Chemical herding and in-situ burning of crude oil in a water basin in Sisimiut, Greenland

Eirini Adamopoulou, Laurens van Gelderen**, Gunvor Kirkelund**, Grunde Jomaas***

** Department of Chemical Engineering , MSc Petroleum Engineering, Technical University of Denmark*
*** Department of Civil Engineering, Technical University of Denmark*

Background

In Situ-Burning is an oil spill response method based on burning the oil at the spill site. The removal efficiency of the method depends on the oil type, fate, slick thickness and the environment.[1]This method has shown high burning efficiencies of over 90% in ice infested waters. [2]

Fire booms are the most commonly used method for oil containment. However in the Arctic, in ice infested waters and remote areas several tradeoffs should be considered. Oil-herding agents could be an alternative method to contain and thicken the oil slicks sufficiently.

The herders are chemical agents used to contain oil slicks on the surface of open water. They can promptly spread over a water surface into a monomolecular layer due to their high spreading coefficient and pressure. [3]

This project focuses on the performance of the herders in the presence of objects, simulating the presence of ice under outdoor Arctic conditions.

Experimental procedure

A 4.0 x 4.0 x 0.1 m^3 basin was created in the soil and wooden planks were used to reinforce the cavity walls. A plastic sheet covered the bottom while reflecting metallic tape and aluminum foil used to cover the top layer of the plastic sheet for protection. Stones from the local area laced inside the basin to cover around 20% of the surface area. Fresh water (480 L) was used to fill the basin.

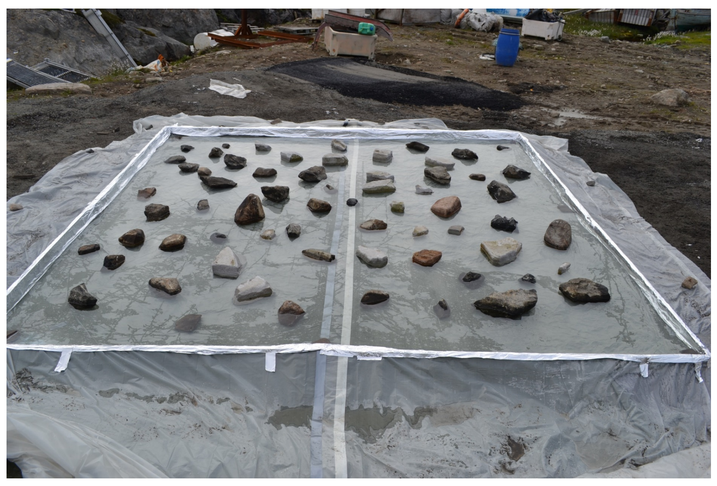

Photo 1. Experimental set up

Table 1. Experimental matrix

	Type of oil	Amount of oil
Experiment #1	Used motor oil	1.88 L
Experiment #2	Oil mixture (used motor oil & gasoline)	2.60 L
Experiment #3	DUC crude oil	3.34 L

The oil was poured in the water basin and allowed to spread. After 30 min **1.200 μL** of the **herding surfactant** distributed equally around the edges of the water basin with a micropipette.

The oil is allowed to thicken for 30 minutes prior to ignition and then ignited with a butane torch blower. The residues were collected with 3M hydrophobic absorption pads.

A camera on a 2 m high stand is used to record the spreading, herding and burning of the crude oil.

Results

Herding performance

Photo 2. The oil spread out before the herding

Photo 3 . The oil after the herding

The herder agent proved **effective** in significanlty contracting the oil slicks. The slick area has been reduced 39%.

Obstacles effect

Photo 4 . Individual oil slicks

After the herding, besides the main oil slick, there were also **individual oil slicks** created around the obstacles.

Slick thickness

Table 2. Results for the oil slick thicknes

	Oil slick thickness before herding	Oil slick thickness after herding
Experiment #1	0.19 mm	1.74 mm
Experiment #2	0.47 mm	1.59 mm
Experiment #3	0.71 mm	6.34 mm

Results

Burning efficiency

The effective burning efficiency of the DUC crude oil was **63%**

1st burn flame area : 0.96 m^2
2nd burn flame area : 0.47m^2

Photo 5. Oil burning in first burn

The used motor oil and the used motor oil – gasoline mixture were not ignitable. The motor oil probably had a high flash point reducing its tendency to burn while for the mixture, most of the ignitable gasoline was evaporated during the spreading time.

Conclusion

- The herder performs very good under outdoor Arctic conditions
- The herder was more effective with DUC crude oil
- Spreading and herding time is an important parameter
- Wind seriously affects the whole process (spreading, herding)
- The presence of objects negatively affects the process of herding by creating individual slicks around them. This results to more than one slicks in the spill site
- It is difficult to fully burn the oil due to the individual slicks created. It is hard to reach and ignite all of them successfully. Therefore, the burning efficiency becomes lower.
- Burning time is also increased since more than one slicks need to be ignited

Future work

Supplementary experiments are going to take place at the DTU Fire lab.

The efficiency of herders is going to be examined under different -percentages of ice coverage.

References

1. Buist, I, Potter, S, Nedwed, T & Mullin, J 2011, 'Herding surfactants to contract and thicken oil spills in pack ice for in situ burning', Cold Regions Science and Technology, vol. 67, Elsevier B.V., no. 1-2, pp. 3–23
2. Buist, I. A., Potter, S. G., Trudel, B. K., Walker, A. H., Scholz, D. K., Brandvik, P. J., Fritt-Rasmussen, J., Allen, A. A., & Smith, P. (2013). In Situ Burning in Ice-Affected Waters: A Technology Summary and Lessons from Key Experiments: Arctic Response Technology
3. Buist, I, Potter, S, Nedwed, T & Mullin, J 2008, 'Herding agents thicken oil spills in drift ice to facilitate In Situ Burning: A new trick for an old dog', in Cold Region Response, p. 6