American Society of Naval Engineers (ASNE)

Overview and Q&A

Insights into the Newest Ice Technology

November 17, 2021

Overview

New acquisition programs have yielded innovative solutions to problems posed by the Arctic and Antarctic environments. On November 17, these three speakers shared new innovations along with decades of experience developing, deploying, and maintaining new technologies in icy waters. Andrew Kendrick, a Principal Consultant with Vard Marine Inc., presented insights and experiences gained from his distinguished background and perspective, while Professor Kaj Riska explored scientific design scenarios and considerations necessary for operating in these conditions. Jukka Mäkiranta will explored new technology options and perspectives, assessing the findings against "the 3 E's" of buyer interest. The collaboration between Vard Marine and ILS Ship Design and Engineering has yielded many new technologies and insights into navigating ice conditions, and this group shared these innovations and perspectives with the ASNE community.

The lively Q&A was able to further explore the use cases and design considerations of the award-winning motorized detachable icebreaking bow (DIBB).

Speakers

Andrew Kendrick - Vard Marine Inc.

Andrew Kendrick is a Principal Consultant with Vard Marine Inc. He is a naval architect with extensive experience in ship design, marine research and development, and public policy formulation, including supporting the development of the IMO Polar Code as part of the Canadian delegation. Andrew's recent design projects include the Canadian Polar Icebreaker, the US Polar Security Cutter, the Chilean Navy Antarctic vessel, and the RCN's Arctic and Offshore Patrol Vessels, the first of which recently completed its maiden voyage through the North West Passage. He has undertaken ice trials on vessels ranging in size from large bulk carriers to ships' lifeboats, and model testing on an equally wide variety of vessel types. Andrew has presented technical papers and presentations to numerous organizations, including ASNE's Arctic Days. He is the President of the Society of Naval Architects and Marine Engineers (SNAME).

Professor Kaj Riska - ILS Ship Design and Engineering

Kaj Riska graduated as a M.Sc. in Mathematics and D.Sc. in Naval Architecture from the Helsinki University of Technology. Was the Professor of Arctic Marine Structures in the Helsinki University of Technology and Director (Helsinki) of ILS Ship Design & Engineering, before becoming Professor II at the Norwegian Science and Technology University in Trondheim to 2021.

Whilst at Total S.A. working as a senior ice engineer, Kaj led the first focus group on operating in Extreme Cold and became responsible for the Extreme Cold R&D. Awarded the Total innovation prize for Arctic LNG carrier in 2014, he was recognised as the Expert in Ice Engineering in 2017.

A specialist on ice action on ships and ice class rules, especially the Finnish-Swedish Ice Class Rules. Contributed to design of several icebreakers and ice breaking ships, and to ice resistant FPSU in the Bohai Bay (with a soft yoke) and the Varandey terminal in the Pechora Sea. At the Helsinki University of Technology, he was responsible for the large ice laboratory at the University. Kaj has near 100 refereed articles in scientific journals and a score of conference papers to further illustrate his breadth of knowledge and appreciation of his peers for his subject matter expertise.

Jukka Mäkiranta - ILS Ship Design and Engineering

Jukka Mäkiranta is a Senior Naval Architect with ILS Ship Design and Engineering Oy. His duties have ranged from concept designs of cruise ships, special vessels and offshore structures to basic design in shipbuilding. He graduated with a M.Sc. degree in Naval Architecture from the Helsinki University of Technology in 2003 and also has a M.Sc. degree in Logistics, from the Turku School of Economics. Jukka's recent design projects include special purpose ships, arctic cargo vessels, offshore structures for demanding ice conditions and LNG fueled Excellence Class cruise ships for Costa Crociere S.p.A.

Q&A

1) Is the design of the connection system for the DIBB similar at all to an ATB-tug combo?

- Yes. The Pushpin® Coupler Systems are ATB (Articulated Tug & Barge) coupling systems. There are two hydraulic pins at the sides and one fixed pin on the centerline, all on the same level above the waterline when connecting.

2) In the overall design comparison between DIBB and single hull, how are the designs normalized for comparison?

- Comparison table only gives information about the limit thickness of light-medium size icebreaking vessels. Limit thickness means the capability breaking max thickness ice without stopping. Icebreaking capability depends very much on the available propulsion power and hull form.

3) How many freedom degrees has the DIBB related to the parent vessel?

- None. They are fixed strongly together.

4) **I am the director of a program called Digital Shipbuilding. We are focused on curriculum development, workforce development, and research for the shipbuilding and ship repair industry. We do some K-20 outreach, curriculum development and workshops. I am looking at ideas to inspire future Naval Archs and Marine Engineers. Have an idea to maybe look at workshops involving ice operations. Wondering if the team would be interested in guest speaking?**
   - Kosteczko, Joseph P. All of us do guest speaking, so certainly happy to consider this. If you provide your email we will get back to you.
   - Andrew Kendrick Thanks. My email is jkostecz@odu.edu. If you want to check-out our website... https://digitalshipva.org

5) **Was there consideration to the use of azimuthing thrusters on the DIBB for directing brash outboard under the ice cover and for an even wider open channel?**
   - Azimuthing thrusters would fit only in the fore part of the bow, and that was considered. Reamer area propulsion with direct shaftlines was found to be technically and economically the most feasible solution. The parent tugboat has azimuth stern drive (ASD) propulsion.

6) **Has the design considered the use of alternative fuels such as LNG or other gas alternatives?**
   - Yes, in addition to the reduction of annual fuel consumption from this solution, we are closely following developments if greener alternative fuels become technically feasible to use. Application of LNG has not yet considered, partly due to lack of LNG refuelling infrastructure, partly due to significant changes it causes for location fuel tanks.

7) **You mentioned the DIBB was designed for level lake ice, do you foresee issues with highly pressured ice or large ridges?**
   - DIBB is excellent in ridge penetration and equivalent tasks, e.g. breaking up and dissolving ice dams. This was verified in ice model tests of the version designed for Baltic Sea right in the beginning. The bow’s propellers break heavy consolidated channel/ridge at vessel sides and push the ice floes aft. Dimensioning of the hull and propulsion will be carried out in accordance with the requirements for the ridge or ice dam size.

8) **What do you actually patent?**
   - ILS has patented DIBB’s propulsion principle, which means propellers are placed below the so-called reamers at the both sides of the vessel. More info can be found from the patent slide.

9) **What types of sonars are used? Do you see a need for greater under ice and under water visibility with the changing ice caps?**
   - DIBB does not have sonar, but parent vessel has usual depth sonar. No info about the need of better underwater visibility.
   - A forward looking echosounder (FLES) would be an option for the parent vessel in shallow or poorly charted areas considering DIBB draft greater than parent. FLES if on a retractable ram could on be used when vessel stopped.

10) **What was the price of Saimaa DIBB?**
   - We estimated during the design period that DIBB building cost is about 25% of the price of an icebreaker with same breadth and icebreaking capabilities. Saimaa was a prototype and included a lot of instrumentation for measurement of the different parameters and a lot of testing in model and full scale. The building contract price was about US$ 8.5 M.

11) **On Slide 34 (Comparison) you the icebreaking tug (4th row) capable of breaking 90 cm@2 kts and then in row 6 the icebreaking tug + DIBB, 80 cm@2 kts. Is there a difference between the two icebreaking tugs or is there an error here?**

- All the existing icebreaking vessels in this table have different propulsion powers. With increased propulsion power, displacement, and suitable icebreaking bow shape it is possible to break thicker ice. The disadvantage is to have larger machinery and icebreaking hull form outside the icebreaking season.

12) **How does the open water transit performance of the DIBB + tug design compare to single hull? Would this be an obstacle for distant polar operations?**
- The DIBB design is optimized in each case separately. The existing designs of the DIBB has bigger breadth than the parent vessel and the reamer is optimized for icebreaking ahead and astern with a very similar way than in multipurpose polar class icebreakers Fennica and Nordica.
- In a polar vessel the DIBB – type (or Fennica type) hull shape would be beneficial even when the bow is a fixed part of the ship. The smaller breadth midships and stern will reduce rolling and the bilge steps at stern reduce the rolling further.

13) **Is the tug crew sufficient for operating the icebreaking bow or does it require a larger crew?**
- Tug's own crew is sufficient. DIBB can be unmanned during icebreaking operations. For instance, the tugboat has six crew members: Captain, Coxswain, Chief Engineer, two deckmen and cook.

14) **The DIBB props seem particularly vulnerable. Could you go into a bit more how the props are designed to withstand the ice loading?**
- DIBB's propellers are ice strengthened based on design rules and the results in ice model tests.

15) **Did you consider a system for reducing the vibrations generated by the DIBB in the global structure?**
- Vibration is an important part of the icebreaker design. In Saimaa - case the pusher Calypso is already ice strengthened and the new design - DIBB and the pusher connected to a new fixed icebreaker unit - was not causing any other changes to the existing pusher than the connecting points and their strengthenings.

16) **What internal ship systems does the DIBB bow have? Does this duplicate significant equipment in the tug?**
- DIBB has own ship systems. DIBB has diesel electric propulsion system and integrated automation system (IAS) for controlling the machinery and auxiliary machinery systems (e.g. fuel treatment, ballast). In addition, there are ventilation and heating system, electric system, lighting, P/A, Alarm, firefighting systems etc. DIBB can be unmanned during icebreaking, all the DIBB's main systems can be controlled from tugboat's bridge.

17) **One could think it is more cost efficient to choose a properly powered tug and connect it to a simple non-technical bow, without any machinery?**
- Larger tugboat with more powerful machinery costs more. And the operation costs (e.g. fuel consumption) are continuously bigger. When compared to DIBB, the same propulsion power is needed for breaking the same thickness ice. The advantage in the case of using DIBB is that it can be detached when the icebreaking season is over. The parent vessel can operate in open water more economically, without the bigger machinery needed for the icebreaking. In addition, DIBB has better maneuvering capabilities in ice due to four propellers.

18) **It would be nicer operationally if the astern icebreaking capability was nearer the ahead limits. Never know when one might get stuck or meet an obstruction that can't go around. If you need to back up when breaking in limiting ice conditions ahead there could be damage trying to go astern, which increases risk and effectively limits where/when it may be operated. Assuming the limiting factor is the pin connections?**

- Due to DIBB's hull form the forward icebreaking capability is better for breaking the thickest ice. Philosophy of all DIBB design is that the vessel needs to be always be capable of reversing back from where it has been able to go.
- Equivalent astern capability would require significant, costly hull and machinery upgrades in the parent vessel.

19) Thinking there may be ballast and bilge equipment in addition to any engine support systems?

- Yes, DIBB has ballast and bilge systems with controls in IAS system.

20) Do you see the icebreaking rules becoming less stringent for the lower ice classes due to global warming?

- No, when operating in ice conditions, the vessel need to have ice capabilities.

21) Could be the DIBB system an alternative for substituting ice class on inland vessels?

- Yes, it most certainly can. It would also increase capability as the inland vessels can serve a greater compliment due to the ice class weighting implications being transferred to the DIBB. Inland vessels need to have ice strengthening when operating areas where ice is present. In combination to DIBB the ice pressure to parent vessel is smaller.

Questions?

The webinar was hosted via the ASNE website at:

http://www.navalengineers.org/Education/IceTechnology2021

If you have further questions, please contact ASNE at education@navalengineers.org.