Aker Arctic
The Ice Technology Partner

Arctic Passion News

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The 12-megawatt diesel-electric port icebreaker *Ob* has completed her first season in the harsh winter conditions in Sabetta, where the vessel is tasked with assisting large LNG carriers to berth. Read about the first winter's experiences on page 4. Photo by Dmitri Lobusov.

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Dear Reader,

I believe all business leaders are currently trying to come to terms with the changes occurring due to COVID-19, and the implications for their companies.

In the maritime sector, we've witnessed a dramatic drop in newbuild orders, with the cruise and ferry markets suffering especially. Further delays in new ship investments are expected.

However, in polar-related projects, most activities are still ongoing, although precautionary measures naturally need to be taken.

The world's newest icebreaker *Ob*, delivered to Atomflot last year, was able to perform its first wintertime tasks in Sabetta port, and it seems that they were carried out highly successfully. This unique port icebreaker proved that it can achieve what it was planned for, and LNG logistics ran smoothly throughout the winter in the Arctic.

With shipping along the NSR increasing significantly, two noteworthy voyages were made. In May, SCF's *Christophe De Margerie* and Teekay's *Vladimir Voronin* completed their experimental voyages through the Northern Sea Route. One nuclear-powered icebreaker provided support and secured the safety of these two Double Acting LNG Carriers. These voyages proved that the practical operation of the vessels is possible and that their capability is sufficient for the route.

In the future, we will see more direct passages through the Northern Sea Route in wintertime. For support on the route, the first 60-megawatt Project 22220, nuclear-powered icebreaker *Arktika*, is nearing completion in St. Petersburg and should be delivered to Rosatomflot this fall, followed by two sister ships.

In April, an ambitious new project kicked-off as the contract for the construction of the massive 120-megawatt Project 10510, nuclear-powered icebreaker *Rossiya*, was signed between FSUE Atomflot and SKK Zvezda LLC. The aim is to have the icebreaker ready by 2027.

Meanwhile, the 160-metre icebreaking research and supply vessel (RSV) *Nuyina* is being constructed for Australia, and its floating hull has been towed from the shipyard in Romania to the Netherlands for final outfitting. Additionally, Ponant's icebreaking expedition cruise ship *Le Commandant Charcot* was towed to Saint-Nazaire in France for the installation of its Azipod propulsion units. The Royal Canadian Navy received its first Arctic and Offshore Patrol Ship (AOPS) from Irving Shipbuilding's Halifax Shipyard.

In August 2020, the German research icebreaker *Polarstern* reached the North Pole as part of the European research project MOSAiC. Our recently designed and delivered polar research vessel, Chinese *Xue Long 2*, is now also conducting its research programmes in the Arctic.

Unfortunate setbacks also happen, as the United States Coast Guard medium icebreaker USCGC *Healy* suffered a propulsion motor fire, forcing her to cancel her mission and return to Seattle for repairs. However, activity in the Western Arctic is increasing with freighters regularly transiting through the Northwest Passage. Old Danish icebreakers, built more than 50 years ago, are going to be scrapped. Furthermore, Denmark is not likely to order new ones as ice has become a rare problem in Denmark. In other parts of the world, old vessels still need to be replaced, and new investments for upgrading icebreaking fleets are now recommended.

Sincerely yours,
Reko-Antti Suojanen
Managing Director

Ob – first winter experiences

During the period November 2019 to June 2020, Ob carried out 109 icebreaking operations to assist other ships and 254 port icebreaking operations.
– Photo courtesy of Atomflot.

The 12-megawatt diesel-electric port icebreaker *Ob* has successfully completed her first season in the harsh winter conditions of Sabetta, where the vessel is tasked with assisting large LNG carriers to berth.

During the period November 2019 to June 2020, *Ob* carried out 109 icebreaking operations to assist other ships and 254 port icebreaking operations. The total distance covered in ice was 3224 nautical miles.

"The maximum thickness of the ice in the Gulf of Ob was about 120 cm during winter navigation," says *Ob's* Captain Alexander Boiko. "The icebreaker overcame this thickness without any difficulties."

Ice removal at double speed

Ob's quad-azimuth propulsion configuration, with two propulsion units in the bow and two in the stern, is a totally new concept. It was selected to provide maximum operability in the thick, consolidated, brash ice that forms in the harbour basin.

"This propulsion solution should be used for any upcoming port icebreaker," Boiko underlines.

"The 2+2 configuration reduces time for berthing preparation in the port compared to a typical icebreaker configuration. It allows the icebreaker, being stationary in relation to the sea bottom, to manage ice along the berthing line and quickly clear it using the propeller flushing effect. The fact of having propulsion units at both ends of the vessel speeds up the process, as there is no need to turn relative to the berth."

Excellent manoeuvrability

Boiko is impressed with the icebreaking capabilities of the icebreaker with its relatively small displacement and its excellent manoeuvrability.

"This was the first time I observed a 'police turn' by a vessel of such size; *Ob* can turn on the spot at full speed. The manoeuvrability is wonderful."

The vessel has multiple handles which require a bit of practice to master. Boiko believes the time required depends on the skipper's experience with Azipod type propulsion units. "The vessel has fulfilled all our expectations regarding performance in ice, but propeller power up to 14 MW could be added for even better performance."

Ob's Captain Aleksander Boiko is very pleased with the first winter's icebreaking performance.
– Photo courtesy of Atomflot.

Seaworthiness

During the transfer from Vyborg to Murmansk and further to Sabetta, the crew had time to become acquainted with the vessel and master the mechanisms and technical features. Seaworthiness was considered to be sufficient for bad weather and ship rolling was moderate.

"The icebreaker is easy to control in open water, which positively influences its manoeuvrability in cramped port conditions. The controls and navigation tools, surveillance and communications systems are conveniently located, and all allow for manoeuvring by only one person," Boiko says.

Positive first winter

Overall, the first winter passed well in Sabetta. There was no downtime in icebreaking, and the crew learnt to take full advantage of the ship's advanced technical capabilities.

"In my opinion, the size of the vessel and its propulsion system are perfect for port work in Ob Bay ice conditions," Boiko highlights.

"Using an *Ob*-type icebreaker increases the safety level of port operations in harsh climate conditions, such as encountered at the Yamal LNG and Arctic LNG 2 projects. Safety is a priority for us, considering the economic importance of these hydrocarbon projects. It is a pleasure to complete the tasks onboard a vessel which is specially designed for the assigned tasks."

The flag ceremony was held in Murmansk in November 2019 before departing on the final leg to Sabetta. – Photo courtesy of Atomflot

The successful result of innovative cooperation

The location of the first Arctic LNG terminal project in such a challenging and entirely new environment required innovating a completely new icebreaker concept. In 2012, Aker Arctic, in cooperation with Yamal LNG, began to develop a port icebreaker charged with the task of assisting large LNG carriers.

The result of thorough development work was an exceptionally powerful port icebreaker design, the Aker ARC 124. This ship would be more capable than many seagoing escort icebreakers and incorporate many advanced technical features.

"Although *Ob* might seem large for a port icebreaker at first, she could not have been smaller considering the enormous LNG carriers she is assisting," says project engineer Tuomas Romu. "Her performance, operability, autonomy time and manoeuvrability have been carefully chosen for optimal output and to serve her purpose in the best possible way."

Quad-azimuth propulsion

Ob has a diesel-electric propulsion system consisting of four ABB Azipod ICE 1400 propulsion units: two in the bow and two in the stern. This propulsion configuration, which had previously not been used in any icebreaking vessel, was selected to provide maximum operability in thick, consolidated, brash ice.

Despite having a total propulsion power of just 12 megawatts (16,000 shp), *Ob* can break up to 1.5-metre-thick level ice in both ahead and astern directions, an unprecedented icebreaking capability for a vessel of her size. Furthermore, the all-azimuthing quad-screw-propulsion configuration provides superior manoeuvrability and control when operating in close proximity to the large LNG carriers.

World's most efficient engines

The main power plant consists of three Wärtsilä 8V31 medium-speed diesel generator sets. In addition to being powered by the world's most efficient four-stroke diesel engines, *Ob* features ABB's Onboard DC Grid to further improve efficiency and reduce fuel consumption.

The direct current (DC) system allows the diesel engines to operate at variable speed, resulting in lower specific fuel consumption (grams of fuel per kilowatt- hour of energy produced) when operating at partial load.

In addition, the system components have a smaller footprint compared to a traditional alternating current (AC) system, saving space within the already compact machinery spaces.

Safety and comfort at –50°C

Besides featuring many "firsts" in its machinery systems, *Ob* is designed to operate in harsh Arctic winter conditions where ambient air temperatures reach as low as –50°C, and provide safe and comfortable living and working conditions for the crew throughout the polar night.

"I want to highlight that the achievement of such an extraordinary vessel is the result of successful cooperation between the designers, FSUE Atomflot, Vyborg

Development work over the years

2012 – Development of port fleet for Sabetta begins jointly with Yamal LNG.

2013 – Concept development of port icebreaker.

2014 – Yamal LNG and Atomflot sign agreement on Sabetta port fleet.

2015 – Contract design and ice model tests at Aker Arctic.

4/2015 – Shipbuilding contract signed between Atomflot and Vyborg Shipyard. Basic design continues.

9/2016 – Keel laying at Vyborg Shipyard.

Shipyard as well as the Russian Maritime Register of Shipping," Romu adds. "The boldness to find and accept new ideas with an open mind has been the recipe for success."

Seven-year-project

At the project's inception in 2012, the initial evaluation considered three alternative designs: a conventional design with two azimuthing propulsion units in the stern, an asymmetric oblique icebreaker with three thrusters, and a novel concept with two propulsors in both bow and stern. It was determined that the most suitable port icebreaker design for the heavy brash ice conditions prevalent at the Arctic LNG terminal would be the quad-screw variant.

The keel was laid at Vyborg Shipyard in 2016 and Aker Arctic continued providing technical support during the entire construction period. The official launch ceremony took place in 2018, and the vessel left for her first sea trials in the Gulf of Finland in September 2019, with delivery to FSUE Atomflot a month later.

Ob is, at the time of writing, still the newest icebreaker in the world.

Even the world's largest and most powerful nuclear-powered icebreaker, 50 Let Pobedy, is dwarfed by the 299-metre Yamalmax LNG carriers transporting natural gas from Sabetta. – Photo by Dmitri Lobusov

Atomflot's largest and smallest icebreakers moored together as Ob receives fresh water from the nuclear-powered icebreaker 50 Let Pobedy off Sabetta. – Photo by Dmitri Lobusov

Future vessels

Construction work in the Gulf of Ob continues. The Arctic LNG 2 project advances at speed and although there is no information yet of what kind of vessels are planned for the new terminals, it is certain that every terminal in this difficult area will need its own port fleet.

"We are now gathering feedback about *Ob* in order to use that information in possible future projects," Romu states. "Already during the design process, new ideas arose which can benefit future vessels. One such possibility is actually using LNG as fuel; we already have experience of designing such vessels, in addition to LNG being the fuel available in the area."

Ice trials postponed

Due to COVID-19, the planned ice trials have been postponed. Romu remains hopeful they will take place, as they provide invaluable information to the designers.

"In our design work, we always strive to design a vessel which is perfect for its intended task and operating environment. The first years of design work include countless hours of planning, innovating and background work. Data from previous ice trials and operator feedback is thoroughly examined during this phase." ■

8/2017 – Float-out for final hull assembly and outfitting.

9/2018 – Launching and naming ceremony.

9/2019 – First sea trials in Gulf of Finland.

10/2019 – Delivery in Vyborg. Ob departs for Murmansk.

11/2019 – Ob arrives in Sabetta.

Ice Load Monitoring System commissioned remotely

The self-propelled, detachable, icebreaking bow, equipped with Aker Arctic's Ice Load Monitoring System (ILMS), was tested in May and will be delivered this autumn after final calibrations. Everything is ready for next winter's icebreaking duties in Lake Saimaa.

The innovative, self-propelled, detachable icebreaking bow was developed by ILS Ship Design & Engineering for the Finnish Transport Infrastructure Agency as part of the WINMOS II project, funded by the EU CEF programme. After delivery, it will be taken into use as soon as ice begins to form on Lake Saimaa and the Saimaa Canal, the waterway connecting Finland's largest freshwater lake with the Gulf of Finland.

Aker Arctic's Ice Load Monitoring System (ILMS) was installed to measure the propulsion loads and pin forces at the connection between the bow and the tugboat *Calypso*, which will push the bow. The propulsion load monitoring system receives signals from both the detachable bow's own two shaft lines as well as from *Calypso's* azimuthing propulsion units. The pin force measurement system, delivered by Turku Repair Yard, is also connected to Aker Arctic´s measurement system, which in turn is connected to the ship's automation system.

Remote testing

Sensors installed on the hull and the shaft lines send information to a central computer for real-time processing. In addition to displaying the information on a monitor on the ship's bridge, the data will be available online.

Designers following the sea trials remotely from Helsinki.

When the bow was taken to sea trials outside Turku in May, Aker Arctic's designers followed the tests remotely from our Helsinki office. A phone connection was also established between the ship and Aker Arctic in order to share real-time feedback about the ongoing tests and measurements.

"All signals from the vessel were displayed on our large monitor, and we knew instantly what was happening during the test," Kari Laukia, Head of Equipment Business, explains. "It was as if we had been on board."

Core idea

Having a remote connection had always been one of the core ideas from the onset in the design of the ILMS, rather than a more recent invention due to COVID-19. Being able to sit in an office and follow the vessel's operations is a big cost saving. However, with travel restrictions it has turned out to be an added benefit.

"The only thing needed is a good network connection," Laukia adds.

Ship operations surveyed

The monitoring systems on *Calypso* and the self-propelled, detachable bow run continuously, and measure loads in both ice and open water. The propulsion effect and other measurements from the propulsion system are additionally followed. The results can be combined to track various aspects related to the ship's operations, such as fuel consumption and optimisation of power use.

"For instance, there are operating situations where increasing power is not economically beneficial, such as in rough seas. In extreme operating situations the propulsion load varies substantially and getting immediate feedback is essential. Using the load monitoring system, this information is conveyed to the captain who can make decisions accordingly, thus protecting the shaft lines, propellers and the engines," Laukia says.

"In an ice situation, the information can be used to supervise how loaded the system is. It also reports

that the actual properties reflect the agreed design."

Laukia adds that the measurements taken mechanically at the shaft will tell the real effect. Otherwise, only a calculated value would be known, which can be close to accurate but never exact.

Knowing the real load effect is important for the ship's longevity. If maximum power is used in all situations, it may result in shorter maintenance intervals than expected.

Service needs identified early

An added benefit of the shaft line monitoring system is that service needs can be identified at an early stage.

"If a vessel is used in the same way for years and suddenly there is a drop in any of the indicators, the captain can react faster and deliver the vessel for a check-up," Laukia highlights.

In addition to the monitoring systems, Aker Arctic designed and delivered shaft lines and propellers for the bow unit. They improve the bow's icebreaking capability and manoeuvrability.

Calypso and the detachable bow will be used for the first time in winter 2020–21 to keep waterways in Lake Saimaa and Saimaa Canal open for an extended period. Ice trials are also planned to be held at that time.

"We'll report more about the ice load monitoring results after the trials," Laukia promises. ■

The monitoring systems are continuously on duty.

Improvement plans for Saimaa Canal

Currently about 2% of Finland's export and import cargo is transported along the Saimaa Canal. This amount could be multiplied, resulting in cost savings and environmental benefits. Photo: Jukka Väisänen

Lake Saimaa is the biggest lake in Finland with a large number of industries located on its widespread shores. The Saimaa Canal connects the lake district with the Gulf of Finland, and is a vital transport channel for exports and imports of goods.

Using Lake Saimaa waterways for logistics offers a cost-efficient, direct link to central Europe with no reloading of goods along the way. It is also an alternative to road and rail, keeping transportation costs reasonable.

Extending the opening time

Depending on the severity of the winter, the Saimaa Canal stays open around 10 months of the year. But for two winter months, the industry in the area is forced to use alternative transportation methods. There are now plans to extend the opening time in the future.

"With the new self-propelled, detachable icebreaking bow, we have high hopes for more efficient icebreaking and also ice management operations," says Jukka Väisänen, Maritime Specialist for Winter Navigation at the Finnish Transport Infrastructure Agency.

"We are very excited about the coming winter and looking forward to seeing what can be achieved with this innovative, high-tech vessel. Ice model tests performed at Aker Arctic have already promised good results."

Structural improvements underway

Structural improvements for the canal are also underway, and over the next two years another 10cm of depth will be added, meaning more cargo capacity. Expanding the locks by 10 metres in length is also planned, pending financing approval.

"In addition to more cargo, this would mean that larger vessels of a higher ice class could extend the traffic season," Väisänen explains.

New ballast water regulations enter into force in 2022, requiring the industry and ship owners to consider investing in new vessels.

"We hope that the funding for expanding the locks will be settled very soon, as companies could then begin to prepare for both the new regulations and the new lock size." ■

The video footage is stitched to a four-picture composite and customers can see all angles of the vessel model during the entire test from their own offices. There is an additional chat feature for immediate questions and responses. Topi Leiviskä is supervising a test.

New online ice model test service

Model testing services have continued as usual despite the coronavirus pandemic. Clients can now observe ice model tests online over a secure connection, and discuss the tests and outcomes with our icebreaking specialists

Throughout spring and summer, Aker Arctic's ice model testing laboratory has continued working full-time on model testing projects. As clients have not been able to attend tests in person, a unique online video streaming service has been developed.

"Under normal circumstances, we shoot videos of all our tests using three cameras," says Topi Leiviskä, Head of Ice Model Testing. "We decided to combine the videos to an online feed which we share with customers through a secured Microsoft Teams link."

Fourth camera added

During testing, the vessel model is filmed from above, from the side and from below the vessel. A fourth camera has recently been added which shoots through the glass bottom of our model test basin below the vessel. This allows us to follow simultaneously how both the bow and the stern of the model behave in ice.

"The video footage is stitched to a four-picture composite, and customers can see all angles of the vessel model simultaneously during the entire test from the safe comfort of their own offices," Leiviskä explains. "Additionally, there is a chat feature for immediate questions, comments and response."

Safe streaming

All tests performed have been successfully streamed to customers, except in one case where the customer's firewall bounced the signal back. A solution to this is under process.

Microsoft Teams has so far proven to be a safe platform for streaming, but other options are also being discussed.
"With a higher number of viewers, we might move to a solution where we stream from our own server. Information security is our priority, so this has to be put in place first. According to our IT-experts, as many as 30 viewers at a time could easily be achieved."

Added value

Leiviskä does not believe that the online service will completely replace onsite visits to the ice laboratory once the situation returns to normal.

"To actually experience the cold atmosphere in the basin gives a very realistic feel to the project," he says.

However, the online service gives an added benefit to customers, who want to follow the tests from their own office and allows more people to easily see the tests.

"A few people could arrive onsite, and the rest watch online. Whatever the arrangement, it is much easier to discuss the outcomes when all participants have actually seen the tests, instead of only reading reports."

Shooting through the unique glass bottom in Aker Arctic's model testing basin, a recently-added fourth camera allows us to follow how both the bow and the rear of the model behave in ice. Toni Skogström manages the streaming.

Helsinki Shipyard was one of the first customers to utilise Aker Arctic's online streaming service of ice model tests.

Customer experiences of the online service

Aker Arctic performed ice model tests for Helsinki Shipyard this past spring when the ice capabilities of a research cruise vessel were investigated.

Due to COVID-19, visitor restrictions were in place at Aker Arctic and distance working was encouraged at Helsinki Shipyard. Therefore, the ice model tests were followed from home offices making use of Aker Arctic's newly developed online service.
"Supervising the tests remotely from the online connection worked surprisingly well," says Timo Kukkanen from Helsinki Shipyard.

Kukkanen has since suggested some improvements to the service concerning how some data could be presented, but is very positive about the overall experience.

"At Helsinki Shipyard we will definitely continue using the service into the future whenever possible, even without any pandemic restrictions. Part of the group could follow tests online and part onsite." ■

Ice-friction tests of hull coatings were performed last spring, and streamed online to both the customer and the Russian Register of Shipping (RS). The tests had to be performed at −20°C and Aker Arctic therefore developed a special measurement rig for the purpose, inspected and approved by RS.

First friction tests for icebreaker paints

Aker Arctic has developed a new method for measuring friction between ice and painted steel plate. The first class-approved tests have now been conducted.

Last year, the Russian Maritime Register of Shipping (RS) changed their regulations regarding paint for ice-going ships. Thinner steel plating on the ship hull is allowed if an approved protective hull coating is used. To qualify as an approved paint, a series of tests regarding hardness, durability and friction needs to be performed.

"The ice friction tests have to be performed with test specimens cooled down to -20°C. We have developed a special measurement rig for this purpose, inspected and approved by RS," Naval Architect Mikko Elo explains.

"Both our customer and a representative of RS followed the actual tests through our newly developed online streaming service." ■

Challenges and demands of Arctic tanker designs

All vessels for Arctic use need to be specially designed to withstand the tough ice conditions and extremely cold temperatures. Oil tankers are no exception. Aker Arctic experts guide us through some of the demands they deal with when designing tankers for the Arctic.

"Every design project begins with two questions," says Tom Mattsson, Senior Specialist on Ice Performance.

"Where will the vessel sail and what will it be used for?"

Then follows an analysis of the vessel's route, its task, ice thicknesses along the route, as well as answering questions such as: "Will the vessel move independently, or with icebreaker assistance," and: "Will the vessel be used year-round, or only during the summer months?" Once the criteria have been established, a ship concept development can begin.

Ice conditions determine hull form

One of the first things to design is the hull form. The ice conditions in the area of operation will largely determine the principles of hull geometry.

"For instance, on the Northern Sea Route, the sections with open water are few, and it is therefore not so important to optimise the hull against slamming and other common open-water conditions, but rather concentrate on icebreaking properties," Mattsson explains.

If the route is along the Pechora Sea, there are long distances in ice, but when sailing to Murmansk, 80 % of the time is spent in open water. In the latter case, the ship's hull has to be optimised for both winter and summer conditions, and an extreme ice bow would not be recommended.

An additional detail to consider is whether the vessel will sail exclusively on the chosen route, or will it later be used for other purposes.

Restrictions on hull

The hull form has an impact on the vessel's draught. Many routes have restricted water depths, which must be considered during the design stage.

The Northern Sea Route is restricted to about 14.5 to 15 metres of depth. Only vessels with a maximum draught of 12 metres are allowed into Sabetta, and a 9-metre draught is the limit for Novy Port in the southern Gulf of Ob.

The Arctic condensate tanker Boris Sokolov has been delivering cargo from Sabetta to the markets since January 2019. The Arc7 ice class vessel is based on the Aker ARC 212 design and operates according to the Double-Acting Ship (DAS™) principle.
Photo by Dmitry Lobusov

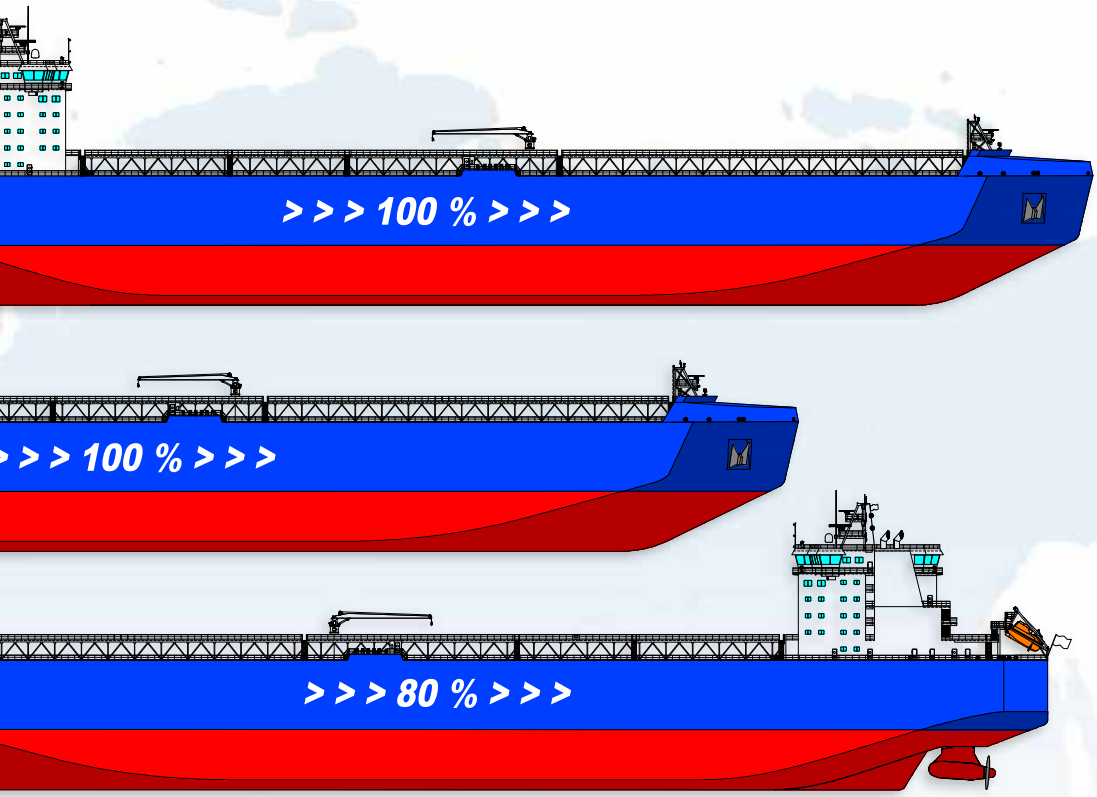
"This means that a standard design cannot necessarily be used," Mattsson highlights.

Classification societies and national administrations have various restrictions which affect both hull form and propulsion. The Russian Maritime Register of Shipping would, for example, previously not have allowed a bulbous bow, but a recent rule update has changed this. It is therefore important to keep a close eye on the development of regulations.

High ice class and propulsion

High ice classes may require at least two propulsion units for redundancy reasons, even if sufficient performance could be achievable with only one propeller.

There are additional physical limitations on how much power one propeller can absorb, which means that two or three propulsors may be needed to achieve the desired performance.



Aker Arctic has been designing Arctic tankers for clients since the beginning of 1990s.

"For example, the LNG carriers we designed for Yamal LNG needed three 15-megawatt propulsion units to meet the performance requirements," Mattsson says.

Choice of propulsion

The choice of propulsion is ultimately a question of the intended route and finances. Shall the vessel be of double-acting design, or of conventional design?

"It all depends on what the vessel will be used for and where."

Azimuthing propulsion is more expensive than conventional propulsion, but on certain routes it is the only viable option. This is especially the case for year-round operations with limited icebreaker assistance, or where fully-independent operation is required. For seasonal operations, a conventional solution can be used in some areas. The size of the vessel and draught requirements also impact the choice of propulsion and the number of propellers.

Mattsson does not believe vessels of conventional shaftline-and-rudder design are suitable for independent year-round operation along the NSR.

"It will get stuck at some point, as it cannot reverse properly."

Operational reliability

Aker Arctic always perform their own analyses regarding any planned route in order to ascertain hull strengthening requirements and icebreaking capability.

"For us there are only two options: either the vessel can manage the route on its own, or with icebreaker assistance," Mattsson emphasises.

Therefore, the hull form and ice-going capability must be correctly designed. The best tool for this is to use the ship design spiral.

"Everything needs to be in balance."

Shturman Skuratov is one of seven Arc7 shuttle tankers transporting crude oil year-round from Gazprom Neft's Arctic Gates oil terminal to Murmansk. The hull form was developed by Aker Arctic and its icebreaking performance was verified at our ice model test laboratory. Photo by Dmitry Lobusov

Training is essential

Training of the crew is something Mattsson would like to help improve. He has noticed that not everyone knows how to handle a high ice-class vessel nor is aware of what the vessel is capable of. Learning from generation to generation on the bridge of ice going ships is rarely possible nowadays with new routes, new shipping companies and new ship types.

"The ice simulator we have developed is an excellent tool for this. Operations in ice can be practiced safely in advance."

Another useful tool he wants to promote is the Ice Operation Manual. It is a ten-page booklet containing the designer's directions on how to handle the vessel safely, including advice on speeds and hazards.

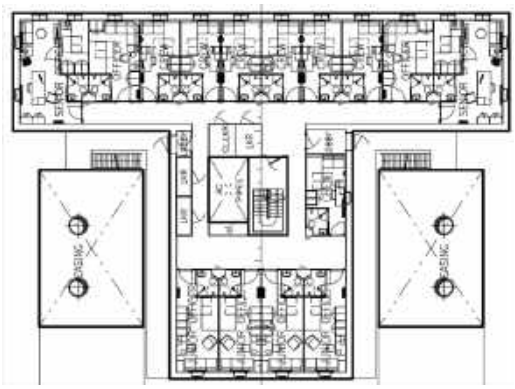
Design for purpose

Mattsson underlines that all vessels bound for the Arctic, including tankers, have to be tailor-made. Once a design is ready, it can be used for a larger series of vessels.

Tom Mattsson and Göran Wilkman at Pechora Sea doing ice condition investigations on routes and loading sites in 1998.

"A vessel 'off the shelf' is not safe in those areas with severe ice and extremely cold temperatures. You can't travel in the Arctic with just any vessel, that is a known fact." ■

General arrangements



For ice going ships, the planning of general arrangements requires special focus on operability issues.

In a Double Acting Ship, good visibility from the wheelhouse, both forward and aft, is essential. Typically, a T-shaped deckhouse is located aft with two funnels standing on the sides of the narrow part while the wider part supports fully-enclosed bridge wings. Good visibility from the aft console is provided for the surveying of all traffic, checking of ice conditions and avoiding ice ridges.

Heating systems, as well as insulation, in both living quarters and technical areas, have to be efficiently taken care of to ensure safe and comfortable conditions in harsh temperatures reaching –50°C. More areas for storage of bulky winter clothes and other winter equipment are also needed. ■

Lars Lönnberg, Chief Designer

Machinery demands

A tanker is often a critical part of a logistical chain. It is therefore important that the ship, its machinery and supporting systems function properly in the harsh ice and environmental conditions the ship is operating in.

One of the first conceptual issues to determine is what operational conditions will the tanker be expected to operate in independently. The appropriate selection of propulsion and machinery concepts significantly affect every ship's price.

A critical issue to decide is what type of fuel the ship will use. Operating in remote locations requires either large fuel tanks to secure sufficient operational endurance or selecting fuel which is available in the Arctic. Additionally, environmental issues, future emission control legislation and a possible ban of heavy fuel oil in the Arctic must be considered. In current projects, liquefied natural gas (LNG) is consequently often considered as primary fuel.

LNG introduces an extra challenge in Arctic ships: Generally, higher propulsion power and special endurance is required for operation in ice and remote areas of the Arctic. In order to achieve the same endurance as diesel, LNG fuel requires about double the tank volume. Therefore, if LNG is being considered, it must be included in the design concept from the very start. ■

Esa Hakanen, Lead Engineer, Machinery Systems

Protecting deck equipment

On Arctic vessels, the equipment on deck is a necessary and important part of ship operations. The equipment is designed to withstand the ambient temperatures of the Arctic by using materials that will not break or suffer reduced capabilities due to extreme temperatures.

Heating and winterisation measures are available and utilized for critical equipment where operational functionality has to be maintained, for example lifeboats, cranes and mooring equipment.

Preventing ice accumulation is key and, on many occasions, this can be achieved simply by covering the equipment with a tarpaulin and keeping to a regular schedule of maintenance and ice clean up. ■

Heikki Juvani, Deck outfitting specialist

Getting the strength right

The size of Arctic tankers has increased significantly in recent years. Prior to the delivery of the Arctic tankers operating in the Pechora Sea, such as the Aker Arctic designed "Mikhail Ulyanov" class of 70,000dwt, the largest Arctic tankers in service were about 20,000dwt. The majority of the classification rules for ice strengthening applicable to Arctic tankers were developed based on operational data – in particular ice damage data – from these smaller ships, for example the Polar tankers of "Samotlor" type constructed in Finland during the 1970s and operated for decades on the Northern Sea Route. This needs to be kept in mind when specifying the strength level of a ship.

At Aker Arctic we typically use our own dimensioning methods which are based on our long experience of calculating and compiling full-scale measurements. We do this in order to select a basic ice class for the tanker, and to prescribe correct strengthening as dictated by the operational requirements of the ship. When those requirements also involve stern first operation, it is especially important that the strength of the stern area overcomes the encountered ice loads. Previous approaches have adopted a "stern as a bow" approach (where the stern is strengthened to the bow strength level) but, in our experience, to consider the whole stern in this manner can be overly conservative. Getting this strength distribution right is essential for cost and operational effectiveness.

For larger Arctic tankers, a significant consideration early on in the design is the decision on which structural configuration to adopt. Transverse framing has typically been utilised for high ice class ships as the most efficient way of strengthening the ship against the ice load. For lower ice class Arctic tankers, a more "open water" approach to the configuration may be adopted. This is done by using longitudinal framing, or in some cases a hybrid approach where longitudinal framing is supplemented by large intermediate transverse web frames in the ice belt. The choice of framing is always a balance between producibility and weight, and needs to be considered in every project, based on the ice class and the ship size. ■

Rob Hindley, Head of Machinery and Structural Design

Winters are changing in the Arctic

Photo by Michael Gutsche, Alfred-Wegner-Institute

The MOSAiC expedition is an international cooperation project, in which scientists gathered information in the Arctic over one year. The aim is to study how sea ice, the ocean and the atmosphere interact, and what impact the climate change in the Arctic will eventually have.

An international scientific community comprising experts from all the natural sciences has been preparing for MOSAiC for the past ten years. Global warming is a joint concern, and the Arctic is currently suffering most, with temperatures rising at twice the rate as elsewhere.

Transpolar Drift

Research Professor Jari Haapala, an expert on sea ice and Head of Marine Research at the Finnish Meteorological Institute, arrived in the Arctic onboard the German polar research vessel *Polarstern* in September 2019.

The vessel anchored in the ice of the Laptev Sea and began its slow journey with the Transpolar Drift Stream. (https://follow.mosaic-expedition.org).

Haapala's task was to lead the sea ice and snow team, collect data on ice movement utilizing the ship's radar, and conduct in-situ ice physics measurements.

"We were surprised at how much the ice actually moves. Not only was the speed of the Transpolar Drift higher than on average, but the pack ice experienced constant dynamic movements such as expanding, shrinking, shearing and closing again," Haapala says. "For those scientists gathering field data, the ice deformation was an unpleasant surprise as some equipment was destroyed, lost or had cables torn off."

"These movements represent the new Arctic. The ice interacts much more with the atmosphere also during winter."

Every year is different

Climate change is a long-term trend spanning 20 to 30 years. Some winters are colder and some are warmer, which is normal.

This year in the Arctic, the ice extent during January-February was close to normal and wider than the previous five years had been. However, in May the situation was back to the same amounts as for the past five years.

"It is hard to say how much of this ice will stay during the summer and become multi-year ice. It depends largely on wind strength and direction. In some years, strong winds have pushed the ice to warmer areas where it melts," Haapala ponders.

No doubt of climate change

Arctic ice data is available for the past 40 years. It is evident that the past ten years are different than the 80s and 90s were.

"There are no doubts that climate change is happening in the Arctic. Every indicator is pointing in the same direction; ice extent, ice thickness, multi-year ice, etc. all show that there is less ice than before," Haapala underlines.

Regarding winter transportation, the biggest changes have occurred in the Barents Sea and the next area of change will be in the Kara Sea.

Research Professor and Expert on Sea Ice, Jari Haapala, from the Finnish Meteorological Institute spent four months in the Arctic onboard Polarstern. Picture Stefan Hendricks.

In general, the Siberian coast has already changed substantially and will continue to do so.

Extreme conditions

"At the same time, it is important to remember that regardless of climate change, the conditions in the Arctic are extremely difficult. During the winter time there are no vessels that can manage there."

According to Haapala, transarctic shipments will not take place for many years to come.

"The Northern Sea Route transport window is widening, but at a very slow pace. In addition, every year is different with ice in varying places, complicating planning even more."

Ice-free Arctic Ocean

Haapala believes that the Arctic Ocean will be ice-free for the first time in September within fifteen to twenty years from now. The North Pole could be ice-free even earlier.

"We are constantly moving towards a situation where the Arctic ice moves and melts away completely. The last time the Arctic Ocean was ice-free in summer was 130,000 years ago."

This worries scientists because they don't know how it will affect the Earth.

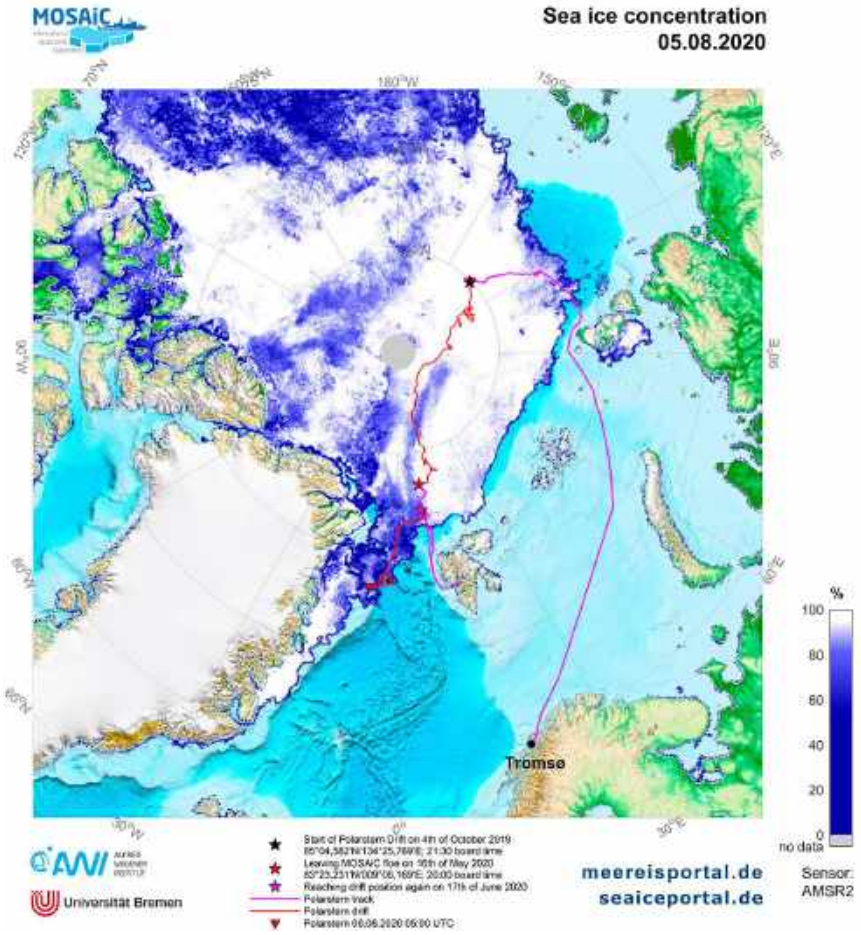
"We don't know how our biosphere can cope with the new situation, nor how the climate and all living creatures will change as we lose the Arctic sea ice," Haapala explains.

Open data in two years

Data will be gathered in the Arctic until September 2020. Scientists have already begun their first analyses, which will continue for many years in international groups. *Polarstern* will return to Germany in October 2020.

Apart from natural scientists, a group of German naval architects stayed onboard the vessel measuring ice loads on the ship's hull. This data will be combined with ice field measurements, such as ice thickness, ice movement and internal ice pressure.

"In two years, all data will be openly available to everyone, both scientists and companies. Ship designers will then benefit from this research project," Haapala adds. ■



Exceptional winter in the Baltic Sea

The past winter was remarkably warm in southern Finland with hardly any snow or ice. However, Lapland and northern Finland received more snow than in many years. Is this our new normal, and what are the implications for winter seafaring?

Senior Ice Expert Jouni Vainio from the Finnish Meteorological Institute has followed the Baltic ice situation for the past 30 years. The Finnish Ice Service produces daily ice charts during the winter months to assist in ice navigation and icebreaking. According to him, it is too early to draw conclusions about an ice-free Baltic Sea.

"Although southern Finland had hardly any snow or ice, northern Finland received extreme amounts of snowfall. Temperatures were higher than usual in the whole country," Vainio says.

"In northern parts of the Bay of Bothnia, ice began to form slightly earlier than usual, i.e. before the end of October. The ice thickness grew to 10 to 15 centimetres, and even though warmer winds arrived around Christmas, the ice did not melt. Strong winds additionally pushed the ice towards the shore."

Icebreakers are necessary

Vessels arriving in ports in southern Finland barely needed icebreaker assistance this year. However, nearly all vessels approaching ports in the northern Bay of Bothnia, i.e. Oulu-Kemi-Tornio, needed help from the three icebreakers Kontio, Otso and Urho stationed there.

"Ice in those ports, and the waterways to the ports, is broken up and refrozen countless times during winter, forming thick layers of brash ice. This is extremely challenging for vessels to move and turn in."

Future winters

The winter of 2010-2011 was unusually cold and the winter of 2019-2020 very warm. Vainio believes these are the two extreme situations, and normal winters in the future will be something in between, with ice also in the Gulf of Finland and the Bothnian Sea. Very likely winters will become shorter; beginning later and ending earlier.

"Even if the sea ice is thin, it will cause problems for vessels as winds push the ice towards the Finnish shores while Estonia and Sweden might have open water," Vainio explains.

Changing rules

"New regulations are lowering the ice-going capabilities of merchant ships, which means that they may not be able to manage even in easy ice. Icebreakers will therefore probably become even more indispensable and required for longer distances in the future."

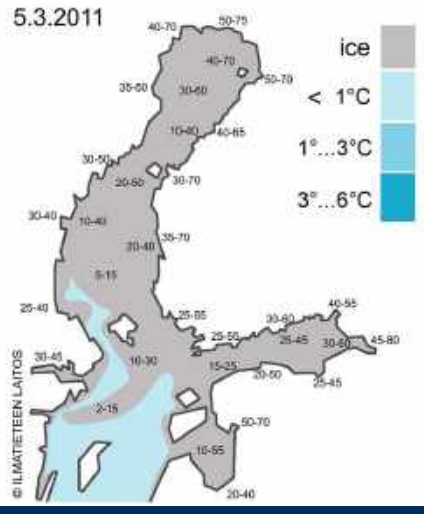
"Merchant vessels are also growing in size, requiring wider ice channels than what can be achieved with current icebreakers."

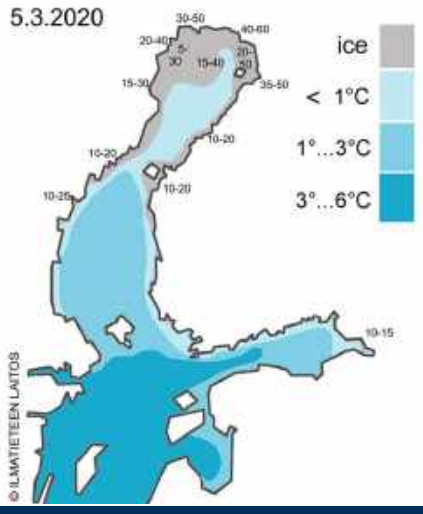
Mild winters are not easy

Vainio wants to emphasise that although winters might become milder, it does not mean they will become easier.

"A tough winter is actually much easier for an ice-strengthened vessel sailing in an ice channel prepared by an icebreaker, than towing in brash ice for many nautical miles."

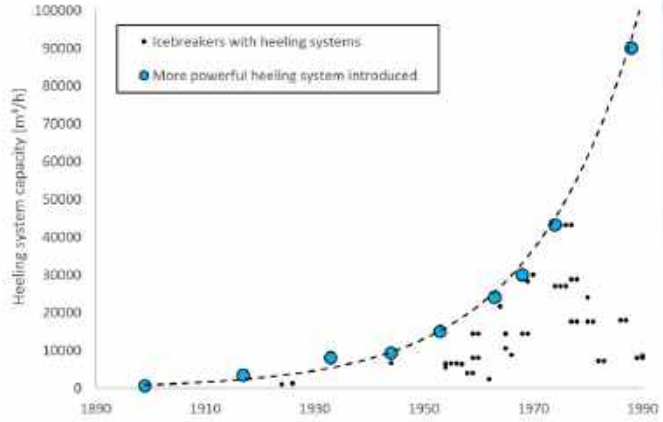
"Additionally, global trade is today very dependent on keeping schedules. Mild winters can eventually put more strain on schedules than hard ones," says Vainio.





Understanding the physics behind active heeling

In addition to unbroken level ice, the effectiveness of the active heeling system was also evaluated in thick brash ice representing a large pressure ridge field.



Through the 20th century, the capacity of active heeling systems increased rapidly with each new icebreaker generation and can be said to having reached its ultimate development with the 1988-built Swedish icebreaker *Oden*.

In the previous issue of Arctic Passion News, we described the initial findings of a recent research project where Johanna Marie Daniel from Hamburg University of Technology (TUHH) studied the effectiveness of active heeling systems in vessels with modern icebreaking hull forms. A more detailed analysis has now been completed, and the encouraging results were presented at the 39th International Conference on Ocean, Offshore and Arctic Engineering (OMAE).

In the late 19th century, Admiral Stepan Osipovich Makarov devised a number of icebreaking auxiliary systems to improve the ice-going capability of the world's first polar icebreaker, Ermak, without increasing its propulsion power. One of these novel technical solutions was a pair of interconnected ballast water tanks used to induce a rolling motion by pumping water back and forth.

Standard feature in the past

This so-called active heeling system quickly became a standard feature fitted to most icebreakers through the 20th century, until the development of abrasion-resistant low-friction hull coatings and the adoption of azimuthing propulsion for icebreaking applications.

Despite the long history and extensive use of active heeling systems in a large number of icebreaking vessels, perception of the systems' overall effectiveness has been based largely on anecdotal operational experience rather than systematic research and quantifiable data.

"One of the reasons why we initiated this research project was to find out how the active heeling system affects the ice-going capability of modern icebreaking bow geometries," explains Naval Architect Tuomas Romu, who supervised the project at Aker Arctic.

In addition to ice model tests at Aker Arctic's in-house icebreaking laboratory in Helsinki, the research project included developing a semi-empirical calculation method to predict the ice resistance of an icebreaker using an active heeling system.

Simulation in model scale

In this project, a mechanical reciprocating weight was used to induce a forced rolling motion on the model. The system parameters were carefully selected to maximize the data obtainable for further analysis: two different weights (heeling tank sizes), two different rolling periods, and two different mass transfer rates (heeling pump capacities). The model used in this research project was one of the latest heavy polar icebreaker designs developed by Aker Arctic.

The two-day test program included performance tests both with and without the heeling system in heavy multi-year ice conditions corresponding to the maximum continuous icebreaking capability of the vessel. Additional tests were carried out to investigate how much energy brought into the heeling system dissipated into the surrounding water and ice.

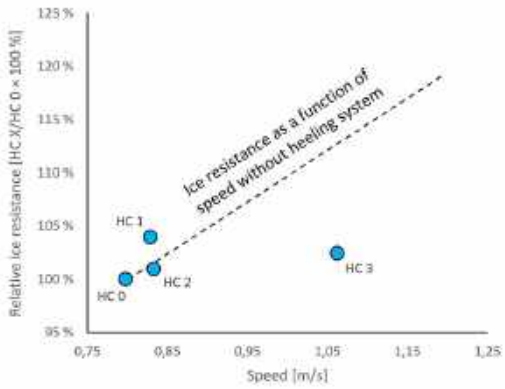
Interesting findings

Analysis of the ice model test results yielded a number of interesting findings.

Firstly, it is possible to improve the ice-going capability of a modern icebreaker operating in extreme ice conditions with an active heeling system.

Secondly, the highest performance gain (+30 % in speed; −10 % in level ice resistance) was observed with smaller heeling angles, indicating high optimization potential for heeling tank size and pump capacity.

Thirdly, to achieve ice-going capability, a correctly designed active heeling system uses less energy than what would be required by simply increasing a vessel's propulsion power. In addition to level ice, positive results were also obtained in thick brash ice used to simulate a ridge field.



Results from ice model tests with heeling system (HC 0 without forced rolling; HC 1-3 with different system parameters).

"Another interesting observation was a significant reduction in zero-speed starting resistance, in line with observations in past full-scale ice trials," says Daniel.

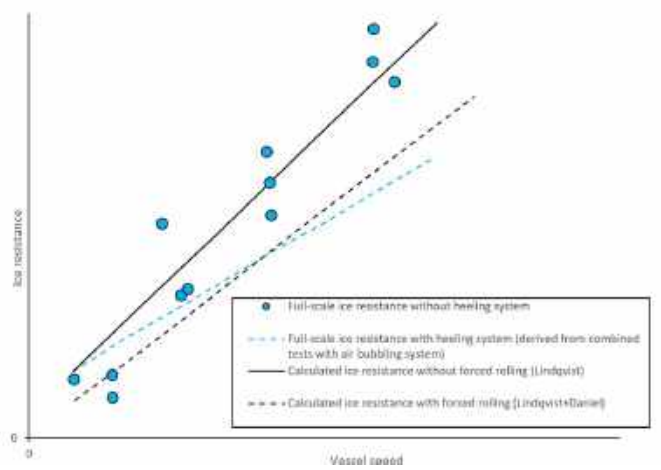
When the active heeling system was activated, the model started moving - even at a reduced propulsion power level that otherwise would not have been enough to sustain continuous icebreaking. Thus, an active heeling system reduces the likelihood of the vessel becoming beset in ice.

Advantages of calculation method

The calculation method developed in this research project takes both the added resistance of the heeled hull, as well as the motion energy of the rolling vessel into account.

The former is estimated by expanding Gustav Lindqvist's well-known semi-empirical ice resistance prediction formulas to consider the asymmetric icebreaking geometry of a heeled hull. The latter includes solving coupled equations of motion (roll and yaw) using two external excitation factors: heeling moment from the active heeling system (energy brought into the system) and hull-ice contact forces in the bow region and channel sides (energy dissipated into the surrounding ice). The result is additional resistance from the rolled state of the vessel as well as additional vertical icebreaking force on the surrounding ice.

In addition to ice model tests, the calculation method was evaluated against data from the full-scale ice trials of the Finnish icebreaker Otso. Although the vessel was not operating near the limit of its icebreaking capability in the 80-centimetre level ice where the tests were conducted, the calculations nonetheless lined fairly well with full-scale data points.



The calculation method was evaluated against data from the full-scale ice trials of the Finnish icebreaker *Otso*.

Icebreaking toolbox

Although icebreaking auxiliary systems are no longer as prevalent as a few decades ago, the active heeling system remains a simple yet effective option to improve a vessel's ice-going capability without increasing its propulsion power. This research project has demonstrated the system's effectiveness with modern icebreaking bow geometries. The new design tools can be used to optimize system parameters by avoiding oversized heeling tanks and pumps.

While modern escort icebreakers are designed to maintain high average speeds in all prevailing ice conditions, other ice-going ships such as polar research vessels may sometimes find themselves operating close to the limit of their continuous icebreaking capability. In such situations, the active heeling system may be the decisive factor that prevents the vessel from getting stuck.

"One possibility is to combine the active heeling system with an anti-rolling tank," notes Daniel. ■

Johanna Marie Daniel is a Naval Architecture and Ocean Engineering student (M.Sc.) at Hamburg University of Technology (TUHH) in Germany, and will graduate at the end of 2020. She visited Aker Arctic during an excursion to Finland in 2018, and decided to apply for a research project as part of her Master's programme.

Benefits of batteries in icebreakers

Battery technology has been evolving and is today increasingly used in both hybrid and fully electric vehicles. Aker Arctic is investigating the benefits of using batteries in icebreakers, not only to reduce harmful emissions to the atmosphere, but also to improve operational capability.

In today's maritime world, batteries are used daily in smaller fully electric vessels, such as car ferries, as well as in bigger cruise ships where they allow short-term operations without main engines. Battery prices have decreased, and there are products available both for fully electric and hybrid use.

However, there are still many open questions regarding durability in vessel use; how battery capacity may decrease over time, safety, and how upgrades can be made as technology develops.

"The technology is still evolving and not one specific solution has yet had a breakthrough, as the various technologies all have their benefits and disadvantages," says Antero Jäppinen, head of Aker Arctic's IT and Electrical Design.

Use in icebreakers

According to Aker Arctic's ongoing research, batteries could be beneficial in modern icebreakers as part of a hybrid machinery system, where batteries function as an additional energy storage between the power generation and electric propulsion system.

"Dual-fuel engines operating in gas mode have a limited capacity to respond to sudden load variations," explains Naval Architect Tuomas Romu. "The usual solution is to install oversized electric propulsion motors with additional torque capacity, referred to as overtorque, to maintain a stable power level as the propeller slows down due to ice interaction. Instead, batteries capable of storing and quickly releasing energy could balance the power demand and offer lower fuel consumption and emissions in long-term operation."

Furthermore, in operational icebreaking situations where power demand can be instantaneous, a battery pack could reduce the number of engines required to be online at any given time and allow the power plant to run at a more fuel-efficient load level. However, the complex equation of sizing the battery pack, amount of usable and available additional energy, system lifetime and cost must be calculated case by case.

"One incentive to make battery packs more attractive could be new legislation related to the reduction of emissions and emission control," adds Jäppinen.

Scandline's 2016-built hybrid ro-ro ferry Berlin, which operates on the Rostock-Gedser route, features a 1.5-megawatt-hour (MWh) battery system.
Photo source Pixabay

Fuel savings with batteries

Currently, batteries are not suitable for entirely replacing traditional fuel in icebreakers.

"However, they can be used in situations where the icebreaker is in waiting mode between icebreaking duties," Romu says.

Other realistic options include quick icebreaking duties within a harbour basin where the icebreaker can recharge on-shore between tasks.

Future in icebreaking

The benefits to the environment of using batteries are clear. Additionally, a large centralized power station is generally more efficient and releases fewer emissions per energy unit than a small diesel engine.

For long-term icebreaking, on the other hand, the energy density in batteries is not yet enough: the primary energy still has to be produced onboard with the vessel's own power plant.

"One solution to this could be using hydrogen fuel cells, a technology which is being tested also in Finland," Romu adds.

R & D project

Aker Arctic is currently conducting a research project, where the use of various alternative energy sources in icebreakers is simulated and investigated.

"Icebreaking and cold temperatures pose additional challenges to the use of alternative technologies. We continue to follow the development in this field, and very likely the next generation of icebreakers will already include some kind of battery solution," Romu says. ■

Finnish engineers design new keel

Ari Huusela is the first Nordic participant ever in the toughest of all sailing races: the Vendée Globe. In November, he will set off all alone on his three-month, non-stop voyage around the world aboard his IMOCA-class sailing boat. Aker Arctic is supporting his race and has helped him, jointly with four other Finnish companies, to obtain a new keel for his boat.

The Vendée Globe solo sailing competition has been called the Everest of the Seas. The sailors spend about three months alone on a boat, sailing around the globe clockwise over the Atlantic and Pacific Oceans. Fewer than one hundred competitors have managed to finish this extremely challenging race, taking place every fourth year since 1989.

Towards new challenges

Ari Huusela began sailing as an adult and was immediately hooked. Beginning with Baltic offshore races, he has continually moved towards bigger challenges, and has raced across the Atlantic four times single-handed and once double-handed.

"In 2016, I watched the Vendée Globe race start and realised that I have more experience than some of the competitors, and that I could actually have a chance of finishing this extraordinary race," Huusela explains.

The following year he bought the IMOCA-class boat, now named STARK, and began preparing for the challenge.

New keel

The boat has been revamped with, among other things, a new satellite system, more electronics, changes to the electrical system, new batteries and charging devices. However, the biggest change yet is the installation of an entirely new keel.

Häkkisen Konepaja has manufactured the new keel. From left Aki Tittonen, Seppo Saviranta, Antti Häkkinen, Ville Valtonen and Reko-Antti Suojanen. Photo courtesy of Häkkisen Konepaja.

Finnish companies Aker Arctic Technology, AH Woods, Häkkisen Konepaja, Mekano and Paneelia have joined forces with Owen Clarke Design / Merfyn Owen to design and manufacture the new keel, which is made of one single billet of forged and heat-treated extra-high-strength stainless steel.

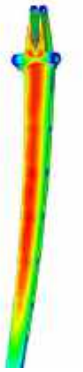
"The yield strength is 800 MPa, which is even stronger than the special steel we use for icebreaker propellers," underlines structural engineer Ville Valtonen from Aker Arctic.

Perfect for this boat

Aker Arctic has engineered the keel to fit into the place of the existing keel, and to carry the loads specified in the 2020 IMOCA Class Rules. Unlike a keel of typical cruising boats, the keel of an IMOCA 60 can be canted about 35 degrees to either side by hydraulic cylinders. This gives more righting moment, allowing the boat to carry more sail and move at higher speeds. The keel is strong enough to carry five times its own weight and survive a grounding force of 27 tonnes, which is more than three times the weight of the boat.

"We use the same calculation tools in our icebreaker design work," adds Managing Director Reko-Antti Suojanen. "Both have in common that they are made from special materials for extreme conditions."

Huusela says he is extremely pleased that Finnish hi-tech know-how was used in this crucial part of the project.



Structural engineer Ville Valtonen has engineered the 4.8m-high keel fin, with a weight of about 960kg, to comply with IMOCA Class Rules.

Eliminating risks

The new keel is especially important from a safety point of view. In 2012, three keels with older designs broke at the beginning of the race, and more stringent requirements for keel design were consequently introduced.

Safety is important for Huusela, being an airline captain for Finnair in his daily work.

"There are many similarities in preparing for a challenging sailing race and preparing for a flight. All potential risks have to be identified and eliminated in advance."

Tolerating stress

Apart from modifying the boat, Huusela trains both physically and mentally to be able to manage stress levels during the race. He can only sleep for short periods, 15 to 45 minutes at a time for three months, as the boat will be moving at speed and other vessels could be nearby.

for Ari Huusela's boat

"When it is time to nap, I have to be able to relax and fall asleep fast."

Huusela tells amazing stories of what has happened to previous competitors and how they managed to solve problems alone, far at sea. No outside assistance is allowed.

"My target is to get to the starting line, sail around the globe and finish the race. I'm hoping to enjoy it a bit too!"

The 9th Vendée Globe starts from Les Sables d'Olonne in France on Sunday 8th November 2020. Follow the race and Ari Huusela on www.vendeeglobe.org.

Route map of the race

Ari Huusela has teamed up with Finnish icebreaker designer Aker Arctic to ensure that his new keel can withstand all the loads it will encounter on his quest around the globe. In the picture Ari Huusela, Ville Valtonen and Reko-Antti Suojanen.

The boats of Vendée Globe all measure 18.28 metres in length with a 4.5-metre draught. They have a large sail area and can move at over 30 knots downwind.

Icebreaking professionals gathered in Helsinki

An ice model test showed in practice an escort operation where an icebreaker was escorting a large cargo ship with nearly twice the beam of the icebreaker.

Aker Arctic's annual customer event, the Arctic Passion Seminar, was held for the 15th time in March 2020. About 80 Arctic specialists and other professionals from around the world gathered in Helsinki just before the global corona pandemic began closing borders.

The opening speech was given by Kimmo Tiilikainen, the State Secretary of the Ministry of Economic Affairs, followed by Managing Director Reko-Antti Suojanen, who gave an update on Aker Arctic's latest projects. He emphasized the importance of long-term partnerships beginning with the initial design idea, continuing to the delivery of an icebreaking vessel and to verifying its performance in full-scale tests.

Future transport needs

Mikhail Grigoryev from Gecon gave an overview of mineral resource developments in the Arctic and what transport schemes will be needed in the future.

Emanuele Putori from North Caspian Operating Company N.V. talked about the Kashagan oil fields and the challenges of shallow waters. The Caspian tug series of five Mangystau vessels have successfully supported the field for ten years. With fluctuating water levels, a new ultra-shallow marine fleet would be desired.

Assisting wide-beam vessels

Head of ship design Mika Hovilainen from Aker Arctic discussed the benefits and disadvantages of increasing vessel sizes and how to assist wide-beam vessels with a narrow icebreaker.

Nina Krupina from the Arctic and Antarctic Research Institute (AARI) showed results from the Aker Arctic-designed icebreaker *Aleksandr Sannikov's* ice trials. The vessel's main purpose is to support loading operations at the Arctic Gates Terminal, keep the ice channel in operative condition, and escort tankers to and from the terminal. All characteristics were confirmed at the trials held in Ob Bay in 2019.

Arctic LNG shipments

Yuta Orito from Mitsui O.S.K. Lines Ltd. presented their experiences of LNG shipping in the Arctic with the Arc7 icebreaking LNG carriers *Vladimir Rusanov*, *Vladimir Vize* and *Nikolay Urvantse*. Orito highlighted that the vessels have contributed to safe voyages in the Arctic and speeded up transportation substantially.

Renato Bolognese from Gaztransport & Technigaz (GTT) told about proven membrane tank use in Arctic LNG vessels. The cruise icebreaker under construction for Ponant has saved deck space using this technology.

Other guest speakers included Sergey Nikulshin from FSUE Atomflot, Viacheslav Konoplev from PJSC Norilsk Nickel, Jari Haapala from the Finnish Meteorological Institute and Ville Valtonen from Aker Arctic. ■

ANNOUNCEMENTS

Sabina Idrissova has joined Aker Arctic as a project engineer in the Consultancy & Technology team. She graduated in 2019 with a Master's degree in Naval Architecture and Marine Engineering from the Saint Petersburg Marine Technical University. During her studies, Sabina also attended Arctic courses at the University Centre in Svalbard and she graduated with a Master's thesis on the prediction of ice loading on ships.

Juuso Lindroos has joined Aker Arctic as a project engineer in the Equipment Business and Special Projects team. Juuso graduated from LUT University (Finland) with a Master's degree in mechanical engineering. He finished his Master's thesis about the use of high strength steels in an ice strengthened container ship and its effects on fatigue life at Aker Arctic in May 2020. ■