

# Newsletter June 2020

Dear participants of CoolFish,

Summer has arrived and here is a summary of what we have done so far in CoolFish and what we plan to continue with this year.

## Industry cases

We have started three of four industry cases:

### Task 2.1: Energy efficient RSW units

Refrigeration equipment vendor Øyangen has installed measurement instruments in the fishing vessel *Selvåg Senior*, which will log temperature, water flow and energy use. The logged data together with information on catch will be used for analysing operational profiles under different situations. In addition, this may be used for increasing energy efficiency, both in this vessel and in other vessels.

Researchers at SINTEF Ocean have been collecting data from several fishing vessels. The data is collected for other projects, but we will investigate possibilities for using the gained knowledge and data in CoolFish.

### Task 2.2: Design concepts for cold utilization from LNG driven ships

This year, master student Muhammad Zahid Saeed delivered his master thesis "Energy efficient and climate friendly cooling, freezing and heating onboard fishing vessels". It will be available to all project partners when the evaluation is finished. He has modelled and simulated two independent systems for utilizing cold from LNG, one for chilling water and the other for freezing. Heat recovery to use for processing of fish rest raw material and integration of a CO<sub>2</sub>-based thermal energy storage was also included.

Zahid will work 250 h in the project this summer, where he will continue the simulations together with other project participants. Some of the work is related to the new *Selvåg Senior*, which will use LNG for propulsion (the vessel is in the engineering phase). Among others, Zahid will also document models, which are developed for simulation of processes for freezing with CO<sub>2</sub> in different configurations.

### Task 2.3: Develop concepts for thermal energy systems on hybrid/electric driven ships

We postpone this task to next year, or we will replace it with another case, depending on the project development.

### Task 2.4: Design concepts for *integrated thermal energy units*, for cooling and heating

MMC has bought components for a refrigeration system with CO<sub>2</sub>, which will be set up with the help of NTNU. The system will be used for gaining experience and measuring different operational situations. The system will have three compressors with flexible attachment to different pressure levels, depending on refrigeration demand for AC, RSW and freezing. The system will also accumulate hot water for processes and room heating. Cold recovery from melting of "return-ice" will also be included. Danfoss will contribute with their competence of regulating systems. Different ejector systems will be implemented to demonstrate benefits of active expansion work recovery.



## Postdoc

A postdoc (Engin Soylemez) was supposed to start early this year, but it has been postponed because of the Corona virus. He is soon on his way to Norway, where he will be in quarantine for 10 days before starting the work.

## Spin-off projects and other projects

We have promised some spin-off projects from CoolFish and have already started to discuss possibilities within industry innovation projects (IPN sent to Research Council of Norway).

Another project with similar topics as CoolFish is the new project CruIZE, which started in June and is managed by SINTEF Energy (Cecilia Gabriell is the project leader). The objective of CruIZE is to develop innovative and energy efficient solutions for hotel power demand of cruise ships, including heating, HVAC, freshwater production, and food chilling. Since several of the research topics are like those in CoolFish, we will be able to share experience between the projects. An example is joint participation in workshops.

FHF (Norwegian Seafood Research Fund) has granted a project where SINTEF Ocean (Sepideh Jafarzadeh) is project leader. The goal is to investigate/develop a system solution for a 13 m coastal fishing vessel with hybrid propulsion based on batteries and fuel cells, both for hydrogen and ammonia as fuels.

## Reports and publications

We will soon publish two reports from the project. The first one summarizes propulsion systems and alternative fuels, which are set to replace the conventional diesel engines. Focus is centred around Norwegian new-built and commissioned fishing vessels. Different operational modes in relation to hybrid propulsion / power supply are also described, since these imply changes to the thermal energy systems onboard, such as reduced access to surplus heat. Furthermore, some examples from the international fishing fleet and future scenarios for the uptake of alternative fuels are presented. The second report describes calculation of carbon footprint. It includes different calculation methods, tools, standards, and certification programs available for estimating the carbon footprint for seafood in general and specifically for fishing vessels and refrigeration systems. Results from former related projects are included in the report, and it will also address current discussions on calculation methods of carbon footprint.

Muhammad Zahid Saeed has submitted a paper to the Gustav Lorenzen conference, which will be held in Japan in December. The title is "Integrated thermal storage and heat recovery of the CO<sub>2</sub> refrigeration system for fishing vessels". He also submitted a paper to the International cold chain conference (ICCC), with the title "Cryogenic cold utilization and system integration possibilities for LNG-driven fishing vessels". Co-authors were project participants from SINTEF Ocean and NTNU. The ICCC was supposed to take place in Nantes in April but has been postponed to August. This conference will be partly online and several from SINTEF and NTNU will participate. Tom Ståle Nordtvedt has a keynote presentation in this conference, with the title "Refrigeration and sustainability in the seafood cold chain".

Kristina N. Widell has submitted a paper to the International Journal of Refrigeration, with the title "Improved operation and design of chilling tanks on fishing vessels". It describes chilling systems onboard Selvåg Senior, tests done onboard and CFD analyses to improve the tanks. This is a result of work conducted in the project "Optikjøl", which ends this summer, but some of its activities will be continued in CoolFish.



We have also planned for a paper on CO<sub>2</sub> systems onboard fishing vessels. This will be in cooperation with the project partners PTG/Kuldeteknisk og Danfoss. The goal is to describe possibilities, so that more fishing vessels switch to CO<sub>2</sub> instead of harmful synthetic refrigerants. Most Norwegian fishing vessels already use natural refrigerants (mainly ammonia), but it is not that common in other countries.

Kristina and Sepideh have written a chronicle, which will be published in "Fiskeribladet" this summer. It describes that the need to change to more climate friendly propulsion systems in fisheries, where LNG is a first step. It also shows some numbers from the master thesis regarding use of cold from LNG systems. It was shown in simulations that at 100% motor engine power, the refrigeration system COP can be increased by 15% by using some of the cold from gasification of the LNG. This was for chilling seawater. Similar number for a freezing process was 6%. Use of surplus heat onboard is another advantage. A thermal storage of dry ice was also simulated, for reduction of peak loads.

## Maritime Refrigeration Technology Hub

We have recently started to discuss the *Maritime Refrigeration Technology Hub*. The idea to establish such a R&D hub originates from an earlier project - *Alternatives to HCFCs and high GWP HFCs in marine vessels* (commissioned by the Nordic Council of Ministers). The goal is to establish a web-based contact point / platform that enables information and knowledge exchange, as well as facilitates collaboration between industry and research institutions, both in Norway and internationally. In the first phase, the platform is primarily aimed at stakeholders in the fishing vessel sector but may be expanded to include several ship segments, for example through collaboration with the CruIZE project.

## Project participants

### Management group

- Sintef Ocean
- NTNU
- Sintef Energy

### Industrial reference group

- MMC First Process
- Ulmatec Pyro
- Selvåg Senior/Sørheim Holding
- Gasnor
- Øyangen
- Perfect temperature group
- Danfoss
- Isotherm Inc. (USA)

### Scientific reference group

- International Institute of Refrigeration
- London South Bank University
- Johnson Controls Denmark

### Project funding

- Norwegian research council ENERGIX

Wish you all a lovely summer!

