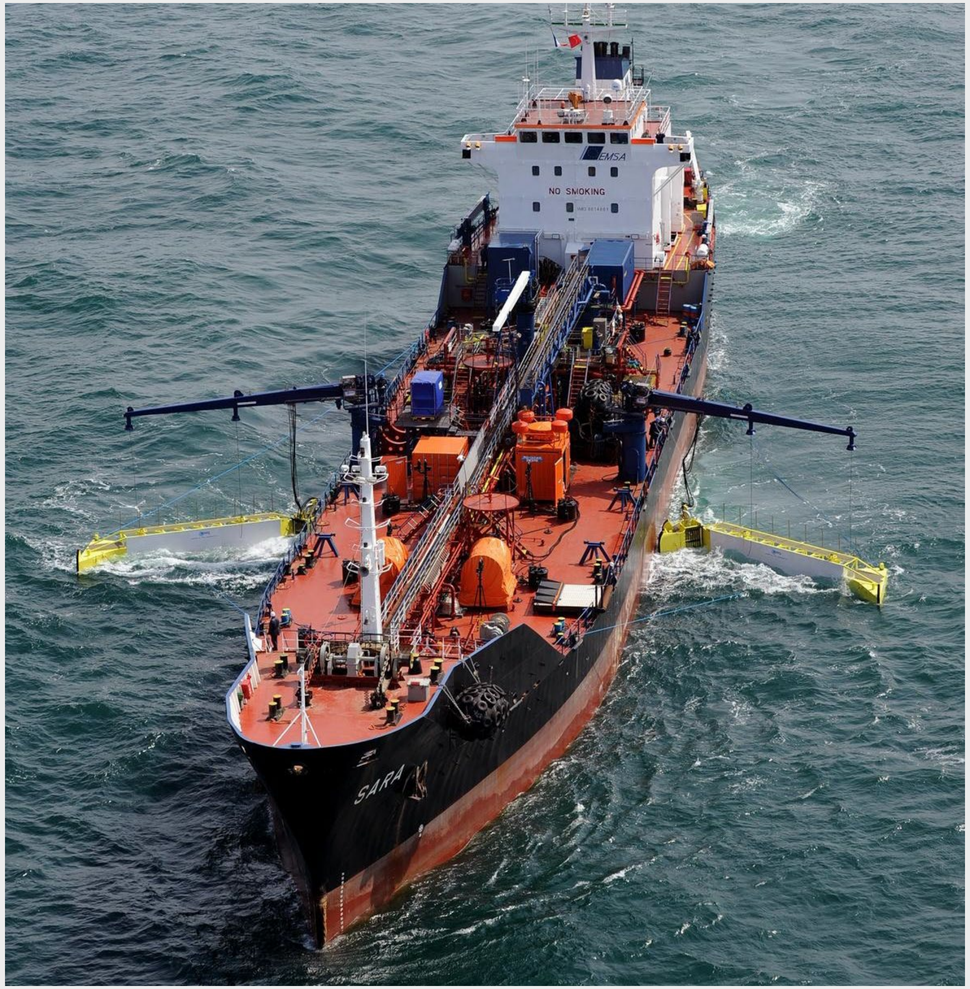
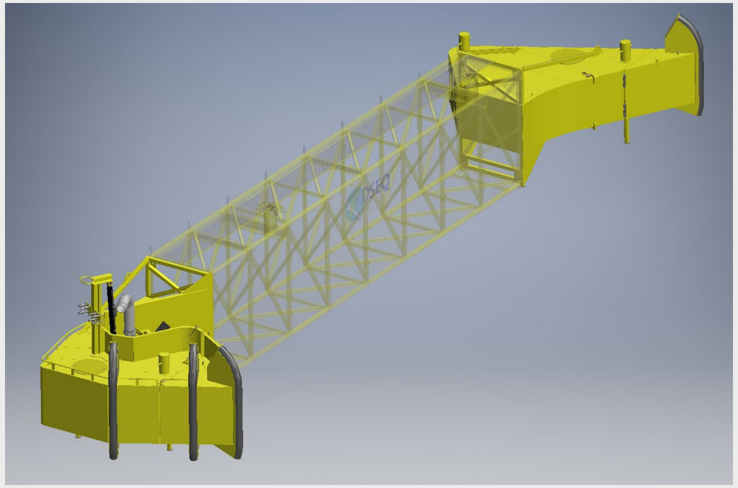
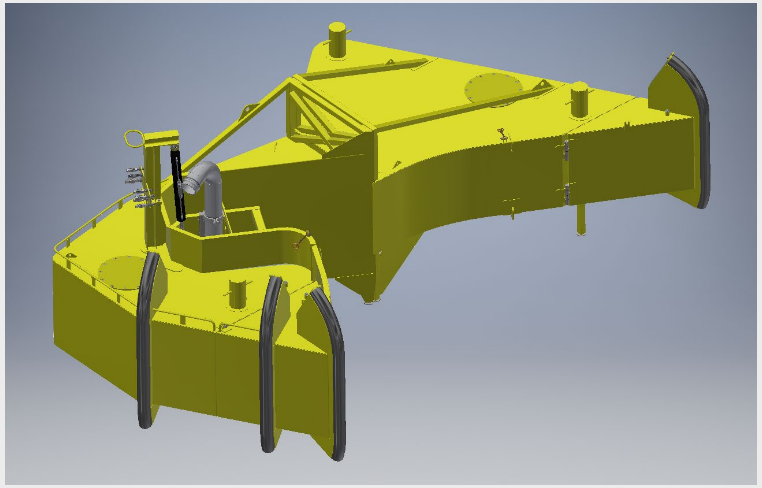
Koseq Imaros$_2$ – Current equipment



- Free floating steel arms, pulled alongside vessel
- Length per arm: from 10 up to 15 meter
- Designed for offshore use, up to Seastate 5
- Operated by 1 man.
- Deployment time: max. 5 minutes
- Equipped with:
  - Weir or brush skimmer
  - Pump, capacity up to 360 m^3/h
  - Discharge pressure up to 6 bar.

Koseq Imaros$_2$ – Modifications





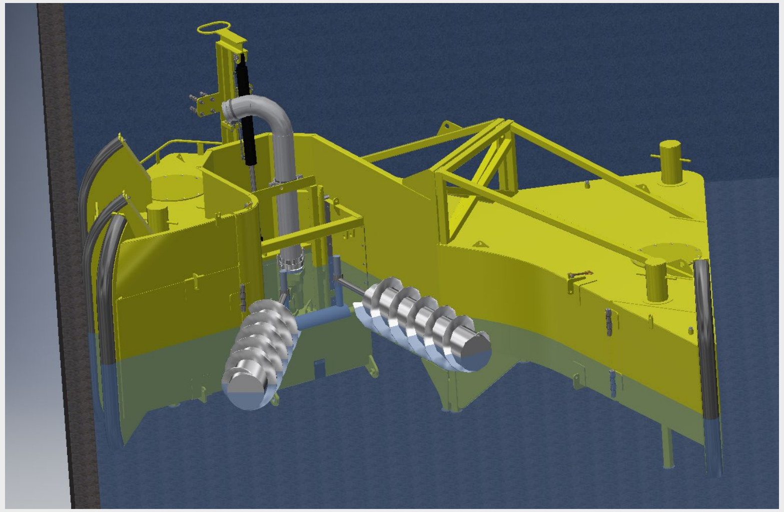
The Koseq rigid sweeping arm system has proven to be very effictive in offshore oil spills in the past. With minor modifications the system will be able to handle LSFO as well.

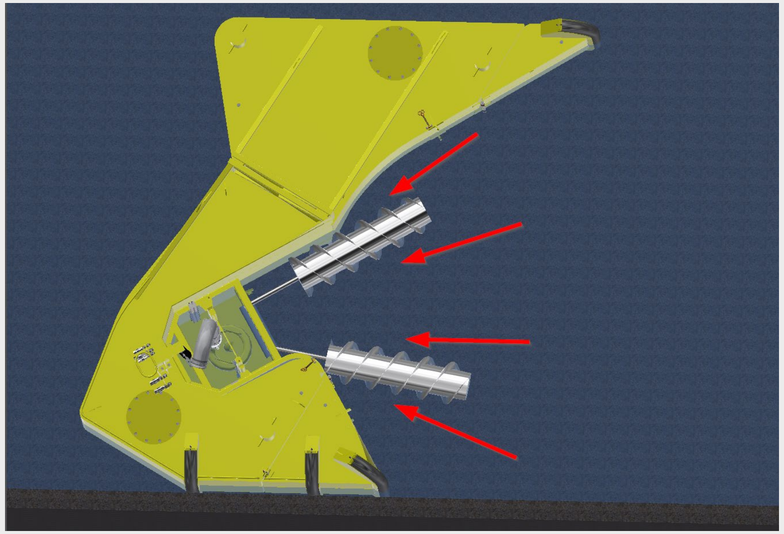
We intend to test in the Horten test basin. The sweeping arms as they are, are too long to fit in, we therefor have to adapt the sweeping arm.

- The bridge piece of the sweeping arm will be removed
- Pontoon will be fitted together
- Additional weight will be added to compensate for the missing bridge piece.

We will add achimedes screw the exisiting weir skimmer to force the oil to the skimmer.

Koseq Imaros$_2$ – Concept





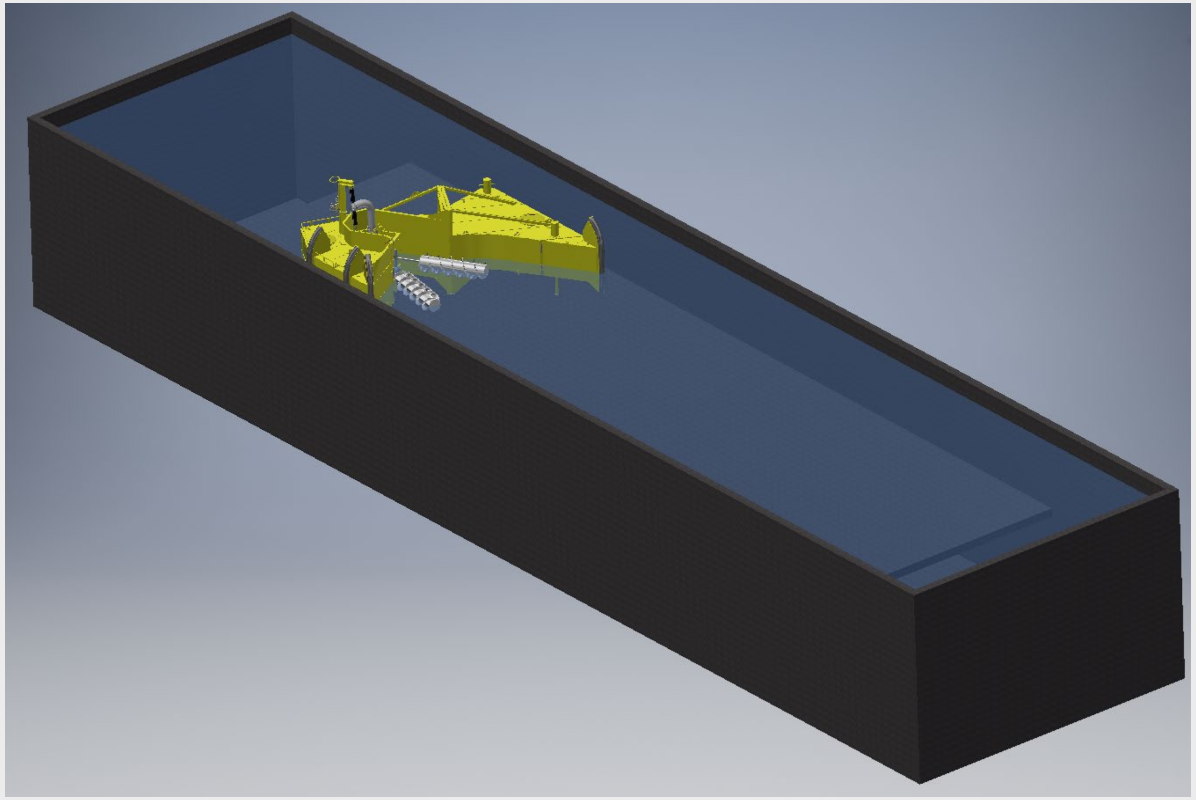
The Koseq rigid sweeping arm is shaped to guide the oil dynamically to the oil collection chamber.

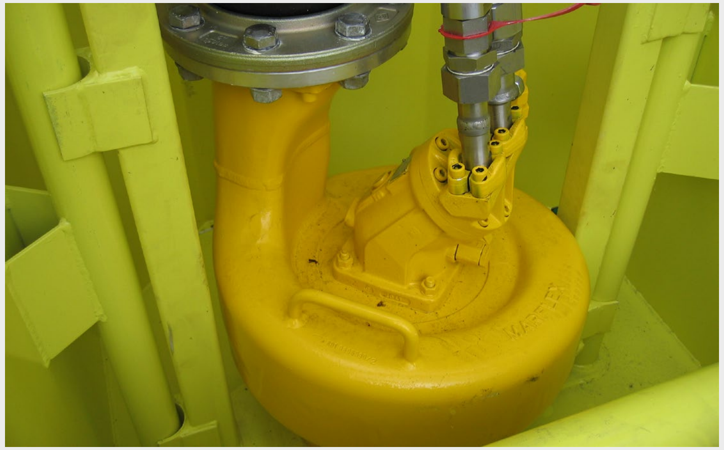
In order to have a continuous flow towards the oil collection chamber (even in case the arm is tested without the Horten current system) additional archimedes screw are fitted.

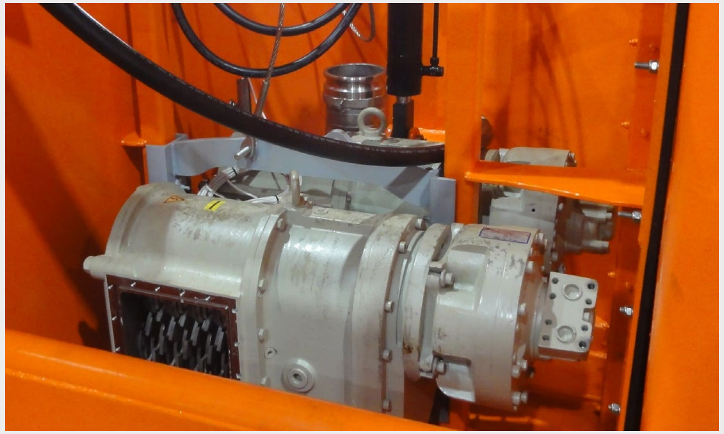
The screws in the sweeping arms can easily be repositioned as they are mounted in a sliding frame.

The screws had been designed for retrofitted to all existing equipment.

Koseq Imaros$_2$ – In Horten test basin







We have 2 different pump types we would like to test:

- The MSP 150 semi-centrifugal pump, in use by Rijkswaterstaat
- Borger rotary lobe pump, in use by the German Coast Guard.

Koseq test proposal Imaros$_2$ – Thoughts

The Koseq arms are designed for a forward speed of 2-4 knots depending on the type of oil and weather conditions. The Arm is pushed against the hull by the forward movement and on top of that the forward movement creates a dynamic flow generated by the ships hull and the angled surface of the sweeping, which makes it different form positioning it only I an static current. Because of the viscous material and different behaviour we will add two Archimedes screws to increase the inward flow to the pump. Both type of pumps have been tested in highly viscous oil, the borger pump has proven records of pumping fluids above 200.000 Cst. The principle of the Archimedes screws has been tested in oil-spills in Canada as well as the oil-sand ponds in Canada.

Koseq Imaros$_2$ – Test and Results Horten

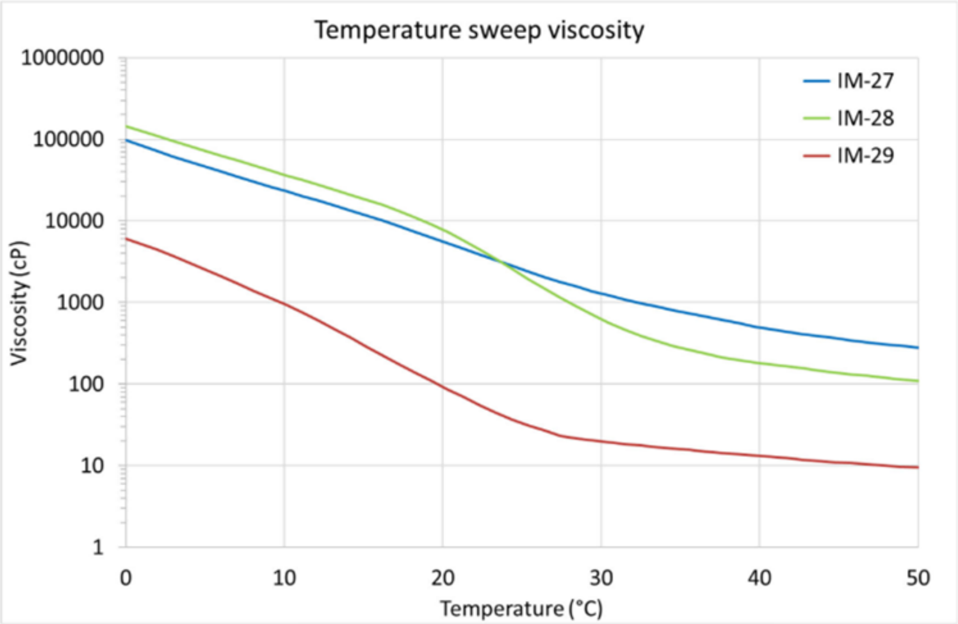
Weight: app. 4300 kg
Pump capacity: max 320 m^3/h
Max discharge pressure: 4 bar

With MSp-150 pump:
Weight: app. 3800 kg
Pump capacity: max 360 m^3/h
Max discharge pressure: 6 bar

Koseq Imaros$_2$ – Test and result Horten

Table 2 *The oils physical properties. Viscosity measurements are from the temperature sweep.*

SINTEF ID	IM no.	Viscosity, temp sweep (cP) 10 °C	Viscosity, temp sweep (cP) 50 °C	Density (g/mL) 50 °C (measured)	Density (g/mL) 15 °C (calculated)	Water content (%)	Pour point (°C)
2024-5377	IM-27	23104	282	0.931	0.954	0.1	21
2024-5378	IM-28	36277	110	0.909	0.932	0.1	30
2024-5379	IM-29	932	9.6	0.866	0.890	0.2	21



Koseq Imaros$_2$ – Test and result Horten IM 27 oil

Koseq Imaros$_2$ – Test and result Horten

This oil is very viscous, but the pourpoint is low: 12 ºC. As the water temperature was app. 17 ºC, the oil flowed nicely.

In total we did 6 test runs. The first run brought an oil percentage of only 6. This was due to the setting of the oil collection chamber. Adjusting this (chamber higher, to minimise the water intake) increased the percentage of oil in the recovered mixture quite drastically.

TEST RUN	Current		Waves	Skimmer height		Time		Rec. rate		% oil
1	1	kn	No	350	mm	51	s	44	m^3/h	6
2	1	kn	No	370	mm	70	s	32	m^3/h	40
3	1	kn	No	400	mm	161	s	14	m^3/h	63
4	1	kn	No	390	mm	75	s	30	m^3/h	48
5	1	kn	Yes	390	mm	70	s	32	m^3/h	39
6	1	kn	Yes	390	mm	117	s	19	m^3/h	79

Notes with these test runs:

- Both HPU's had to run slow, and at very low pressures during the test runs.
- Waves helped the oil to flow to the oil collection chamber.
- Run 6 had the highest oil percentage, but this run was not smooth. We could hear the pump also pump a lot of air.

Koseq Imaros$_2$ – Test and result Horten IM- 28 Oil

Koseq Imaros $_2$ – Test and result Horten

This oil is viscous, but not as viscous as the IM-27. The pourpoint is high: 27 ^{0}C. As the water temperature was app. 17 ^{0}C, the oil did not behave like a liquid and formed lumps.

This oil appeared extremely difficult to recover. The screws pushed the first of the oil in the oil collection chamber, but didn't pull the rest of the oil in. The oil didn't flow towards the oil collection chamber.

Increasing the current didn't help, the only difference it did make was that the oil was pulled down below the sweeping arm.

Koseq Imaros$_2$ – Test and result Horten IM-29 Oil

DUTCH INNOVATION
in combating oil pollution

Koseq Imaros$_2$ – Test and result Horten

This oil not very viscous, but the pourpoint is high: 27 ^{o}C. As the water temperature was app. 17 ^{o}C, the oil did not behave like a liquid and formed lumps.

This oil layer builds up from behind: when the oil flows towards the sweeping arm and finally hits it, the layer that touches the arm is thin. The following oil layer is thicker and thicker. This is opposite to IM-28: this one is thick in the front.

Just like with the IM-28, the screws did not have grip on the slick. Increasing the current didn't help much, adding waves however did help.

We did 3 test runs, here an overview of the results:

TEST RUN	Current	Waves	Skimmer height	Time	Rec. rate	% oil
8	1 kn	No	360 mm	274 s	8 m^3/h	70
9	1,5 kn	Yes	360 mm	200 s	11 m^3/h	39
10	1 kn	Yes	360 mm	145 s	16 m^3/h	53

Notes with these test runs:

- Again both HPU's had to run slow, and at very low pressures during the test runs.
- Run 8 had the highest oil percentage, but again this run was not smooth. We could hear the pump also pump a lot of air.

Koseq Imaros$_2$ – Conclusions and lessons learned

Operational limitations that limited final conclusions

- Size of the basin : normally a full size ridgid sweeping arm is pushed against the vessels hull when in forward motion (approx 2 – 3 knots forward speed) , to our and operational team involved this has a huge advantage above the enforced water flow , current and waves in the basin.
- Despite real test with the augers in the oil sand disposal ponds in Canada, the bridge effect as seen during previous skimmer tests had a desastrous impact on the inflow into the pump that was equiped with an adapted suction entrance to guide the oil to the pump. The augers made holes in the oil and had absolutely no possitive impact on the inflow.
- The bridging effect caused the layer of oil to increase away from the pump entrance and eventually fold to dissapear underneath the skimmerboxe.
- Our expectations are that only the pump inflow adaption without any aid in front, it would have worked much better. Koseq may perform this test in an actual opeartional situation with the börger pump as well as with the open impellerpump next year, if we get a permission or situation to try this.
- Expectations are that the water content will increase, which will not a big issue – speed is of the essence with these oils, as a recent spill in europort showed. As soon as the temperature drops it will be more difficult to pump and it starts to behave differently in a saline environment compared to a fresh water envorinment.

Koseq Imaros$_2$ – Conclusions

After 3 days of testing we learned that a lot, and we can conclude that:

- The IM-28 and IM-29 did not form a sticky homogeneous layer as we expected. As the water temperature was way below the pourpoint of the oils, lumps without any cohesion were formed. The screws did not have any grip on it.

- As the test was about to fill a collection tank of only 1,6 m^3, the sweeping arm pump had to run very slow. At full speed the tank would be filled in 18 seconds.

- The highest oil percentages in the recovered mixtures was achieved with the oil collection chamber set high, to minimize the water intake. This makes however that the pump on certain moments will run dry.

- The smoothest run (regarding pump noise) was run 4, where a mixture was pumped that contained 48% oil. This seems to be the optimal setting.

- The screws also had to run at low speed, they had almost no resistance from the oil. The HPU ran about stationary and at minimal pressure.

- Increasing the current above 1 knot caused the oil to dive down and appear on the back of the sweeping arm. This effect is caused because of the relative narrow and indeed test basin, forcing the water stream to go down when encountering the sweeping arm. In open sea a speed of 1,5 to 2 knots is not a problem.

Koseq Imaros$_2$ – Conclusions

SO……we are not quite there yet, more testing in openwater under protected conditions is required and we are discussing with operators and authorities where we can do that next year.

To be Continued and we keep you posted

Thank you for the good Cooperation and team spirit