Simulation tool assists in environmental decisions

IMO's control measures aim to gradually reduce ships' fuel oil consumption and carbon dioxide emissions. Lower carbon intensity is the target by reducing CO_2 transportation emissions. Finnish icebreaker Polaris uses liquefied natural gas as fuel, with lower emissions as a result. Photo: Catarina Stewen

Environmental concerns guide investments and hence new solutions appear at a fast pace. A simulation tool to calculate and compare overall energy efficiency can help to make the right decisions.

In 2018, the International Maritime Organisation (IMO) adopted a strategy to reduce greenhouse gas emissions from shipping. The strategy included a roadmap with possible short term, mid-term and long-term measures to support its strategy towards a less carbon-intensive shipping sector.

In November 2020, IMO approved some amendments to its control measures, including an earlier starting date of the Energy Efficiency Design Index (EEDI) Phase 3. Draft changes have also introduced further control means to lower greenhouse gas emissions from ships, such as the Energy Efficiency Existing Ships Index (EEXI), which includes equivalent requirements as for EEDI, but will apply to existing built vessels.

Pressure on icebreaking vessels

IMO's control measures aim to gradually reduce ships' fuel oil consumption and carbon dioxide emissions. Lower carbon intensity is the target by reducing CO_2 transportation emissions.

IMO's energy efficiency requirements are not, however, focused on icebreaking vessels, and EEDI requirements are not applicable for Polar Code Category A ships. Icebreaking vessels generally have to be powerful to perform in ice in order to ensure safe and reliable icebreaker assistance for commercial vessels. Also, it would be difficult to set a baseline to enable gradual reduction of greenhouse gas emissions.

Nevertheless, even if IMO control measures do not have a direct impact on icebreaking vessels in general, there will likely be indirect influences and also general pressure to reduce greenhouse gas emissions. Operators may have their own climate strategies and different countries may have high ambitions and national goals to cut greenhouse gas emissions.

Variety of fuels

IMO is also likely to introduce requirements that will lead to the adoption of less carbon intensive fuels, at least in the mid-term. Additionally, there are a lot of ongoing developments regarding the use of alternative fuels.

These, together with current advancements in engine technology, will probably result in an increased variety of available fuels in the future.

Energy efficiency calculations

Aker Arctic is following these developments closely, as well as innovating new energy-efficient solutions in icebreaking ships for clients. For that purpose, a simulation tool is needed which can be used to study different energy efficiency solutions. Various energy saving, energy storage and energy recovery systems can then be studied for specific operations.

"The tool is a simulation model consisting of expandable equipment blocks and system parts based on a set

operational profile," says Esa Hakanen, Lead Engineer, Machinery Systems. "The input operational profile can be either generic, more accurate and dynamic, or even based on full-scale measurements from real operations of a reference vessel."

Comparing emissions

The tool will be highly useful when studying the feasibility and simultaneous operation of different systems contributing to energy consumption in changing operational profiles and conditions.

"Various fuels, their characteristics, and their emission factors can be studied. They can then be compared for use in specific conditions and specific operations," Hakanen continues.

The luxury icebreaking cruise vessel Le Commandant Charcot, designed for cruise company Ponant, is an LNG-electric hybrid fulfilling clean ship requirements. Photo: Sasha Lalane/ Ponant

Recent study

A recent study investigated how to reduce emissions from vessels used in Arctic rivers. The conclusion was that one ship design is not necessarily applicable to all rivers, as each river has its own characteristics.

"Each river has to be studied individually and every vessel has to be designed fit for purpose. The infrastructure in place; ice, environmental and port conditions; distances in open water and distances in ice; the ice period; what type of fuel is available in the area. All these factors must be taken into account," says Alexey Dudal.

The study also included investigating the possibility of using an energy storage (battery) system.

"A comprehensive understanding of a ship's operational profile is required to determine if a battery system is feasible or not, both from economic and environmental perspectives. Boundary conditions, such as when it is practical to charge batteries and when power may be utilized has to be known," says Hakanen.

Emissions as a whole

Different technologies such as liquefied natural gas as fuel, catalytic reduction system (SCR), usage of diesel particulate filter (DPF) to reduce particulate matter (PM), and black carbon (BC) emissions were additionally studied.

"Emissions should be considered as a whole. There is no point in focusing on only reducing one thing, as it might increase something else," Hakanen highlights. ■

Meet Esa Hakanen

Esa works as Lead Engineer for Machinery Systems, mainly as discipline leader in various ship projects.

He is a mechanical engineer and joined Aker Arctic 15 years ago, having previously worked at Helsinki Shipyard in the machinery design department.

Examples of recent projects in which Esa was responsible for the machinery and HVAC design are: icebreaker *Ob*, icebreaker *Polaris*, icebreakers *Aleksandr Sannikov* and *Andrey Vilkitsky*, and polar icebreaking research vessel *Xue Long 2*. ■