sources of energy.

DISADVANTAGES:

- High initial cost.
- Produce relatively less power.
- High maintenance cost .
- Prove economically effective in equatorial and temperate region.
- Would have to install an alternative propulsion system for use in heavy weather and in night.

SANDWICH PLATE SYSTEM (SPS):

The Sandwich Plate System (SPS) is a technology in which two metal plates are bonded to a compact elastomer core. The elastomer provides continuous support to the plates and stops local plate buckling, eliminating the need for stiffeners The metal faceplates are generally steel, although other metals and sheet materials may be used, and the elastomer cores are a specific class of polyurethanes, which provides the material with greater resistance to point and high loads that is, the SPS panels behave elastically over a larger range of loads than conventional steel panels. The injection process of a typical SPS section takes only a few minutes to complete.

Conclusion

Green Ship of the Future is the vision of a shipping industry that is green in the sense of being sustainable. The primary purpose of the project is to develop green ships that – by virtue of environmental and energy efficient technology – contribute to reducing the harmful emissions caused by shipping. However, sustainability is not achieved by energy-efficient technology alone. Green technology is definitely a necessary, but not necessarily a sufficient, condition for cleaner shipping. Only when the technology is operated by a person with a green consciousness does it come up to its full potential, because only then it will be operated in accordance with its design.

Acknowledgement

We, the authors of this paper on “GREEN SHIP TECHNOLOGIES” are grateful to our institute MANET, Prof. VG Mehendale (Chief Engineer), Prof . AV Kadam (Chief Engineer). Our sincere appreciations and regards for all the support by all concerned.

References

- Google
- Marine insight
- Green shipping
- Wikipedia
- Marine world