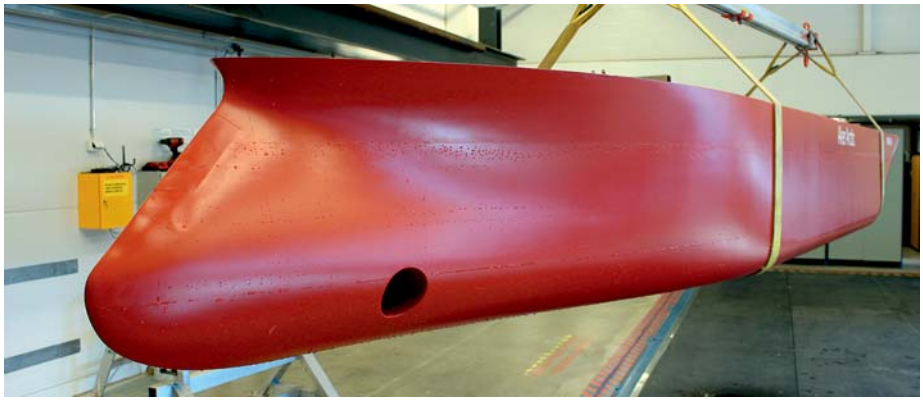
Testing EEDI bow forms

The IMO Energy Efficiency Design Index (EEDI), introduced in 2013, will change the hull forms of new vessels and lower the engine power and service speed in order to fulfil the new open water efficiency requirements. Aker Arctic has recently performed tests to evaluate how well the new EEDI-compliant vessels manage in ice conditions as part of the BowForm project.

Photograph: Neste Oil

Naval Architect Mikko Elo was onboard cargo vessel Suula to observe the real ice conditions in Bay of Bothnia in winter 2017.



Suula is a conventional product tanker with a bulbous bow designed for ice operations.

The winter navigation system in the Baltic Sea requires all merchant ships, even those usually escorted by icebreakers, to have some ice performance and accordingly the Finnish-Swedish Ice Class Rules include a requirement for minimum installed power. On the other hand, the Energy Efficiency Design Index (EEDI) imposes a power ceiling for ships, resulting in somewhat contradictory regulations. To proceed in ice ships require higher installed power than is in use when sailing in open water. In EEDI calculations this handicap is compensated for with a correction factor in order for ice classed ships to be on the same level as average open water ships. There is a fear, however, that the EEDI requirements will have an impact on the winter navigation system and an increase in icebreaker services would be needed to maintain an efficient and fluent navigation system. If this is the case then the entire aim of lowering carbon dioxide emissions is lost. Consequently, the Winter Navigation Research Board funded a research project named BowForm, with the aim to see how well the new EEDI-ships manage in ice conditions in practice compared to ships of conventional design.

Testing programme

In the Finnish-Swedish Ice Class Rules the installed power requirements for each ice class are based on the ship's ability to maintain a speed of 5 knots in a brash ice channel of certain thickness.

"In real life, nature is never perfect and ice channels are not always available," Project Manager Ilkka Saisto explains. "Due to that reason, our aim was to investigate also conditions where there is no defined channel, or situations where no icebreaker is available."

Aker Arctic Naval Architect Mikko Elo was first onboard tanker *Suula* in March 2017 to gather information about the real ice conditions. *Suula* is a conventional product tanker with a bulbous bow designed for ice conditions.

"We started the trip from Porvoo, via Oulu onwards to Vaasa," Elo says. "We had open water until the Bay of Bothnia, where the ice thickness was only about 30 cm. No ice ridges were encountered but a strong wind from southwest resulted in pressure in the ice field, which slowed us down at times. Outside the Oulu fairway there was additionally a narrow patch of thick brash ice at the edge of the fast ice cover which turned out to be the most challenging ice conditions during the trip."

Based on these observations a testing programme was established.

For the tests a two-part model with a changeable bow was used.

"The advantage is that it is basically the same ship with different bows so the results are easy to compare," Saisto says.

Two different bow forms, an "EEDI bow" designed to fulfil the requirements of low water resistance and the Suula bulbous bow, were tested in two different ice conditions.

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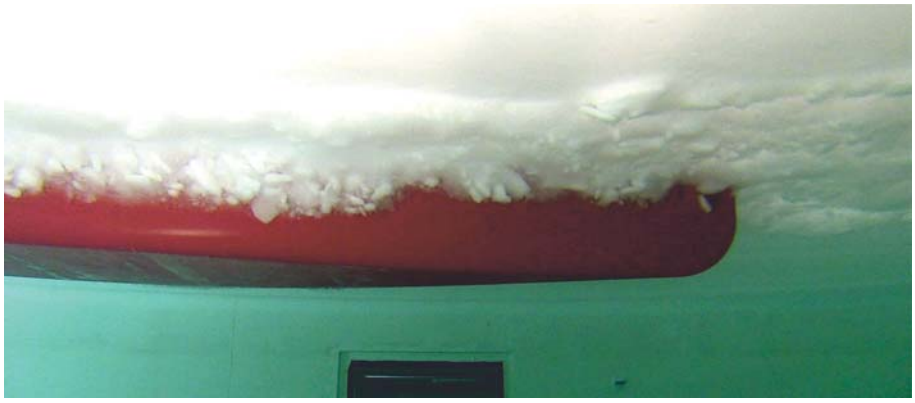
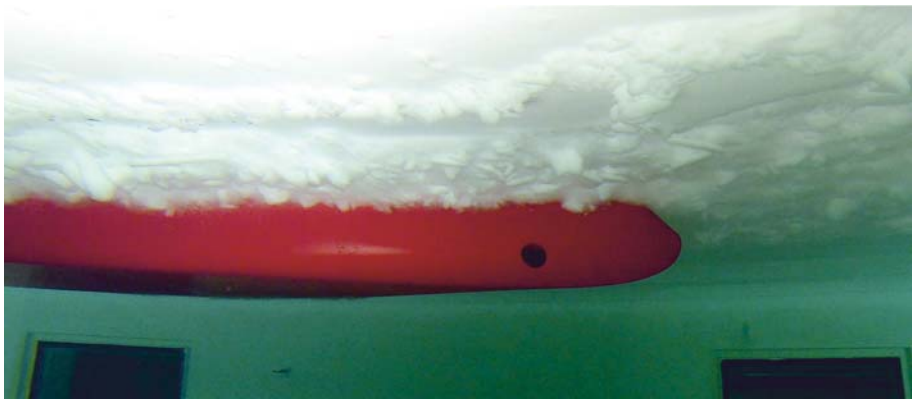
"EEDI bows" are typically more vertical and straighter than conventional bows. They are optimised for open water and summer use and are more energy efficient in these conditions. However, they are not designed for use in ice. Vessels with EEDI bows are also difficult for icebreakers to assist due to the narrow shape of the bow. Vessels with EEDI bows can be ice strengthened and classified according to the ice class rules.





Two sets of tests with both models were performed.

"Both vessels performed well in the test channels prepared according to ice class rules," says Senior Designer Tom Mattsson. "However, tests in level ice with the 'EEDI bow' did not go well at all, whereas the *Suula* bulbous bow could manage. The results from the tests indicate that there are possibilities to manage in broken ice but not in level ice."

The full results will be available later this year.

Other projects

The Winter Navigation Research Board has also funded other research projects related to EEDI and ice navigation. Mattsson has recently finalised the PREEDICT project in which he has, together with the Finnish Transport Safety Agency (Trafi), developed a proposal for new correction factors for installed power to be able to compare ice going ships with open water ships.

"As a continuation of these projects we are now working with Tevo Lokomo Oy to research how ice class affects the propulsion performance," Mattsson adds. "The results will be ready by the end of this year."

All the Winter Navigation Research Board's reports can be found on the following website https://www.trafi.fi/tietopalvelut/julkaisut/talvimerenkulun_tutkimusraportit

The purpose of the IMO Energy Efficiency Design index (EEDI) is to promote energy efficient ships and thereby reduce CO_2 emissions by 30% between 2013 (phase 0) and 2025. The coefficients vary for different ship categories. This example is for tankers.