

■ imaros

Final conference

A black silhouette of a single oil drop with a small white dot in the center.

Task 3.2 – Weathering of 3 VLSFO

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Task 3.2 : Oil Weathering

Laboratory protocols:

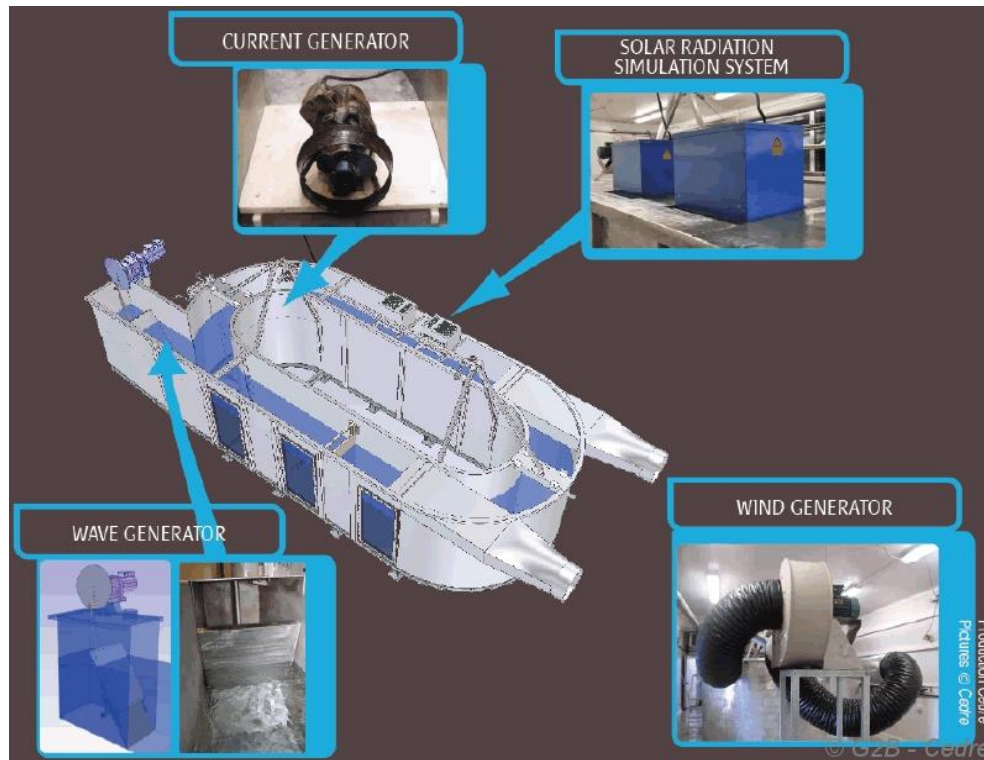
- asses oil weathering and get information (time-window of opportunity for dispersant use, evaporation by distillation at various temperatures, creation of water-in-oil emulsions): 17 samples representative of potential evolutions at sea
- do not take into account all the parameters simultaneously, which are affected by the interactions between various phenomena

Characterisations	Fresh Oil	Residues of distillation (vapors temperature)			
		150°C+	200°C+	250°C+	250°C ph. ox.
Volume topped (%)	-	m	m	m	-
Residue (% wt.)	-	m	m	m	-
Specific gravity	m	m	m	m	m
Pour Point (°C)	m	m	m	m	m
Flash Point (°C)	m	m	m	m	m
Viscosity (mPa.s)	m	m	m	m	m
Viscosity of 50% emulsion (mPa.s)	-	m	m	m	m
Viscosity of 75% emulsion (mPa.s)	-	m	m	m	m
Viscosity of max. water emulsion (mPa.s)	-	m	m	m	m
Maximum water content (%)	-	m	m	m	m
Halftime for water uptake (hours)	-	m	m	m	m
Wax / Asphaltenes	c	c	c	m	-
True Boiling Point (TBP) curve up to 250°C					



Task 3.2 : Oil Weathering

Meso-scale (Polludrome®): Simulates the various processes realistically and simultaneously



Parameters followed:

- Viscosity
- Density
- Evaporation
- Emulsification
- Flash point
- Treatment possibilities (oil dispersibility and oil adhesion)

Typical sampling times

Sample reference	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16
Time (hours)	0	1	2	4	6	8	14	22	26	30	48	53	72	77	96	101	168

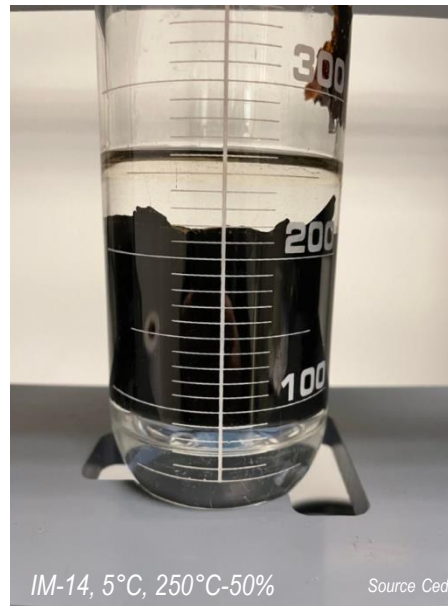
Task 3.2 : Oil Weathering / Laboratory results

Fresh oils	IM-5	IM-14	IM-15
Evap. (% vol.)	9.5	1.0	9.6
Pour point (°C)	+ 15	+ 27	+ 3
Flash point (°C)	90	> 100	94
Asphaltenes (% wt.)	0.6	0.8	1.3
Waxes (% wt.)	8.9	10.5	18.0
Density 5°C / 15°C	0.92 / 0.91	0.94 / 0.94	0.96 / 0.95
Viscosity fresh (mPa.s) 5°C (10 s ⁻¹)	3 051	71 747	19 406
Viscosity fresh (mPa.s) 15°C (10 s ⁻¹)	507	17 121	4 305

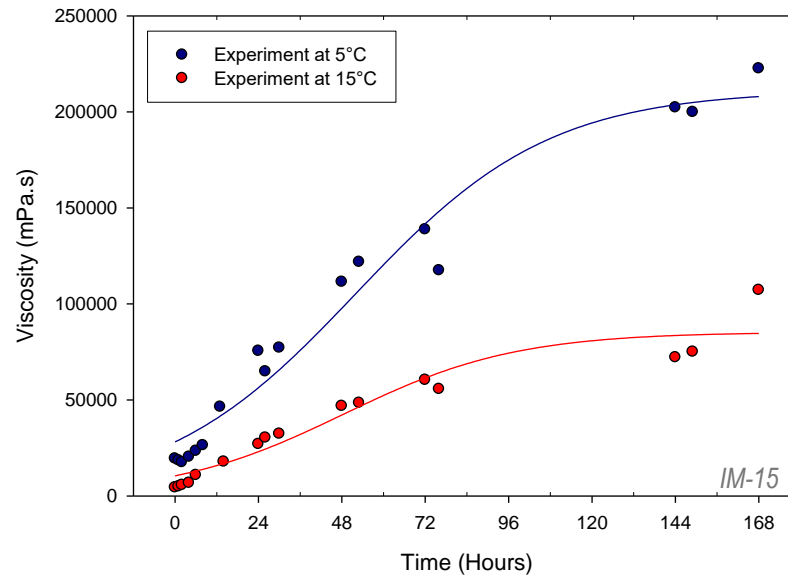
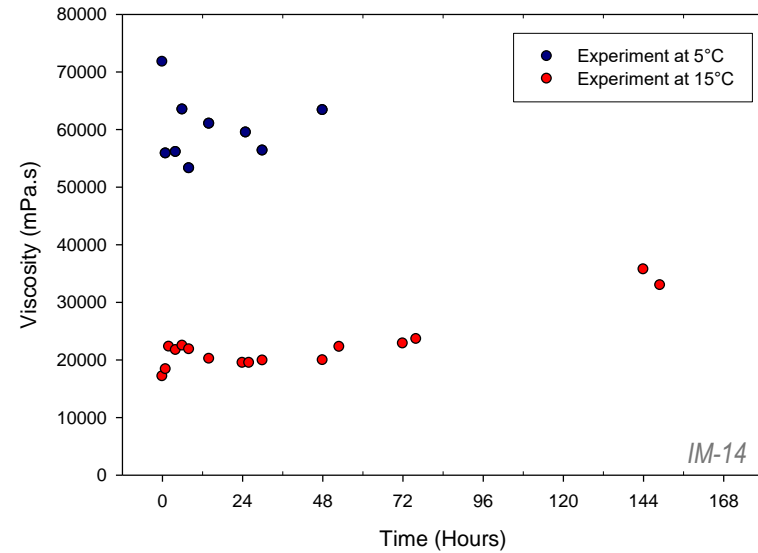
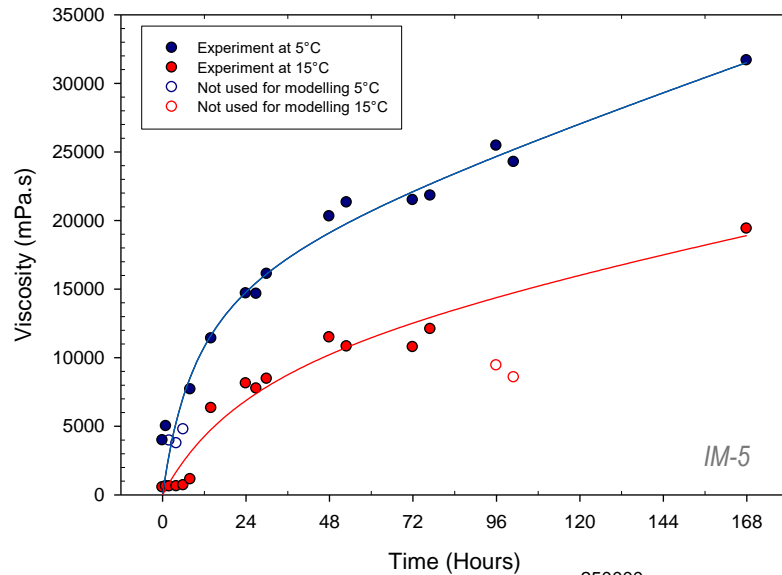
- Values in agreement with Task 3.1
- Shear thinning behaviour
- Difficulty to obtain an homogeneous sub-sample (waxes)

Weathering at the laboratory scale

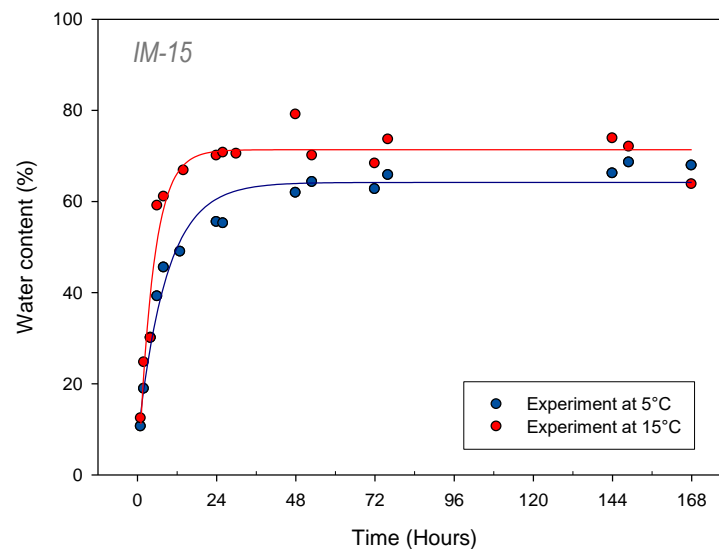
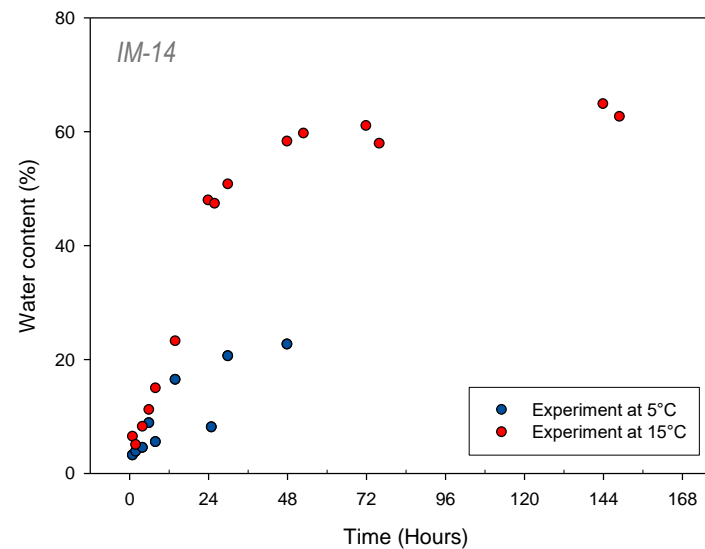
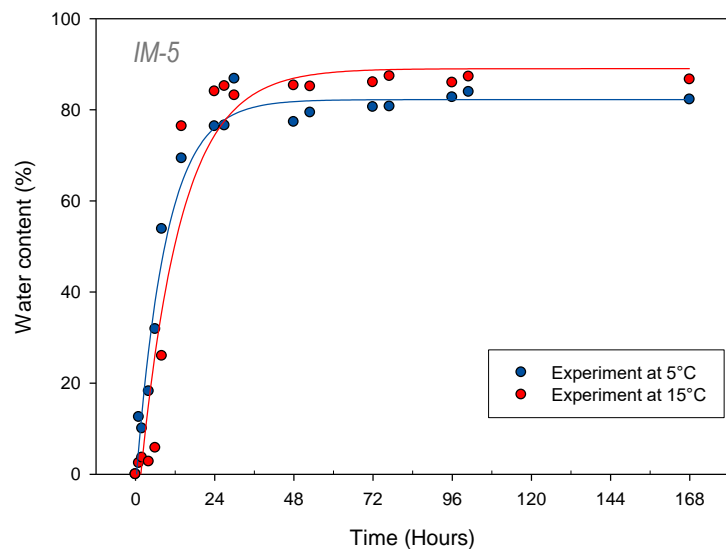
- Difficulties generally encountered to form emulsions on viscous oils (and also on VLSFO...)
- Some emulsions could not be formed (the oil froze in the rotary funnels, IM-14)



Task 3.2 : Oil Weathering / Pilot scale results



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Task 3.2 : Oil Weathering / pilot scale results

IM – 5 / 15°C



T0

Viscosity (10 s^{-1}) $\sim 500 \text{ mPa.s}$



Tf

Viscosity (10 s^{-1}) $\sim 19\,000 \text{ mPa.s}$

Density = 0.997

Water content = 87 %

Evaporation $\sim 8 \%$

Task 3.2 : Oil Weathering / pilot scale results

IM – 14 / 15°C



T1

Viscosity (10 s^{-1}) $\sim 17\,000 \text{ mPa.s}$



Tf

Viscosity (10 s^{-1}) $\sim 33\,000 \text{ mPa.s}$

Density = 0.92

Water content = 72 %

Evaporation $\sim 1 \%$



Task 3.2 : Oil Weathering / pilot scale results

IM – 15 / 15°C



T0

Viscosity (10 s^{-1}) $\sim 4\,300 \text{ mPa.s}$



Tf

Viscosity (10 s^{-1}) $\sim 80\,000 \text{ mPa.s}$

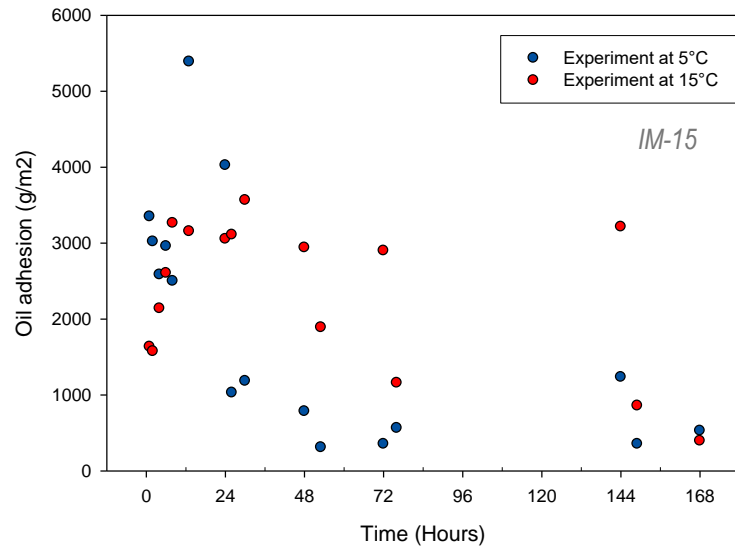
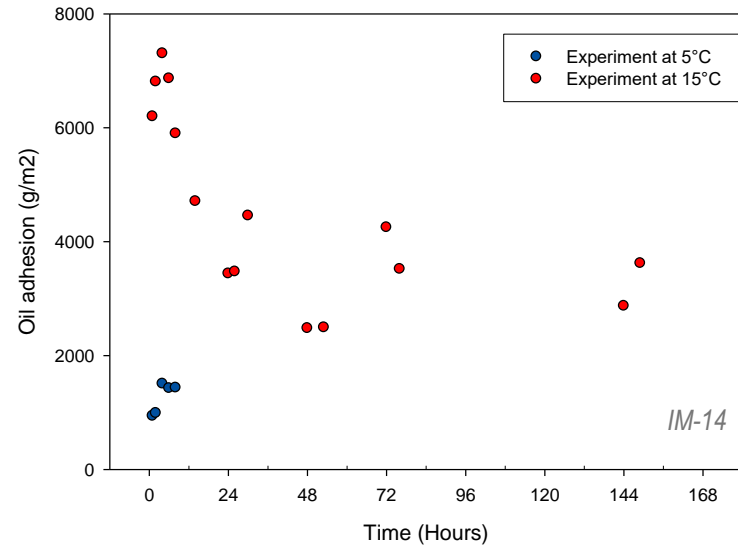
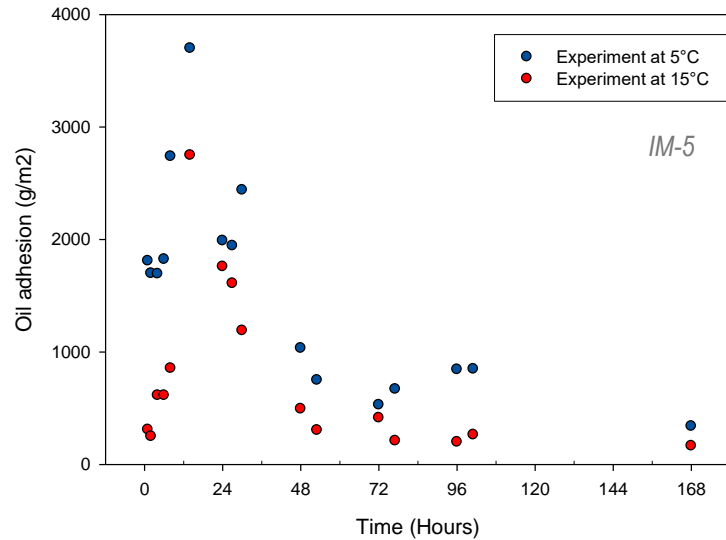
Density = 0.99

Water content = 60 %

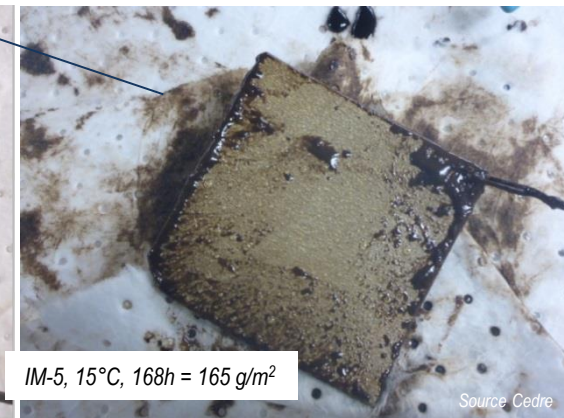
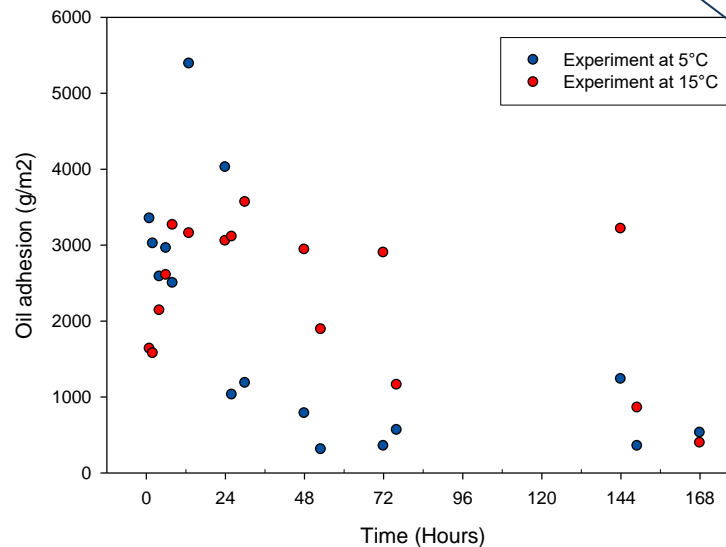
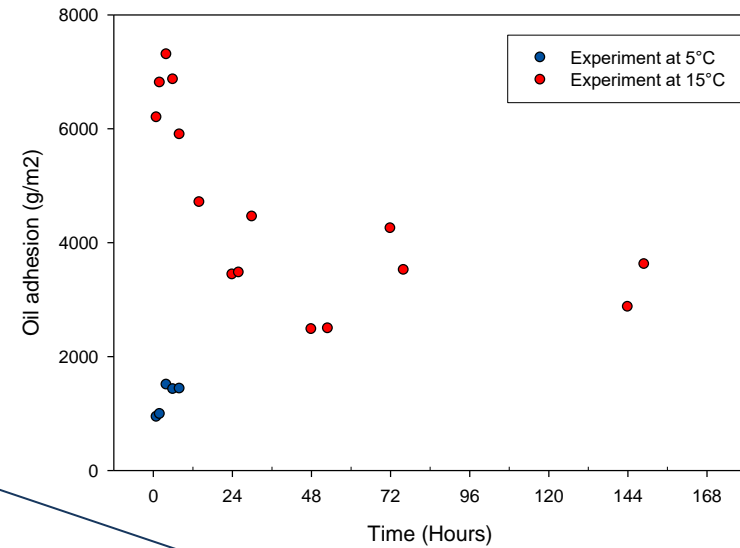
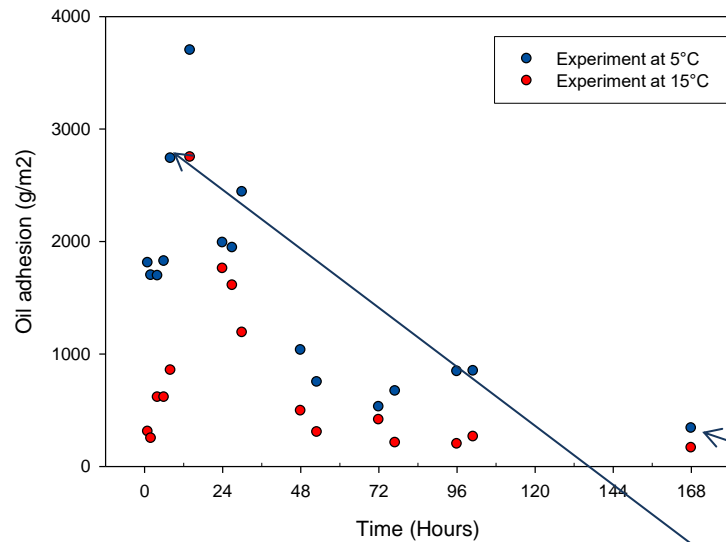
Evaporation $\sim 10 \%$



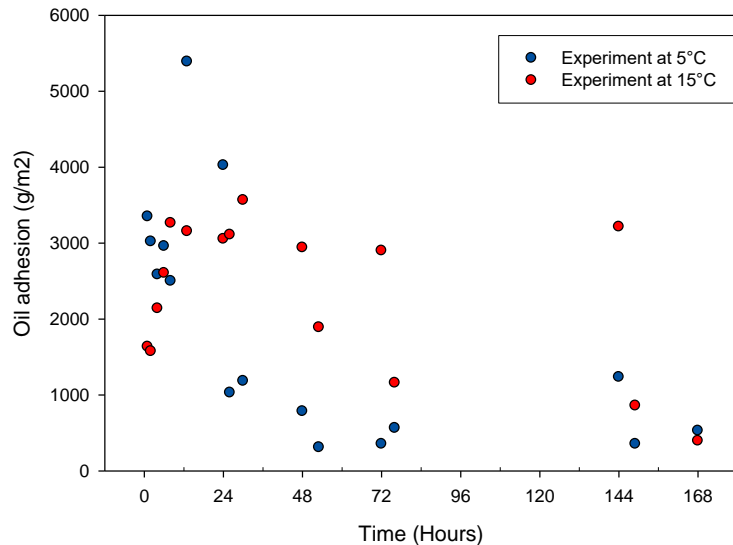
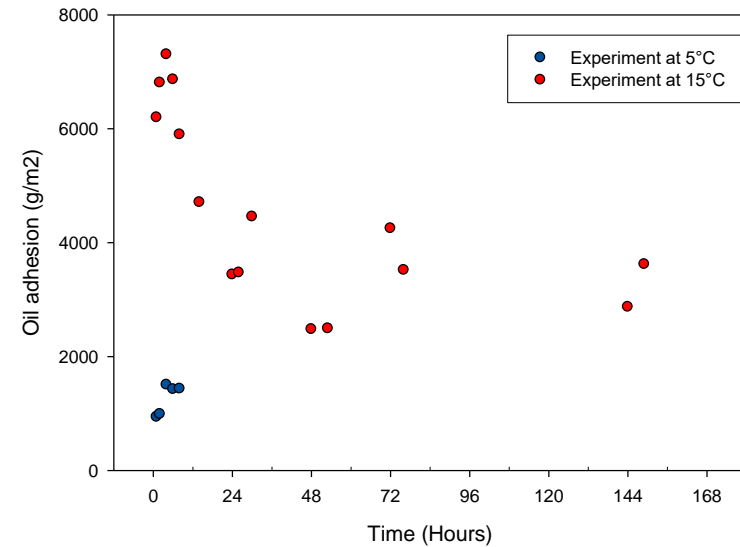
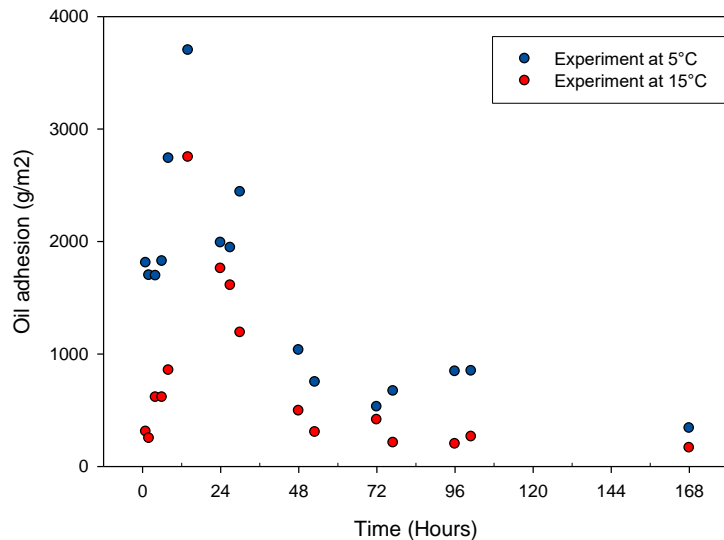
Task 3.2 : Oil Weathering / Pilot scale results / Oil adhesion



Task 3.2 : Oil Weathering / Pilot scale results / Oil adhesion



Task 3.2 : Oil Weathering / Pilot scale results / Oil adhesion



Good adhesion on oleophilic plate during the first 24 hrs.

After 24 hrs: uncertainties

Task 3.2 : Oil Weathering / Pilot scale results / Dispersibility

Efficiency (%)	Dispersible	Possibly dispersible	Poorly dispersible
IFP	> 50	20 - 50	< 20
MNS	> 70	15 - 70	< 15

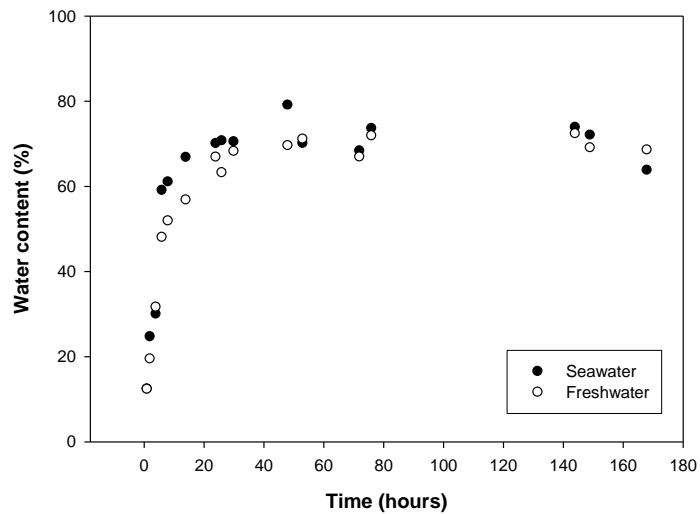
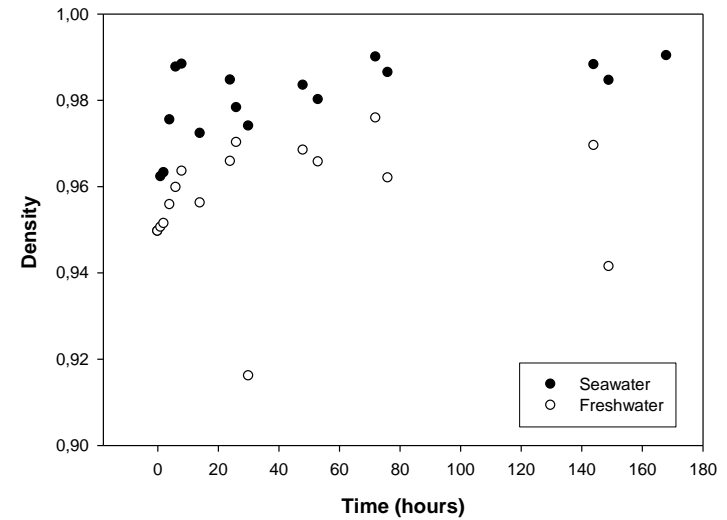
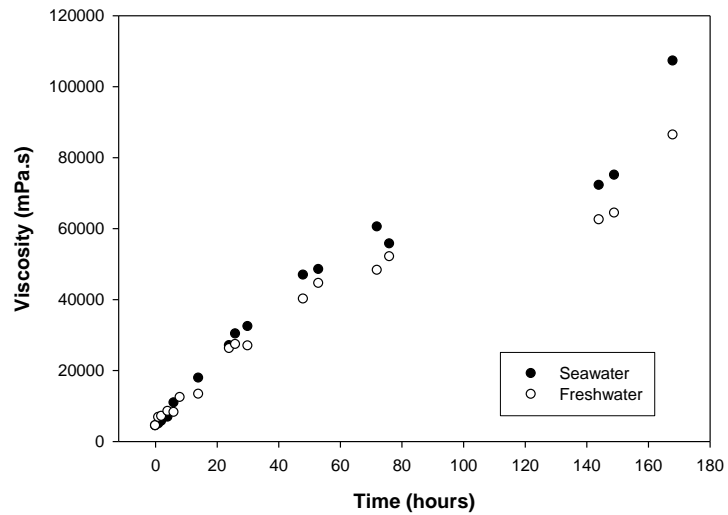
Sample	Temp. (°C)	IM-5		IM-14		IM-15	
		IFP	MNS	IFP	MNS	IFP	MNS
Fresh	5°C	53	66	0	0	12	0
	15°C	56	44	0	0	(42) *	(21) *
200°C-50°C	5°C	15	23	nd	nd	4	0
	15°C	37	39	nd	nd	11	1
250°C-75%	5°C	0	11	nd	nd	0	nd
	15°C	0	5	0	0	nd	nd
250°C- photoox- max%	5°C	0	2	nd	nd	nd	nd
	15°C	0	4	nd	nd	nd	nd
CONCLUSION		Dispersible when fresh		Not dispersible		Not dispersible	



* do not represent real dispersion but rather fragmentation / big droplets

- Same conclusion as from Task 3.1: Dispersibility limited at the studied temperatures

Results Freshwater IM-15



Tf



- **Variability** of the samples confirmed
- **Safety**: No flammability issues. Emergency response staff should wear appropriate PPE
- **Slick immersion** could occur, especially in freshwater and/or concentrated suspended matter
- Some oils may exhibit a potential for **dispersibility** when fresh but this dispersibility seems to rapidly decrease with the weathering time.
This response option seems thus not to be appropriate to treat a spill involving VLSFO.
- **Recovery**: oleophilic skimmers could be appropriate for spills involving fresh and moderate weathered oils. For weathered products, uncertainties remain
- Viscosity could be a limiting factor for recovery and pumping operations

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