Arctic semi-submersible transport vessel developed

Two new Arctic semi-submersible heavy transport vessel concepts of ice classes Arc5 and Arc7 have been developed recently. They are designed to operate independently or with icebreaker assistance. Bow form, stability, propulsion options and dual-fuelling have been part of the research.

Aker Arctic conducted the feasibility study in co-operation with JSC Atomenergo and developed the Arc5 and Arc7 ice classed Arctic semi-submersible heavy transport vessel (SSHTV) concept designs for JSC Atomenergomash (AEM).

Focus on bow geometry

The Arc5 SSHTV is designed to operate independently in open floating first-year ice and with icebreaker escort in more challenging ice conditions.

The bow geometry incorporates Aker Arctic's latest research and development work related to escorting large vessels with icebreakers that have a smaller beam than the following cargo ship. This allows efficient escort operations, not only with the huge LK-120 type (Project 10510 "Leader"), but also with the big LK-60 type (Project 22220) icebreakers that will be built in greater numbers.

Arc7 independent operations

The Arc7 SSHTV is designed to operate independently in challenging ice conditions including up to 1.4 m-thick close floating first-year ice (essentially unbroken level ice) without icebreaker escort. For this purpose, the second concept features a flared icebreaking bow which incorporates operational experience from the existing heavy transport vessels *Audax* and *Pugnax*, designed earlier by Aker Arctic.

Both Arc5 and Arc7 SSHTVs represent the contemporary type with a raised forecastle, open aft cargo deck, and detachable buoyancy casings. The removable buoyancy casings increase the vessels' flexibility and allow the transporting of modular cargo without submerging the SSHTV for loading and unloading.

Propulsion options

While the feasibility study showed that both shaft line and azimuthing propulsion are suitable for both vessel concepts, the Arc5 SSHTV was developed with twin shaft lines and rudders while the Arc7 SSHTV features two azimuthing propulsion units.

In both cases, the propulsion system is diesel-electric with the power plant located in the forward part of the vessel. Additional transverse thrusters are fitted to provide IMO Class 2-level dynamic positioning capability.

Ballast water arrangement

During the development of the concepts, significant effort was put into developing a ballast water tank arrangement. In addition to providing the ability to submerge the vessel to the desired depth, the ballast water system must be capable of maintaining the vessel on an even keel with no heel in all intermediate and final floating positions, as well as provide sufficient stability during cargo loading and unloading operations.

Both SSHTVs are designed to operate in cold ambient temperatures.

Tank heating is not necessary, but the energy need must be minimized when the vessel is transiting in ballast.

Ensuring stability

One of the principal challenges in the development of SSHTV designs is to ensure sufficient stability during cargo loading and unloading operations. The critical phase of such operation is the moment when the cargo deck submerges into or emerges from the water, resulting in a sudden significant change in a vessel's waterplane geometry and stability characteristics.

"In order to evaluate the extent of the stability challenge, we investigated several types of theoretical cargo geometries. The analysis gave an insight into cargo handling limits and defined the maximum allowed vertical centre of gravity above cargo deck as a function of cargo weight and dimensions," says Head of Ship Design Mika Hovilainen.

Dual-fuel is possible

The feasibility of using a dual-fuel power plant in the SSHTV was also evaluated.

Liquefied natural gas (LNG) has a number of advantages over traditional marine fuels such as heavy fuel oil and marine diesel oil. In addition to lower emissions and reduced risk to the environment, LNG is produced locally and therefore ready-to-use in the Russian Arctic.

It was found that in a semi-submersible vessel the only technically feasible location for the LNG fuel tank would be above the maximum submerged waterline where the low-density liquid would not require additional ballast to offset its buoyancy. Alternative locations were also considered with the conclusion that both designs can be modified to use LNG as primary fuel. The vessels may become the world's first LNG powered semi-submersible transport vessels.

Operations in the Arctic

"Through the feasibility study, we identified the major challenges and potential issues related to adapting this specialized ship type for operation in ice-covered waters," says Naval Architect Tuomas Romu.

The study concluded with proposing technical solutions for future successful construction and operation of semi-submersible heavy transport vessels in the Arctic, as well as identifying issues that should be investigated in further development stages to ensure safe operation in extreme conditions.

"The design of the Arctic SSHTV is unique and it was a challenging project, especially considering the dual-fuel concept. However, these kinds of innovative projects are Aker Arctic's specialty, and with the accumulated competence and experience, we are happy to solve challenges and help our clients," says Project Manager Alexey Dudal.

Transportation vessels are needed

Steady development of hydrocarbon production in the Russian Arctic and active new projects in the Arctic demand vessels for the transportation of heavy modules and other oversized cargo. Presently, there is not a single Russian shipping company operating heavy transportation vessels, thus creating significant risks for proper project execution.

JSC Atomenergomash (AEM) had the task to develop a new cutting-edge Arctic semi-submersible heavy transport vessel (SSHTV) featuring the latest technologies, and decided to work with Aker Arctic to complete it.

"We expect that the new vessel will be built in Russia and operated under the Russian flag to ensure transportation of heavy cargo, including new floating power plants developed by Energy Corporation Rosatom," states Kirill Selyutin, Head of Shipbuilding and Marine Technics Department at JSC Atomenergomash. ■

Technical details:

- Length overall: 254.4 m
- Beam: 49.6 m
- Design draught: 10.5 m (Arc5)/12.0 m (Arc7)
- Design deadweight: 70,000 tonnes
- Cargo deck: length 200 m; maximum submersion 14 m