Technical solutions to environmental demands

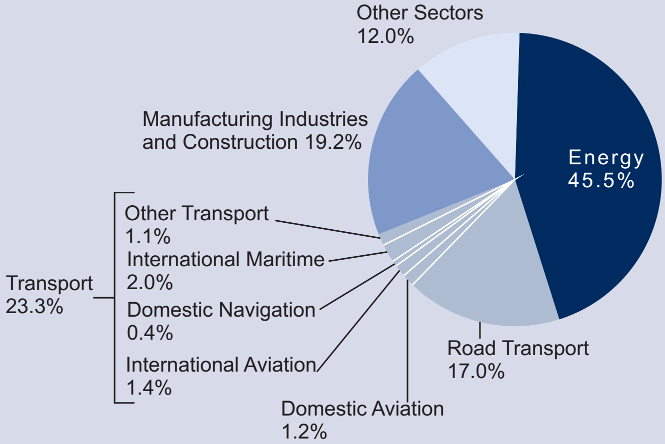
Marine traffic emissions include various products, which are considered harmful for the environment. Aker Arctic has developed technical solutions to meet tightening regulations and tries to keep one step ahead of rules in designing new concepts.

Exhaust gas composition depends on the fuel type used and engine characteristics, such as the engine load. If traditional fuel oil is considered, the exhaust gas contains mainly nitrogen, oxygen, carbon dioxide and water vapour, as well as small quantities of carbon monoxide, sulphur oxides, nitrogen oxides, non-combusted hydrocarbons and particulate matter. Other marine traffic emissions include human waste, paints and other hazardous materials.

Although marine traffic is not a big polluter compared to other methods of transport, industry or electricity production, emissions generated by marine traffic are garnering increasing amounts of attention from all over the world. IMO and other countries have set up limitations for emissions covering various components found in exhaust gases, such as Emission Control Areas (ECA) and Energy Efficiency Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP) and Energy Efficiency Operational Index (EEOI), as well as economic mechanisms such as emission trade, bunker fees and international GHG-fund.

CO_2 Emissions 2005

Global CO_2 Emissions from Fuel Combustion



Source: EDGAR 4.0 (JRC/ PBL) 2009 and IEA.

Marine traffic accounts for about 3 % of global CO_2 emissions.

Emission control

The Emission control areas (ECA) currently include the Baltic Sea, North Sea, North American coastline and the United States Caribbean area. Of these, the Baltic and North Seas have SO_X limitations solely and the other two have additional limitations for NO_X and particulate matter (PM).

SO_X emissions are directly related to sulphur content in fuel. The allowed sulphur limits have a three-tier reduction plan on a global scale and a similar approach for ECA zones. The allowed sulphur percentage levels decrease quite rapidly in the ECA, where the very strict limit of 0,1% already came into effect in January 2015. On a global scale, the next drop in allowed sulphur levels is scheduled to be enforced in 2020, with a level of 0,5%. The NO_X limitations have been divided into three steps, of which the two first are already enforced by IMO.

The Energy Efficiency Design Index (EEDI) is a mandatory design method for new vessels above 400 GT. The intent is to reduce CO_2 emissions by regulating the installed propulsion power of new vessels with considerable conversion. At the moment, ships with icebreaking capability of more than one metre and ships with diesel-electric propulsion are excluded from EEDI requirements.

Reducing emissions

There are many possible ways to improve the energy efficiency of ships, for example the hull form, propeller and machinery can be made more efficient and thereby decrease emissions.

Emission reduction can be achieved in various ways either by simply changing the fuel oil from HFO to low sulphuric options like marine diesel or changing the type of machinery system for utilisation of Liquefied Natural Gas (LNG), or by installing systems that purify the exhaust gases to acceptable levels. Scrubber technology can be used for reducing the SO_X emissions of engines. A scrubber's basic function is to wash sulphur components from exhaust gases. For reducing NO_X emissions, there are catalysers for marine applications, so called SCR-types (Selective Catalytic Reduction)

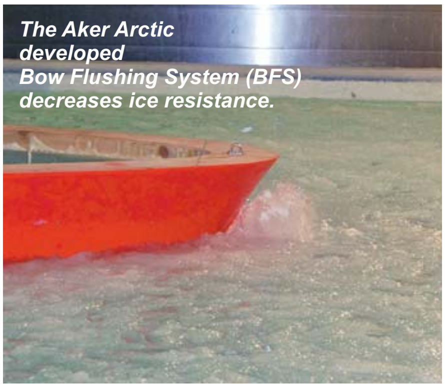
Aker Arctic's solutions

"Methods for cleaning emissions are good, but it is important to remember that the emissions are still there, they are just treated so that they don't escape into the atmosphere. Additionally, some of the cleaning equipment affects the performance of the ship's machinery to a certain extent," Mr Kari Laukia, Head for Ship design and Engineering, emphasises.

> "Our approach at Aker Arctic is to design lean solutions, which lower vessels' efficiency needs and do not affect the operational capabilities of ships. Our purpose is to design a vessel that takes into account all emission demands and is also efficient in operations. This is especially important in ice, when engine loads can vary considerably and the dynamic capability of the propulsion has an important role."

One example is the LNG-fuelled vessel. LNG-fuel has no SO_X and very low NO_X and CO_2 emissions and therefore fulfils emission requirements. But, a diesel engine using LNG-fuel has lower engine load vs. speed capacity compared to a diesel engine using normal marine fuel oil. When moving in ice, the reaction time for propulsion increases and the LNG fuelled engine would need to react fast in order to win high propeller ice loads. .

"Our solution to this is to either design a hull form that minimises propeller/ice interaction, or to design a vessel with more temporary power/torque. However, the latter is more expensive and therefore we usually strive to optimise the hull form," Mr Laukia explains.



The Aker Arctic developed Bow Flushing System (BFS) decreases ice resistance.

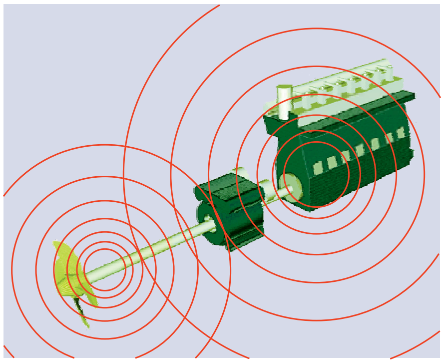
Located in the bow, the Aker Arctic developed new auxiliary system called the bow flushing system (BFS), which is used in harbours as normal side thruster but in channel ice as a vertical thruster, thus decreasing the ice resistance and simultaneously decreasing the needed propeller power, is a further option. Model tests with a standard tanker have demonstrated a decrease of needed propeller power of more than 10% for 1A class vessels and of more than 20% for 1A Super class. It is also a good solution to retrofit BFS on existing vessels.

"We are constantly developing new hull forms and bow forms, which require less and less power to perform the same icebreaking as before. We can design a vessel to use LNG as its main fuel and optimise the propulsion concept. But, as most of the vessels also have open water requirements, we often have to make compromises. There is no standardised option available, for each vessel we have to take into account the operational profile before deciding on the optimal solution."

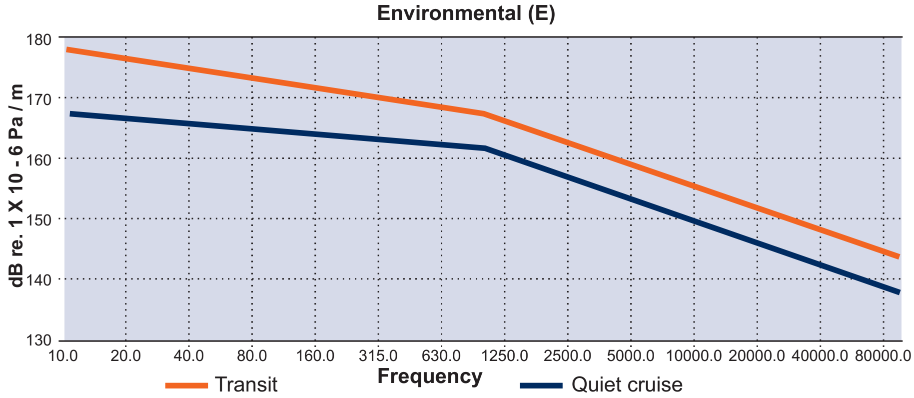
Underwater noise

One of Aker Arctic's specialities is designing research vessels, which today need to fulfil the limitations for underwater noise. Underwater noise is generated mainly from the propulsion units, the machines inside the ship, the auxiliary equipment and especially propellers. Some guidelines are available, e.g. in the DNV rules there are two requirements for underwater noise, either Environmental class E or Research class R.

"Low noise vessels have to be designed from the beginning as such, it is practically difficult to reach low noise criteria in existing vessels. So far, noise requirements only concern some special vessels but this might change in the future. Our know-how in this area will then be of use," Mr Laukia assures.



Main underwater noise generators.



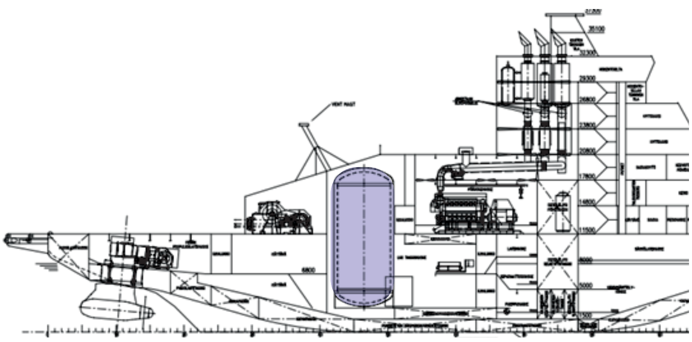
Maximum allowable noise levels in 1/3 octave bands environmental class notation SILENT-E. Source: Det Norske Veritas AS.

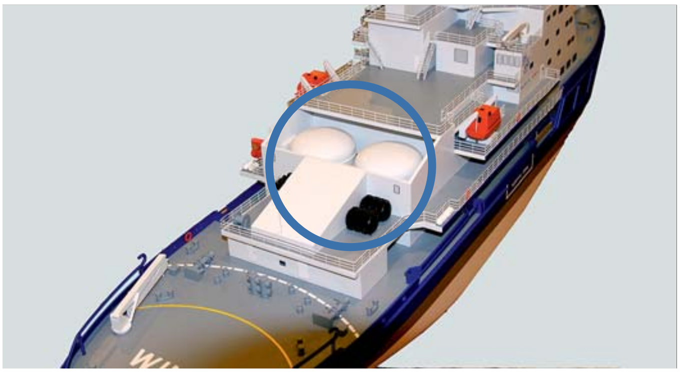
Experience in LNG-vessels

Aker Arctic has gathered years of experience in designing LNG-fuelled vessels.

"We have recently developed LNG-tankers for Yamal LNG, where the boil-off gas from transporting LNG is used as fuel. The hull of the Finnish patrol and coast guard vessel *"Turva"* for the Finnish Border Control is our design, as well as the concept of the new icebreaker for the Finnish Transport Agency, which will be the first LNG-fuelled icebreaker in the world. We also made a concept and feasibility study for an LNG-fuelled river icebreaker quite recently for one of our customers," Mr Laukia says. ■

Finnish patrol and coast guard vessel "Turva" uses LNG-fuel.





LNG fuel can with today's technology also be used for ice-going vessels and icebreakers, which are exposed to fast power variations. Dual-fuelled Diesel-electric machinery of a Finnish icebreaker concept. (Picture: Aker Arctic)