Aker Arctic
The Ice Technology Partner

Arctic Passion News

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- New polar vessel for Argentina
- An icebreaker hull in a fortnight
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Front cover

The development of the next-generation Baltic assistance icebreaker has progressed to the next phase. The Aker ARC 130 S design has been finalized in close co-operation with the Swedish Maritime Administration and optimized for Sweden's icebreaking needs. The decision to construct two new icebreakers for Sweden was made in December 2022. The first vessel is scheduled for delivery in 2026 and the second about a year later. The state-of-the-art icebreaker with unrivalled energy efficiency will be the first methanol-ready icebreaker in the world. Read more on page 4.

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Contact details

AKER ARCTIC TECHNOLOGY INC
Merenkulkijankatu 6, FI-00980 HELSINKI
Tel.: +358 10 323 6300
www.akerarctic.fi

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May	31.5. –1.6. Åland Maritime Day, Mariehamn, Finland
June	11.6. – 16.6. International Conference on Ocean, Offshore & Arctic Engineering (OMAE), Melbourne, Australia 12.6. – 16.6. Port and Ocean Engineering under Arctic Conditions (POAC), Glasgow, UK
December	5.12. – 8.12. Marintec China, Shanghai, China

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Dear Reader,

Icebreakers and icebreaking ships have always been a distinctive segment in the marine industry and shipbuilding. Naturally, there are also many other types of special ships with different purposes and roles.

An icebreaker's design, however, is driven by environmental conditions, not only the tasks of the ship. Therefore, there are many types of icebreakers for diverse applications.

Icebreaking itself is not the singular reason

to build an icebreaker; a clear definition of its mission is also necessary. In its purest form, an icebreaker is an escorting vessel with the sole task of assisting other ships by literally breaking ice. Still, even for these icebreakers, other important and useful tasks are often added. Our portfolio of vessel types, combined with the excellent icebreaking capabilities that we have learned to design, has grown to become quite large.

Today, it is obvious that the needs for Arctic ships have changed. Traditional purposes related to industrial development in the Arctic region are fewer – especially seen from a western world perspective. Even operations within the Arctic Council and scientific co-operation are on hold due to continued international sanctions against Russia. This also changes the needs for icebreaking technology.

The green energy transition

is driving further changes. I am referring to a recent study and estimate by one of the energy majors, BP, expecting that fossil fuel-based energy production will be halved by 2050. The remaining part must be replaced by renewable energy. In today's situation, this is influenced by some main drivers: the global trend in sustainability, public opinion, the challenge of having affordable energy and national or regional safety of production.

The trust that energy can be bought and transported by anybody is questioned in today's political climate. Furthermore, transportation of renewables is more challenging and costly compared to fossil fuels. This means that new energy sources will most likely be more localised and produced by trustworthy parties.

In past decades,

one of the drivers for new icebreaking technology was the need to develop large tankers transporting oil & gas products, while supporting icebreaking and ice-classed ships were indispensable in production or loading operations. Now, the focus has returned to more traditional tasks and needs.

This can also be seen in this issue's articles. The modern escort icebreaker designed for Sweden has new fuel options aiming towards a carbon free future. Polar research and scientific needs are drivers for the polar research ship for Argentina. Canada, being a major Arctic icebreaker operator, needs a renewed fleet of multitasked ships. Technically demanding propulsion lines, even for navy ships, and renewable energy production by offshore wind is expanding rapidly also to icy regions.

All these new demands will require even more developed technology and optimised design solutions which we here at Aker Arctic are well prepared to meet, together with our clients.

Sincerely yours,

Reko-Antti Suojanen

Managing Director

Swedish icebreaker proceeds to construction

The state-of-the-art icebreaker with unrivalled energy efficiency will be the first methanol-ready icebreaker in the world.

The development of the next-generation Baltic assistance icebreaker has progressed to the next phase. The Aker ARC 130 S design has been finalized in close co-operation with the Swedish Maritime Administration (SMA) and optimized for Sweden's icebreaking needs.

Selection of shipyard

The decision to construct at least two new icebreakers for Sweden was made in December 2022. The first vessel is planned to be delivered in 2026 and the second about a year later.

Currently, SMA is evaluating shipyards which would have the expertise and possibility to build the vessels. This assessment should be ready in February 2023.

"After that, we can send out requests for tenders and continue the dialogue with our shortlist of shipyards," says Dan Broström, project manager at SMA. "We aim to sign the agreement in September 2023 and begin construction preparations immediately."

Methanol chosen as fuel

The initial concept was prepared with the possibility of adapting the design for various alternative fuels. After Sweden selected renewable methanol as the future non-fossil fuel of its next-generation icebreakers, the design was finalized to consider the special requirements of methanol fuel and to maximize achievable autonomy time during assistance icebreaking operations.

"Currently, the plan is to build the icebreaker initially for fossil-free renewable diesel oil (hydrotreated vegetable oil; HVO) with readiness to adopt methanol fuel as soon as the technology has matured and fuel availability is secured," Broström outlines. "The harbour generators will use methanol-based MD97 fuel from the start."

However, since engine manufacturers are working tirelessly to advance the technology as fast as possible and various bio- and e-methanol plant projects are progressing in Sweden, it might well be feasible to build the icebreakers directly for biomethanol use.

Technical pioneers

The Swedish icebreakers will be the first methanol-ready and potentially the first methanol-fuelled icebreakers in the world. This continues the trend with the Baltic icebreakers as technical pioneers, the previous one being Finnish icebreaker *Polaris*, the world's first LNG-fuelled icebreaker.

When the project began, *Polaris* and two Russian icebreakers, *Aleksandr Sannikov* and *Andrey Vilkitsky*, had recently been commissioned, all being part of the

Aker ARC 130 family of icebreaker designs developed by Aker Arctic.

"We could benefit from the previous designs and develop them further," says Mikael Sandström, Master mariner, nautical expert at SMA, who has been in charge of overseeing the technical details.

New hull form

There are multiple specialities which set this icebreaker design apart from its predecessors in addition to the fossil-free fuels.

"The hull form is new and does not correspond to anything built before. The ice resistance is extremely low for an icebreaker of this size which improves fuel efficiency, lowers emissions, and is cost-efficient in use," Sandström explains.

"The energy storage system will also help to keep engine hours down, minimizing service costs and reducing emissions."

Channels for Panamax vessels

Cargo vessels arriving to the Baltic Sea are growing in size. Panamax-sized vessels with a breadth of 32 metres are visiting harbours more frequently, requiring assistance during the winter navigating season.

"Shipping lanes on the Bay of Bothnia are rather narrow in winter which means that a Panamax vessel beset in ice could effectively block traffic. We don't want that to happen," explains Broström. "At the same time, we cannot afford to use two icebreakers to assist a single ship while numerous others are in need of assistance in our freezing waters. Therefore, one icebreaker has to be able to handle one assisted vessel."

Accordingly, the new icebreakers will be able to create channels of variable widths up to 32 metres. "We had the chance to try how to make a wide ice channel with a narrower ship hull in full-scale on *Polaris*, and are confident that all vessels, even wider than 32 metres, will be taken care of," Sandström adds.

Full-scale tests with *Polaris* showed how a wide channel can be achieved with a narrower ship hull. The new icebreakers will be able to create channels of variable widths up to 32 metres.

Sharp manoeuvring

The chosen triple-azimuthing propulsion layout, already proven with *Polaris*, will ensure excellent steering capabilities.

"The manoeuvring will be fast and sharp, which saves time. We will be able to turn 90 degrees and move backwards as fast as forwards, which will enable us to assist large vessels on all sides without delay," Sandström says.

"Icebreakers are bottom-heavy and roll unpleasantly if not countered with an anti-rolling system. Therefore, this was another important feature for us to add in the design. Cruise ships can have fin stabilizers, but these are not suitable for icebreakers," he says.

In order to make assistance operations safer, easier and more efficient, special attention was paid to the layout and user-friendliness of towing equipment.

Tests to verify selections

The essential features have been tested in Aker Arctic's ice laboratory as well as in SSPA's open water basins in Sweden to compare options and confirm results.

Close-coupled towing is a common way to escort commercial vessels in the Baltic Sea during winter. For the first time, close-coupled towing tests were performed in model-scale to compare different towing solutions.

"The competence development has been tremendous for us in Sweden, but I believe also our partners have learned from our constant questions and challenges to established procedures," Sandström says.

"We are confident that the final design meets all our expectations, and that the vessel will be as successful as we have envisioned. Through the fruitful three-party cooperation work with Aker Arctic and the Finnish Transport Infrastructure Agency we have come up with many ingenious solutions," he adds.

State-of-the-art icebreaker

Sandström and Broström are extremely proud of the final icebreaker design and that it will meet future environmental demands.

"Regardless of the fuel we use, the icebreakers have the potential to become completely fossil-free," they say. "Also, in today's volatile market, it is good to have two options."

Equal efficiency in operations will be achieved using either renewable diesel oil (HVO) or methanol sourced from renewable feedstock.

"Our target was to design a vessel with 70% less emission than Atle-class vessels. According to our life cycle cost (LCC) and life cycle assessment (LCA) calculations, we are exceeding this goal by a good margin," says Maximilian Vocke, project manager at Aker Arctic Technology.

"We are building a state-of-the-art icebreaker which combines the best technical features available today with the best renewable fuels for icebreaking. It will meet today's and tomorrow's needs to secure maritime traffic in the Baltic Sea, and will assist in ensuring the supply of goods in both Sweden and Finland," Broström emphasizes. ■

Study on fuel alternatives

Aker Arctic has compared various future fuel options for icebreaker use (read more on page 20).

"From our research, we concluded that methanol is the most favourable fuel alternative from a technological point of view and provides the longest autonomy time which is crucial in icebreaking activities," says Chief Designer Tuomas Romu, Aker Arctic Technology. "Other evaluated alternatives such as ammonia and hydrogen have more challenges for icebreaking applications."

New polar vessel for Argentina

The ship will transport supplies and personnel between Ushuaia, the southernmost city on the South American continent, and Argentina's thirteen Antarctic stations

Since May 2022, Aker Arctic has been working on the basic design for a new polar vessel for Argentina. The concept development began already in late 2014. The basic design, scheduled to be completed in April 2023, includes updates to comply with the newest international regulations and accommodate the latest technical features.

Fulfil tasks independently

The Antarctic logistics vessel is intended to supply Argentina's thirteen Antarctic stations with provisions, fuel, fresh water, dry cargo and equipment. It will additionally transport research and shore facility maintenance personnel between Ushuaia on the mainland and Antarctica during the southern hemisphere's summer months.

Most of the country's research stations are located on the Antarctic Peninsula, whereas the southernmost station, Belgrano II, is located on the south shore of the Weddell Sea, with ice presence and extreme hydrometeorological conditions.

Therefore, the vessel's own capabilities must fulfil all its tasks independently: travel to and from the polar region while supporting simultaneous and sustained helicopter, boat and amphibious craft operations for embarking or landing personnel and cargo.

Map: Dexxter, CC BY-SA 4.0

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Cooperation between Argentina and Finland in the maritime context has a long-standing history, dating back to the construction of A.R.A. *Almirante Irízar* at Wärtsilä Helsinki Shipyard nearly 50 years ago.

General arrangement

The vessel has been designed to accommodate 190 persons with pantry and mess areas for each accommodation deck. The crew amounts to 118 persons, plus 60 special personnel and 12 passengers.

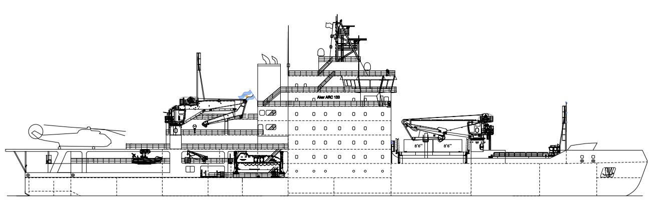
The extensive foreship cargo areas are well protected for carrying fuel with a low flashpoint. There is space for fifty 20 ft containers and two reefer containers, as well as a separate provision hold for the ship's own use.

In the stern, there are cargo holds for miscellaneous cargo, a helideck with two hangars for helicopters which are needed to transport cargo from the ship to the stations, as well as two landing craft to take cargo from the ship to the shore.

Cost-efficient transit

The machinery consists of three main diesel generators and two electric propulsion motors of 5 MW each, driving conventional shaft lines. This solution is reliable and cost-efficient on long transport distances.

The ship is further equipped with fin stabilizers, which is a less common feature on icebreakers. However, the vessel will transit 90% of its time in open water, exposed to the South Atlantic's harsh conditions. From the port of Ushuaia on Tierra del Fuego en route to Antarctica, the vessel crosses the Drake Passage, known for its storms and heavy seas where the fin stabilizers will be an advantage.



Technical details

Length: 130 m
Breadth: 23,9 m
Draught: 8 m
Propulsion: 2 x 5 MW
Speed in open water: 16 kn
Icebreaking capability: 2 knots in 1 m first-year level ice with 20 cm snow cover
Autonomy: 15,000 nautical miles
Service Temperatures: +35 °C to –30 °C (hull –40 °C)

Extra-strengthened hull

The vessel will be able to advance at a speed of 2 knots in first-year level ice, which is 1.0 m thick covered with 20 cm of snow.
"Snow-covered ice increases resistance due to higher friction," project manager Lars Snellman explains.

"The ship's ice class will officially be PC 4, according to DNV's classification, but the hull will be strengthened above and beyond that to withstand the harsh conditions encountered on the way to Belgrano II, " Snellman adds.

Prepared for emergencies

An added special feature is the readiness for emergency situations. If needed, the vessel will have the ability to overwinter while beset in ice. While most of the personnel would be transported off the ship by helicopter, the vessel will have enough fuel and provisions for a skeleton crew to maintain the vessel until the spring thaw.

Ice model tests were performed at Aker Arctic during the concept design. Recently, open water tests, including manoeuvring and seakeeping tests, were performed at SSPA in Sweden. Full-scale ice trials will be conducted after the vessel has been built.

The plan is to upgrade Tandanor Shipyard's facilities in Buenos Aires in order to build the new polar logistics vessel in Argentina. At present, the construction schedule is not yet confirmed. ■

Multi-Purpose Vessel designed for Canada

Aker Arctic has completed the hull form and contributed to the concept development for Canada's sixteen new Multi-Purpose Vessels. They form part of the Canadian Coast Guard's fleet renewal programme.

The Canadian Coast Guard has a diverse but ageing fleet, with many kinds of ships for various missions built in the 1970s and 1980s. As part of the National Shipbuilding Strategy (NSS), a fleet renewal programme has been initiated with the target of replacing existing icebreakers, buoy tenders, fisheries research, and oceanographic science vessels while rationalizing the number of different classes of ships.

Seaspan Shipyards is responsible for delivering the non-combatant vessels being built under the NSS. The Multi-Purpose Vessel (MPV) is a key part of this portfolio.

A multitude of tasks

The MPV is replacing up to three classes of older ships with one platform. The target is to develop a compact ship with a multitude of operational roles. The sixteen vessels will mainly replace the Type 1100 class built in the late 70s and early 80s, often called the "work horses" of the fleet, doing the day-to-day work of supporting shipping by maintaining fairways, aids to navigation, and icebreaking.

The MPVs will also perform cargo missions, bringing supplies to northern communities, carry out search & rescue and patrol missions, in addition to icebreaking. Most of their time will be spent on the St Lawrence River, the Great Lakes, and along the Canadian East Coast. Additionally, they will have a summer Arctic mission leaving from Victoria in British Columbia and travelling north around Alaska to the Canadian Arctic.

Due to the wide variety of tasks, the long-distance mission to the western Arctic, and the fact that some of the waterways have a limited depth, the vessel needed to be compact with a shallow draught, narrow beam, high endurance, and with a large cargo capacity.

Collaboration from the start

Contrary to many other governmental projects, the Coast Guard opted for a collaborative model which involved the owner and operator, the shipyard, and the designer working jointly on creating the concept from day one.

"This method has proven efficient and fruitful, as all the shipyard's learnings from previous builds for the customer have been possible to implement at an early stage," says project manager Rob Hindley, team leader, Structural Design at Aker Arctic.

"It also ensured that the overall parameters, i.e. hull form, size, main dimensions and main powering are validated, forming a basis which the shipyard can further refine and build."

Mutual understanding

The Coast Guard had a clear idea of their needs and wanted assurance that the main dimensions, volume and shape of the hull were suitable for fitting everything needed.

"They conveyed their desires efficiently which ensured a mutual understanding of what they wanted from the beginning. The design process included balancing priorities and what could be fitted in. Furthermore, the shipyard gave valuable input on limitations in construction work, so that we did not add in any features which would be impossible to build," Hindley underlines.

The MPV is replacing up to three classes of older ships with one platform

Due to the wide variety of tasks, the long-distance mission to the western Arctic, and the fact that some of the waterways have a limited depth, the vessel needed to be compact with a shallow draught, narrow beam, high endurance, and with a large cargo capacity. Background image: Kyle Pearce/CC BY-SA

Aker Arctic's aspiration was to develop a concept design with a hull form which balanced icebreaking, seakeeping and open water performance, and was compact yet big enough to accommodate everything.

"As part of developing the hull form, we needed to demonstrate that the envelope allowed the ship to achieve its planned missions," Hindley says.

The end result is a hull form which has had its performance confirmed through ice model testing. Aker Arctic has also provided the design documentation which the shipyard now takes into the functional design phase, developing the design details and approving it by the classification society.

Weekly meetings

The collaboration has required frequent communication and sharing of knowledge. To enable an efficient flow of design information Aker Arctic held online weekly meetings with Seaspan and the Coast Guard, regardless of time differences.

"It has been key to the success of this project," Hindley emphasizes. "The effort to keep the coordination going paid off as we understood at all times what the owner and operator wanted and could develop the solution together."

Optimisation of the design

During the design process a need arose to evaluate the future environmental impact and greenhouse gas emissions, bearing in mind that this is a long-term project.

In the end, the Coast Guard decided to update the design with an optimized version, where the ship was redesigned to allow for future alterations when alternative fuels become available. For this, new calculations were made on the impacts of a future lengthening on stability and weight.

"We also anticipated what the ice loads would be if the ship's displacement is increased and designed a hull which is stronger to allow for a mid-life modification," Hindley says.

"Although every aspect was not possible to anticipate, we managed to design a hull form that meets the Coast Guard's requirements of performance, is as compact as possible, and has a provision for future modifications built into the design."

Learnings from the evaluation

A number of energy-saving devices were also evaluated. These included energy-storage devices such as battery packs; thermal storage in the form of waste heat utilisers capturing and reusing heat from the power plant; and alternative energy sources such as energy stabilizers, solar panels and wind turbines.

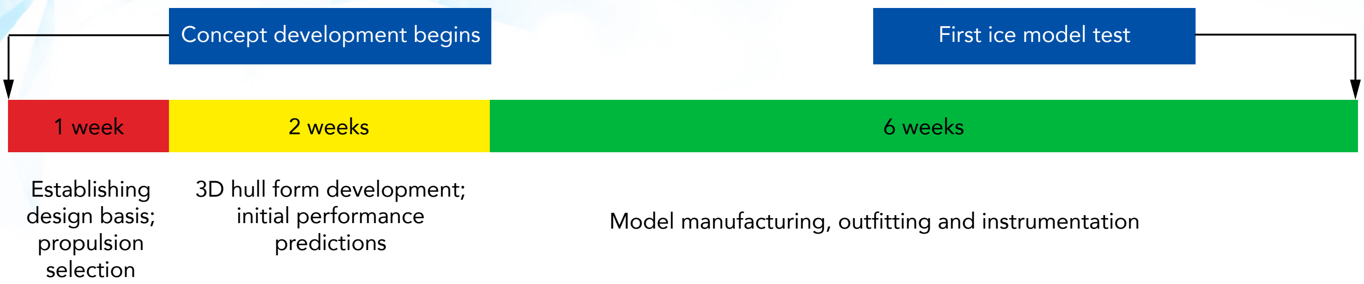
The aim was to evaluate the present state of the technology and how practical it would be to implement it into the design for optimal environmental efficiency.

Due to the ship's size, a decision was made to prioritize the missions against using space for energy-saving devices at this stage. However, as the design continues to progress and spaces and weights become finalized, there is the possibility of implementing some of the options.

As Seaspan Shipyards now progresses towards the functional design work, Aker Arctic continues to support Seaspan particularly on the hull and performance aspects to ensure that everything meets the requirements set out by the Coast Guard. ■

Technical details Aker ARC 146
Length over all: 99.9 m
Bream: 20.3 m
Design Draught: 6.2 m
Displacement: about 8500 tons
Propulsion: diesel-electric; two azimuthing propulsion units
Ice class: Polar Class 4

An icebreaking hull in a fortnight



A new icebreaker hull form in two weeks and model tests just six weeks after that? Correct – a fast-track design spiral is possible when time is limited.

Every icebreaker is designed individually to fit a certain purpose and operational area.

"Therefore, using an existing design for new tasks is not a recommended option," says naval architect Tuomas Romu. "Especially, as an experienced designer with hundreds of references, we can develop a tailored hull in a very short time – even within two weeks – if the schedule is tight."

Steps in the design

Once the design basis – the vessel's mission and intended area of operation – is known, performance requirements such as icebreaking capability can be established. The following step is to decide the propulsion configuration based on project-specific boundary conditions.

"When you have extensive experience, hull form development is relatively straightforward," Romu says. "The myth that this phase takes years is simply not true."

Model tests for verification

After the hull form has been developed in a three-dimensional CAD environment, the initial icebreaking performance predictions are done using Aker Arctic's proprietary calculation methods, powerful CFD tools, and the design reference database. Then, a physical model can be built and tested in the model basin to verify that, indeed, the design functions in ice as intended and performs in speed trials as expected.

"This proof of concept verifies that critical icebreaking functions and the agreed parameters are fulfilled," says naval architect Maximilian Vocke.

"In a fast-track scenario, this could be done as early as six weeks after the hull form has been developed, but usually such a tight schedule is not necessary. The model testing can also wait until a later stage in the design, when the concept has been further developed, and also include tests in open water."

Existing hull forms

Using an existing hull form is seldom advocated for several reasons. Firstly, the hull form is an integral part of the ship and cannot be designed as a separate entity. Secondly, an icebreaker is always designed to specific operational conditions and missions.

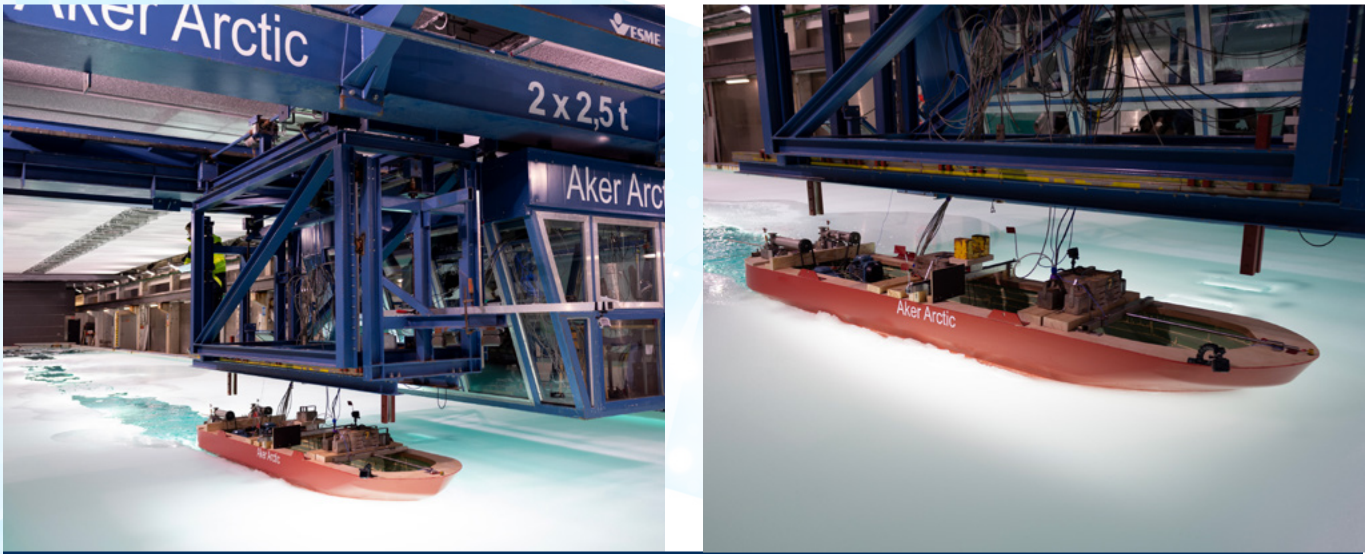
"A good example is the Baltic icebreaker concept we have developed recently. Although Finland and Sweden border the same Baltic Sea, the final design for the Swedish icebreaker is different from the reference design because it has been tailored for Swedish needs," Vocke explains.

Avoiding pitfalls

New regulations, technology and design tools develop at a fast pace. A design which was top-of-the-line a few years ago may not be the most advanced and efficient of its kind today.

"Designing an icebreaker is a complicated process requiring know-how and experience. Small changes in the design can result in big improvements, but this is true also in reverse, and using something you are not familiar with can result in costly rectification," Romu adds.

"It is particularly important to find the correct balance between icebreaking capability, open water performance, and seakeeping characteristics which are unique for each project."



Ice model testing is the only way to examine certain performance-critical phenomena such as the interaction between hull, propulsion and ice.

The heavy module carrier Audax took 28 months from beginning the design work until the vessel was constructed and operational.

Model tests visualise the design

In the 17 years that model testing has been offered at Aker Arctic's ice laboratory, about 1500 ice sheets have been prepared. Prior to that, countless more model tests were made in the two previous model basins.

"Ice model testing is the only way to examine certain performance-critical phenomena such as the interaction between hull, propulsion and ice. Sometimes the hull form can be tweaked for even better performance based on visual observations," Romu clarifies.

Comparing alternatives

In addition to performance trials in different ice conditions, operational tests can be used to evaluate how an icebreaker would perform in various tasks such as breaking free a beset vessel or turning while towing a cargo ship. Development of smaller details and design features is also possible.

"For example, we have tested different skeg geometries with model tests and then chosen the best one for the final design after seeing the results," Vocke says.

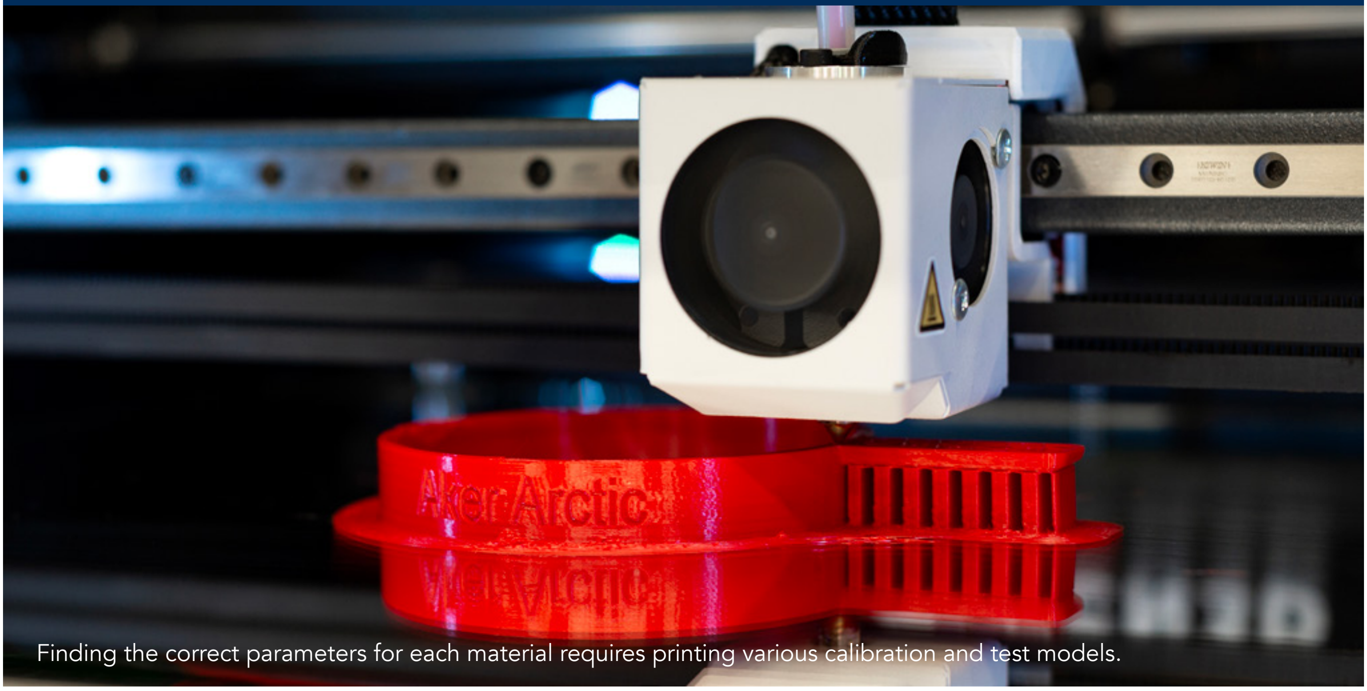
"When developing the port icebreaker *Ob* a few years ago, the final position and alignment of the vessel's four azimuthing propulsion units were determined through iterative ice model tests."

Cost savings with model tests

When reliable results are available early in a project, cost savings can be substantial in the more detailed design and construction stages. After all, model testing comes at a fraction of a ship's construction price.

"There are three main benefits of model tests," Vocke lists. "Firstly, they are used for verification of critical functions and contractual agreements. Secondly, if a customer is considering new operational principles, model tests can confirm that the chosen parameters are correct. Thirdly, if several options are considered, model-scale testing is a cost-efficient way to examine and compare results; for example, different propulsion configurations were tried recently for the Swedish icebreaker." ■

Flexibility in tests with 3D printing



Finding the correct parameters for each material requires printing various calibration and test models.

About a year ago, Aker Arctic acquired a 3D printer to investigate if certain parts for model testing and prototyping could be produced in-house to improve flexibility. The results have exceeded expectations.

Previously, hull parts for model tests were manufactured by milling out the desired part from closed-cell polymeric foam. The parts had to be ordered from an external provider with a certain delivery time and limited possibilities for alterations.

Easier to test options

Today, 3D printing is used in-house to produce azimuthing propulsion unit (APU) covers, rudders, ice knifes, bilge keels and other smaller parts for the models.

"The main advantage is that we can produce variants of parts quickly if we want to test various options or alter something in the design," development engineer Olli Kokko says. "This improves flexibility in the model testing. With 3D printing, we can now obtain perfectly-sized alternative parts, tailor made for each test, instead of using existing stock as we did in the past to save time."

Models can be further modified with add-on parts at short notice.

Ecological choice

In the traditional subtractive manufacturing method, the raw material is a chunk of polymeric foam which is then milled to shape. In the additive manufacturing method with fused filament 3D printing, only the necessary amount of plastic filament is used to manufacture the part to the desired shape and strength.

"The part becomes noticeably lighter and produces much less waste, but has enough strength for model testing," Kokko points out.

There are numerous alternatives for 3D printer filaments depending on the intended use of the components. After a thorough evaluation, the type of plastic Aker Arctic has decided to use shows good stability when submerged in water, is durable, and remains cost-effective for 3D printing. Additionally, it was decided to use filaments that are completely made of renewed materials.

Finding the parameters

The total production time of a part depends on its form; be it simple or with complicated support structures inside. The priority is to find the right parameters for manufacturing and ensure that the strength is suitable.

"For instance, a complete APU cover takes a few days to manufacture. Additional post-processing, such as spray filler and painting, can be done to achieve the desired surface quality, which is particularly important when testing hydrodynamic properties," Kokko explains.

"We are constantly looking for new ways to utilize 3D printing in our work. Currently, part size is a limitation, but we can join smaller segments together to create large assemblies," he adds. ■

Offshore wind farms tailored for winter

In the Baltic Sea area, investments in offshore wind parks are growing. The demanding winter conditions prevalent in this area create unique challenges during planning, design, installation, and operations phases.

Wind power is one of the most viable options globally in our shift towards renewable energy, lower emissions and a smaller carbon footprint. It is also strongly linked to the production of green hydrogen. Finland has declared its aim to become carbon-neutral by 2035, going hand in hand with legislation evolving in surrounding waters.

Solid foundations to withstand ice

Apart from being winterized above the surface, offshore wind parks in the Baltic Sea area require foundations robust enough to withstand waves and ice.

Having designed and tested numerous fixed and floating structures for the offshore industry, Aker Arctic has gained considerable expertise in dealing with phenomena such as drifting ice and rubble pileup.

Almost ten years ago, Aker Arctic performed extensive model tests for Technip Offshore Finland. The results obtained were used in the design and construction of the foundations at Tahkoluoto wind farm off Pori, the world's first offshore wind farm built in a freezing sea.
Four different model-scale foundation structures were tested in various ice conditions to find the technically and economically optimal design. Additionally, ice-induced vibrations were evaluated to find an optimised structural design to bear them. A new technique to create a triangular profile ice ridge developed for these tests has since been used for other foundation tests as well.

"Having designed and tested numerous fixed and floating structures for the offshore industry, we have gained considerable insight into the challenges of designing offshore wind turbine foundations in freezing seas, and expertise in dealing with phenomena such as drifting ice and rubble pileup," says Cayetana Ruiz de Almiron at Aker Arctic.

Logistics and installation play a key role

In addition to physical towers, tur-

Apart from being winterized above the surface, offshore wind parks in the Baltic Sea area require foundations robust enough to withstand waves and ice. Photo: Irfan Alijagic on Unsplash

bines and foundations, there are many other factors to consider when planning an offshore wind park. Transit and logistics planning becomes important in the early phases of development, and not only because construction and logistics are significant cost factors for the investment. A special fleet and other solutions fit for the wind park's particular environment are also required and have to be defined in advance.

It is essential to understand what sizes of different vessels – dredgers, transporting vessels, installation vessels and cable layers – are needed for each phase. Further decisions must be made regarding the location of infrastructure, such as available ports which are able to accommodate large ships and with enough quay area to store windmill components (towers, blades and nacelles).

Aker Arctic was involved in extensive logistics studies for the Arctic port of Sabetta. This included designing the supporting icebreakers operating in the harbour. Similar studies can be made for offshore wind parks where ice is a crucial aspect to consider.

Service vessels needed for maintenance

Once the wind farm is up and running, it must be serviced year-round. For this, service operation vessels (SOV), capable of reaching the wind park at any time and in any weather, are needed. Aker Arctic's naval architects are currently working on a concept design for wind park service operations in seasonally freezing seas.

"Icebreaking vessels are our core expertise, and we believe there will be an increased demand for ice-classed SOVs in the future," Ruiz de Almiron says.

"We are also developing new foundation concepts particularly tailored for icy waters. The most suitable solution depends on the project; some foundation concepts may be low cost in production, but high cost for installation, or vice versa."

The transport vessels Audax and Pugnax, which were used to transport construction parts for LNG production facilities in the Arctic, are also an Aker Arctic design. Lately, the vessels have been used to transport towers and foundations to offshore wind parks.
Photo: Yunlin Com_Taiwan

Results from model tests were used in the design and construction of the foundations at Tahkoluoto wind farm, the world's first offshore wind farm built in a freezing sea.
Photo: Suomen Hyötytuuli Oy

Team Renewable Arctic Finland

Aker Arctic is part of the industry ecosystem *Team Renewable Arctic Finland*, established two years ago. Its 21 Finnish companies are combining their services to provide more comprehensive proposals. Simultaneously, they are also developing know-how and much needed services for future requirements in offshore wind parks.

"Our goal is to become the leading consultant for offshore wind farms in the Baltic region, with in-house concept design, testing and detailed engineering services," Aker Arctic's managing director Reko-Antti Suojanen emphasises. ■

Efficient propulsion solutions for ice-going vessels

The most recent propulsion package order is for the new ice-going Pohjanmaa-class multirole corvettes for the Finnish Navy.

Reliable propulsion performance is a balance between strength, efficiency and operational requirements. Aker Arctic's solid competence in this field stems from a long history of both designing and constructing ice-going vessels and icebreakers.

Once upon a time, Aker Arctic was part of Wärtsilä Helsinki Shipyard. Although the shipyard changed ownership and names several times over the years, building ice-going vessels always remained as one of its core businesses. Developing in-house ice model testing capability and gathering vast amounts of full-scale data resulted in abundant intellectual property on icebreaking technology.

In 2005, the winds of change steered the shipyard's ice engineering unit on a new course as an independent company, Aker Arctic Technology Inc. The know-how of constructing ice-going vessels and icebreakers, how they behave in ice, and the extensive database gathered over the past seven decades still form the strong foundation of the company today.

Equipment supplying service

"In the beginning, we focused on ship engineering and ice model testing, but about ten years ago we began building up an equipment supplying service that would not only complement our own design projects, but could also be offered independently," says Kari Laukia, head of the equipment business at Aker Arctic.

"Our experience in designing shaft lines for ice-going vessels operating in all Arctic conditions, combined with our database with full-scale reference details from past decades until today, has given us the unyielding expertise to balance strength and operational efficiency in the propulsion system."

Recent deliveries of propulsion packages

In 2015 and 2016, Aker Arctic delivered four 5.4-metre Polar Class (PC) 3 fixed-pitch propellers, including materials and installation, for the Arctic module carriers *Audax* and *Pugnax*. The vessels and their propulsion systems have since proven their strength and capabilities in the harsh ice conditions of the Arctic.

The equipment supplying service either supplements our design projects or is offered separately. In 2015 and 2016, we designed and delivered four PC 3 propellers to the Arctic module carriers Audax and Pugnax, to complement the vessel design we developed in 2014.

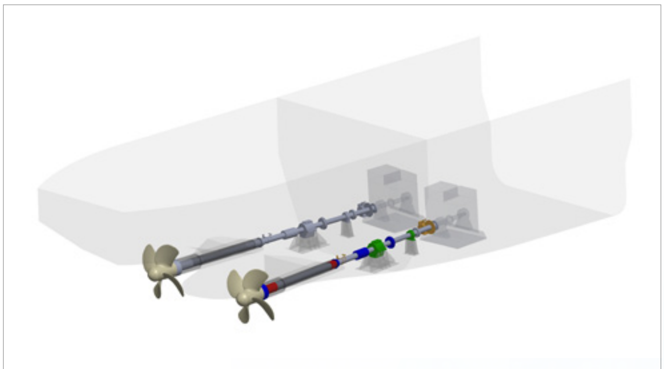
In 2016, we designed two bronze ice propellers for the multipurpose vessel *Louhi*. The innovative approach was to use new dimensioning principles to enable the use of bronze at a higher ice class than typically used before. The propellers were consequently tested in full-scale in the Gulf of Bothnia during winter.

Two high ice-class bronze propellers were delivered to the 1A ice-class tug *Calypso* in 2018 and have since been in use during winter. The tug is paired with the detachable bow *Saimaa*, equipped with two shafts of its own that were also designed and delivered by Aker Arctic.

Following a detailed inspection of the propellers in drydock, the new dimensioning methods for bronze propellers were validated. As a continuation to the success of *Louhi's* propellers, two more high ice class bronze propellers were delivered to the ice class 1A tug *Calypso* in 2018.

When paired with the detachable bow *Saimaa*, *Calypso* is able to break up to 70 cm thick ice. *Saimaa* is equipped with two shaft lines of its own, despite being pushed by the tug. Aker Arctic designed and delivered the complete propulsion package for the vessel which was commissioned in 2020.

"Due to special operational requirements, the strength of the shaft line exceeds the requirements of the highest Finnish-Swedish ice class, 1A Super," Laukia says.



Complete propulsion package solutions comprise the propeller, the stern tube system and the shaft system, in addition to the engineering and commissioning. The scope of supply can also be one or several of these parts.

The most recent propulsion package order is for the new ice-going *Pohjanmaa*-class multirole corvettes for the Finnish Navy. Aker Arctic has designed the state-of-the-art propellers and the shaft lines. Combining the Navy's operational requirements with different operational areas have been the basis for the design. In total, eight shaft lines are planned to be delivered to four vessels between 2023-2025.

Scope of delivery varies

Complete propulsion package solutions comprise the propeller, the stern tube system and the shaft system, in addition to the engineering and commissioning. The scope of supply can also be one or several of these parts.

"A system performance guarantee is included when we take care of the propulsion package," Laukia emphasises.

Other services can also be provided such as Aker Arctic's ice load monitoring system, hull lubrication solutions (bow flushing and air bubbling systems) as well as a patented external ice protection enclosure, known as side pool, for research vessels.

"Our equipment service continues to evolve, as we are constantly developing new solutions. The aim is to save costs for our customers while ensuring reliability in both open water and ice throughout the lifetime of the vessel," Laukia says. "Let us know if you want to hear more about our newest inventions," he adds. ■

Bronze propellers: Four years in use

In January 2023, the pusher tug *Calypso* and the self-propelled detachable icebreaking bow *Saimaa* were deployed to assist shipping to and from the Finnish ports in Hamina and Kotka.

Bronze propellers delivered by Aker Arctic for high ice class vessels have been used on the tug *Calypso* since 2018. Measurements show that the propellers are working well.

Bronze has numerous benefits in marine applications. In addition to good resistance against corrosion, the material is easy to work with both during manufacturing and when carrying out maintenance and repairs. Furthermore, compared to stainless steel, the availability of bronze for propellers is better and the price is more competitive.

For these reasons, bronze has been the primary choice for open water and lower ice class ship propellers while stainless steel has been the option in higher ice classes and more demanding ice conditions.

First installation

In 2018, the first Aker Arctic bronze propellers developed for high ice class vessels were installed on the Alfons Håkans -owned tugboat *Calypso*.

During the summer season, *Calypso* uses a pair of regular bronze propellers with nozzles providing maximum thrust in tug operations. During the winter season, the nozzles are removed as they tend to become clogged with ice.

Calypso´s bronze propellers for winter navigation have been used successfully since 2018. Photo from the shipyard, where the propellers waited for the winter season.

Therefore, removing the nozzles for ice operation required new propellers of either a high-strength material, such as stainless steel, or a special solution involving bronze propellers. The latter choice became Aker Arctic's new ice-strengthened bronze propellers. Although this arrangement requires a change of propellers twice a year, it provides optimal performance for both seasons.

Successful choice

During the summer months, *Calypso* is used in harbour management tasks to assist vessels in seaports in southern Finland. Since the winter of 2020-2021, she has pushed the self-propelled detachable icebreaking bow *Saimaa*.

The pusher-bow combination has kept waterways open in the seasonally freezing Lake Saimaa area and the Saimaa Canal but was in January 2023 deployed to assist shipping to and from the Finnish ports in Hamina and Kotka.

Calypso and *Saimaa* were tested in full-scale trials in March 2021.

Aker Arctic measured the propulsion loads which confirmed that the new bronze propellers work well in ice conditions. You can read more about the tests in Arctic Passion News #22 (2/2021).

Years of research

Aker Arctic has researched the possibility of using bronze propellers in high ice class vessels for years in co-operation with Finnish propeller manufacturer TEVO.

Based on results from full-scale ice trials in the Bay of Bothnia with Finnish multipurpose vessel *Louhi* in 2016 and 2017, it was concluded that bronze propellers can be designed up to ice class 1A Super, the highest in the Finnish-Swedish ice class rules, and even beyond.

The Finnish multipurpose vessel *Louhi* was fitted with a bronze propeller for full-scale tests and taken to harsh ice conditions of 60 to 85 cm thick level ice and 6 metres thick ice ridges in 2016 and 2017.

In addition to normal shaft measurements, propeller-ice interaction was also observed with underwater cameras, giving valuable information for designing bronze propellers for higher ice class vessels. You can read more about these trials in Arctic Passion News #12 (2/2016).

Based on these tests, Aker Arctic developed the dimensioning method for bronze propellers in ice. This has now been successfully verified with *Calypso*. ■

Hybrid propulsion gains popularity

Two azimuthing propulsion units flanking a shaft line in the middle has become an increasingly popular design alternative to explore in icebreaker projects as it combines the advantages of both options.

Choosing the propulsion configuration is one of the most important decisions in a new icebreaking concept. The alternatives are usually determined by several internal and external factors ranging from the vessel's future mission and principal dimensions to the prevailing ice conditions and water depth in the intended operational area.

Best of both worlds

A traditional shaft line is very efficient when sailing straight ahead in heavy ice whereas azimuthing propulsion provides exceptional manoeuvrability. In addition, the latter allows incorporating the Aker Arctic DAS™ solution, whereby a ship sails ahead in open water and lighter ice conditions but turns around and proceeds stern-first through heavy ice.

Although the idea of combining azimuthing propulsion with shaft lines had been brewing since the late 1980s, the full potential of this type of hybrid configuration in icebreaking was realized during the development of the first icebreaking LNG carriers in the 2000s. This propulsion layout has also gained popularity in icebreakers in recent years.

Decision based on efficiency

"The trend has been to use azimuthing propulsion in small-to-medium-sized icebreakers and independently-operating double acting merchant ships, whereas shaft lines have been preferred in icebreaking research ships and heavy polar icebreakers," says Tuomas Romu. "However, the decision concerning which propulsion configuration to use should always be done on a case-by-case basis depending on project-specific boundary conditions."

If two azimuthing propulsion units do not provide enough thrust and a third one is considered, the width of the hull often becomes a limiting factor, as multiple adjacent units require a considerable area for turning 360 degrees. Combining azimuthing thrusters with a shaft line can then become a viable option.

"While two larger azimuthing units could also be chosen, the drawback is increased vessel draught and the limited availability of very large propulsion units," adds Maximilian Vocke.

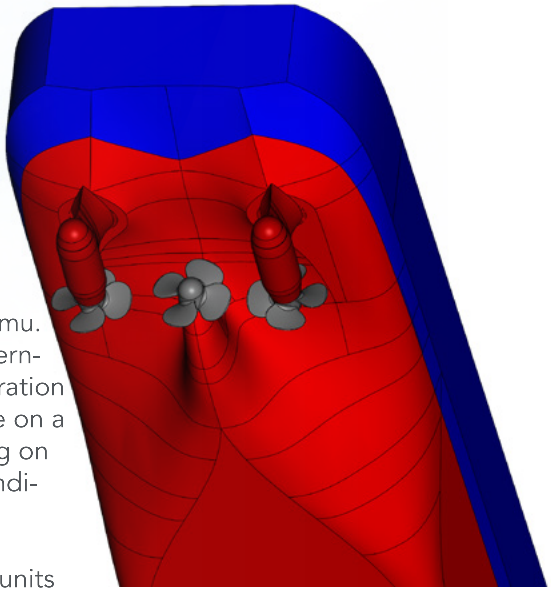
No power limitation

Turning in heavy ice can be a challenge for a vessel equipped with conventional shaft line propulsion and rudders. Combining it with azimuthing thrusters not only improves manoeuvrability, but also allows extended astern operation in ice.

"A noticeable advantage with shaft lines is the possibility to go beyond 20 MW, a power level currently not possible with azimuthing thrusters," Vocke underlines.

So-called twin-azimuth hybrid propulsion is thus especially valuable for heavy polar icebreakers and large commercial ice-going vessels to achieve reliability, redundancy, maximum icebreaking capability and good manoeuvrability in both open water and ice.

"On the other hand, it has become an interesting option also in smaller icebreaker projects where a shallow draught may limit propeller diameter and, consequently, thrust," Romu points out.



It is important to achieve a correct balance between the three propulsors to ensure the desired outcome.

Various configurations tested

Over the years, Aker Arctic has tested various configurations in model scale to determine the optimal hull geometry, propulsion power split, and position of azimuthing propulsion units relative to the shaft line in the middle.

"We have discovered that there are certain challenges which have to be addressed in the design to ensure that the end result is what the customer desires," Romu emphasises. "Some issues have been revealed through trial and error in ice model tests."

In modern heavy icebreakers, the combination of azimuthing propulsion units and shaft lines has replaced the classic triple-shaft configuration prevalent since the late 1800s. ■

Four concept designs to decarbonize icebreaking

As even carbon-free fuels are no longer beyond a distant horizon, Aker Arctic's naval architects have explored four alternative energy sources to research what advantages and challenges are involved in the adoption of emerging climate-neutral solutions for icebreaking vessels.

The long-term overall aim in shipping is to become completely carbon-free. Initially, it means moving away from purely fossil fuels – heavy fuel oil, marine diesel oil and liquefied natural gas (LNG) – to alternative carbon-neutral fuels such as biogas and bio-methanol. In the long run, the goal is to transition fully to carbon-free fuels, such as ammonia and hydrogen, produced with renewable energy.

By 2030, carbon dioxide emissions per transport work (ton-miles of cargo) should be reduced by 40% from 2008 levels, and, by 2050, the International Maritime Organisation (IMO) has set the ambitious target of a minimum reduction of 50% for total annual greenhouse gas emissions from 2008 levels.

High power demand in icebreaking

Despite continuous improvements in icebreaking and propulsion technology, breaking ice remains an energy-intensive process. An icebreaker needs high propulsion power to be able to break ice, perform towing duties, clear pathways for commercial vessels, and keep harbours open.

However, with the technology already available today and the technology currently under development, it is already possible to design carbon-neutral and even zero-carbon icebreakers. Aker Arctic's naval architects have made a study of a smaller icebreaker for Baltic Sea conditions based on four alternative energy sources. The sketch concepts are evaluated against a baseline design.

Common characteristics

All concepts share the same general design, main dimensions, and icebreaking capability. With a length of 86.6 m, beam of 22.4 m and draught of 7.5 m (7.0 m with hydrogen), the icebreakers are only slightly bigger than *Voima*, the oldest and smallest member of the Finnish icebreaker fleet.

The 12-megawatt twin-azimuth propulsion system gives the icebreakers superior manoeuvrability, improving safety and efficiency when operating near other ships. With a modern double acting icebreaker hull form, they can achieve a speed in excess of 8 knots in 80-centimetre level ice, an icebreaking capability similar to the renowned *Otso* class.

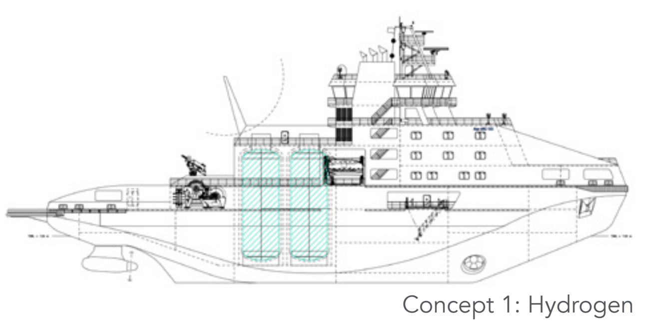
The ice class of the vessels, Polar Class 4 Icebreaker(+), is the same as that of the newest Finnish icebreaker *Polaris* and considered sufficient for all escort icebreaking operations in the Baltic Sea, including the most severe ice conditions in the Bothnian Bay.

When developing the alternative fuel concepts, some forward-looking assumptions have been made in line with the stated development goal of the world's leading engine manufacturers.

Baseline concept: Renewable diesel

Renewable diesel oil, which can be stored in normal structural hull tanks and has a higher energy density compared to the fuel alternatives, provides the baseline concept with the longest autonomy time: 22.4 days at full icebreaking power.

As hydrotreated vegetable oil can be readily used as fuel in any marine diesel engine, the power plant technology is already available on the market. However, in order to meet IMO Tier III emission limits for nitrogen oxides (NOx), selective catalytic reduction with urea solution is required.

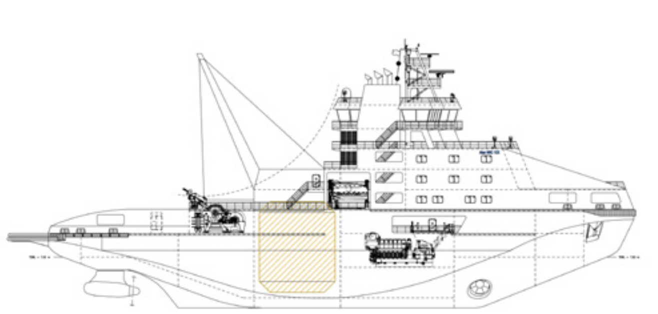


Concept 1: Hydrogen

Concept 1: Hydrogen

The hydrogen-fuelled icebreaker concept has four cylindrical vacuum-insulated IMO Type C tanks for storing cryogenic liquefied hydrogen with a total net volume of about 1400 m³. Due to the low density of liquefied hydrogen, the fuel capacity is restricted by volume rather than weight and, consequently, the draught of the icebreaker has been reduced by 0.5 m compared to the other concept alternatives.

The achievable autonomy time is 4.6 days at full icebreaking power or 21% of the baseline concept.
In addition to hydrogen-burning internal combustion engines, hydrogen can also be used in fuel cells; both technologies are still in development. Hydrogen-burning gas engines may be able to meet IMO Tier III limits for NOx emissions without exhaust gas after treatment.

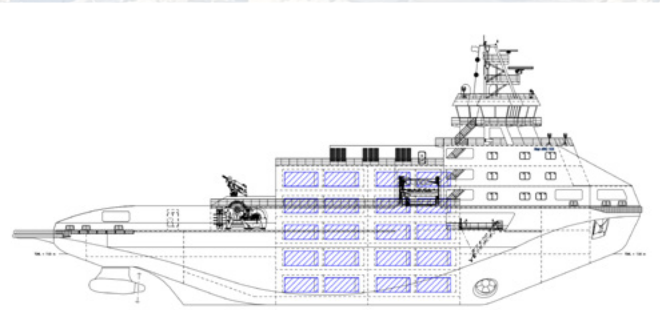


Concept 2: Ammonia

Concept 2: Ammonia

The ammonia-fuelled variant requires a special tank – in this case an IMO Type A prismatic tank – for storing refrigerated liquid ammonia. The significantly lower net calorific value of ammonia and the added weight of the storage tank limit the achievable autonomy time to 7.3 days at full icebreaking power or 33% of the baseline concept.

Ammonia-burning internal combustion engines are currently in development and the technology is expected to become available in a few years. In order to meet IMO Tier III requirements for NOx emissions, ammonia-fuelled ships will require emission abatement with selective catalytic reduction.



Concept 3: Battery-powered icebreaker

Concept 3: Battery-powered icebreaker

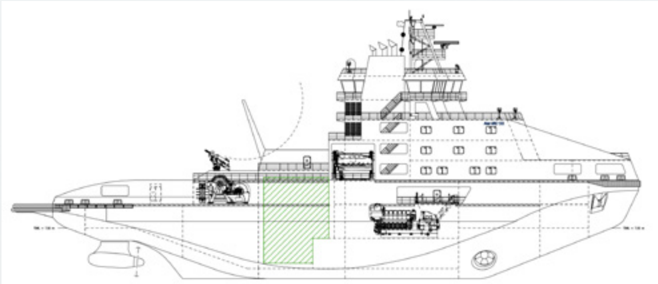
In the fully electric battery-powered variant, the conventional power plant and its auxiliary systems have been replaced entirely with a large energy storage system consisting of battery packs. As the battery-powered icebreaker produces no emissions of any kind, even the funnel has become obsolete.

With the energy density of present-day battery technology, achievable autonomy time is limited to less than 6 hours at full icebreaking power or about 1% of the baseline concept, even if energy required for heating is not considered.

Concept 4: Methanol

In the methanol-fuelled variant, fuel is stored in a structural steel tank separated from other compartments with a cofferdam. The achievable autonomy time is 9 days at full icebreaking power or 40% of the baseline concept. Similar to ammonia, the fuel capacity is limited by the displacement of the icebreaker and the lower achieved autonomy time is a consequence of lower net calorific value of methanol.

Methanol-burning internal combustion engines are already available on the market. These engines may be able to meet IMO Tier III limits without selective catalytic reduction.



Concept 4: Methanol

New inventions bring new possibilities

As focus turns increasingly to a green transition, intense research and development efforts are bringing new engines suitable for new fuels to the market and better ways to produce and distribute energy are invented. Decisions to invest in new distribution infrastructures are also underway.

"The timeframe from a ship's design to final product is at least 2-3 years, which means that bunkering infrastructure in the intended area can also be built during that time," says Reko-Antti Suojanen, Managing Director for Aker Arctic Technology.

"However, choosing a zero-carbon fuel may not be worth the effort if the alternative fuel is produced using fossil energy or if it has to be transported over long distances with conventional tankers," Suojanen continues.

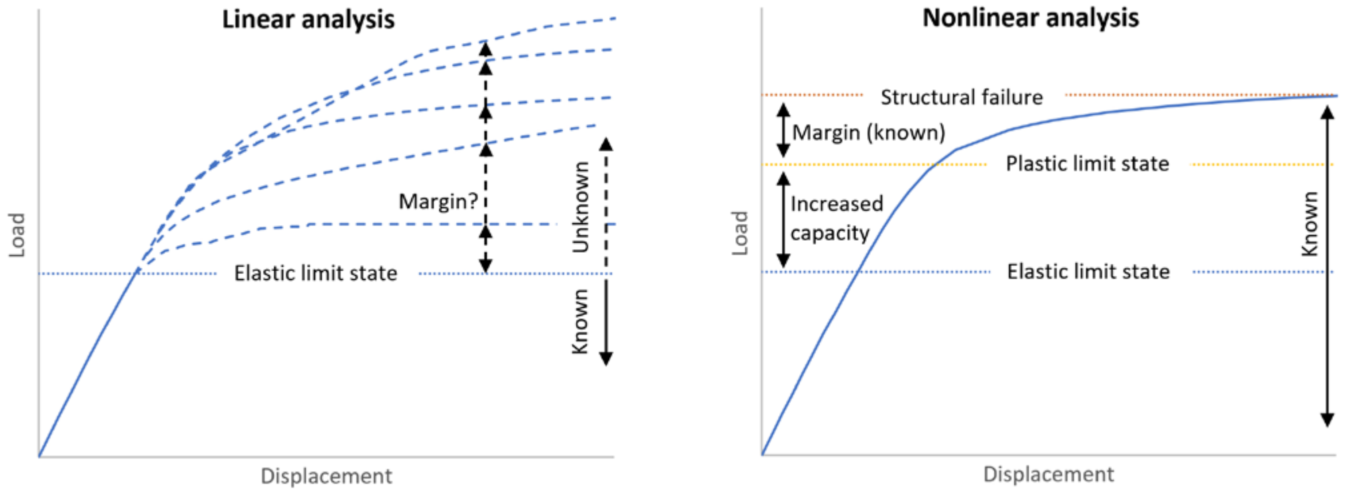
Reduced range and autonomy time

Another aspect that needs to be considered carefully is the reduced operating range and autonomy time of icebreakers using alternative fuels with lower energy density.

"The impact of more frequent bunkering stops or refuelling voyages on vessel availability and overall energy consumption need to be evaluated in both fleet-level operations planning and when drafting the performance requirements of future icebreakers," Suojanen says.

"Perhaps in the future, icebreakers will come into port once per week instead of once every two weeks," he adds. ■

Nonlinear analysis tool benefits high ice-class vessels



In linear elastic analysis of a vessel's primary structures, the safety margin is assumed (left). In nonlinear plastic analysis the point of failure is calculated, and the safety margin is therefore known (right). Additionally, it is known how a failure will happen which can thus be prevented with other targeted solutions that strengthen the structure instead of adding unnecessary steel.

Excessively heavy primary structures can be avoided with Aker Arctic's new design method. This translates to lower construction costs, more load capacity, improved safety and reduced emissions.

Since the Polar Class rules were established in 2006, an imbalance has appeared in the primary and secondary structures when comparing new designs with older, proven, high ice-class ships. This imbalance materialises as excessively heavy primary structures compared to the shell and frame structures.

Structural engineer Ville Valtonen from Aker Arctic led a group investigating this problem a few years ago. The group, consisting of Valtonen, Rob Hindley from Aker Arctic and James Bond from the American Bureau of Shipping (ABS), published their research in the scientific journal Marine Structures in 2020.

They proposed new, robust and simple-to-use assessment methodology and acceptance criteria by using the finite element method (FEM), showing that a nonlinear analysis provides better insight into the behaviour of a structure, giving designers the tools to reduce weight and improve safety.

"Since then, we have been developing a set of practical and efficient tools to use when designing high ice class vessels, because we can achieve a better ship with lower construction costs for our customers," Valtonen says.

Lower steel weight and costs

The nonlinear calculations provide significant reduction in the scantlings of primary structures, thus considerably lowering the steel weight of the vessel.

"Our method allows for steel weight savings of 100 to 300 tons in a typical icebreaker. Calculating the cost of raw material and work adds up to large figures," Valtonen says. "In addition, the ship can, for example, carry more fuel or cargo or we can design a smaller vessel with less draught for shallower water areas."

"Our method allows for steel weight savings of 100 to 300 tons in a typical icebreaker."

The production of steel emits large amounts of CO_2. Less steel thus means lower emissions from production, on top of the reduced fuel consumption of a lighter ship.

"The environmental benefits are obvious," Valtonen adds.

Improved safety with nonlinear analysis

It may come as a surprise, but a lighter high ice-class ship designed using nonlinear analysis is actually safer.

"Nonlinear calculating methods allow us to calculate the exact point where a structure begins to fail, and we therefore know for certain the safety margin. Furthermore, we can design other more targeted solutions to strengthen vulnerable parts of the structure. In essence, it allows us to strengthen the structure in the most efficient way," Valtonen explains.

"On the contrary, with linear elastic analysis the safety margin can only be assumed, and the exact margin is unknown."

The results from nonlinear calculations have been compared to instances of real ice damage that Aker Arctic has documented and investigated for years. The calculated failure loads and failure modes - the way a structure fails - align very closely with the observed damage, giving confidence in the accuracy and reliability of the method.

Additionally, the vessel structures reflect older high ice-class vessel designs, which have a proven track record of safety in Arctic conditions. When the Polar Class rules were established, these older vessels did not fulfil the requirements.

"Now they align much better," Valtonen says

Learning curve

According to Valtonen, Aker Arctic's structural designers have learned considerably during the past three years and have an even better insight into the behaviour of vessel structures than previously.

"We now know exactly why something happens and have been able to improve our design tools accordingly. We have, for example, streamlined some structures to make it easier for the shipyard constructing a vessel."

While nonlinear analysis is more laborious than linear elastic analysis, the cost savings and other benefits compensate for the extra work.

"The efficient tools we have developed have also reduced the calculation time significantly," Valtonen says.

First projects

The first vessel project developed utilizing the new design method is the Aker ARC 130 S Baltic Sea escort icebreaker for the Swedish Maritime Administration. The classification society, Lloyd's Register, has thoroughly evaluated and approved the methodology. Two additional projects are currently underway.

"In any high ice-class vessel project we begin to design today, we recommend using our new tool to calculate primary structures. This will give our customers a better ship while reducing costs. Excessive steel in a vessel does not add any value to the ship," Valtonen emphasises. ■

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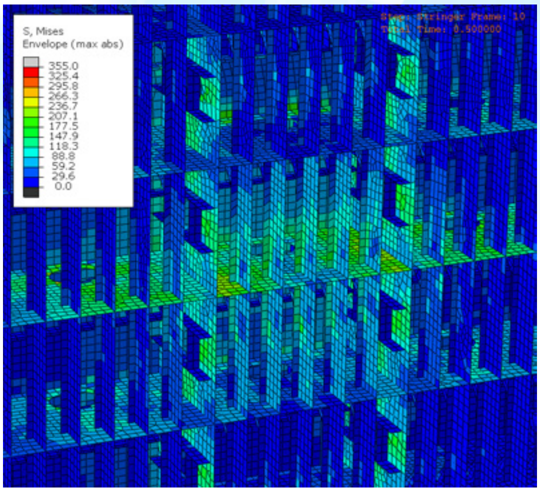

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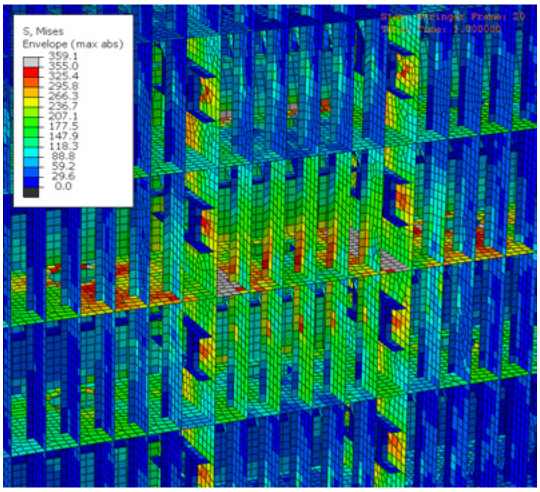

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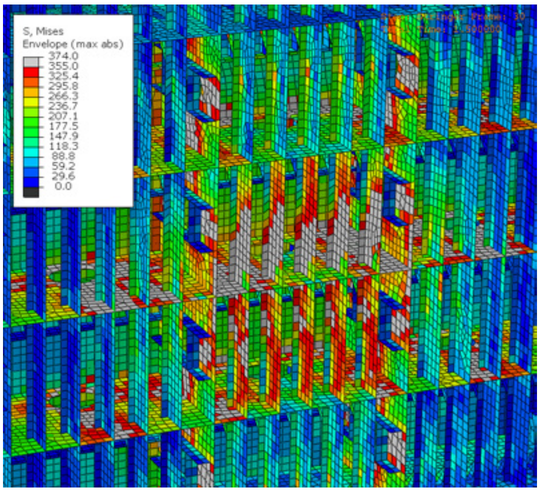

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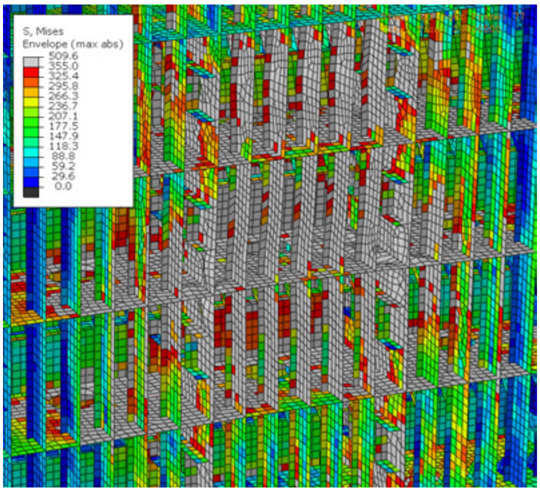

Nonlinear analysis showing when and how failure will take place. Figures 1-4 show the model at 50%, 100%, 150% and 200% of the design load.

ANNOUNCEMENTS

Henri Helenius has joined Aker Arctic as a machinery systems designer in the machinery team.

Henri graduated from the Mechanical Engineering Department at Aalto University in 2013. He studied naval architecture as his major, internal combustion engines as his minor and did his master's thesis at ABB Marine & Ports on energy storages in diesel-electric icebreakers in 2012. He also spent a year in Germany during his studies.

After working several years with vendors, such as ABB and Eniram (later acquired by Wärtsilä), Henri transferred to the design field at Deltamarin before joining the Aker Arctic team.

Tommi Hietamäki has joined Aker Arctic as a senior naval architect in the ship design team.

Tommi graduated from the Helsinki University of Technology (today Aalto University) with a master's degree in Naval Architecture in 2007. Before joining Aker Arctic, he worked at Deltamarin for 16 years. Tommi has extensive experience in concept development of various kinds of vessel types, including passenger, cargo and special vessels.

Eetu Seppänen has joined Aker Arctic as a research engineer in the ice performance team.

Eetu studied shipbuilding at Aalto University and graduated during summer 2022.

He first started his work at Aker Arctic as a trainee in model testing, about two years ago, and then wrote his master's thesis for the company on the subject: Model test method development to review notch towing properties of an icebreaker. After graduating, he entered his full-time position as a research engineer in model testing.

Lars Snellman has joined Aker Arctic as a project manager in the naval architecture team.

Lars graduated as B.Sc. Naval Architecture from the Swedish Institute of Technology in Helsinki in 1994. He began his working career at Kvaerner Masa Yards Helsinki New Shipyard (later Aker Yards) as a designer and later as a project manager in the deck outfitting design team. In 2006, he moved to Finstaship (later Arctia) where he worked as a superintendent for icebreakers and fairway vessels. The work involved responsibility of technical maintenance and development of vessels. In 2011, he joined Lamor Corporation as a project manager, focusing particularly on oil recovery equipment to vessels and workboats.

Oskar Veltheim has joined Aker Arctic as a project engineer in the structures team.

Oskar graduated from Aalto University with a master's degree in mechanical engineering, in 2022, after completing his master's thesis about determining ice loads on a ship hull using an inverse method.

Christmas at the office

Just before the end of the year festive season, Aker Arctic's staff gathered to enjoy a delicious lunch together at the office. The company's own band, consisting of Riikka Matala, Olli Kokko, Aaron Tam, Rob Hindley and Miika-Matti Ahokas, was in charge of the entertainment, and surely got everyone into a cheerful mood. ■