New energy-efficient icebreaker for the Baltic Sea



The Swedish Maritime Administration and the Finnish Transport Infrastructure Agency launched a joint project with Aker Arctic last year, aiming to develop an icebreaker concept with lower environmental impact for the Baltic Sea, as well as an ability to escort wider ships.

The size of merchant vessels entering the Finnish and Swedish ports is growing. At the same time, more stringent environmental requirements gradually limit the engine power of the ships. These combined factors weaken the vessels' ability to navigate through ice. The next generation of icebreakers will hence have to be able to break a channel as wide as 32 metres to more effectively assist the future merchant fleet.

"For the Baltic Sea, this is an entirely new size of icebreaker," says Project Manager Maximilian Vocke. "Current icebreakers break channels with a width of around 25 metres."

Fossil-free fuel

As winters are getting warmer, the ice moves around more, increasing the amount of pack ice and ridges in the Bay of Bothnia. Therefore, the new icebreaker will also be efficient for tackling these demanding conditions.

The biggest challenge in the design work is the requirement for lower environmental impact. Compared to the Atle/ Urho-class, which it



The Atle/ Urho-class icebreakers have successfully kept sea channels and Baltic ports open for merchant vessels during winters for more than fifty years. They are now nearing the end of their operational lifetime.

is replacing, the greenhouse gas emissions should be reduced by 70%, and the icebreaker has to be able to use at least one fossil-free fuel.

"To reach this goal calls for innovations, some of which we don't even know yet," Vocke underlines.

In-depth analysis before selection

The project advances in two phases, of which the first is now almost concluded.

The Swedish Maritime Administration prepared four different propulsion concepts that Aker Arctic then evaluated. These included an in-depth feasibility study, identification of applicable regulations, class notations and completion of a number of studies.

Aker Arctic prepared a concept design for all propulsion concepts to evaluate the technical feasibility of each solution. Three of the four concepts were tested in model scale in ice at Aker Arctic's own ice basin in Finland, and in open water at SSPA in Sweden. Based on these results and other calculations, Aker Arctic carries out lifetime cycle cost (LCC) and life cycle assessment (LCA) analyses, evaluating construction and lifetime costs, as well as environmental impact.

"Once the final concept is chosen, we will continue to develop the design, including the tender specification, which will be used for construction proposals from shipyards. This will include further technical development and verifying model tests with the chosen design," Vocke explains.

Joint development project

Tender requests for the new icebreakers will likely go out to shipyards later this year and construction contracts are aimed for 2022, although no decisions on construction have yet been made. The current Swedish icebreakers are approaching the end of their operational lifetime, as well as some of the Finnish fleet, and need replacing soon.

The Finnish Transport Infrastructure Agency partnered the Swedish Maritime Administration in the development work in March 2020.

Finland and Sweden have cooperated in icebreaker acquisitions before with successful results. In the 1970s, when the Atle/ Urho-class was developed, the two countries engaged in a similar collaboration.

Four propulsion concepts

The in-depth studies comprised four different propulsion concepts, three of which were tested in Aker Arctic's ice model basin over seven weeks:

1. A reference vessel, a 32-metre-beam icebreaker, equipped with two forward straight shafts and two aft straight shafts with rudders, similar to the Atle/ Urho-class.

2. An icebreaker equipped with two straight shafts forward and two straight shafts aft with rudders as in #1, but with the 32 m channel width to be created by other means.

3. An icebreaker equipped with one azimuth propulsion unit forward and two azimuth propulsion units aft. This is the same propulsion concept as the latest Finnish icebreaker *Polaris*.

4. An icebreaker equipped with two straight shafts forward and two azimuthing propulsion units aft, combining the propulsion solutions from #2 and #3.

Inventions to reduce emissions

To reach the goal of reduced emissions, new technologies will need to be implemented.

"These can include new hull forms, engine technology, and emission treatment systems, to mention a few possibilities," Vocke says.

Additionally, Sweden has a target of fossil-free shipping by 2030. The demand is that the icebreaker will use fossil-free fuel by then. This technology is only in development stages right now. LNG, which the Finnish icebreaker *Polaris* uses, is not fossil-free, although emissions are lower than those of marine diesel oil, and therefore other options are needed.

"Alternative fuel engines are being developed and we are in close dialogue with engine manufacturers. For instance, hydrogen, ammonia or methanol are being investigated in addition to super capacitors and battery technology," Vocke explains.

New engine technology

The new icebreaker will be designed with the new engine technology integrated so that it can take fossil-free fuel into use either directly, when it is available, or following a retro-fit.

Energy density in different fuels vary substantially, which affects the size of fuel tanks. This also has to be taken into account already in the design stage.

"For example, methanol requires almost triple the tank size compared to marine diesel oil. If the operational endurance is required to be the same, the larger tank sizes have to be included in the design already from the beginning. Alternatively, the autonomy time is cut shorter," says Vocke.

Innovating totally new concepts and solutions is one of Aker Arctic's strengths and trademarks.

"This project is definitely an intriguing challenge, where we are looking well into the future and inventing new ways to do things."

Suom

Finland's newest icebreaker Polaris was delivered in 2016 and incorporated the latest technologies available for lowering emissions. The new icebreaker being planned will go even further with a fossil-free target by 2030.