



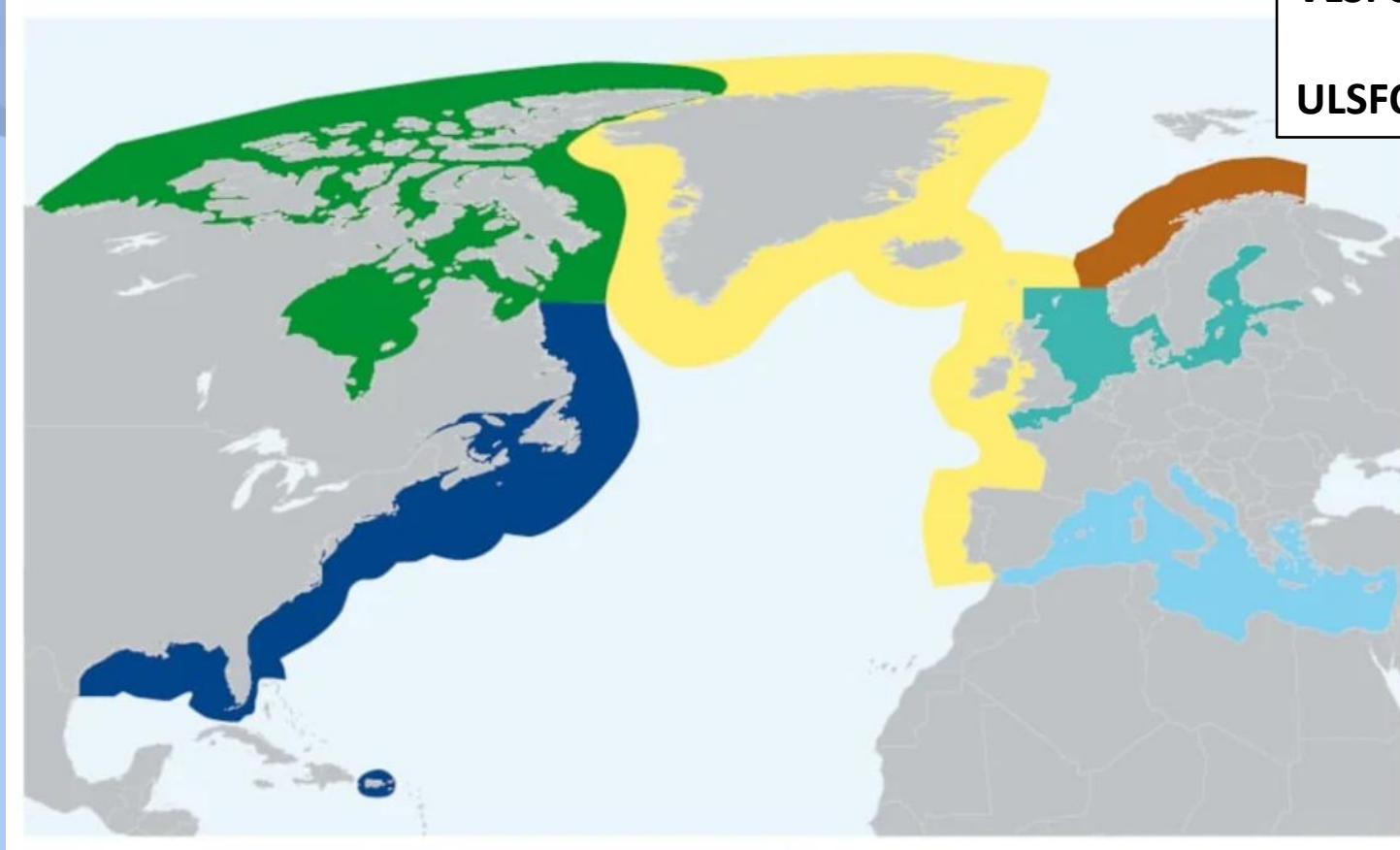
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Forum for framtidens oljevern

Silje Berger, 10. September 2026



MARPOL Annex 6 – Sulphur Emission Control Areas



VLSFO – Very Low Sulphur Fuel Oils – $S < 0,5 \%$

ULSFO – Ultra Low Sulphur Fuel Oils – $S < 0,1 \%$



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- Økt kunnskap om lavsvoveloljers (LSFO) egenskaper ved utslipp, samt bedre beslutningsgrunnlag på alle nivåer i en aksjon mot akutt forurensning fra LSFO
- Forbedre kapasiteter for mekanisk opptak og strandrensing



Prosjektpartnere



Rijkswaterstaat
Ministry of Infrastructure
and Water Management



KYSTVERKET
NORWEGIAN COASTAL ADMINISTRATION

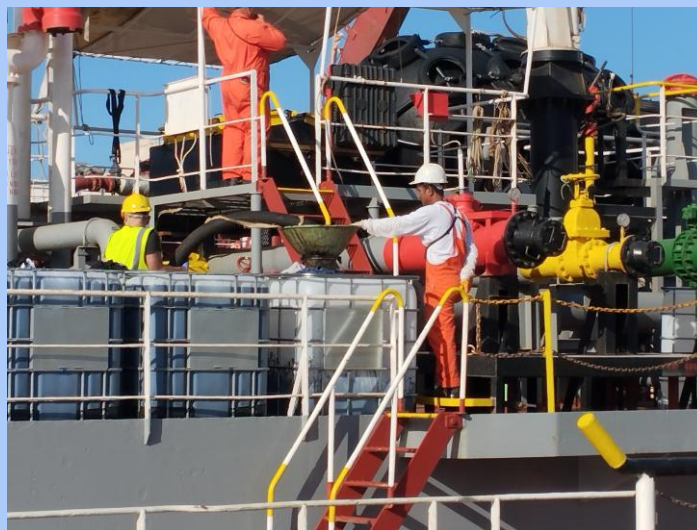


KUSTBEVAKNINGEN



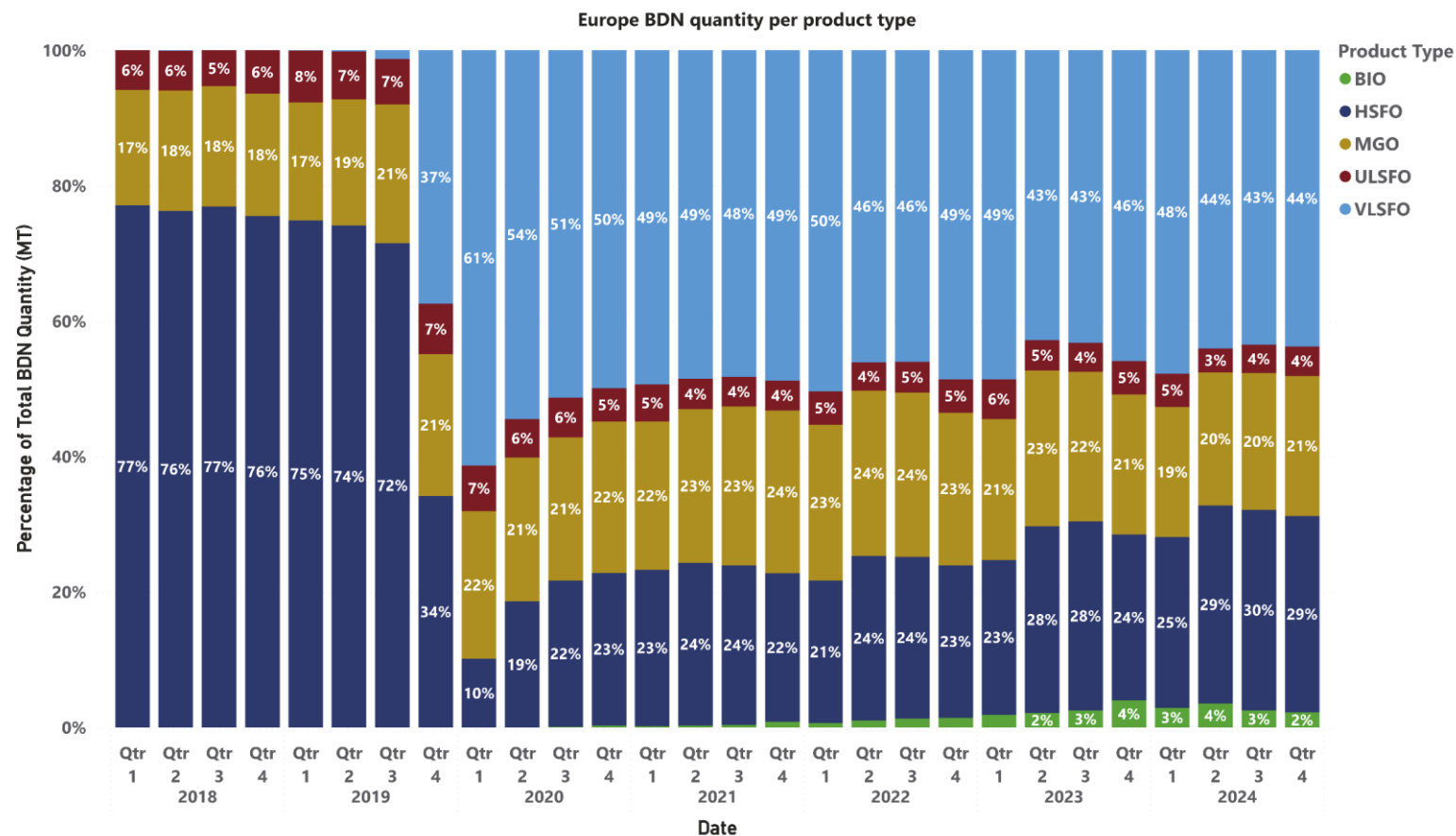
Oljeprøver

- Mer enn 60 oljeselskaper, bunkersleverandører og havner forespurt om prøver
- Residual LSFOS – ulike “blends”
- 16 “små” prøver til WP3 “chemical characterization”
- 3 “store” prøver for utvidede tester, 2 VLSFO, 1 ULSFO



Bunker Delivery - Europa

Data fra VPS



Prøver

19

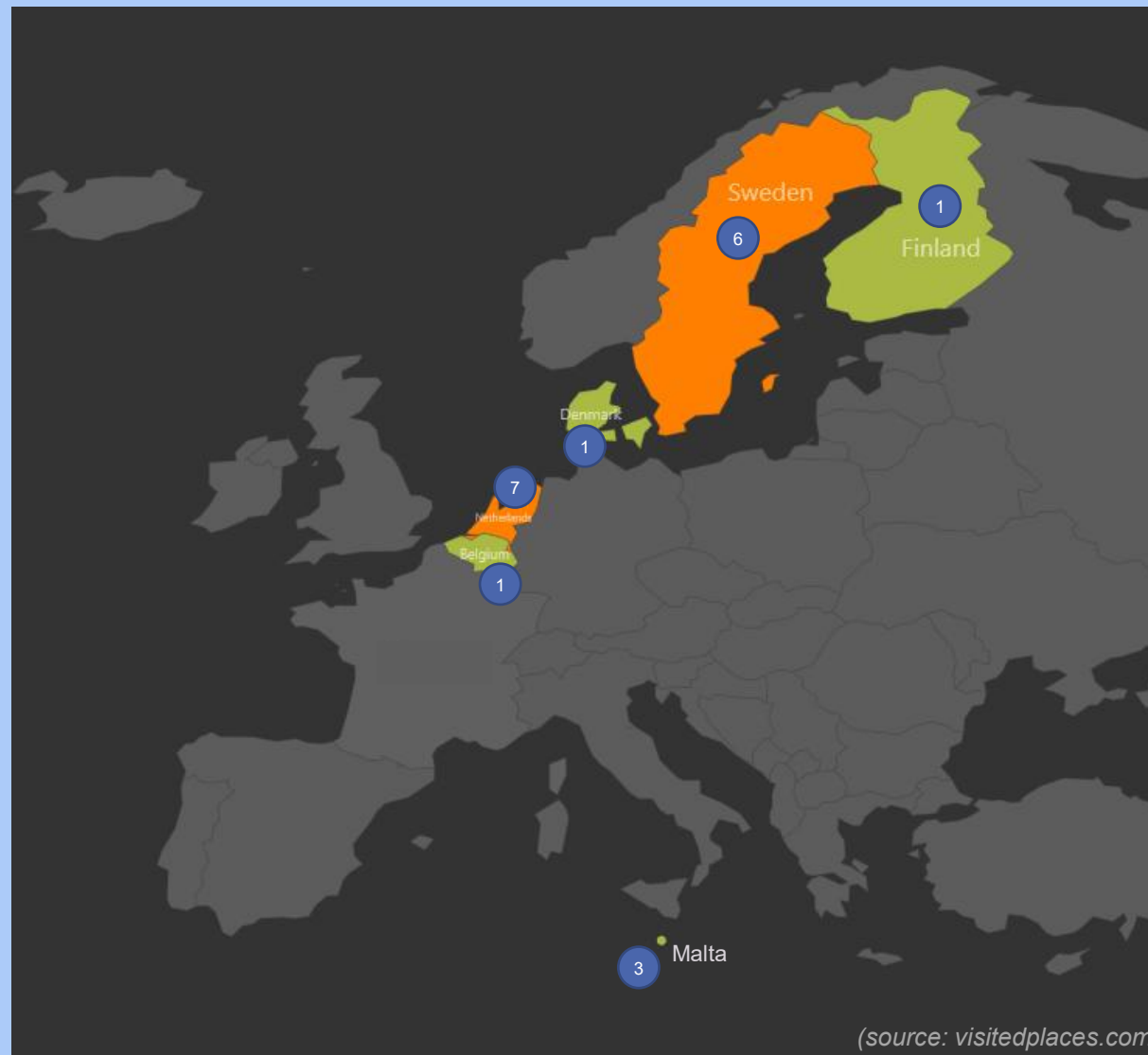
16 små, 3 store

❑ 6 land (FI, SE, DK, NL, BE, MT)

5 ULSFO

14 VLSFO

❑ Raffinerer og
bunkersleverandører



Ved ~20°C:

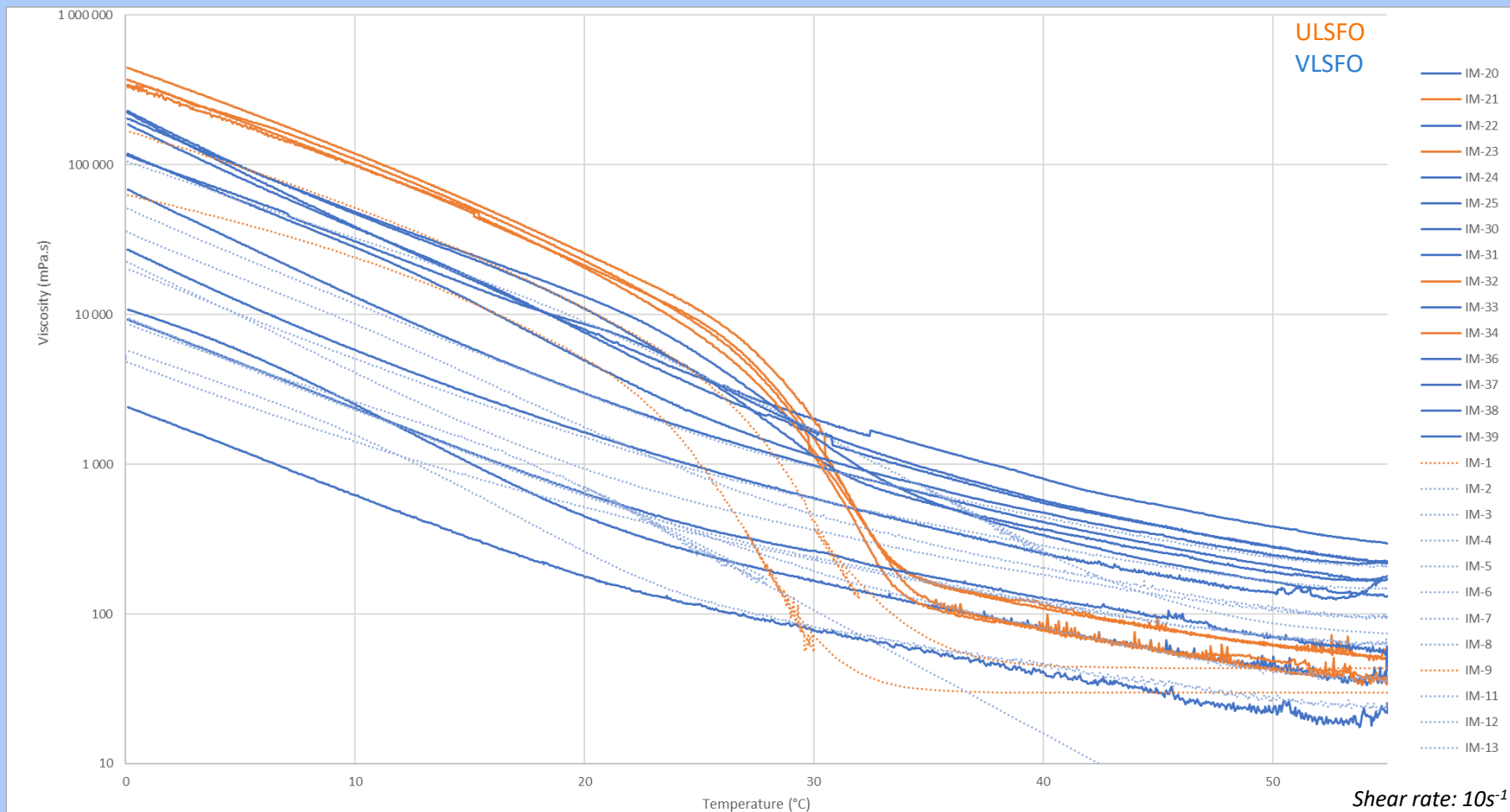
- 9 flytende
- 10 ikke flytende

Viskositet

Små prøver

Stiplede linjer:
IMAROS

Heltrukne linjer:
IMAROS 2



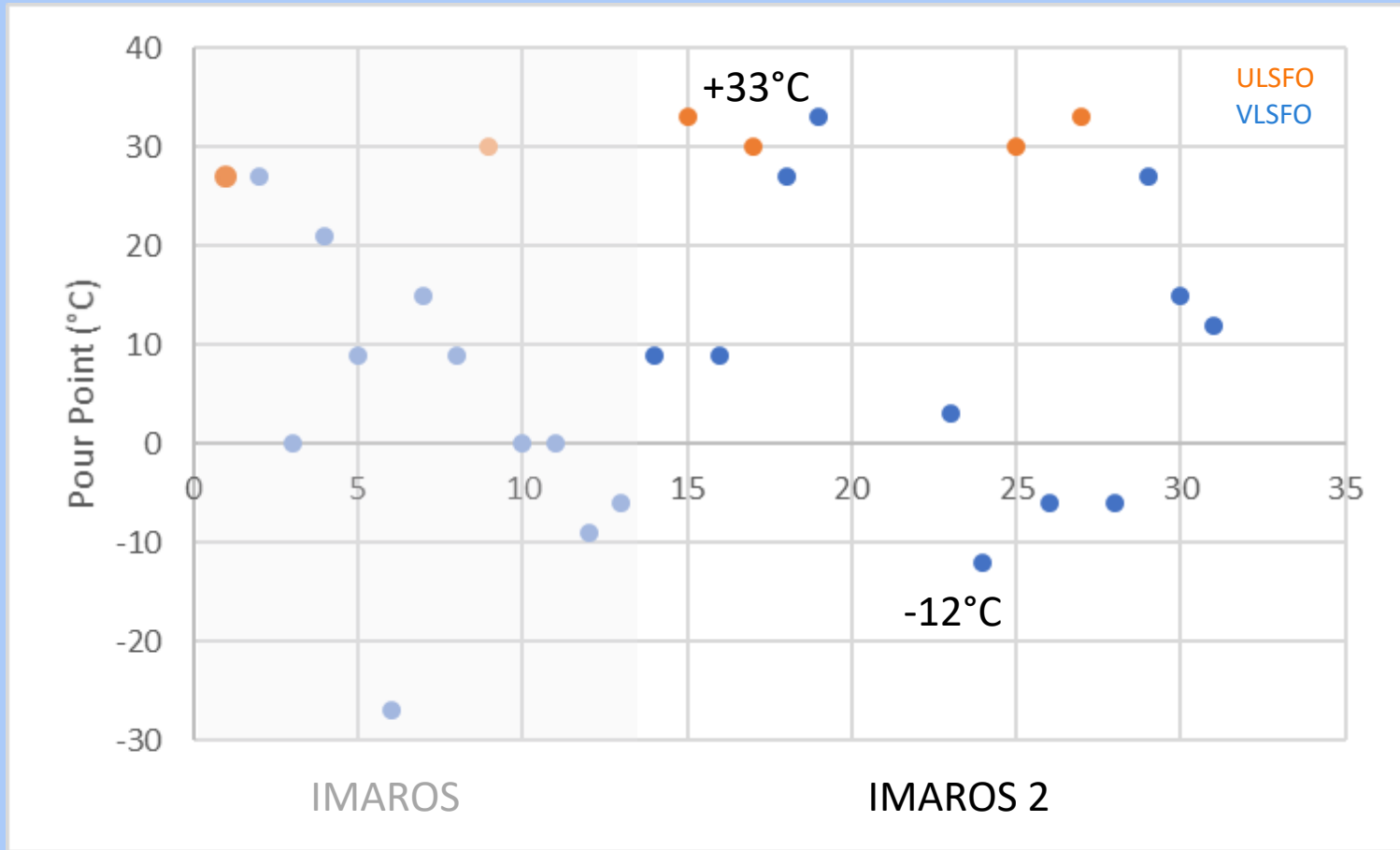
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Cedre



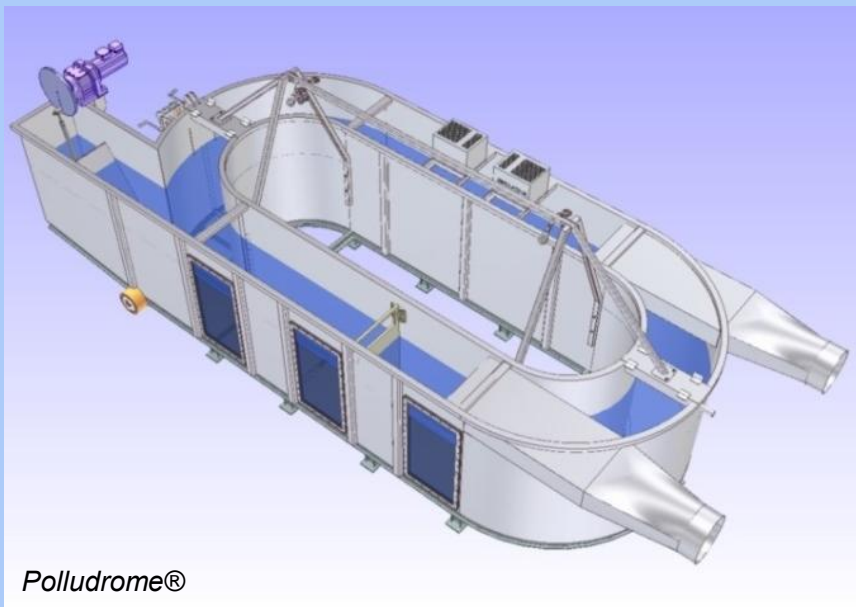
Pour Point

Små prøver



Forvitring - store prøver

	Visc. 50°C CoA from suppliers (mm ² /s)	Pour point Cedre (°C)	Density 15°C	Visc. 5°C (10s ⁻¹ , mPa.s)	Visc. 25°C (10s ⁻¹ , mPa.s)	Evaporation rate (% vol.)	Asphaltenes (%)	Waxes (%)
IM27 (VLSFO)	322	9	0.96	165 205	7 592	3	2.1	7.6
IM28 (VLSFO)	124	24	0.94	249 952	21 221	1	1.5	14.1
IM29 (ULSFO)	39	18	0.89	42 782	331	8	0.4	13.3



3 testbetingelser for hver olje:

5°C i sjøvann

5°C i ferskvann

25°C i sjøvann

IM-28, 5°C, Sjøvann

+1h



+144h



	Fresh oil	Weathered oil
Viscosity (mPa.s)	250 000	380 000
Density	0.94	0.97
Water content (%)	-	40

Dispergering – fersk olje

IM-27

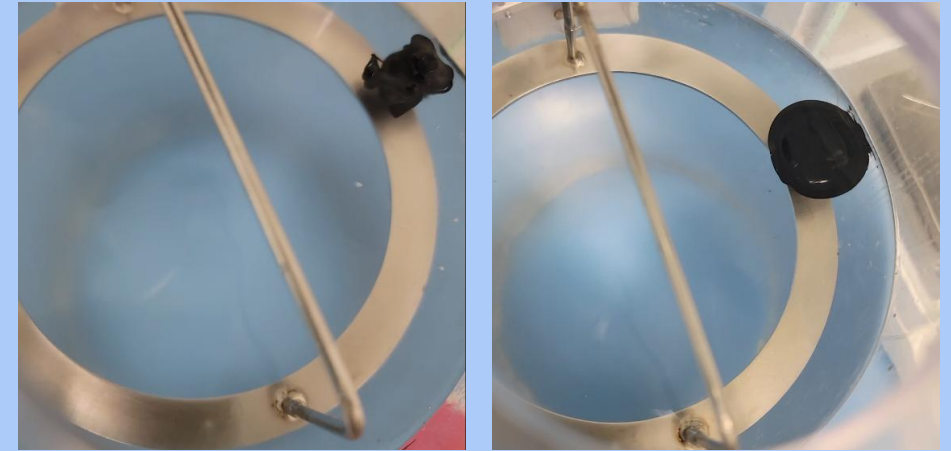


IFP test – 5°C

IFP test – 25°C

	Visc. 5°C (10s ⁻¹ , mPa.s)	Visc. 25°C (10s ⁻¹ , mPa.s)
IM27	165 205	7 592
IM28	249 952	21 221
IM29	42 782	331

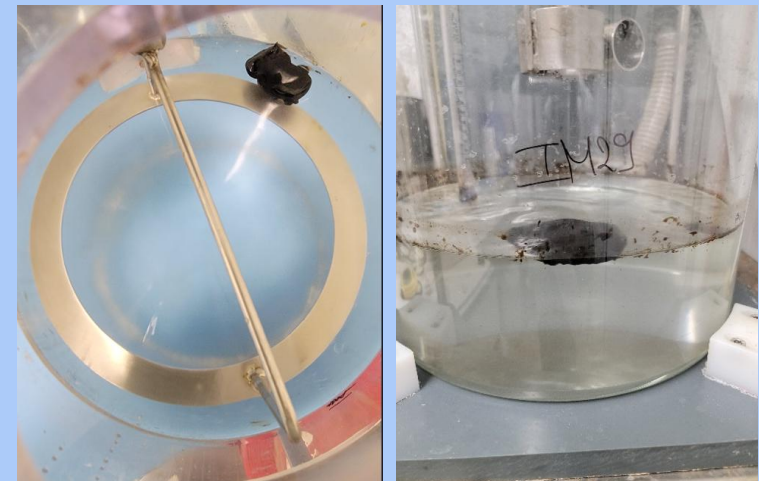
IM-28



IFP test – 5°C

IFP test – 25°C

IM-29



IFP test – 5°C

MNS test – 25°C

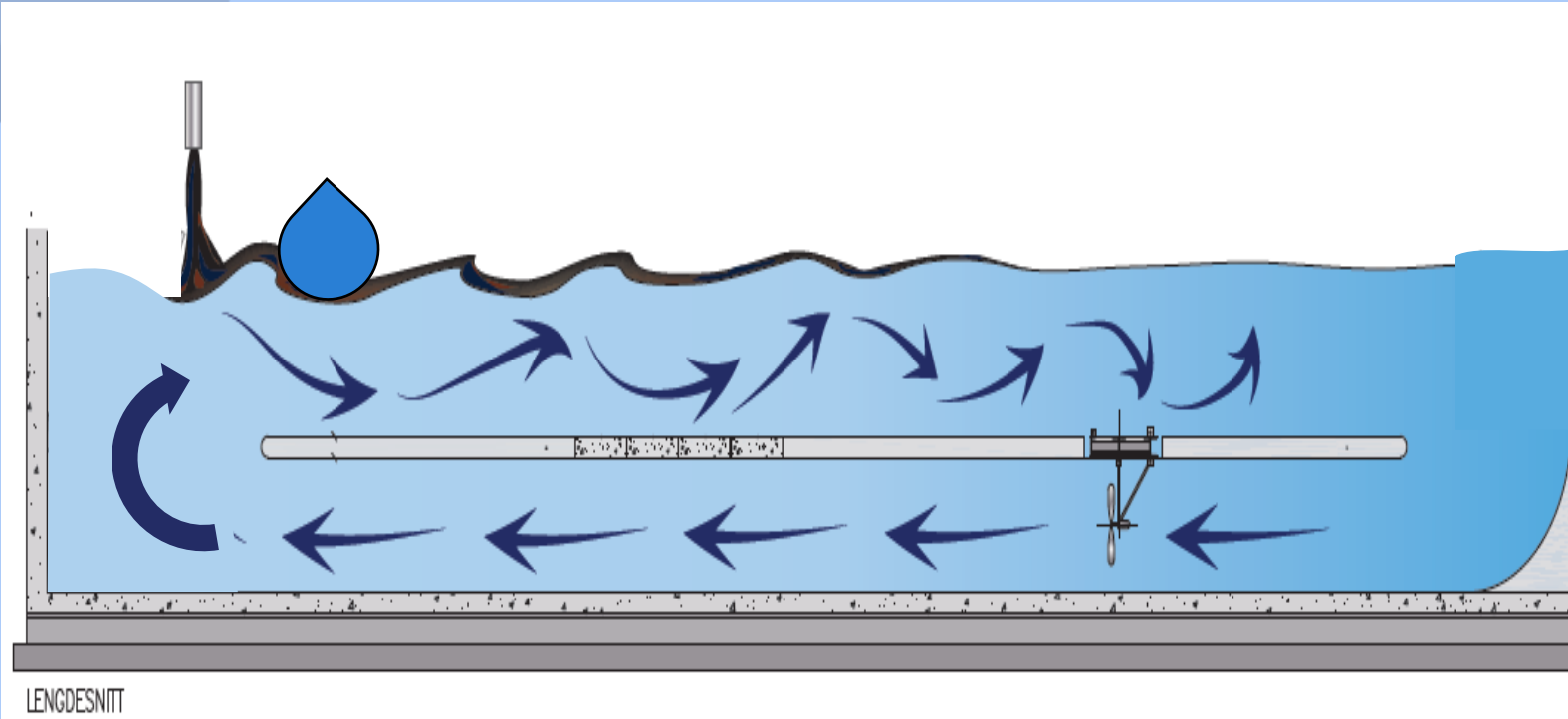
Mekanisk opptak

- Leverandørkonferanse arrangert av Kustbevakningen
- Invitasjon til å bidra inn i prosjektet:
 - 11 selskaper meldte sin interesse
- Prosess med alle prosjektpartnerne for å velge ut de mest lovende og relevante konseptene
 - 3 konsepter for testing i Horten (2 testperioder)
 - 2 konsepter for testing i Kotka (isforhold)
 - 1 konsept for testing i Horten med modifisert testoppsett
- Målinger av personellets eksponering for olje (STAMI)





Nasjonalt senter for testing av oljevernutstyr



- Lengde 30m
- Bredde 7m
- Dybde 4.4m
- Strøm 3 - 4 knots
- Bølgehøyde 1.1m

Testoljene

Imaros 2 ID	Oil type	Viscosity of fresh oil, temp sweep (cP)		Viscosity of emulsion at 10°C (10s ⁻¹)	Pour point of fresh oil (with max. and min.)
		10°C	50°C		
IM-27	VLSFO	23104	282	9998 – 42548	21 (9, 21)
IM-28	VLSFO	36277	110	21386 – 54734	30 (21, 27)
IM-29	ULSFO	932	9.6	12173 – 18492	21 (15, 24)

This creates difficulties
for recovery equipment.



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Testing under isforhold - Kotka, Finland



- Testing av skimmer under vinterlige forhold
- Opptak av VLSFO (IM-27) fra is
- Testen simulerer is i farled etter isbryting
 - Air temperature: -2,0°C
 - Water temperature: 0°C

Testing under isforhold - Kotka, Finland



WP5 – Strandrensing



T5.1 - Rock cleaning

Effektivitet av rengjøring ved bruk av høytrykksspyling



T5.2 - Efficiency of cleaning agents

Effektivitet av strandrensemiddel og høytrykksspyling



T5.3 - Natural recovery and rock colonisation by biota

Rekolonisering av steinfliser og nedbrytning av olje under ulike miljøforhold

WP5 – Strandrensing



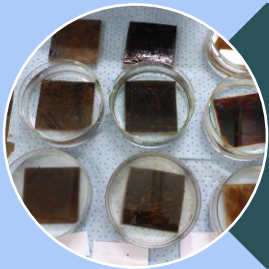
T5.4 - Interaction with sediments

Adhesjon og nedtrengning i løse sedimenter



T5.5 - Observations on practical cleaning techniques

Evaluerer av ulike praktiske metoder for strandrensing



T5.6 - Release and toxicity of oil absorbed in rocks

Utlekking av olje fra forurensede fliser og effekter på alger og hoppekreps.

Strandrensning på hardt underlag



	Mass of oil recovered after drying (g)	Oil recovered after drying (%)
IM-27	2.2	72
IM-28	1.0	36
IM-29	0.6	24
HFO	2.5	89

Strandrensing på hardt underlag

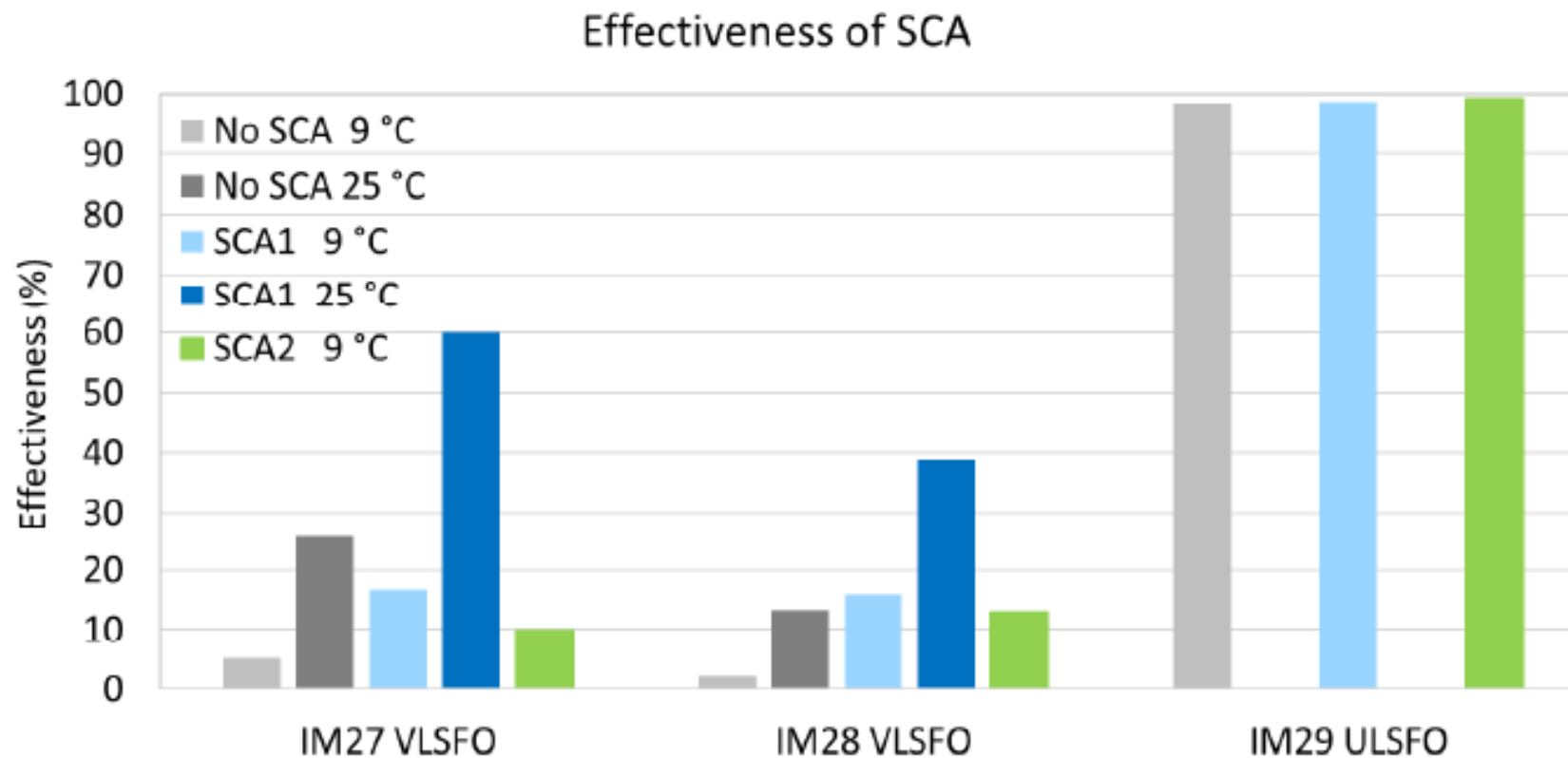


Spyling av flisene:
2 temperature (~15°C / 50°C)
2 trykk (50 bars / 100 bars)

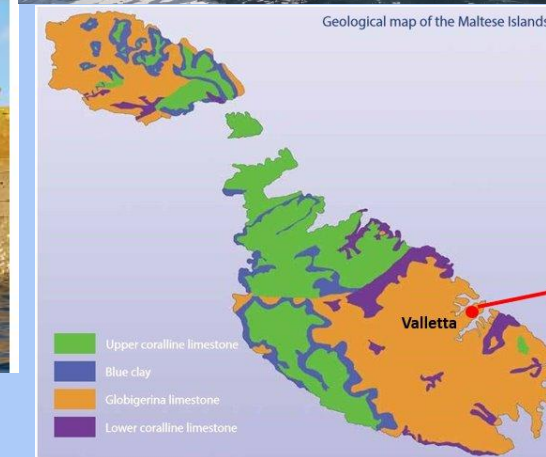
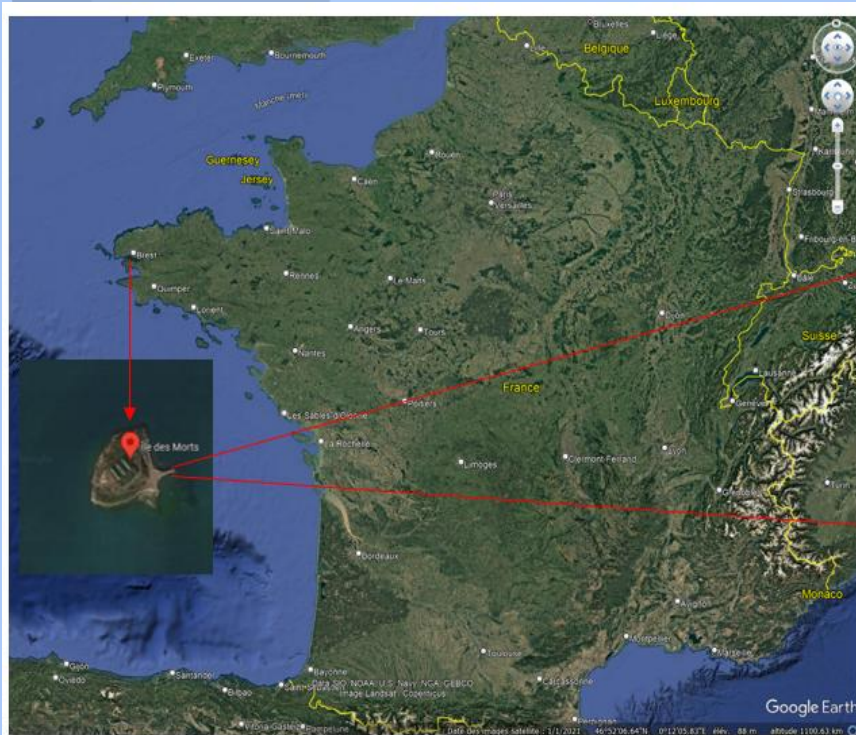
- + Kontroller: Forurensset, Ikke vasket

$$\text{Cleaning efficiency} = \frac{\text{amount of oil extracted after the washing robot cleaning}}{\text{amount of oil extracted from the control tiles}}$$

Effektivitet av strandrensemidler



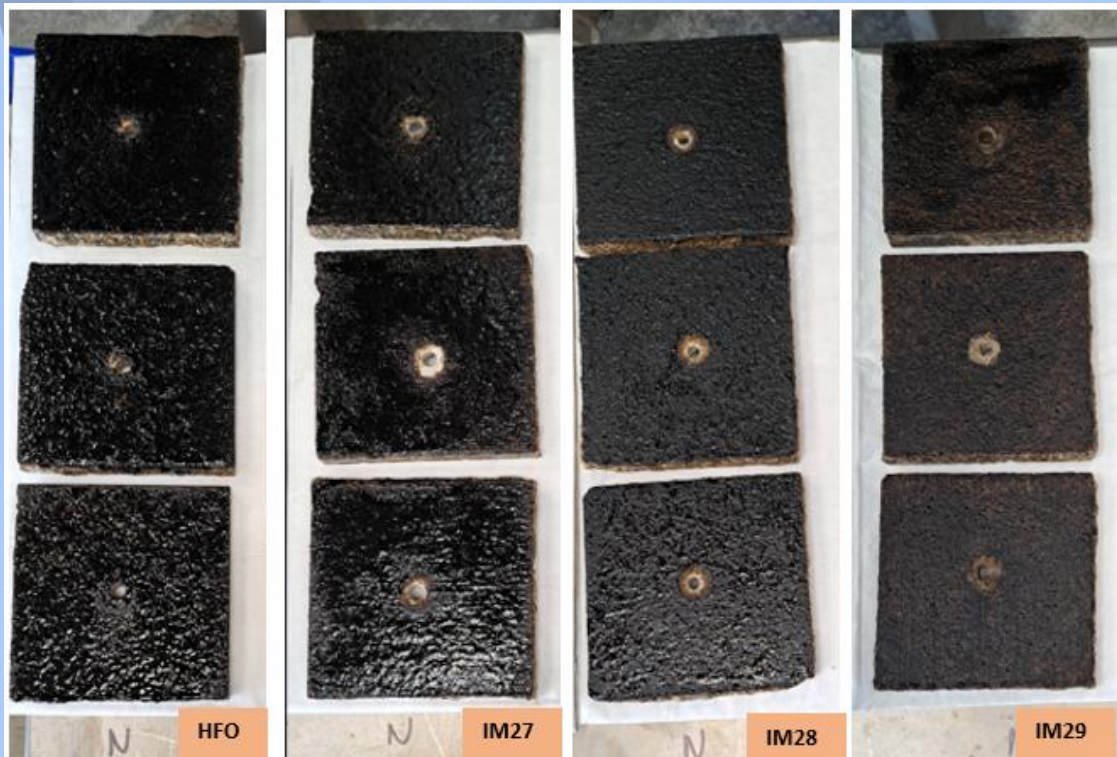
Nedbrytning av olje og rekolonisering på hardt underlag



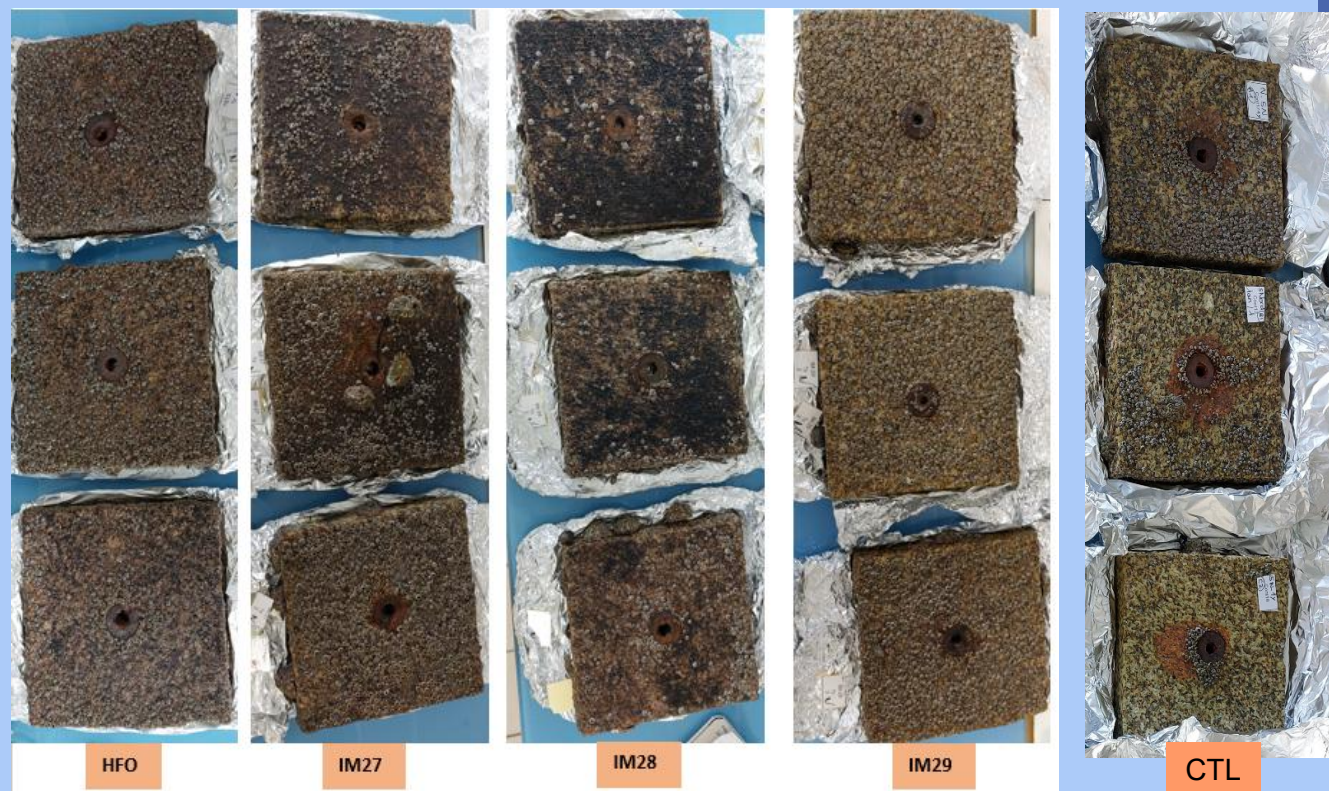
Nedbrytning over tid

France
North Face

T0



Tf (+ 11 months)



Test av strandrenseteknikker i containerløsning



Adjustable angle of the shoreline

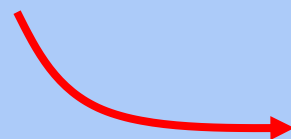
Artificial shoreline

Småskalatest – Tromling





11.June 2025



23.October 2025

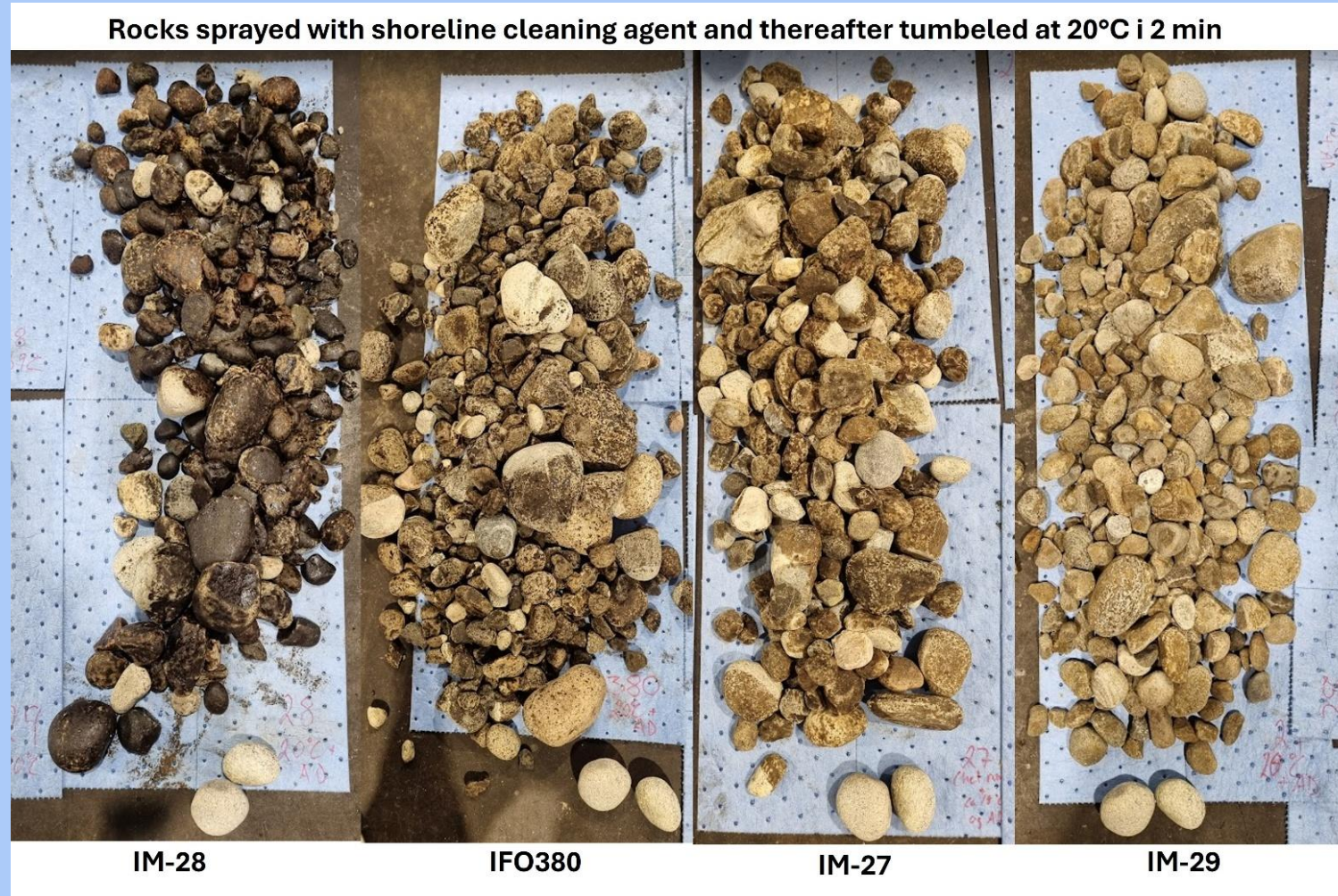
Forvitring over tid

imaros₂

11.August 2025



Forvitring over tid - tromling



Oppsummering strandrensing

- Stor variasjon i lavsvoveloljenes egenskaper gir mange ulike scenarioer for strandpåslag, fra faste klumper til inntrengning i underlaget
- Tradisjonelle strandrensemetoder fungerer, men
 - Effektivitet kan være svært temperaturavhengig
 - Fare «re-attachment» da noen LSFO er svært klebrige
- Testing og verifisering av metode i felt



Veiledningsdokumenter



Version: 1.0 (28.11.2025)



OPERATIONAL GUIDELINES – SEA OPERATIONS

CHALLENGES WITH RECOVERING LOW SULPHUR FUEL OILS AT SEA

LSFOs slick behaviour

LSFO slicks at the sea surface may behave differently than conventional oils depending on the LSFO's physical-chemical properties and temperature.

LSFOs may appear as either fluid, semi-solid or solid slicks at the water surface. This is highly related to the variability in pour point of LSFOs. Some LSFOs may not form a slick at all but appear as small solid lumps in the water.

Some LSFOs have been observed to submerge in the water column, and reappear to the water surface, creating challenges with detection and containment.

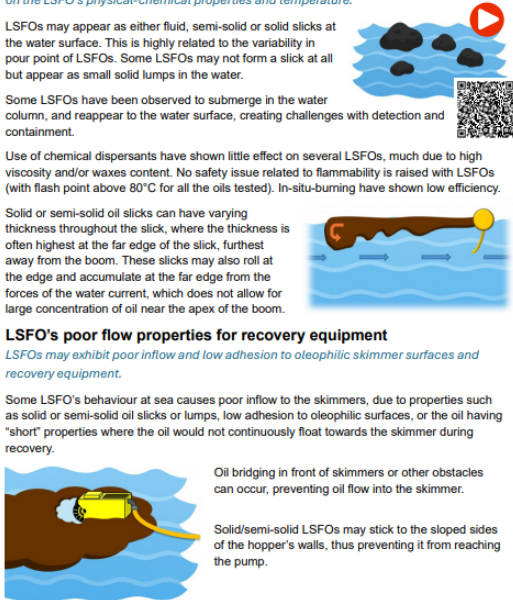
Use of chemical dispersants have shown little effect on several LSFOs, much due to high viscosity and/or waxes content. No safety issue related to flammability is raised with LSFOs (with flash point above 80°C for all the oils tested). In-situ-burning have shown low efficiency.

Solid or semi-solid oil slicks can have varying thickness throughout the slick, where the thickness is often highest at the far edge of the slick, furthest away from the boom. These slicks may also roll at the edge and accumulate at the far edge from the forces of the water current, which does not allow for large concentration of oil near the apex of the boom.

LSFO's poor flow properties for recovery equipment

LSFOs may exhibit poor inflow and low adhesion to oleophilic skimmer surfaces and recovery equipment.

Some LSFO's behaviour at sea causes poor inflow to the skimmers, due to properties such as solid or semi-solid oil slicks or lumps, low adhesion to oleophilic surfaces, or the oil having "short" properties where the oil would not continuously float towards the skimmer during recovery.



Oil bridging in front of skimmers or other obstacles can occur, preventing oil flow into the skimmer.

Solid/semi-solid LSFOs may stick to the sloped sides of the hopper's walls, thus preventing it from reaching the pump.







Version: 1.0 (22.12.2025)



OPERATIONAL GUIDELINES – SHORELINE OPERATIONS

BEHAVIOURS AND CHALLENGES WITH SHORELINE CLEANING OPERATIONS OF LOW SULPHUR FUEL OILS (LSFO)

Physical-chemical properties of LSFOs are highly variable, especially the pour point which can range from -10°C to more than 30°C. LSFO's behaviour will differ from one oil to another and will be highly temperature dependant.

When spilled at sea, weathering can cause LSFOs to progressively emulsify, forming larger viscous patches. Additionally, some LSFOs may break apart and solidify into small granular tarballs, resulting in diffuse shoreline pollution spreading over a wide area. This behaviour complicates detection, making oil patches difficult to locate and increasing the likelihood of remobilisation.

Depending on the oil's nature, weathering time at sea, and temperature, LSFOs can interact with the sediment as fluid, small fragmented tarballs or semi-solid highly viscous slicks (Fig. 1 and Fig. 2):

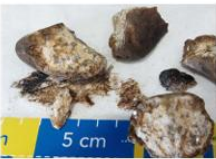
- Wash-up of fresh and fluid LSFOs may lead to full penetration of the LSFOs on sediment beaches (sand and pebbles).
- Solid/semi solid LSFO might melt into the sediments and thereafter solidify again – making it harder to find and remove.



Fig. 1: Full penetration of a fluid LSFO in sandy sediment.

Fig. 2: Semi-solid LSFO on sandy sediment. Can be rolled and leave the sediment clean.

Some LSFOs are very sticky, especially to man-made surfaces such as metal and painted surfaces, which can complicate cleaning operations. LSFOs take-off from pebbles can also re-attach to other substrates if not efficiently flushed with water, leading to re-contamination and reduced effectiveness of flushing or surfwashing operations.



Penetration into rocks may occur, depending on the LSFOs and the rock natures. This phenomenon seems specific to this type of oils (Fig.3).

Recolonisation of polluted substrates by algae and biota is observed with time (Fig.5). Release of soluble and toxic compounds from lightly polluted hard substrates will most likely not induce higher toxicity than traditional heavy fuel oils.





Takk for oppmerksomheten!

IMAROS 2:

<https://civil-protection-knowledge-network.europa.eu/projects/imaros-2>

<https://www.kystverket.no/oljevern-og-miljoberedskap/forskning-og-utvikling/imaros-2/>

Takk til:

LAMOR, DESMI, VIKOMA, KOSEQ and NEW NAVAL

IMAROS 2 er støttet av EU under UCPM-2023-KAPP, prosjektnummer 101140015

