Newsletter April 2022

Dear CoolFish participant,

Here you will find a summary of our recent accomplishments in CoolFish as well as our plans for future work.

Update on project partners

One of our industry partners, Bluewild, has decided to participate with a larger financial contribution in the project, which means that we have fulfilled the requirement from the Norwegian research council of having 20 % financing from industry partners. Thank you all for contributing!

Project meetings and workshops

In November we had a project meeting/workshop in Trondheim (in Norwegian) and this was the agenda:

- Kristina Norne Widell: Om CoolFish (About CoolFish)
- Tom Ståle Nordtvedt: Bærekraft i fiskeindustrien (Sustainability in fishing industry)
- Cecilia Gabrielii: Mer klimavennlig sjømatproduksjon (More sustainable seafood production)
- Andrea Viken Strand: Deling av data og informasjon i norske fiskerier (Sharing of data and information in Norwegian fishing industries)
- Prem Kumar Sherman: Sustainable production of fish protein hydrolysates
- Armin Hafner: Fordamperopsjoner for CO_2 kuldeanlegg (Evaporator alternatives for CO_2 refrigeration systems)
- Egil Sørheim: Orientering om tiltak i nye Selvåg Senior (Information about the new Selvåg Senior)

The day after we had a workshop about thermal energy storage, a collaboration between the projects CoolFish, CruiZE, PCM-store, ZEN and HighEff. It was a full day of presentations and discussions, and it was possible to participate both physically and online. Programme and presentations are available here.

The presentations from earlier webinars are available here: www.sintef.no/en/projects/coolfish

Industry cases

Here follows information about activities in the industry cases.

Case 1: Energy efficiency on board fishing vessels

A research cruise will be conducted with the sea-going trawler Ishavet this autumn. The vessel will be equipped with metering devices and sensors in September this year, while data will be collected on the subsequent fishing trip. A full report from this research cruise is due before the end of the year. This work is partly financed by the Directorate of Fisheries.

Case 2: Design concepts for cold utilization from LNG driven ships

Zero emission technology and/or fuels is not yet readily available for fishing vessels, but LNG has been pointed out as a steppingstone towards that goal. Senior Selvåg is a project partner and is building a new fishing vessel, employing LNG as fuel. The vessel is a combined vessel equipped with purse seine and pelagic trawl capability, which makes the operational profile of the vessel complex and enables extended time on sea throughout the year. Egil Sørheim, shipowner, had a presentation at the CoolFish workshop in November about what kind of low-GHG and energy efficient technologies will be part of the new design. Based on previous works there is identified a possible fit between available 'free' cooling from the LNG regasification process and cooling demand from the RSW system, which will be explored through modelling.

Case 3: Freeze concentration

The new lab-scale freeze-concentration system was developed and build in the dewatering lab at NTNU. The crystallization process and ice separation were modelled and evaluated. The next stage (April-June) is validation of the model and optimization of the freeze-concentration process with respect to thermal and physical properties of hydrolysate. The main aim is to obtain the highest solids fraction in concentrate (over 20 %). This will significantly decrease the energy costs of the dried hydrolysate powder production. For example, increasing of the solid fraction from 20 to 30 % will decrease the energy costs of the powder production by 25-30 %.

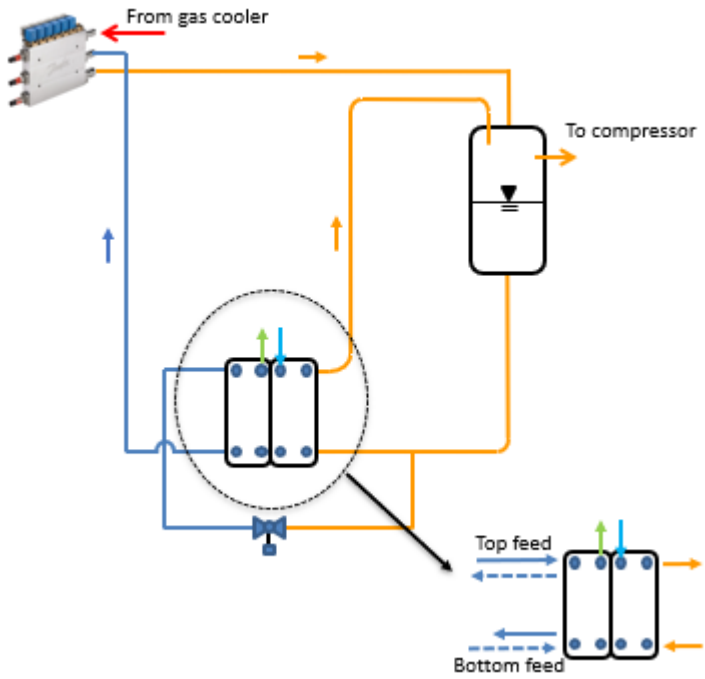
The first quarter of 2022 was devoted to pre-processing of hydrolysates with the aim to determine the optimal quality parameters of hydrolysate, which can increase the yield of concentrate after freeze-concentration process. The following methods were investigated:

- Sedimentation
- Membrane filtration: micro, ultra, nano filtration
- Reverse osmoses

Three bachelor students were also involved.

Case 4: Design concepts for *integrated thermal energy units*, for cooling and heating

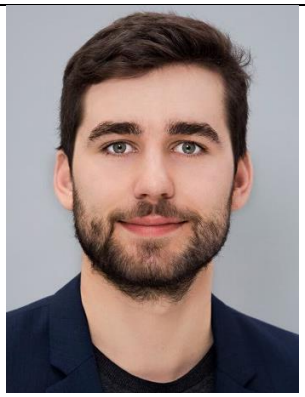
We are investigating a new evaporator configuration, as shown in the picture below. The first measurement results will be presented together with Alfa Laval during GL2022. The concept is to integrate two evaporators in one unit, so that the connection on the liquid side (water) is simple and compact. The advantage of two-stage evaporation is that the suction pressure of the compressors can be raised by utilizing pre-compression via the ejector. It will also be possible to use two-stage evaporation with an ejector in plants where the end-user would like to produce ice (or charge a thermal storage) and at the same time maintain production of ice water or RSW.



Postdoc and master students

These are our four master students within CoolFish:

Muhammad Umar Khan Thesis: Design and analysis of freeze-concentrator for processing of fish protein hydrolysate	
Prem Kumar Sherman Thesis: Sustainable production of fish protein hydrolysates: Overall system architecture and footprint	
Jomar Mandal Leth-Olsen Thesis: Design of CO_2 heat pump and refrigeration system for hydrolyzation & freeze concentration processes	

Jan Bengsch Thesis: Investigation and analysis of a CO_2 refrigeration unit with novel evaporator configurations	

We will also recruit master student for CoolFish activities via the project INDEE+, which officially started 1.9.2021, ensuring that we meet the tasks set in the project description. These students are a resource not only for NTNU, but for all partners of the project, since it gives a unique opportunity to follow next generation engineers in their last phase of the master program, with the potential for hiring them as new colleagues.

Reports, publications, and visibility

Previous reports are available on the project's webpage.

We have completed a report on traceability in the fisheries supply chain. The report deals with current practices and methods for collecting, storing, and sharing data in the value chain of fishery products in Norway. The report will be published after the conference Sustainability and the cold chain.

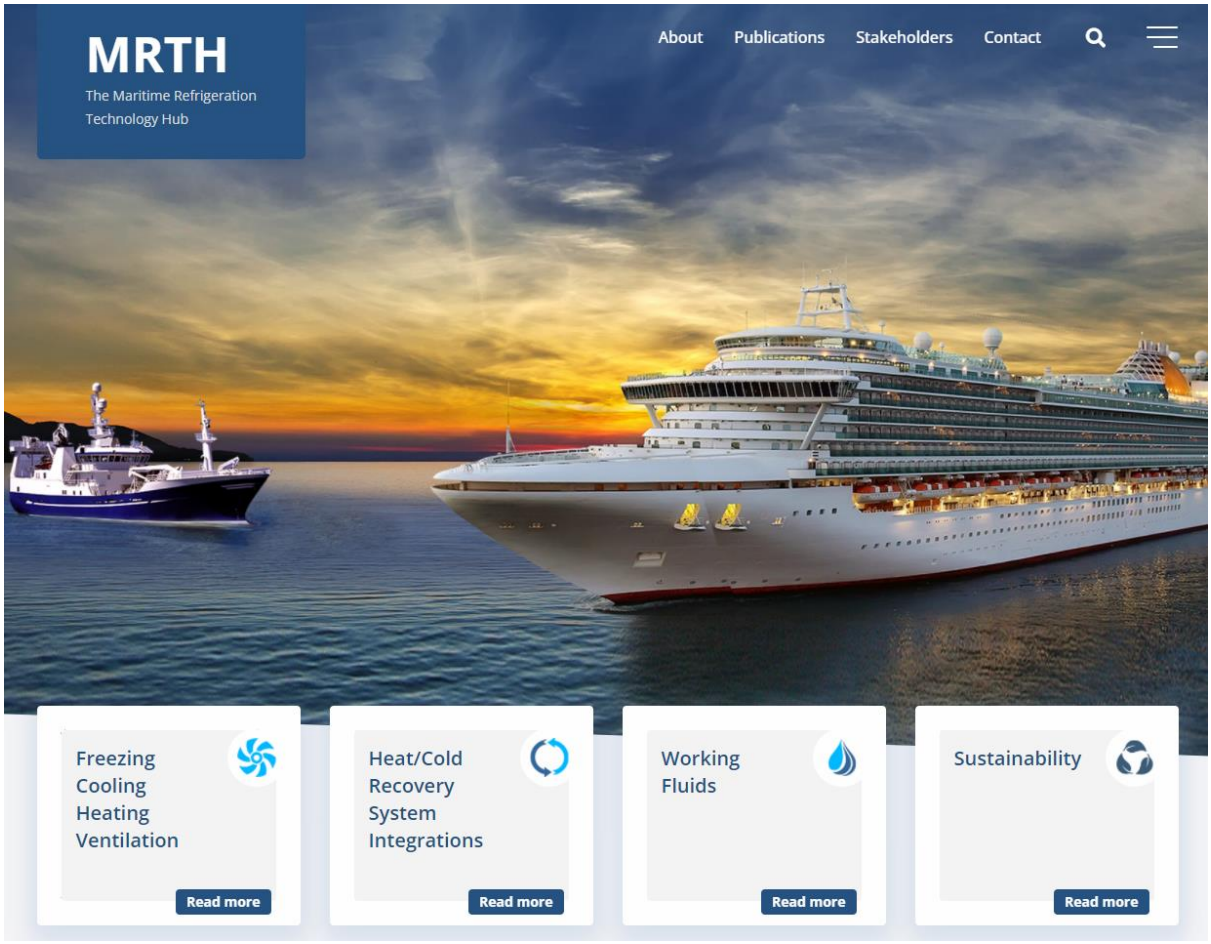
In November, we had a visit from a student group at Nordnorsk Lederutvikling (NNL), including Christian Sørheim, technical manager for Selvåg Senior. We presented the CoolFish project, focusing on sustainability. The students are now finalizing a sustainability report for the new Selvåg Senior. We have contributed to the report with, for example, arguments for LNG as a fuel and the importance of efficient refrigeration systems on board. The report will be available on CoolFish's website.

At the end of 2021, a report on the potential of implementing thermal energy storage onboard fishing vessels was completed. This was a collaboration with the FME HighEff. In the report, multiple theoretical designs were described and evaluated. A paper exploring integrating an ice slurry system onboard a pelagic purse seiner has been submitted to the Gustav Lorentzen conference. The work showed potential for further exploring ice slurry as thermal storage for fishing vessels. Development of an optimization model using cooling demand, fuel consumption, and refrigeration system operation has started.

We will participate in three conferences this year:

- Sustainability and the cold chain (11-13 april, online)
- Gustav Lorentzen conference (13-15 juni, Trondheim)
- Norsk kjøleteknisk møte (27-29 april, Tromsø)

Maritime Refrigeration Technology Hub



The MRTH is established as a mean to disseminate information that will facilitate and speed up the transition into more climate and environmentally friendly solutions for heating and cooling systems onboard maritime vessels. The MRTH will go online at the end of April and will with time develop into a dynamic site where information and experience is shared between researchers, vendors and other actors and stakeholders in the field. In the ideal case the hub should work as a guideline for shipowners seeking to implement the latest and the greenest technology available.

Information from other relevant projects

INTERPORT aims at developing sustainable solutions for ports as energy hubs. We are in the process of defining reference ports to be used as case studies, among them a fishery port. One research focus in the project is to identify synergies between different energy carriers and anergy demands. One example is the utilisation of waste heat and oxygen from local hydrogen production in port, which could be supplied to nearby fish farms.

MAREN – Maritime Energy Transition – is a project financed by Nordic Innovation, running in 2022-2024. The aim is a more coordinated development among the Nordic countries towards a sustainable maritime industry. The project will host webinars and workshops covering different kind of topics. as well as being a "project generator" for innovation projects throughout the Nordic region.

The EU project ENOUGH now has a webpage, where more information is available: enough-emissions.eu

Project participants

Management group

- SINTEF Ocean
- NTNU
- SINTEF Energy

Industrial reference group

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

Scientific reference group

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

Project funding

- Norwegian research council ENERGIX
- Industrial partners are contributing with 20 % of total budget

Happy Easter!

Kristina

+47 918 93 026

kristina.widell@sintef.no