Challenges and demands of Arctic tanker designs

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

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

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

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

Ice conditions determine hull form

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

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

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

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

Restrictions on hull

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

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

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

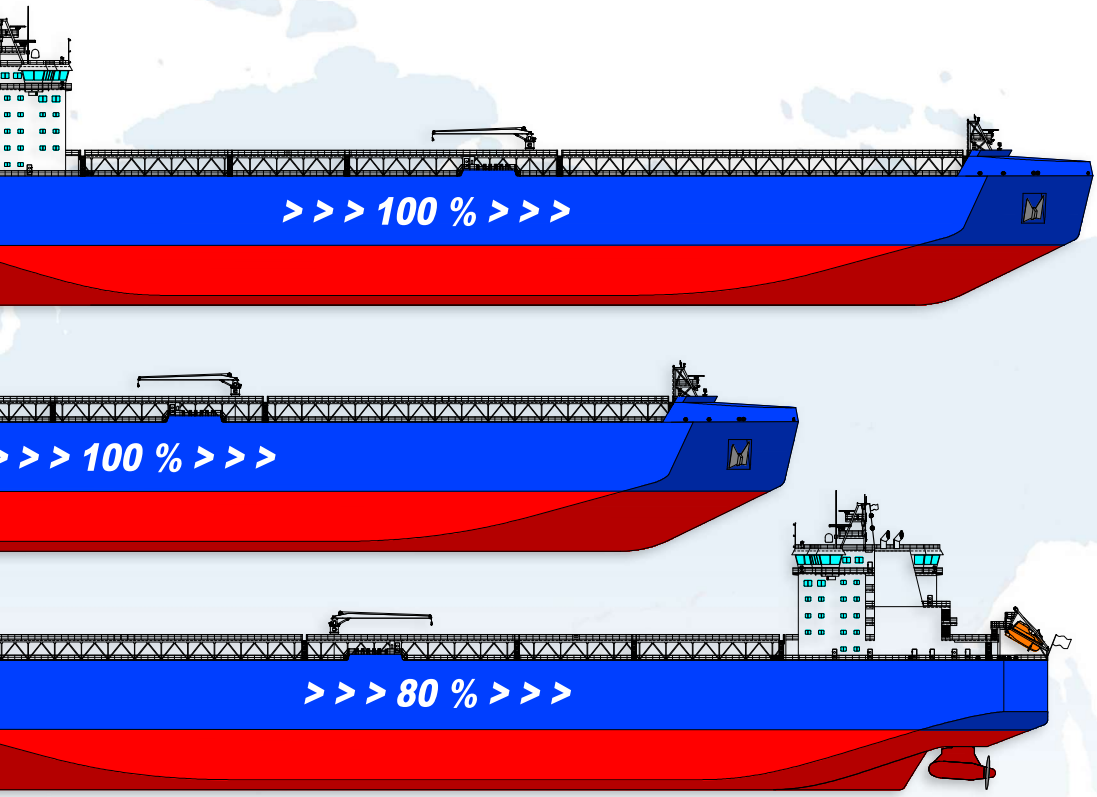
"This means that a standard design cannot necessarily be used," Mattsson highlights.

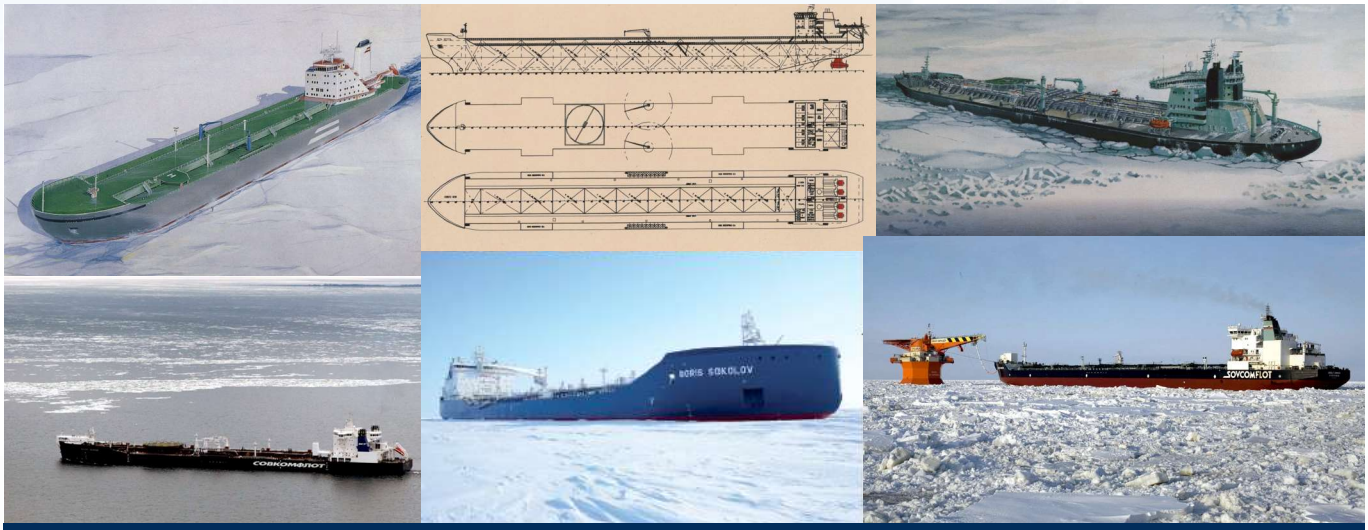
Classification societies and national administrations have various restrictions which affect both hull form and propulsion. The Russian Maritime Register of Shipping would, for example, previously not have allowed a bulbous bow, but a recent rule update has changed this. It is therefore important to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

High ice class and propulsion

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

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





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

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

Choice of propulsion

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

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

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

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

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

Operational reliability

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

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

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

"Everything needs to be in balance."

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

Training is essential

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

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

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

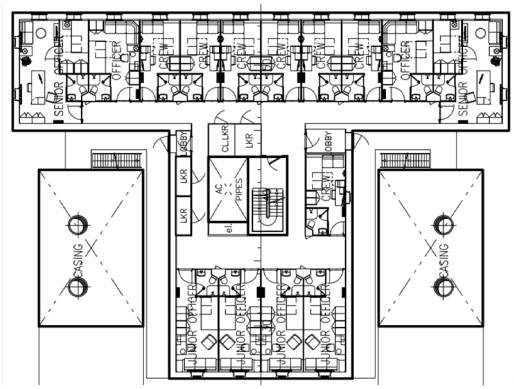
Design for purpose

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

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

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

General arrangements



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

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

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

Lars Lönnberg, Chief Designer