OIL RECOVERY UNDER ICE PROJECT

Porvoo/Finland 2019

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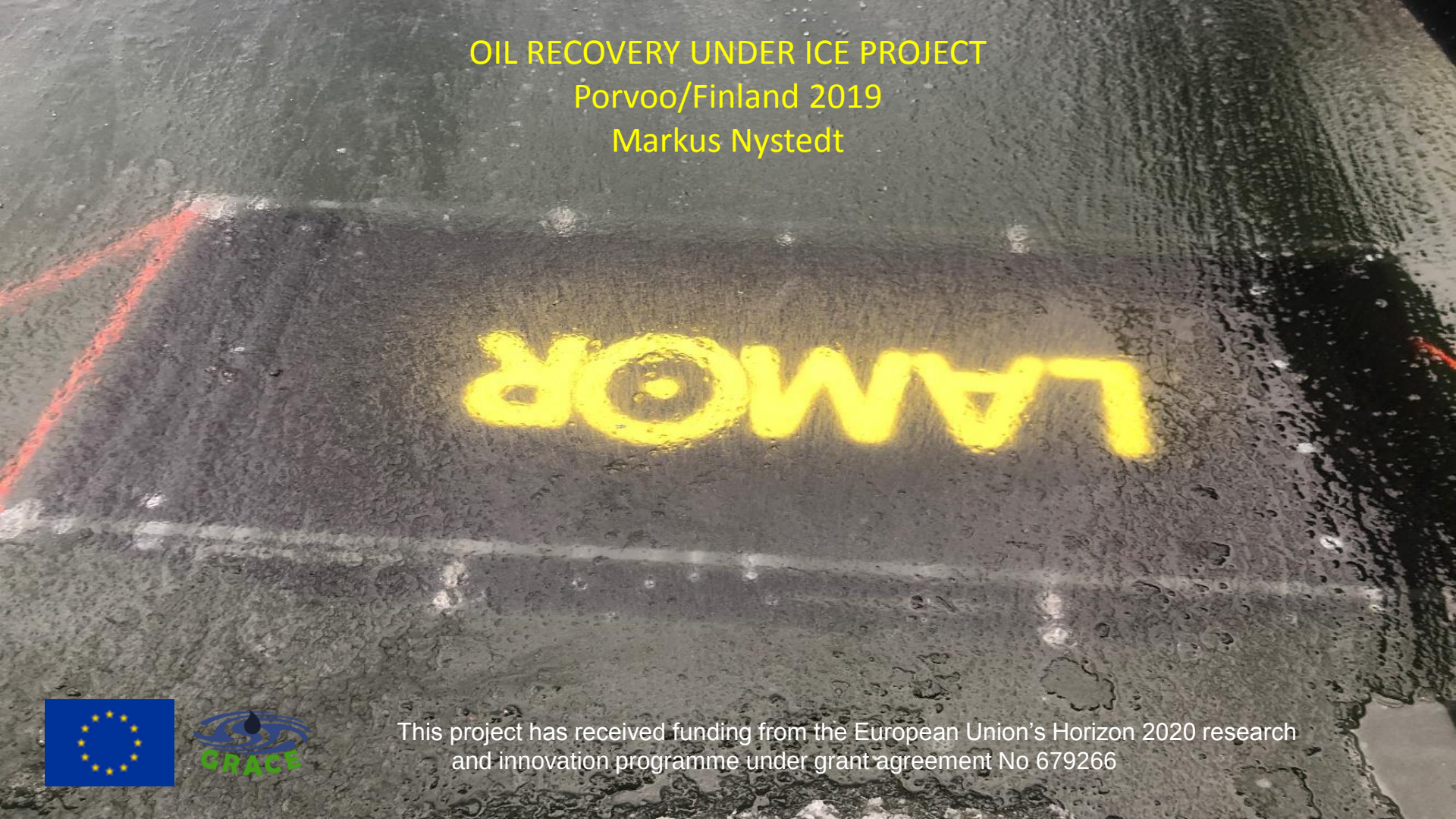

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Purpose of project

Along with the new commercial Northern Sea Routes and increased oil exploration in the Arctic region comes also the risk of potential oil spills in the area. Oil spill response possibilities as well as currently available technologies are much more limited in arctic areas versus oil spill response in open water environment and thus development is required.

Within the GRACE project, Lamor was assigned a task to develop an unit for oil spill recovery from under ice.

Project plan and first steps

The project was started by understanding the environment and condition and a set of scenarios where determined. Based on these, requirements and limitations were defined and a test environment for validation of such systems was built.

As a first test in the new developed test environment, the oil behavior under ice was performed to understand how the oil will flow in correlation to currents and also how recovery should be performed in most effective way.

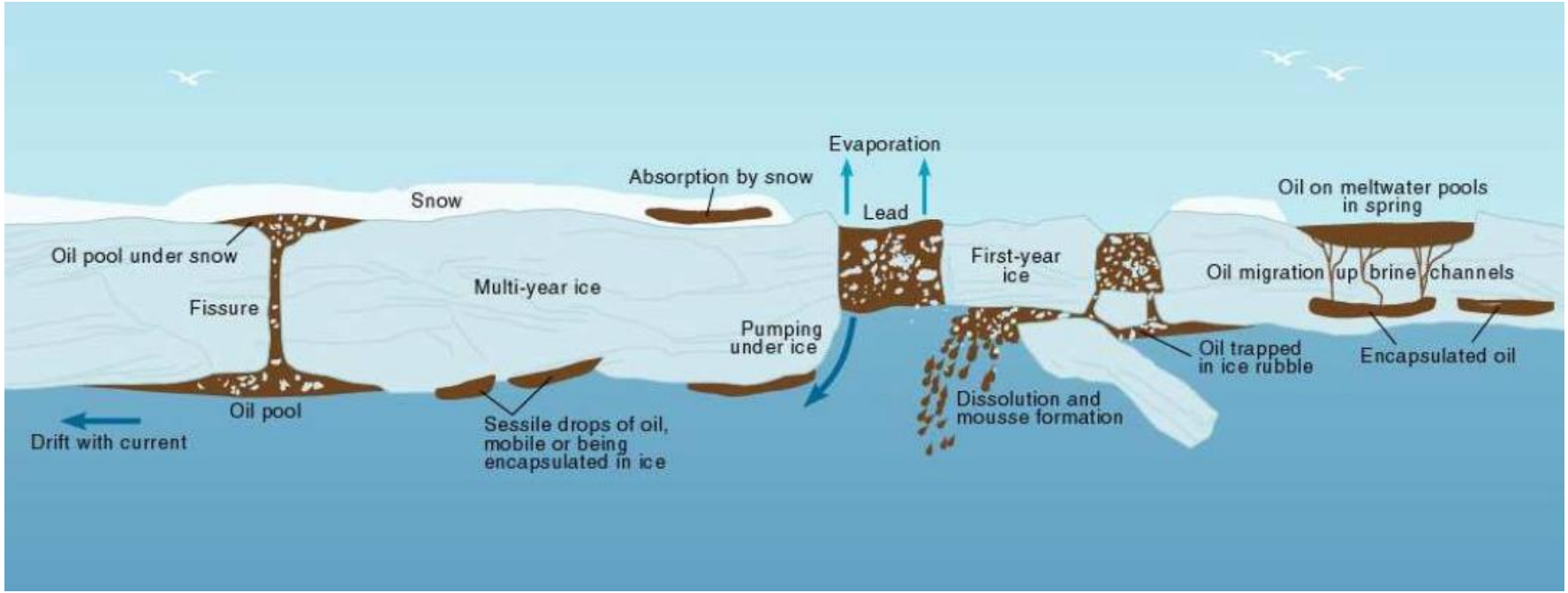
Outcome of testing

Two main recovery methods and three different ways to move the unit was identified. After two years of planning, designing and testing, a unit was developed that was proven to be able to recover the oil from under the ice.

These identified methods were tested and based on the outcome, one prime solution was seen to be the most effective of these. This was a unit using an inclined rubber scraper in combination with an increased water flow near the under-ice surface combined with integrated preliminary oil water separation method and additionally an oil suction method from above the ice surface.

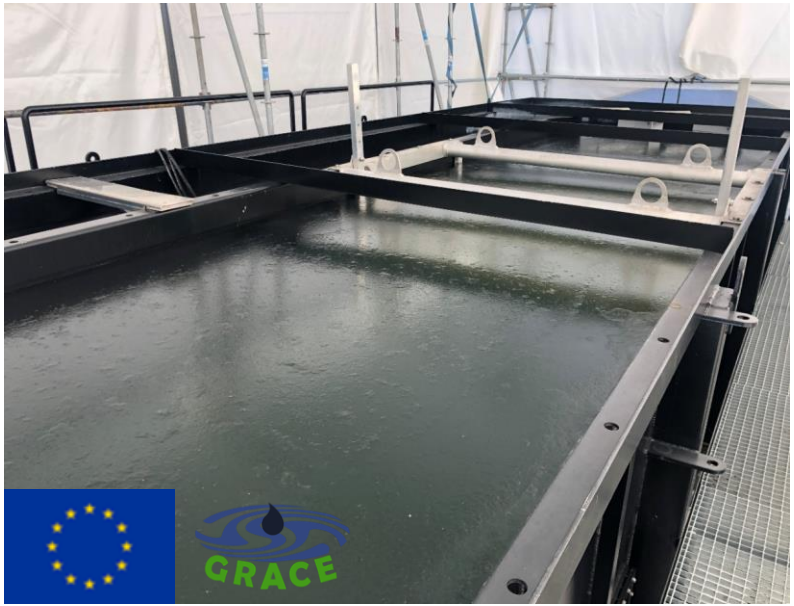
The water content in the recovered oil could be significantly reduced by using the integrated separation. The unit was designed to be modular and to fit on existing ROV's utilizing them for the movement and observation.

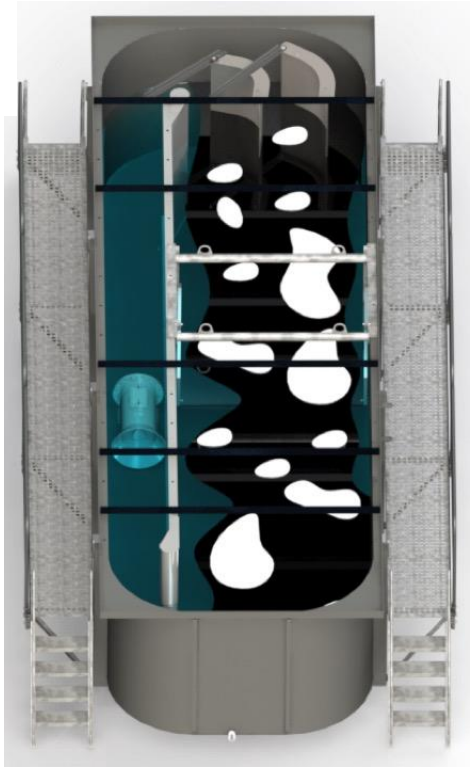
Oil under ice scenarios



Test tank

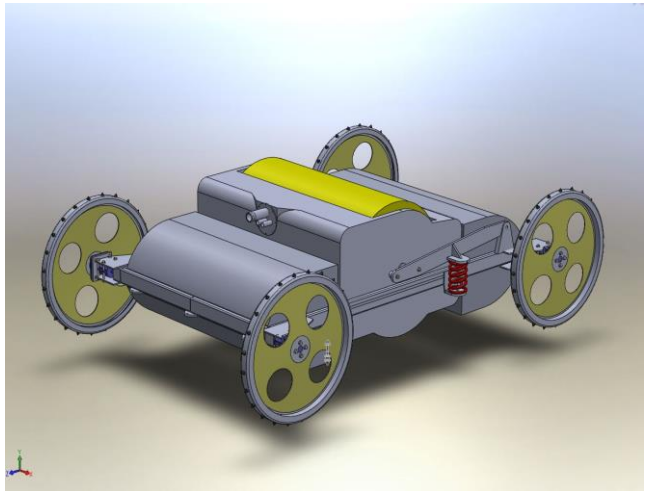
- Steel test tank, 10 x 3 x 1,8 m, approximately 30m³ of water (fresh water)
- Hydraulic flow propeller (approximately 10kW) to generate water flow
- Water heating power 5kW (used when needed)
- Test tank covered in tent

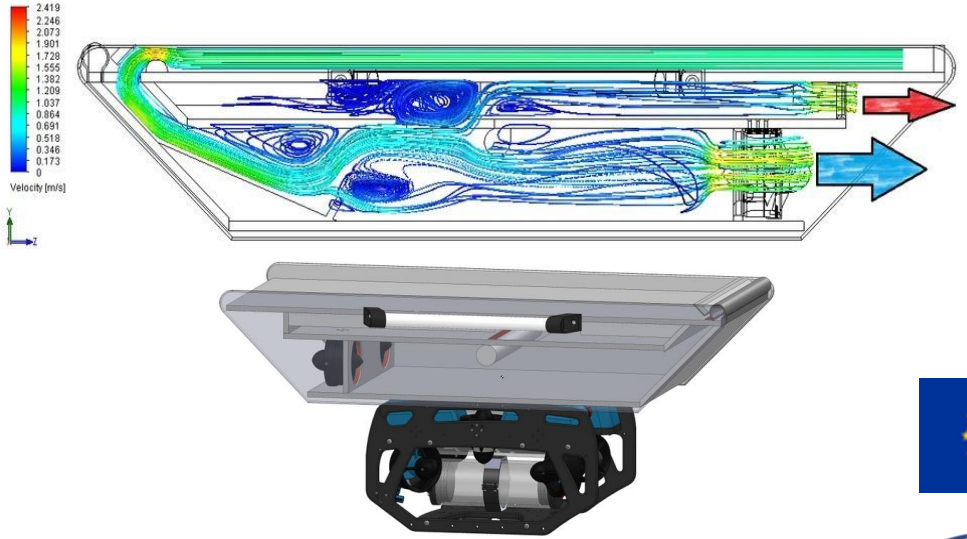




Designs

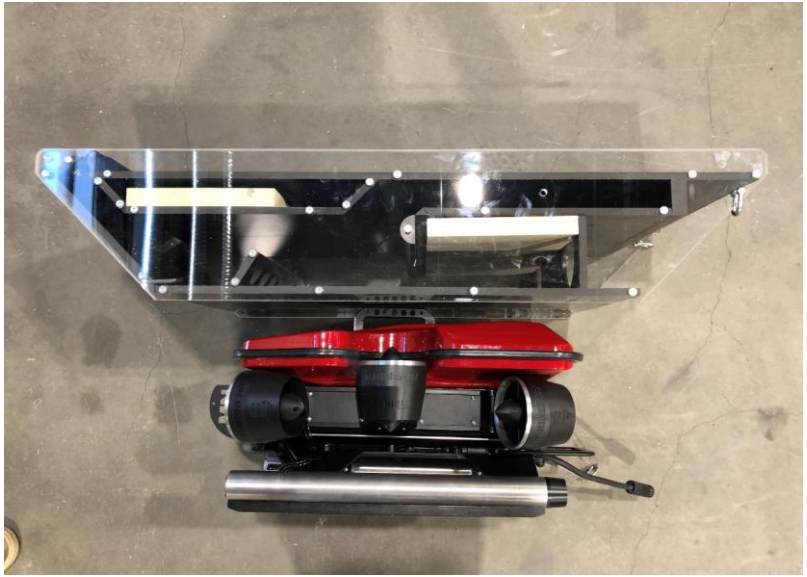
- Original design of recovery unit with spiked wheels and brush module (bottom left)
- Latest proto-type version of recovery unit with integrated oil water separation and utilizing existing ROV





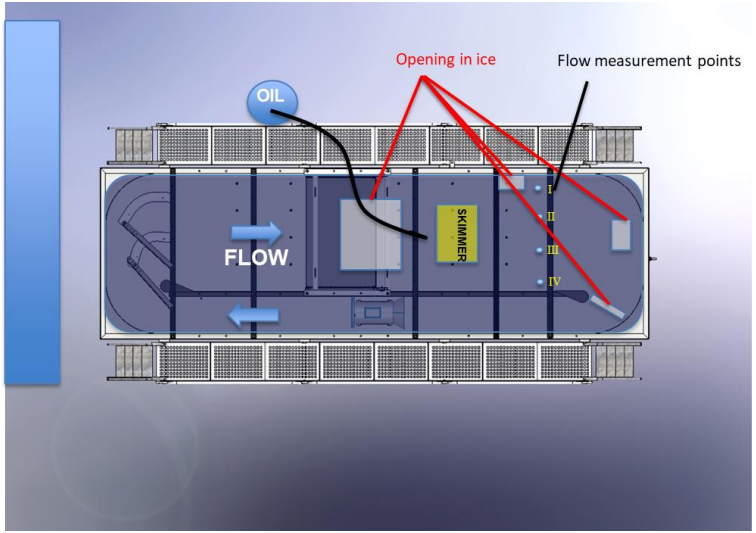
Under Ice Oil Recovery Units

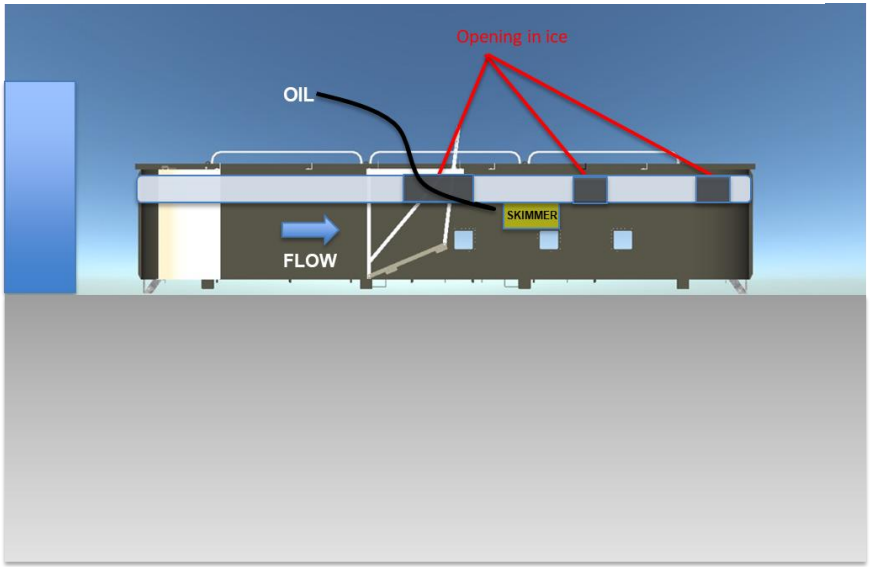
- First test with brush wheel unit utilizing Lamor existing MM25 brush wheel skimmer (bottom left)
- Latest proto-type version of recovery unit with integrated oil water separation and utilizing existing ROV



Testing set-up

- Opening cut in ice for entrance of skimmer under ice
- Holes drilled for both measuring flow speed and also pumping in oil under ice





Monitoring phase 1

Test unit in phase 1

Camera 1 (Cam 1), view in front of brush

Camera 2 (Cam 2), side view of brush

Camera 3 (Cam 3), view after brush

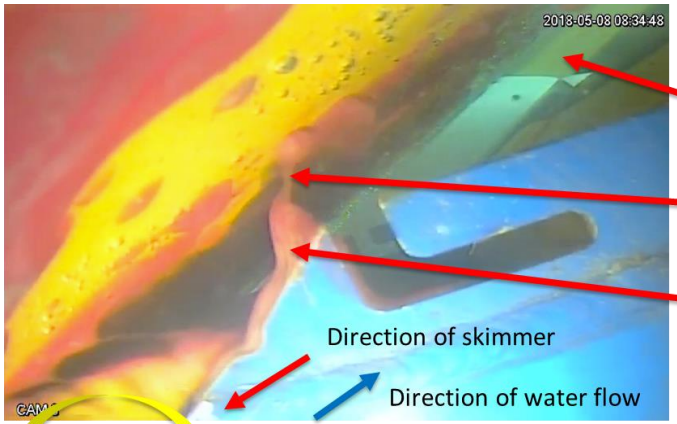
MM25 skimmer

Guide rail to enable movement under ice

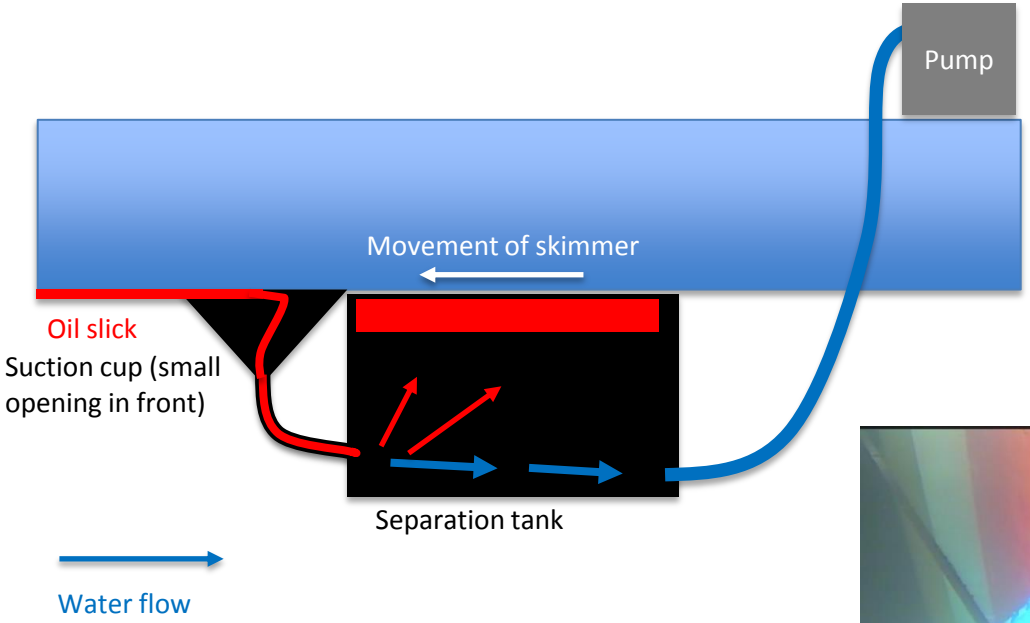
Testing brush wheel recovery unit

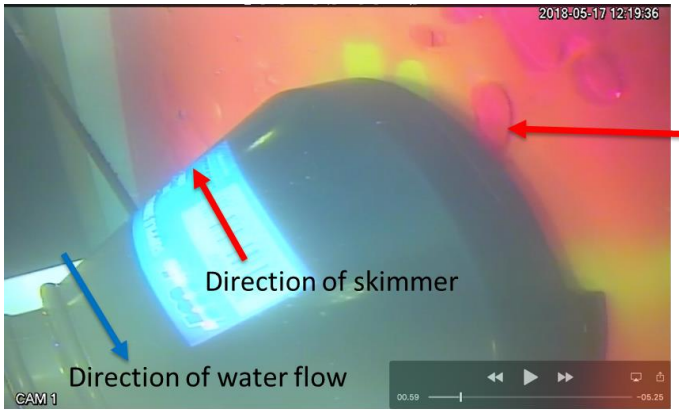
A) Brush direction of rotation along with skimmer movement

B) Brush direction of rotation towards skimmer movement

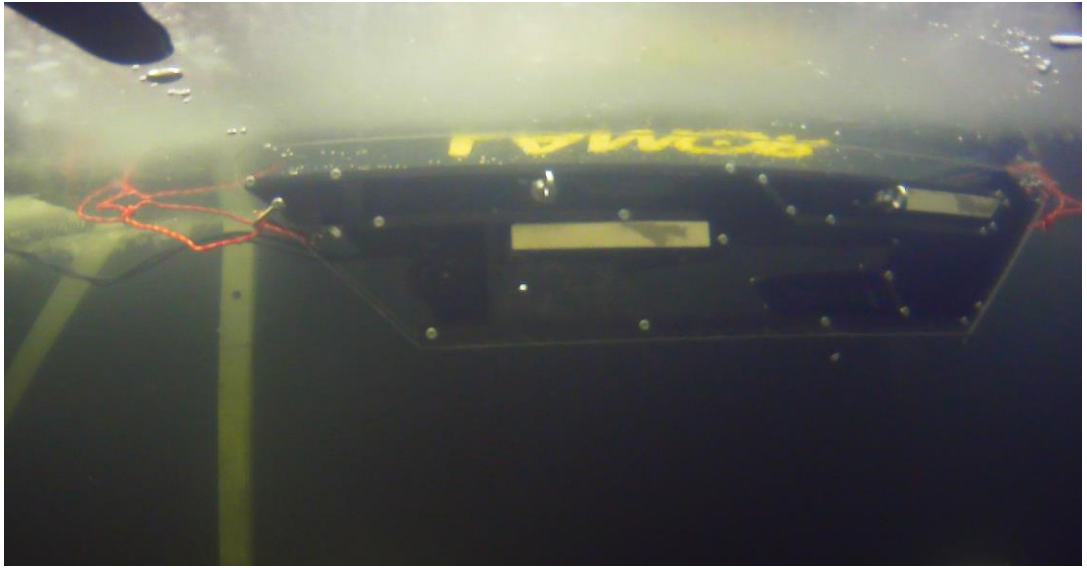


Testing suction oil recovery unit



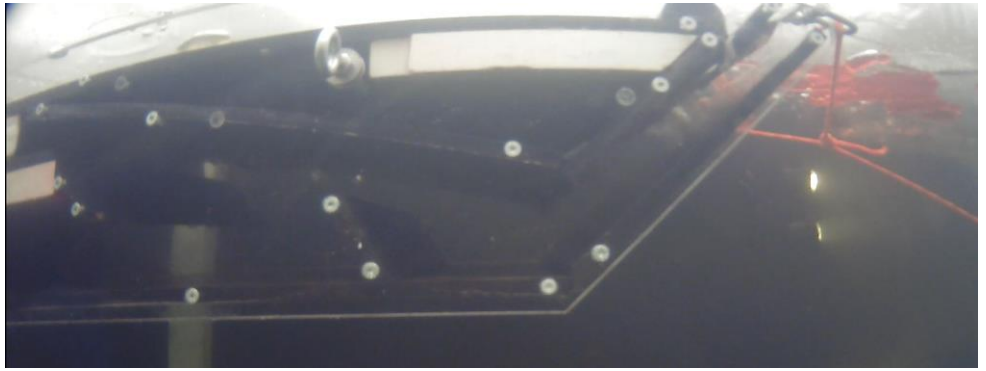


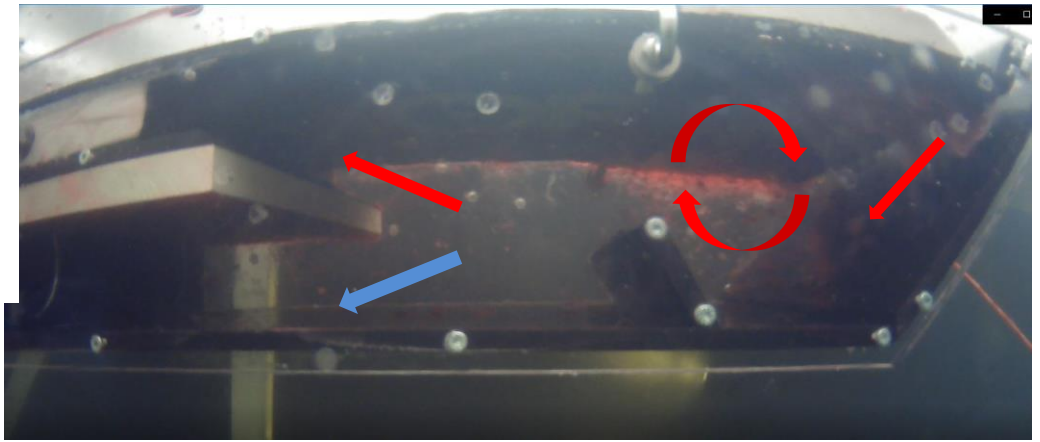
Testing of prototype and monitoring



Oil recovery with prototype

- Prototype was designed to be able to recover oil both in “forward” direction and “reverse” direction
- After some modification, the recovery seem to work very well.
- Oil and water separation was challenging and focus during last test phase was put on that.
- Internal design was modified together with flow speed and this significantly improved oil water separation.





Results - Oil flow and how well oil gets stuck under ice

- In order for fresh oil to get moving from under ice water current (measured 50mm below ice) need to be in range of 1,5…2 kn and higher.

- Fresh oil remained liquid and de-attached from the ice at least within the first 24h. During this period, the oil was easy to remove from under the ice.

- For a period of 1-3 days, the oil started gradually to be encapsulated within the oil. This was naturally linked to the ice growth and temperature variation.

- When fully encapsulated, the oil could not be removed from under the ice as it was in the ice (hence ice need to be crushed).

Results - Recovery and separation

- Brush wheel was considered as prime option for recovery and separation under ice. Brush would give and advantage of recovering the oil when gradually stuck to the ice or slightly un-even ice but for fresh oil, the simplicity of suction was seen to be more effective. With the brush wheel, the oil was collected and ice surface cleaned but oil was released from the brush directly after the brush. Hence, the benefit of oil water separation was lost (compared to oil recovery above water surface)

- For a rubber scraper with a enhanced water flow into the recovery unit (as the built prototype has), it was found to be effective way of recovering. The built prototype collected all fresh oil that was released under the ice.

- In both cases, the oil water separation was seen as the key challenge. This in order to avoid having pumped large quantities of water above the ice surface. The built prototype had an integrated primary oil water separation. In the first version, a lot of oil droplets was however lost with the water flow inside the skimmer but the design was adopted and flow adjusted with result of relatively good oil water separation.

Next steps

The proto-unit was built to successfully recover the oil but a final design is still under work with aim to build a final unit during summer 2019.

For future considerations, also the following aspects are

- recovery of oil under a non-flat surface
- Tracking system for ROV's to be investigated (not developed)
- Location of oil under ice with a ROV in live cases to considered. Plan is to next winter deploy the ROV under real ice and verify what potential it may have for local detection

LAMOR

Thank you

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