Aker Arctic Technology Inc Newsletter

September 2014

Arctic Passion News

2 / 2014 / 8

LNG

In this issue

Announcements

Jorma Koponen *has been appointed Project Manager for the Ice simulator. He was previously at Navis Engineering Oy, where he worked in marketing and sales of Vessel Dynamic Positioning-, Joystick control-, Remote Steering and Thruster Control systems.*

Anders Mård *has been appointed Project Engineer in the Engineering Department. He graduated as Naval Architect from Aalto University in 2013 and his thesis considered the experimental study of the ice-breaking process of an icebreaking trimaran.*

Ilkka Rantanen *has been appointed Business Development Manager and IPR Manager. He will be in charge of IPR and Offshore business at Aker Arctic. He comes from STX Finland Oy in Rauma, where he has held several positions in Sourcing, Development and Sales & Marketing. Earlier in his career he worked at Hollming Works Group as Business Development Manager and Workshop Manager.*

From the Managing Director

The year 2014 has been interesting and challenging in many ways. The recent changes in the political atmosphere have also affected the business environment. Specifically, this also concerns the oil industry, which is one of the main drivers for the recent icebreaker projects and for arctic development in general. However, we all must hope the situation will not escalate and both developers and operators can continue to work in sustainable way in the arctic development projects.

We at Aker Arctic have been very active in the projects with our clients. The development of the first-ever arctic class heavy cargo carrier has been a very interesting project technically. With the shipowner, we have developed a vessel for high arctic requirements and created interesting technical solutions, all within a very tight time schedule. It is also the second vessel of our design to be constructed in China, and it will result more co-operation with China in the future as well.

Other vessel projects and consultation work have also kept our design staff busy, and it seems the market activity is high, with the ice model testing basin having been in full use during the year. There has also been continuous research and development where we have been concentrating on new services, like the ice simulator, and on the development of our vessels' fuel economy and environmental friendliness.

My first eight months as the managing director of Aker Arctic have been interesting times, showing all the aspects of the business; from the very sad and unexpected accident of our long-time colleague Karl “Kalle” Hamberg, but also opening new client relations and projects and continually bringing new highly skilled staff into our company. The successful services that the company can provide to our clients will be our main priority, and this further gives us all a good position to look toward the future with high expectations.

Reko-Antti Suojanen
Managing Director

Karl Hamberg in Memoriam

Our dear colleague and friend Karl Hamberg has passed away. Karl worked all his life in ship design, first at Wärtsilä Helsinki Shipyard, then at Kvaerner Masa-Yards, Aker Finnyards and since 2006 at Aker Arctic Technology, where he acted as Design Manager coordinating the activities of the highly skilled team of experts on ship design and arctic operations until 2011. Since 2011 Karl concentrated on IPR issues and acted as Design advisor. In his career he participated in the designing, building and commissioning of nearly 50 significant ships. He was a great person and his commitment to and excitement about ships and design was exceptional. His kind and elegant personality was well liked by all his colleagues and we all miss him.

Front cover:
Aker Arctic has in cooperation with Meritaito carried out a field measurement research project, with the goal being to test and evaluate the applicability of a new method for profiling ice formations and brash ice channels. This new method combines scanning with laser and sonar instruments. Read more on page16.

Design and License Agreement for Aker ARC 121

Photo: Arctech Helsinki Shipyard

Aker Arctic has made the concept design for the new Ice Breaking Standby Vessel (IBSBV) known as Aker ARC 121 to meet the demanding criteria of Sakhalin Energy Investment Company Ltd. (SEIC). Arctech Helsinki Shipyard signed a contract in August 2014 with Russia´s largest shipping company Sovcomflot for the building of three of these vessels. They will be built for the North East Sakhalin Offshore region oil and gas field where they will serve the operator of Sakhalin-2, Sakhalin Energy Investment Company Ltd. (SEIC). The vessels will be delivered between September 2016 and March 2017 and the total value of the construction order is about USD 380 million.

Sakhalin Energy and Sovcomflot have in July signed contracts for the construction and long-term operation of the three multifunctional icebreaking standby vessels to serve the Sakhalin-2 offshore energy platforms. Operations under the contract will continue for 20 years. The vessels will be used as year-round personnel carriers and also as supply vessels for offshore platforms in the Sea of Okhotsk. In an emergency, the vessels can be deployed for personnel evacuation and oil spill response. They will be operating in thick drifting ice for ice management and icebreaking in temperatures as cold as -35°C. The icebreaking capability of the standby vessels is very high; the vessels are able to proceed independently in 1.5 metre thick ice.

This new series of IBSBV´s is a further development of the Aker ARC 105 concept, whilst the design and technical parameters of the new vessels were specially modified to meet the needs of the Sakhalin-2 project.

"The Aker ARC 121 design is developed to meet the demanding design criteria set forth by SEIC. The final design work will begin this autumn by Arctech according to the demands of both the owner and operator. Our responsibility will be to define hull form and conduct open water tests as well as ice trials once the vessels have been constructed," says Maximilian Vocke, Project Manager at Aker Arctic Technology.

www.sovcomflot.ru, www.sakhalinenergy.com, www.arctech.fi

This new series of IBSBV´s is a further development of the Aker ARC 105 concept, whilst the design and technical parameters of the new vessels were specially modified to meet the needs of the Sakhalin-2 project and the demanding design criteria set forth by SEIC.

First Arctic module carrier for Yamal LNG plant

Aker Arctic has actively been involved in researching and creating logistic and operational solutions for Yamal LNG since 2010. In addition to developing LNG-carriers, port icebreakers and assisting in designing the harbour of Sabetta on the Yamal Peninsula, we have helped in preparations for the new LNG plant. The plant construction is based on a modular principle, with modules manufactured all around the world, gathered in Europe and then transported to Yamal. Aker Arctic has recently been responsible for designing two Polar class heavy deck carriers for the safe transportation of these modules to the plant construction site. The development work has been carried out in close cooperation with ZPMC-Red Box Energy Services.

Main dimensions

Length	206.6 m
Breadth	43 m
Draught	7.5 (max 8 m)
Deck load	max 21 800 tons
Flat cargo deck area	7 500 m²
Propulsion	2 x 12 MW

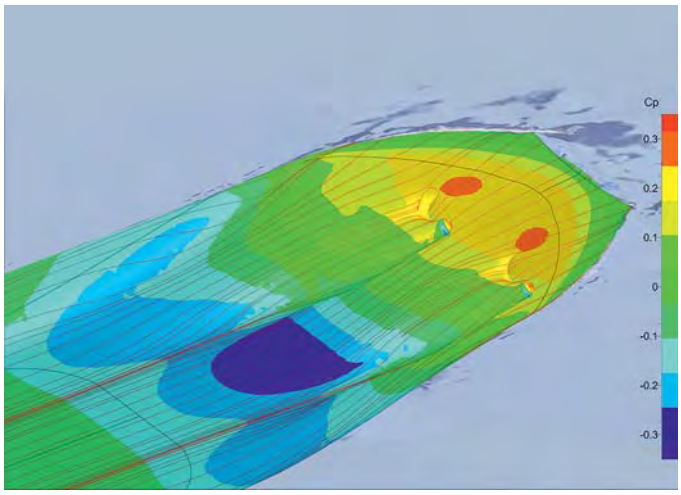
The Liquefied Natural Gas plant in Sabetta will be constructed of several hundred different modules, which are built at different locations around the world. These modules weigh up to 10,000 tons and will be gathered in a European harbour before shipment to Yamal. It will take about four years to deliver them all to the Arctic area. Due to the harsh conditions found in the area with temperatures down to minus 40 degrees Celsius for part of the year, no ordinary vessel is able to take care of this kind of transportation.

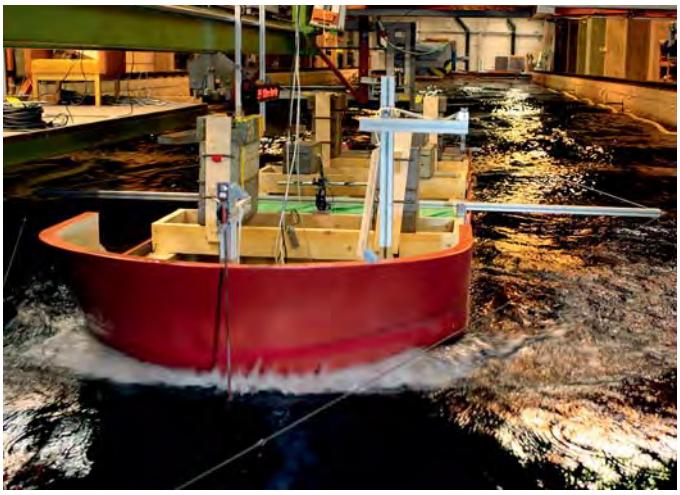
Cargo ship with Polar Class 3

Aker Arctic has now, in close cooperation with ZPMC-Red Box Energy Services, developed two module carriers, which can operate year-round in delivering the modules to Yamal. These carriers are different from anything designed and constructed earlier. They are typical heavy cargo ships with a wide cargo deck, but designed for exceptional ice circumstances as they need to be able to move in the Gulf of Ob round the year in order to keep the construction of the LNG plant on schedule. The ice class is therefore Polar Class 3.

"Two of the major challenges in designing the vessels were firstly the weight of the modules and secondly the way they will be loaded onto the ship, as the ship needs to stay balanced at all times. We had to optimise the construction so that it did not become too heavy but remained strong enough to manage the weight," Project Manager Mika Hovilainen explains. "The ship draught had to be between 8-12 metres and loading needed to be done regardless of changing tides. Additionally, we had to take into account the Arctic weather and the schedule was tight. We began the project in autumn 2013, construction will begin autumn 2014 and delivery of the vessels will be at the end of 2015/beginning of 2016."

Rinse van Lievenoogen, Chief Technical Officer at ZPMC-Red Box Energy Services, and responsible for the ongoing collaboration between the ZPMC-Red Box and the Aker Arctic Design Teams states,

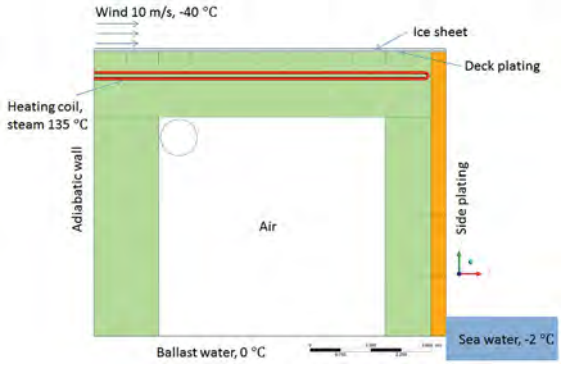


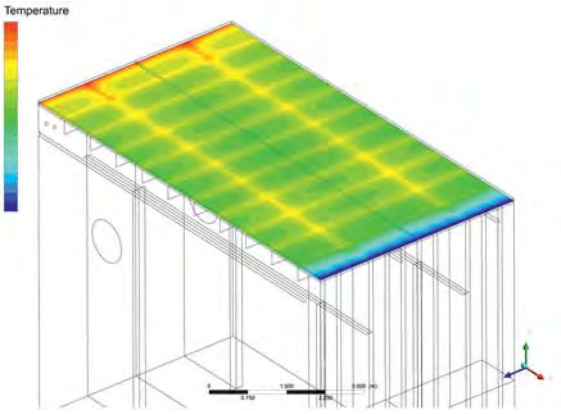


”The stability requirements of a vessel like this requires a highly sophisticated ballast system. The additional complexity of operating this ballast system above the Arctic Circle posed a major technical challenge in the concept design phase of these unique vessels. Maintaining equilibrium between the vessel deck and the loading quay throughout the tidal cycle while at the same time being able to precisely manage the trim of the vessel during the discharge of ultra heavy cargoes was a critical criteria in our required specifications.

ZPMC-Red Box contributed a new ballast system design which transfers ballast water internally in such a way as to improve the control and efficiency of discharge operations. The safe discharge of high value modules for energy infrastructure projects has been an area of constant focus to our Team at ZPMC-Red Box and we were extremely pleased with the close cooperation we enjoyed working with our partners at Aker Arctic on these PC-3 Module Carriers.

We were also pleased to see Aker Arctic incorporate our suggested Bridge design, which not only complies with the NAUT-AW requirements, it assures maximum visibility, from every position on the Bridge, allowing the safest possible Arctic navigation while maximizing the performance of the vessels in the most extreme arctic conditions."





The surface temperature field of the deck after the specified heating time. The highest temperatures are located above other structural members, whereas the lowest temperatures can be found near the cold side plating.

CFD calculations were used for optimising open water characteristics.

A special feature of the ship is the deck heating system. After extensive calculations and modelling, the final solution was to place steam pipes below the deck, which are turned on 24 hours before unloading.

Deck heating system

A special feature of the ship is the heating system of the deck. Spray blown off the sea and freezing immediately on contact with the ship can create snow and ice cover on the large 43 by 175 metre deck area. Ice in particular must be removed from the deck to ensure safe operation during offloading. Various options were studied in order to find the best solution for the removal of the ice.

“We used CFD tools to model both radiation and convection from possible heating systems to the deck. ▶

Icebreaking port tug ARC 125 underway

The basic design process of an icebreaking port tug for Yamal LNG is underway with model testing already done. In the beginning she will assist the Arctic module carrier in harbour operations and later other vessels. Her primary tasks are escorting services, icebreaking, assistance in harbour operations and ice management functions.

She is designed for year-round operations in the Sabetta harbour area. Her ice strengthening enables independent operations in pre-broken thick first year ice and her hull form is designed for operations in thick brash ice conditions, while still maintaining adequate operability as an escort and harbour tug.

The tug is able to proceed at a speed of 2 knots in both 1.0 metre level ice and 4 metre thick brash ice with consolidated layer on top in limited water depth, which prevails in Sabetta harbour.

Aker ARC 101 design IBSSV "Fesco Sakhalin" at an oil platform in the Sakhalin-1 project.

The challenge was to optimise the heating system so that it is efficient, but does not create too much weight," Structural Engineer Teemu Ikonen tells. "The final solution was to place steam pipes below the deck, which are turned on 24 hours before the arrival. The heat melts the ice enough to create a thin water layer below it so that the rest can be shuffled away mechanically."

Extensive model testing

The vessel will have an operation profile where most of the voyage will be sailed in open water and following a route along the Norwegian coast with challenging wave conditions. An extensive amount of model testing was made in order to ensure that the requirements of both good open water features and ice performance were met without construction prices becoming excessive. Slamming pressure measurement was particularly important. CFD calculations were used extensively for optimising open water characteristics.

“Our aim was to develop a carrier with a good performance combination both for open water and ice, and we succeeded in this," Mr Hovilainen adds. "The carrier can proceed at a speed of 3 knots in 1.5 metre thick ice with 2 x 12 MW propulsion power."

Expertise at all stages

"In this project, we have been able to offer our know-how at all stages, making the initial feasibility studies of the Yamal area, developing LNG transport solutions, assisting in the harbour design, planning various assisting vessels, and now continuing with delivering a design for this arctic module carrier for the constructing shipyard Guangzhou Shipyard International in China," Project Manager Heikki Sipilä emphasises.

"For the module carrier, we were first responsible for the design concept and we are continuing now with the basic design process. All development work is carried out in close cooperation with the shipowner ZPMC-Red Box Energy Services.

Once the vessels are built we will take care of the full-scale ice trials. This is an important reference for us, which shows how we can serve our customers throughout a project. It is also an example of how both our theoretical and practical expertise can be combined."

Special vessels needed for supply operations in the Arctic

The Arctic area is challenging, not only because it is remote, conditions are harsh for a substantial part of the year, but also because there is no infrastructure in place. The vessels needed in this area have to be specially designed for the prevailing conditions.

During the warmest summer months, lower ice-class vessels can be used but as soon as temperatures drop, the operative window closes if vessels are not adequately designed. Also, supply operations need special vessels.

"These kinds of vessels are typically not available for charter as they have to be tailor-made, which means that the delivery time is long. As the operative window is narrow in the Arctic, it can become very costly if investment decisions are delayed and consequently the time frame extends, not only by a few months but even by a year because of the operative window. Our core know-how is how to plan successfully for operations, logistics and supply functions in the Arctic, so we welcome customers who have investment plans to come forward and talk to us for advice in all these matters at an early stage," explains Marketing Manager Arto Uuskallio.

Meet Heikki Sipilä

Heikki Sipilä joined Aker Arctic last year in April. He has worked all his life with ship development and ship engineering in Turku, Finland, first with Wärtsilä, then Masa Yards and lastly at STX Life cycle services before beginning his employment at Aker Arctic.

He lives in Turku with his wife and drives between the Turku and Helsinki offices, often several times per week. Apart from work, he takes an interest in forestry at his leisure cottage in the Tampere area. Heikki is responsible for the basic design of the Arctic module carrier.

Trimaran icebreaker family grows

One of the latest innovations in icebreaking is the use of a trimaran concept. Tests have shown that a trimaran is more efficient in breaking ice than a conventional icebreaking vessel of the same width. It is also lighter and uses less power to create a wide channel. Aker Arctic has now developed three different sizes of the trimaran concept.

The icebreaking trimaran family has grown and includes now three different sizes: a Baltic Sea icebreaker, an Arctic icebreaker and an Icebreaking harbour tug. The earlier developed concepts are the Baltic Sea icebreaker and the Arctic icebreaker with the most recent addition being the smaller icebreaking harbour tug, which has been developed up to concept design stage.

Icebreaking harbour trimaran

This vessel is intended for year round operation in e.g. the Baltic Sea, to work as an escorting icebreaker tug assisting cargo vessels mainly in areas with first-year ice. It is planned to be an ice management vessel in harbour brash ice conditions, servicing fairways in open water conditions, oil recovery and fire-fighting, as well as acting as a multipurpose salvage tug.

The vessel has a main centre hull and two pontoons on the sides. The main icebreaking direction is in ahead mode and it can create a channel about 27 metres wide, which makes it excellent for assisting wide cargo vessels in ice.

Due to the large deck area, the vessel is suitable for large light deck cargoes. Its stability makes it excellent also for maintenance work. The vessel is 45 metres long and 25 metres wide with ice-breaking capabilities of 0.4 metres at 7 knots. Theoretical icebreaking capability is about 1.2 metres.

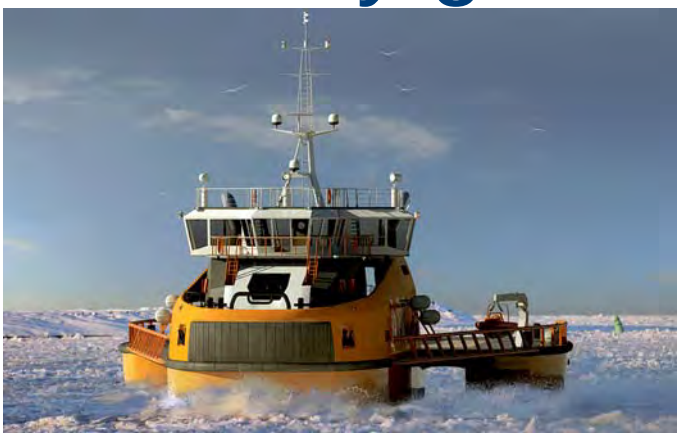
Further testing of trimaran concept

"Last year, we performed extensive model tests in our testing basin for the harbour icebreaker; we measured loads and verified the calculated ice loads when the vessel encounters large ice features, such as ridges. The results showed that nothing dramatic happened and that loads were slightly lower than expected. This proves that the concept is feasible from a structural viewpoint and good for icebreaking," Structural Engineer Ville Valtonen says.

"We also researched the optimal width for icebreaking purposes. The results indicated that a width of up to 50 metres worked best. The original trimaran is 40 metres wide. Tests also showed that the trimaran breaks ice more efficiently than a conventional ship of the same width, because of the construction with a centre hull and two pontoons on the side."

In August open water tests were performed in order to verify calculated loads, slamming loads and research on the wave conditions in which the vessel's motions are such that working on the vessel is still possible.

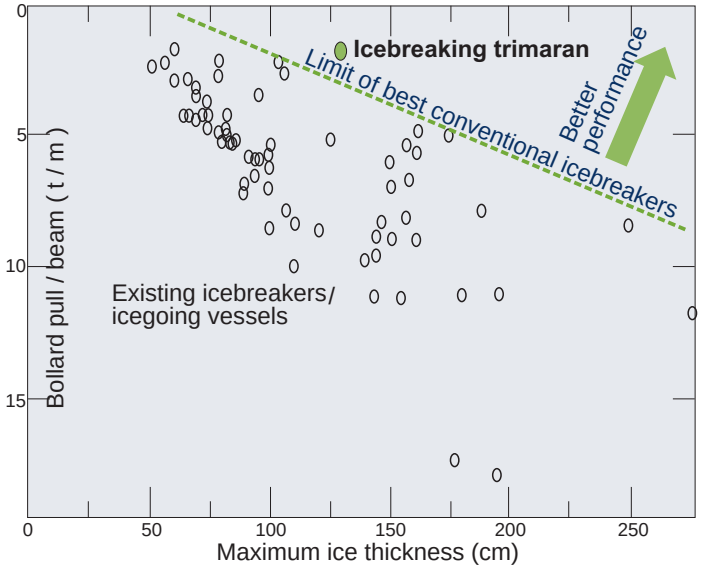
"The test went very well and results are promising. We will present the results in more detail in the next issue of Passion News, " Mr Valtonen promises.



A smaller sized trimaran harbour icebreaker is the latest addition to our icebreaking trimaran family.

Trimaran icebreaking capability

Level icebreaking capability



Tests showed that the trimaran breaks ice more efficiently than a conventional ship of the same width, because of the construction with a centre hull and two pontoons on the side.

The side hull encounters an ice field with micro cracks caused by the middle hull. These micro cracks work for breaking the ice between the hulls. Furthermore, the ice edge caused by the middle hull is freely supported whereupon the inner side of the bow of the side hull breaks the ice between the hulls with radial cracks using little energy. The outer side of the bow of the side hull breaks the ice traditionally with circumferential cracks, which often propagate all the way to the free edge caused by the middle hull.

The ice simulator offers an excellent tool for both planning and training operations in ice.

Ice simulator reduces risks

Requirements of safety and risk elimination are top priorities in the Arctic. With the new Aker Arctic developed ice simulator, operations in ice can be simulated and vessels' behaviour in ice can be practised in advance, which greatly reduces risks for accidents. It is also useful in the planning stage and therefore reduces investment risks for ship owners.

Aker Arctic's Ice simulator offers an excellent tool for simulation and training. It is based on the knowledge of ice we have gathered for decades in our database, made into a visually appealing program and installed at The Finnish Maritime Academy Aboa Mare in Turku. Aboa Mare has trained seafarers now for 200 years.

The ice simulator is in use on two of their ship bridges and they help students grasp what it really feels like navigating a vessel through ice. Individual vessel designs can be programmed into the simulator so that a new or planned vessel can be tested before it is constructed. The ice simulator is also sold separately for use at customers' own premises.

Both for planning and training

“The ice simulator is a tool that can be used in many stages of a vessel project. In the planning stage it can be used to test how a ship design will function in ice. A ship owner can also use it when planning operations. Before sending a fleet on a mission the situation can be simulated in order to evaluate e.g. how many ships will be needed. It can then be used to train the icebreaker crew or commercial ship crew," Project Manager Jorma Koponen explains.

The ice simulator now features icebreaking in different ice types, cutting a vessel loose from ice and propeller washing. It is constantly being improved and new features added. Next to come are close towing in ice, inclining effect of ships and maybe in the future, calculation models for e.g. fuel consumption, depending on the specific needs from customers.

"A practical example is for instance towing in ice, which is extremely challenging as the vessel being towed can push the assisting vessel into a difficult position against an ice ridge. With the simulator this can soon be practised, therefore substantially reducing risks when performing such an operation in a real-life situation," Mr Koponen adds.

Lower investment risk

"We can now offer our clients the entire package: from planning and designing to testing and training. And most of it can actually be done before constructing the vessel when plans can still be changed. This is a new possibility, which greatly reduces also the monetary risk of investments," Mr Koponen emphasises.

First feasibility study using ice simulator

We have recently done our first feasibility study for a customer who wanted to simulate how a planned port would function and how vessels would move in that port. Our customer was able to navigate a transportation vessel and an assisting icebreaker in different ice circumstances and in different wind conditions in order to see if plans would work as intended, or if there was a need for adjustments. The ice simulator was programmed to include exact designs of the port and the two vessels for an accurate simulation. The simulation took place in Turku at Aboa Mare's training premises last July.

"The customer was really happy with the possibility to have a full-mission simulator study to test the viability of the port design and find operational limits for the port and the vessel in year-round conditions. Later when the vessels are constructed, the crew can be trained using the same simulator," Mr Koponen tells.

Our customer used the ice simulator to navigate a transportation vessel and an assisting vessel in different ice and wind conditions in order to see if plans would work as intended or if there was a need for adjustments.

Safe winter navigation on the Baltic Sea

The European Union is funding a project called Winmos, where the plan is to develop safe winter navigation on the Baltic Sea. Our ice simulator is also being developed as part of this project, with an educational program jointly with Kalmar Maritime Academy. The Finnish Meteorological Institute is additionally planning an icebreaker plot, a situation awareness system, which would provide icebreakers with satellite images of ice-covered areas and show the vessels moving in that area for improved safety.

"The visual choices in our ice simulator are realistic and therefore it is easy to use and trust," Mr Koponen says.

“The cost for using the ice simulator is low in comparison with all the possibilities it offers in increased safety and preventing accidents in winter navigation.”

Aker Arctic Ice Simulator is shown at SMM Exhibition in Hamburg in September.

Meet Jorma Koponen

Jorma Koponen joined Aker Arctic last April and is responsible for developing the ice simulator and bringing it to the market.

He began his career building boats, proceeded to marketing and then studied to become a Captain at Aboa Mare in Turku. He transferred from Navis Engineering Oy, where he was selling DP units equipped with simulators. Being a captain himself, he says he can really understand the needs of ice-going vessels' skippers.

“Navigating in ice is a challenging situation for a captain, and the chance to practice in advance with the ice simulator is simply fantastic," he says.

Jorma spends his free time with his wife and two boys. He has a special hobby: orienteering with his six brothers.

New era in Antarctic vessels

Activities in Antarctica are limited to science only by the Antarctic Treaty for the next few decades. Still, Antarctica has gradually become an increasingly important research place, which has and will intensify permitted activities progressively. The available research vessels are getting older and there are more and more plans to upgrade or replace these vessels.

Antarctic operation, predominantly research, is not commercial business as such. However, where money is required, business elements are involved. The same cost and business elements are involved regardless of which kind of organisation operates and owns Antarctic vessels, whether it is government directly, a government-managed and -owned institute, or a private enterprise. Without exception, all countries are suffering from a lack of funding for Antarctic operations. Thus, there is tremendous pressure to deliver more in science for less money.

First-class technology

Aker Arctic can offer cost-competitive and technologically first-class products for Antarctic operations, and we have been involved in more than ten different vessels/projected vessels for Antarctica. With our experience in all kinds of demanding ice-going vessels, we can be considered an expert in vessels for commercial, support and research use.

Antarctic vessels are required to act both as cargo-carrying vessels, people-carrying vessels and ocean research platforms. An additional challenging feature is that the vessels have a long open water leg – very often in rough seas – and ice conditions can be very difficult when approaching the destination.

Generic concept for future vessels

Based on our understanding of future activities, the general level requirements for an Antarctic combination vessel serving average needs are outlined on the right. This can be used as the basis for developing a concept, which is optimised for desired technical functions and minimum costs.

Scientific laboratories: 250 m²
Science deck aft: 400 m² with A-frame and other "standard" equipment
Scientific personnel: about 30 people for ship-based research
50 passengers to be carried to and from the Antarctic bases
Dry cargo volume: 200 m³,800 tons
Liquid cargo in tanks: 800 tons
Maximum flexibility between scientific areas and dry cargo areas
Minimum crew
Maximum speed

in open water:	16 knots
optimum transit speed:	10–12 knots
Icebreaking capability	1.2 m

Endurance:
Europe to Antarctica at transit speed
60 days in Antarctica, 50%
of that time in ice
Over-wintering in case of emergency
Helicopter operations and helicopter base
Cargo handling:
Crane
Helicopter
Ice strengthening IA Super plus (PC 5 to 4), adjustment for differences in ice conditions between Antarctic waters and Baltic
Waste return capability
Top of the line environmental protection

The European polar research icebreaker Aurora Slim is a cost-effective and technically unique design developed, designed and tested by Aker Arctic.

From a technical point of view, an azimuthing propulsion system has benefits in manoeuvring capabilities and in vessel design, but the shaftline alternative is also a good choice if the vessel's operation profile allows it. Both can be combined with the double-acting concept, which we have developed, where a ship operates with a bulbous bow first in ice-free conditions and in very thin ice. In heavier ice, the ship operates in stern-first mode. The bulbous bow gives the ship significant advantages such as better fuel efficiency, better seakeeping characteristics and a better platform for equipment sensitive to hydrographical disturbances. It is to be noted that if ramming in heavy ice is expected, an icebreaking bow is justified.

Recent research vessel projects

The most recent research vessel projects we have been involved with are the Chinese polar research vessel, which is now being constructed in China, and the European polar research icebreaker Aurora Slim. S.A. Agulhas II is a South African icebreaking polar supply and research ship built in Finland in 2012, in which Aker Arctic had a strong design and development involvement. Other upcoming projects worldwide are from the UK, Australia, Argentina, Chile, Peru, Germany, India, Korea and Norway.

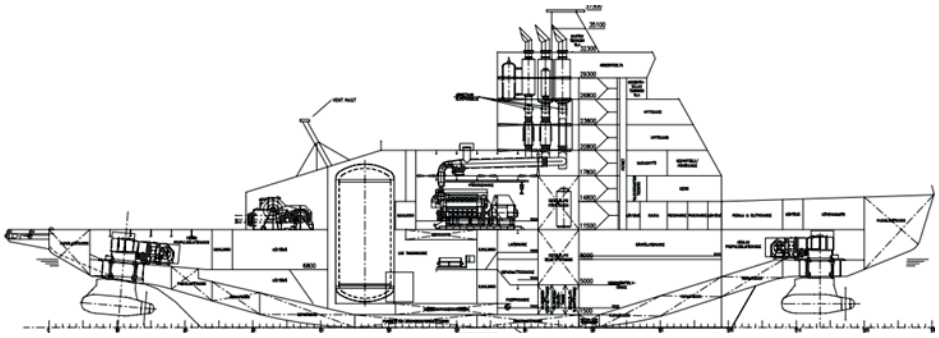
The advanced icebreaking research vessel we have designed for the Polar Research Institute of China will be used for polar oceans research mainly in Antarctica.

“The last boom in Antarctic research vessel projects was twenty years ago, so not many people remember all the issues from that time. Therefore, it is essential to choose a partner with the capability to advise and give input on the different options which are possible within the range of a given budget," Sales and Marketing Manager Arto Uuskallio emphasises.

"Researchers are naturally looking for the best technical equipment available, but this is not always possible with government-funded projects, where money is a limiting factor. We can help by providing options which will fulfil most researchers' needs, in addition to designing a top-of-the-line vessel." ■

LNG fuelled machinery is a clean option

The use of LNG (liquefied natural gas) fuel is currently growing at a rate of 7-8% per year. Tightening environmental regulations is one reason but also proven LNG technology, lower fuel costs and vast gas resources are other driving forces behind new investment decisions.



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

Using gas as fuel in ships is nothing new. Since the early 1970´s LNG carriers have used the natural boil-off from LNG cargo as secondary fuel while transporting LNG to the market. Primary fuel is HFO or intentionally vaporised LNG. Still, the majority of conventional LNG carriers are fitted with steam turbine machinery, which can easily utilise the energy from the boil-off gas evaporating from the LNG while keeping the cargo cold.

Dual fuel engine technology

Since the beginning of 2000, diesel-electric machinery with dual fuel engines has taken over and is the most common choice in new ships. These ships are equipped to use both LNG and fuel oil as the primary fuel option.

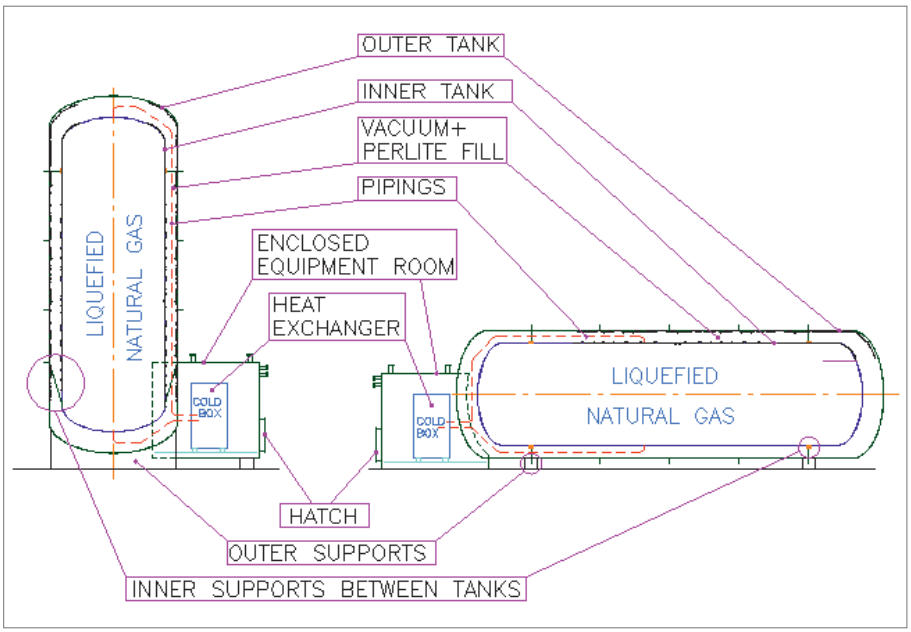
Gas engine technology has developed quickly, with Finnish company Wärtsilä Finland being a forerunner, and medium speed gas engines are now available in various sizes. Also, lean burn (gas only) type engines are on the market covering even the smallest engine range. Recently, large slow speed engines using either high pressure gas or lean gas have been introduced for marine use and have entered as rivals to medium speed gas engines.

"On the outside, dual-fuel engines look like ordinary oil-burning diesel engines. They are more expensive than ordinary diesel engines as they have two fuel systems. The change from one fuel to another can be done with the engine running and if a disturbance occurs in the gas fuel system or if the power rate gets too low for gas mode, the oil mode is switched on automatically. Dual-fuel engines develop about 10% less power than same sized oil-fired engines but their thermal efficiency in gas mode is slightly better," Mauri Lindholm, Principal Naval Architect at Aker Arctic Technology, explains.

Additional systems for gas-fuelled machinery are necessary. They include the LNG fuel tank with tank insulation, LNG vaporiser with heating system, gas fuel piping and ventilation of hazardous spaces. All these require space and add weight to the vessel. On the other hand, less equipment for fuel oil storage and use is needed.

"When liquefying natural gas, it shrinks to 1/600th of its original size. As a very light liquid, it still takes up more space than fuel oil with the same energy content. The storage tanks also need to have either an outer insulation, or a second enclosure with vacuum in-between the double structure for insulation and safety. A vaporiser unit is typically integrated in the LNG fuel tank.

Such a tank module is placed in a tank room – if the tank is placed inside a ship's hull. This means that storing LNG fuel may require more than three times the storage space compared to a fuel oil tank that can be constructed as a structural tank in a ship's hull. For ship designers this poses a challenge, as valuable space has to be used for fuel tanks. Also, when planning to modify existing vessels this is an important point to consider. One option is to position the storage tanks vertically to save space or, to place the gas fuel tanks on open deck – if the ship design allows," Mr Lindholm continues.



Vacuum insulated LNG fuel tank: Vertical and horizontal tank configuration (Aker Arctic).

Emission comparison

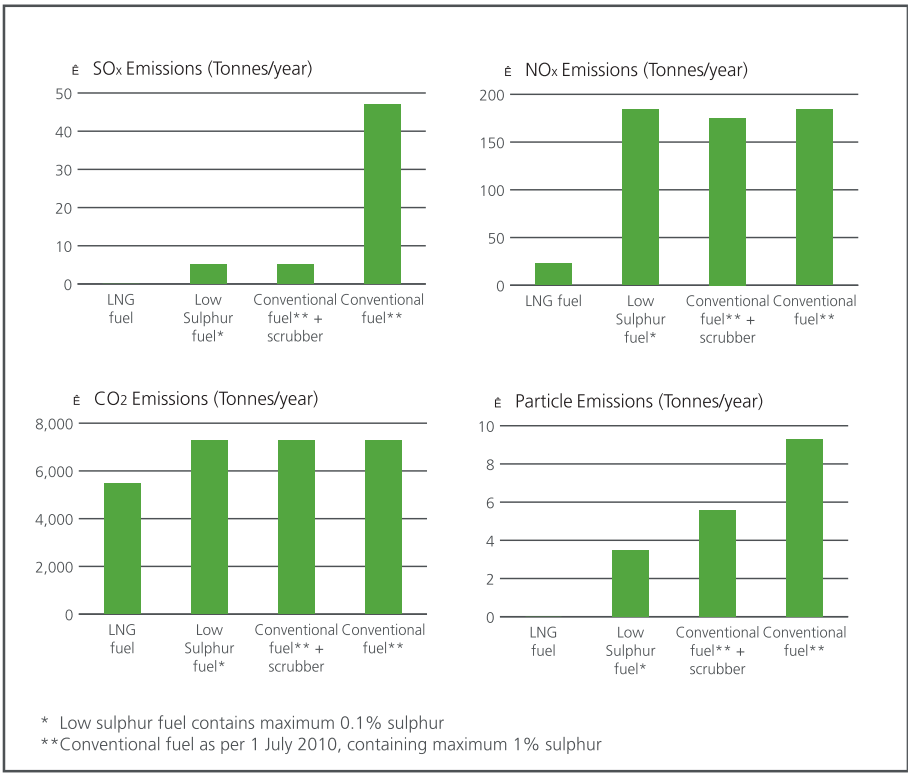
When burning LNG in combustion engines, a reduction of 80 to 90% of NOx emissions is achieved compared to fuel oils. LNG contains no sulphur and therefore a 100% reduction in SOx emissions as well as a 25 to 30% reduction in CO_2 is achieved. Particles like soot in exhaust gases are almost none and the smoke is invisible. There is less need for overhauling engines, lubrication oil purification or maintenance.

From 2015 onwards the Emission Control Areas (ECA) will have tighter emission regulations, and by using LNG fuel these are fulfilled and even surpassed. Older vessels can install scrubbers or use fuel with low sulphur content, but these actions may become expensive and do not reduce emissions to the same extent as LNG. Also, EEDI (Energy Efficiency Design Index) is expected to introduce more environmentally efficient ship designs.

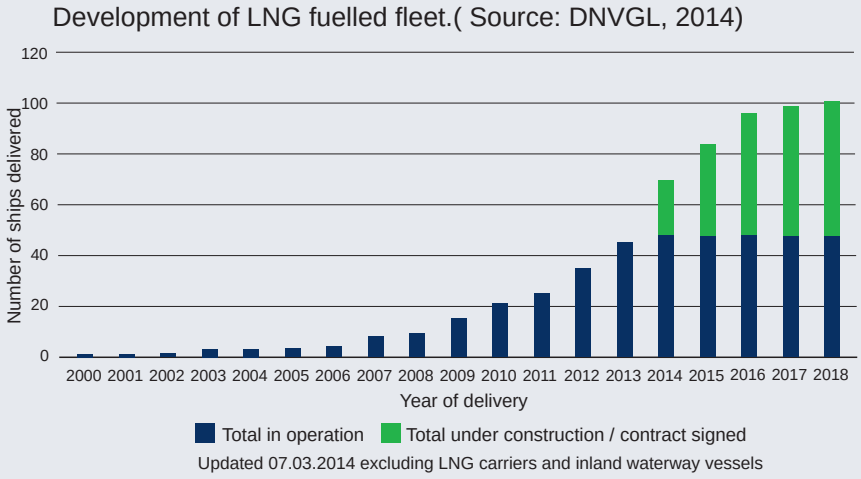
"Natural gas reserves are vast. Availability and distribution of LNG is improving all the time. LNG has become an everyday commodity with prices going down so that it can now be lower than that of HFO, therefore offering savings in fuel costs," Mr Lindholm adds.

Ships today and tomorrow

Today, there are proven gas engines of various sizes available. Apart from over 400 existing LNG tankers and 126 such ships on order, there are more than one hundred LNG fuelled ships around the world, many of them in Norway.
They comprise of offshore supply and service ships, patrol and coast guard ships, passenger and car ferries, smaller cargo ships, tankers, tugboats and river ships with more to come. According to future scenario reports, LNG will be the fuel of choice in 20 years' time. ►►



LNG is superb as cleaner fuel. A study of exhaust gas emissions of different fuel options (Source: DNV, Greener shipping in the Baltic Sea, 2010).



Development of LNG-fuelled fleet – excluding LNG carriers and inland waterway vessels (Source: DNV 2014)

The dual-fuelled offshore patrol vessel "Turva" for the Finnish Border Guard. The vessel was built by STX Finland in 2014. (Photo: Pentti Heikkilä)

"Viking Grace" receiving LNG fuel from a bunkering ship (Photo: Karl Gabor)

The new dual-fuelled icebreaker for the Finnish Transport Agency. The vessel is under construction at Arctech Helsinki shipyard and is due service at beginning of 2016. (Picture: Aker Arctic)

"The technology is available and a well-functioning solution can be designed for any ship type according to its needs. Ice-going vessels, especially icebreakers, that are exposed to fast power variations were initially a challenge, but this is not the case anymore as solutions to this operation have been developed," Mr Lindholm emphasises.

Finland will soon have three LNG fuelled vessels. The first one, introduced 2013, was the car passenger ferry *"Viking Grace"*, which became the first of her kind and today uses solely LNG fuel although she has dual-fuel machinery. The second is the patrol and coast guard vessel *"Turva"* for the Finnish Border Guard; Aker Arctic had a key role in its design developing the hull form, the machinery concept as well as performing the model tests. The third vessel is the new icebreaker for the Finnish Transport Agency now being built, which will be the first LNG-fuelled icebreaker in the world. Aker Arctic in cooperation with ILS and the Finnish Transport Agency have developed the vessel, made the conceptual design and related model testing of the ship.

Challenges with LNG

LNG is natural gas in liquefied form with a temperature of -160°C. It is a colourless, odourless, non-toxic, non-corrosive gas and its main component is methane, a greenhouse gas with lower CO_2 emissions compared to other fossil fuels. It is flammable, but its self-ignition temperature is high. The main risks are therefore fire, cold burns or leakage. With good design and operating principles adopted from gas carriers these risks can be minimised and an equivalent level of safety as with fuel oil is achieved by using the IMO Guidelines as a baseline standard. Adequate training is also essential.

The main challenge currently is the availability of LNG, but infrastructure for its supply and distribution is being planned in the Baltic Sea area and increasingly also elsewhere.
"The use of natural gas as a fuel is a promising and safe option that complies with upcoming air emission limitations and thereby preserves our environment for future generations. In many recent and on-going projects we are involved in, the LNG fuel option has been taken into consideration," Mr Lindholm concludes.

LNG fuel can with today's technology also be used for ice-going vessels and icebreakers, which are exposed to fast power variations.

Meet Mauri Lindholm

Mauri Lindholm has worked in shipbuilding and design for 34 years. He lives and works in Turku starting his career as Naval Architect at Turku Shipyard, which has changed owner and name several times since.

In 2005, he joined Aker Arctic Technology. Mauri usually works with conceptual ship designs and feasibility studies. He works closely, in addition to clients and colleagues at Aker Arctic, with cooperation partners of whom many are located in Turku. He is our LNG expert.

In his free time he enjoys sailing in the Turku archipelago, cooking and gardening with his wife and children.

Optimised friction saves money and environment

The hull of an ice-going vessel needs a protective layer for two reasons. Firstly to prevent corrosion and secondly to make the hull smooth, so that friction is minimised. We have recently tested new options for hull protection.

About 20-30% of vessels resistance in ice comes from friction between hull and the ice. The smoother the hull is, the less friction is evident, which saves both money and is ecologically important as fuel consumption is highly related to friction. A corroded vessel has the most friction in ice. In difficult conditions, the difference between high- and low-friction coatings can be the difference between making progress and getting stuck.

Different options

For the past twenty years, epoxy-based paints have been widely used for hull protection as they offer low friction and good durability for ice navigation. Usually some touch-up painting is done when ships come into dry-dock every five years.

Another option is attaching a compound layer of stainless steel to the ice-belt region of the hull.

"Technically this is a good alternative, but unfortunately it is also expensive. However, in all newer Finnish icebreakers this protective layer has been chosen and experiences have been good," tells Structural Engineer Ville Valtonen.

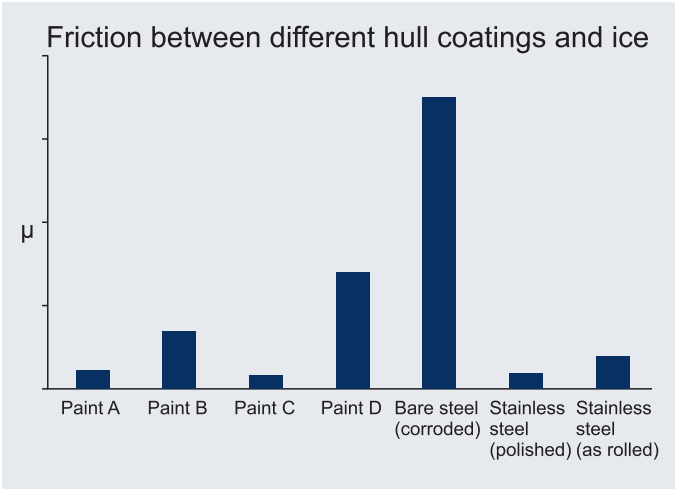
On a theoretical level, concepts of making ship hulls of stainless steel or aluminium have been discussed, but none of these have been tested, as stainless steel is expensive and the strength of an aluminium hull in ice navigation has not been thoroughly researched.

Recently, new paints for icebreaking hulls have entered the market. Some of these new paints differ from the traditional epoxies and have a good strength. However, it is essential to test the friction before starting to use these new paints.

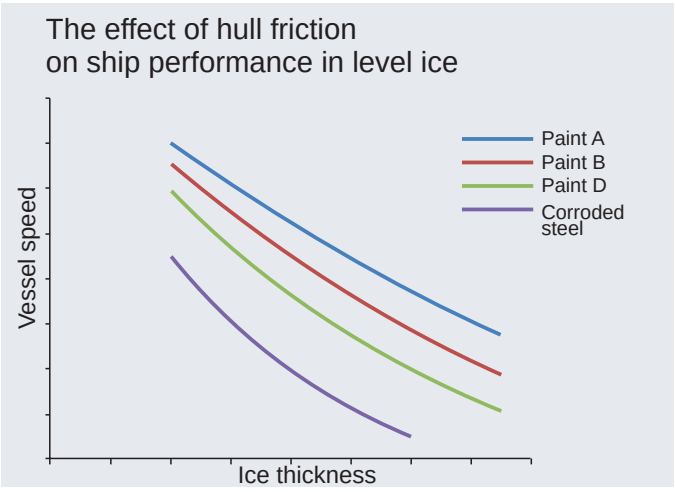
Friction testing for ice vessels

"We have now tested some new paints with our friction-testing machine, which we use to test the friction between ice and hull coatings in wet contact, which is the most relevant condition for icebreaker paints. The testing machine has been developed specially for the job and ice friction has been tested with it already for decades. Comparisons of results with full-scale measurements have shown that the lab results are reliable," Mr Valtonen assures.

“Results from our recent tests are confidential but it is important to note that there are substantial differences between paints and therefore it is essential to carry out tests before starting to use something new. Otherwise, unpleasant surprises in ice resistance and consequently in fuel consumption may arise."



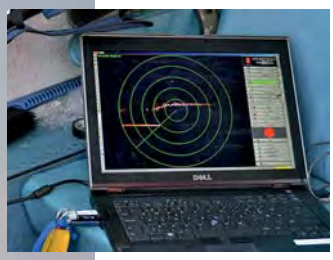
This picture clearly shows the impact on friction between different hull coatings.



Hull friction affects a ship's performance in ice. The more friction, the more fuel is needed, which is both expensive and ecologically harmful.

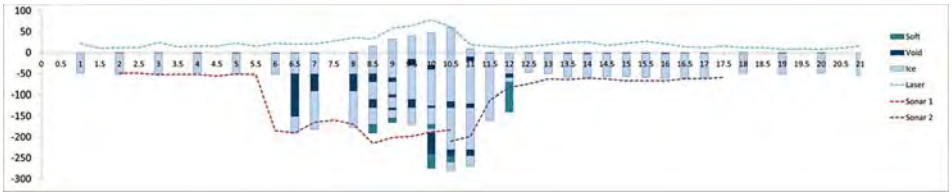
New methods for measuring ice ridges

Sea ice ridges are challenging for winter navigation and offshore activities in ice covered seas since pressure ridges may become ten times thicker than the initial level ice. Traditional measuring methods are time consuming and Aker Arctic has now tried a new faster method together with Meritaito in a project funded by the Winter Navigation Research Board.



Sonar scanner plot gives instant information during the measurement.

Lowering of sonar scanner under the level ice in front of the ice ridge.



Results from drilling (bars), laser (top surface, blue dashed line) and sonar (bottom surface, red and purple dashed line). Profiling of ice ridge no 1.

Ice ridges are formed under high compression due to wind or currents. In the Baltic Sea, the usual thickness is around 10-15 metres, but in the Arctic Ocean, the maximum recorded keel depth is over 45 metres. Usually the cross-section of a pressure ridge keel has a triangular shape with most of the thickness submerged. Therefore a reliable estimate of the thickness and width based on the visible part cannot be made making measurements of the submerged area necessary. Traditionally, measurements are made by drilling holes in the ridge. This method is both arduous and time consuming and thus new quicker methods for profiling and measurements would be beneficial.

Laser and sonar scanning

Aker Arctic has in cooperation with Meritaito carried out a field measurement research project, with the goal being to test and evaluate the applicability of a new method for profiling ice formations and brash ice channels. This new method combines scanning with laser and sonar instruments. Laser scanning is regularly used for measuring the top surface and has shown to give accurate results. Different sonar techniques have previously been used for detecting the underwater portion of the ice cover and for ice ridge measurement, but they have proven time consuming to analyse due to multiple reflections of sound pulses and noise. In this study, a single beam scanning sonar was used and the results were compared with measurements made by traditional drilling in order to evaluate the feasibility of the scanning method.

“All data was collected during a field trip to the Bay of Bothnia last February. One ice ridge was first measured with traditional drilling. It was conducted along the transverse line of the ridge in order to gain a cross-sectional profile," tells Ice Physicist Annu Oikkonen.

"Secondly, the ice ridge was measured by sonar scanning. A hole was drilled in the level ice on both sides of the ridge and the sonar lowered into the water first on one side of the ridge and then on the other side in order to get data of both sides. The sonar scanner plot immediately started to report data and the cross section profile was shown. In the drilling method more drill holes are required, which takes time."

"Another ice ridge was then measured with scanning first and then drilling, after which a comparison of the measurement results from drilling, sonar and laser scanning was made. Overall, the results are fairly compatible. The most prominent difference between drilling and sonar scanning results can be seen in the area where the deepest keel was recorded (figure 3) at the location of 10-11 m in the measurement line. The discrepancy between the two methods may result from the drilling causing changes in the shape of the keel. Another important finding was the ice drilling result at the location 6.5 m. The drilling result was recorded as level ice with a thickness of 50 cm. Later, sonar scanning showed ice at a depth of nearly 2 metres in the same location. Ice drilling results were then checked with a longer drill and the sonar recording was verified. The explanation for this is that drills used for thick ice ridges contain several extensions, which are added one by one as drilling progresses. Ice ridges consist of ice blocks and voids, and the general practice is to stop drilling when water is encountered for more than one metre. Therefore drilling may sometimes lead to an underestimation of the total thickness if an empty space is mistaken for the bottom of the ice formation."

Conclusions

In general, the results from scanning and drilling methods correspond. A clear advantage of the new scanning method is the shorter measurement time and an instant overview of the ice formation. The sonar also captured ice blocks underneath the level ice, which were not observed in ice drilling. Scanning with laser and sonar determines more clearly the location of top and bottom surface of the ice ridge.

The advantage of ice drilling is the information gained about the internal structure of an ice ridge.

"For a research trip it would be beneficial to use both methods in gathering ice data. There is much potential in the new method and further research should be made, especially for measuring brash ice channels. We will continue our cooperation with Meritaito in this area," Ms Oikkonen assures.

9th Arctic Passion Seminar

The ice model demonstration test showed Aker Arctic's design of an Arctic heavy module carrier for Yamal LNG.

Undersecretary of State Mr Matti Anttonen gave the opening speech, where he emphasised the importance of the Arctic.

Doctor Kaj Riska and Mr James Bond enjoying the coffee break.

The annual Aker Arctic Passion Seminar gathers every March the key persons working in the maritime business from all over the world in Helsinki. One of this year's highlights was the introduction of Aker Arctic's new Managing Director Reko-Antti Suojanen, along with an update on current projects and topics in Arctic maritime business.

Mr Reko-Antti Suojanen, Aker Arctic's new Managing Director taking over from Mr Mikko Niini, reviewed Aker Arctic's last year and future plans. Mr Ole Johansson, newly appointed Chairman of the Board, shortly addressed Aker Arctic's ownership changes. After this Mr Matti Anttonen, Undersecretary of State for External Economic Relations, Ministry for Foreign Affairs of Finland, opened the day by talking about importance of arctic development.

Mr Mikko Niini gave the first keynote speech about past ideas and innovations and their role in technological steps taken in Arctic development.

Then followed Dr Mikhail Grigoriev, GECON, giving an account of the current status of realised and planned Oil & Gas projects on the Russian Arctic Offshore.

The Italian Ambassador in Finland, Mr Giorgio Visetti continued by presenting Italy's cooperation with Finland in Arctic developments.

IMO's Polar Code and its implications for Ship Design and operations were discussed by Mr Andrew Kendrick, Vice President, Operations, STX Marine.

Ice model testing is one of the services provided by Aker Arctic. Mr Reko-Antti Suojanen introduced how it works and a demonstration ice model test was held for all participants.

DNVGL has made a concept study on Arctic shipping in 2030. Mr Jan Kvålsvold, Director, Global Business Development talked about what they believe Arctic Shipping will look like in the future.

He was followed by Mr Kaj Riska, Ice Engineer, Total E&P/North Caspian Operating Company, telling about the development of the Kalamkas field, with particular emphasis on ice questions.
Mr Kari Laukia, Design Manager, Aker Arctic Technology, then presented the Canadian Coast Guard Polar Icebreaker Shaftline Analysis.

The day was concluded with two presentations: development for the people of the North was discussed by Canadian Trade Commissioner Seppo Vihersaari from the Embassy of Canada to Finland, and then the new icebreaker for the Finnish Government was introduced by Captain Jarkko Toivola, Head of Winter Navigation Unit at the Finnish Transport Agency.

All presentations can be found on our website www.akerarctic.com.

Mr Ole Johansson, newly appointed Chairman of the Board discussing with new Managing Director Mr Reko-Antti Suojanen.

Retired Managing Director Mr Mikko Niini, Professor Jukka Tuhkuri and Mr Tommi Viherkoski sharing views on the Arctic technology.

Ice trials of IBS Vitus Bering last winter

Photo: Arctech Helsinki Shipyard

Topi Leiviskä, Jukka-Pekka Sallinen and Teemu Heinonen joined *IBS Vitus Bering* on her regular supply trip between Sakhalin Island and Orlan oil platform on Sea of Okhotsk last winter. The purpose of the trip was to verify the performance of the icebreaking vessel. The tests were conducted during the vessel's normal operations, which is a cost effective way but may result in challenges in finding good ice conditions for the testing as the vessel is not free to sail searching for ice.

"Her operational capability in ice was verified to meet the requirements and she performed all planned tasks successfully on the area of operations. *IBS Vitus Bering* is an offshore supply and standby vessel and works most of the time in broken ice," says Topi Leiviskä, Manager of Research and Testing services.

The vessel was constructed at Arctech Helsinki Shipyard and delivery took place in December 2012.

Trials were conducted in winter 2014 and give us once more an important reference and the possibility to verify full-scale measurements against the model test results.

Oblique icebreaker exceeds expectations

The first Oblique icebreaker ever built was delivered to the ship operator Gosmorspassluzhba (Russian Marine Emergency Rescue Service) in May 2014.

Baltika was tested in extreme conditions with 3 metres wave height in the Gulf of Finland last spring before delivery. The open water testing surpassed all expectations.

"All the requirements were met or exceeded greatly and also the movement in high waves was a pleasant surprise," Chief Designer Mika Hovilainen says. The ice cover was not thick enough for proper testing of the oblique icebreaking mode so full ice testing is scheduled for next winter.

"We have instrumented the vessel hull for full-scale measurements. The intention is to perform long-term measurement over several years, which will provide valuable information on the design loads. This will increase the understanding of the behaviour of this unique concept. The measured data will be utilised in the design of the Heavy-duty Oblique icebreaker for arctic use more in detail," Mr Hovilainen adds.

Team Arctic Finland creates business opportunities for Finnish companies

Team Arctic Finland is a new cooperation model focusing on creating new business opportunities in the Arctic market for Finnish companies. The program consists of 14 large companies and is coordinated by the Federation of Finnish Technology Industries. At the moment, Team Arctic is developing concrete concepts and international market initiatives that will be used to approach international investors and corporations responsible for Arctic projects. According to studies, the total value of the Arctic market from now until the year 2020 is approximately 240 billion euros.

“The Arctic region will need a wide variety of services and solutions in addition to traditional transport and ice-breaking services," says the program's leader Merja Salmi-Lindgren from the Federation of Finnish Technology Industries.

The companies in Team Arctic have technologies, expertise and references from Arctic business ventures. Therefore, Team Arctic gathers a cluster of reliable Finnish companies that can put together large concepts, provide services to big international clients and get challenging commissions in the Arctic region, taking into account the requirements of sustainable development.

Team Arctic consists of the Federation of Finnish Technology Industries, Gaia Consulting, Aker Arctic Technology, Arctia Shipping, Boskalis-Terramare, ESL Shipping, Fortum, the Finnish Meteorological Institute, Konecranes, Lamor, Pemamek, Rolls-Royce Marine, Rautaruukki, STX Cabins Finland, STX Finland and Technip Offshore Finland.

First LNG-fuelled icebreaker Aker Arc 130 under construction

The world's first LNG-fuelled icebreaker, designed by Aker Arctic, is now under construction at Arctech Helsinki Shipyard for the Finnish Transport Agency.

We are actively involved in the building process together with the owner and the shipyard. According to the schedule, delivery is planned for winter 2016.

Cooperation with Aalto University

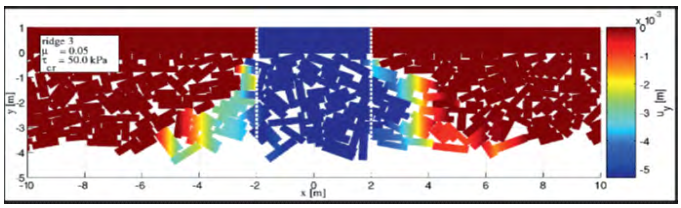
Aker Arctic works actively together with research organisations. One of its closest partners locally is Aalto University.

"Aalto University is world-renowned for developing the Discrete Element Method (DEM) and Finite Element Method (FEM) to model ice behaviour in nature. With DEM and FEM analysis, the effect of different variables on ice interaction with marine structures, for instance, can be studied effectively. We are promoting this scientific development work and investigating possibilities to combine ice model testing with these analyses in order to provide added value for our customers in the future,"

Project Manager Sami Saarinen says.

Additionally, there are new plans for cooperation with the model testing facility at Aalto University.

"Model testing in our own basin is very popular and we can see benefits of combining the strengths of both basins. Aalto University in Otaniemi has an ice model-testing basin, which is large and square in shape. This combination will provide great possibilities to serve our clients with more capability and unique tests, for example manoeuvring, ice management tests and other operational testing," Topi Leiviskä, Manager for Research and Testing service, adds.



Example of DEM/FEM simulation showing deformation patterns of an ice ridge in a punch-through test. Photo: Arttu Polojärvi, Aalto University

Chinese polar research icebreaker advances

The new highly advanced polar research icebreaker for the Polar Research Institute of China has now reached the basic design stage.

The conceptual design and ice model tests were completed last year and the details of the functional requirements have been fine-tuned.

The vessel is intended mainly for research and logistics tasks in Antarctica, where China has three permanent research stations.

"The next step is to choose the main equipment suppliers for the main engines, electric propulsion and automation system, and then the basic design process can be completed," Project and Design Manager Kari Laukia says.

Customer relationship training graduation

As part of our new employee training, a six-month customer relationship- training programme was arranged together with Mercuri. After successfully completing the programme, a graduation ceremony was held in August.

In total, twelve employees have been participating in the training programme for the past six months. Sessions have been held once a month, which have included both theory and practical exercises.

"A special focus has been on how to create trust in a customer relationship, how to deepen a customer relationship more towards partnership, and how to package our know-how to best support our clients' needs. An important element has also been how to take corrective action if something goes wrong in a project," Sales and Marketing Manager Arto Uuskallio explains.

Positive feedback

Participants have been positive about the training programme.

"In the beginning I was a bit sceptical, but as the programme moved on, I noticed how I could use the acquired knowledge in practice. All in all, I found the training both interesting and useful," Project Engineer Tuomas Romu recalls.

"Prior to the training I had not worked much in sales, so I found particularly useful the customer interface training and learning how I can support sales in my role as a project engineer. I believe this will help me in my future tasks."

According to Anders Mård, Project Engineer and responsible for IT, the program was great and the topics were important, especially all the subjects related to sales, supporting sales, negotiation procedures and customer relations. "Many examples were practical and from the shipbuilding industry, which taught us things useful in our daily work. It was also good to learn how satisfied Aker Arctic's customers are with our achievements."

Exercising together is fun

Last August, Aker Arctic Technology's staff enjoyed a day of sports and fun together in sunny Helsinki.

The day began with a healthy breakfast, as our coach for the day gave us a lecture about how to move and exercise and take care of our physical condition. Then we all went for a two-hour Nordic walking tour by the seaside in beautiful weather. Nordic walking is a sport, which has gained in popularity during the last ten years, as it is suitable for persons of all ages. Rapid walking with sticks in the hands exercises the entire body, and the outdoor activity increases oxygen intake and relaxes the mind.

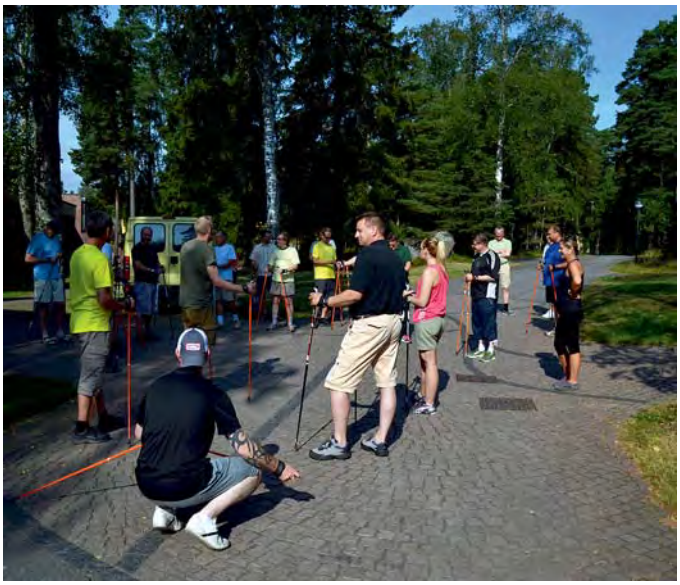
After lunch and a lecture about business dress, we could choose either kayaking around the nearby islands or a round of crazy golf.

The latter was a playful golf tournament suitable even for beginners.

The sporting activities ended with a game of FastScoop where the design team took on the other staff. The design team won the game.

No Finnish summer event is complete without a sauna, which felt wonderful in order to relax the muscles and calm down after the sports and games.

We ended the day with a barbeque dinner and celebrated Mr Kauno Sarkkinen, who recently reached the age of 60!



Aker Arctic staff ready for a Nordic walking tour by the seaside.

Kayaking around nearby islands was a beautiful experience.

FastScoop was a new game for many of us.

Kauno Sarkkinen enjoying the sunshine.

Meet us here!

We will participate in the following events:

SMM Hamburg
9-12 September 2014

Arctic Shipping North America
St. Johns 20-21 October 2014

Sakhalin Oil and Gas
Jusno, Sakhalin
24-26 September 2014

Russia Offshore Moscow
17-20 February 2015

Arctic Passion Seminar
Helsinki, March 2015

ATC Copenhagen
23-25 March 2015

OTC Houston
4-7 May 2015

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