Mid-term evaluation CoolFish (294662)

The primary objective is to develop technology and increase knowledge for more energy efficient and climate friendly cooling, freezing and heating onboard fishing vessels.

Energy efficiency has been a continuous topic throughout the project activities. We are also regularly in contact with the industry, both vendors and end-users, which makes the project dynamic and flexible, while at the same time with deep connection in the theoretical background. A pelagic fishing vessel has been monitored with sensors, collecting information of the energy consumption and operational pattern. This gives valuable information for dimensioning a new LNG driven pelagic fishing vessel. Monitoring and measurements for a whitefish trawler will also be conducted and the information will serve as a base for planning innovative solutions on new vessels.

Developing technology is conducted within the industry cases, together with the industry partners. The project allows the industry to get advice from research and university sector as well as from other stakeholders.

Increasing knowledge has also been important and this will continue even more, also after the project ends. One way is to educate master and post doc students, where they at the same time can provide necessary results to the project. We have also had many meetings, both within the project team and with others. We have presented results at several workshops, webinars and at conferences. Publication level is also high and is likely to increase as more results are expected to come. We have also started on several new ideas for projects within the topic of CoolFish, both focusing on innovation and knowledge building.

Refrigerants have different global warming potential and the project has focus on helping end users to select the right ones. We have also other projects and activities to spread the knowledge about the best alternatives, which are the natural refrigerants.

Secondary objectives

Adapt simulation models for system analyses, development and optimisation of integrated refrigeration systems

Simulation models, describing the main parts of the refrigeration systems, are further developed and applied to predict the effect and impact of different design parameters on existing systems, without changing actual operation. The main simulation environment is Dymola (Modelica), where different system alternatives have been modelled. This works continuous also with experimental campaigns in the laboratory of NTNU, to enable a proper validation of the developed modules for the system simulation.

Develop design specifications for robust and compact refrigeration technology using natural refrigerants, for high energy efficient operation at varying conditions

The natural and clean refrigerant CO_2 is an excellent working fluid for refrigeration onboard fishing vessels. A Norwegian partner is developing and installing these kinds of systems in most of their deliverables towards the Norwegian Fishing sector. The potential to utilize CO_2 is high also for additional applications, e.g. on shore food process plants. The possibility to achieve and maintain freezing temperatures below -50°C can be a major advantage, as this reduces the freezing time considerably.

Develop systems for increased utilization of combined heating and cooling, including compact heat and cold thermal storage and heat pumps

While the refrigeration plant is producing cold, it is also producing high temperature water (up to 100°C with CO_2 through the gas cooler). This kind of surplus heat is valuable as it can replace auxiliary boilers. Surplus

heat sources and heat demands are explored to increase thermal integration. Together with thermal storage, this can improve the overall energy efficiency onboard as well as reduce the green greenhouse gas emissions.

Develop concepts for utilizing surplus cold onboard LNG fuelled vessels

One vessel with LNG as fuel has been launched in Norway and a few more is being planned and built. LNG is a fossil fuel, but with less carbon footprint than conventional fuels. It also facilitates a change to bio-based fuels (biogas) when available. In the project we have analysed the potential of utilizing the surplus cold from the LNG fuel system for cooling of fish. Together with the activity on measuring onboard energy use for different operations, we see that there is a potential to reduce energy use for cooling onboard fishing vessels.

Evaluate and adapt methods for calculating and communicating the carbon footprint and environmental impact of refrigeration systems

In the project we have provided two reports which give an overview of alternative fuels and propulsion systems for fishing vessels and a review of standards, methods and tools related to carbon footprint assessment of fisheries.

We are also systemizing industry practices for sharing sustainability information in the Norwegian seafood supply chains to evaluate how traceability can be used to improve sustainability information in this sector.

Establish a Maritime Refrigeration Technology Hub for R&D

The R&D hub will be a web-based platform that enables information and knowledge exchange, as well as facilitating collaboration between industry and research institutions, both in Norway and internationally. Focus is put on maritime refrigeration technologies applying natural refrigerants. The first version, to be launched in 2022, will primarily aim at stakeholders in the fishing vessels sector, but also in the cruise ships industry (through KPN CruiZE).

Educate one PhD or one Postdoc and six MSc candidates

Two Postdoc candidates are currently involved in CoolFish, primarily working on the simulation tool development and laboratory validation of the tools. Until October 2021 we have educated two master students who have finished their theses. Currently there are four master level students performing their project work within topics developed from the CoolFish team. Three of them will perform the master thesis work in the spring semester 2022 at NTNU. There is large interest from the students in working within this topic and we expect to encourage several NTNU and international students to perform their project- and master thesis from autumn 2022 towards 2023.

Deliveries

We have had several publications within the project and most of them (38) are registered in Cristin. The project also has a webpage which gives an overview of the project and where publications can be found and downloaded. News of the project are shared in newsletters, which are sent to all partners and also available online.

Challenges

The main challenge within the topic of CoolFish is the low availability and quality of operational data for fishing vessels, making it difficult to perform proper energy analyses. For example, disaggregated data on fuel usage between propulsion and refrigeration are required, as well as reliable temperature measurement for the cooling system. In this context, the research cruises that are performed within CoolFish, with additional financial support from Directorate of Fisheries, are highly essential.