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Final conference

A black silhouette of an oil drop is located to the right of the "Final conference" text.

Task 4.1 – Mechanical recovery of 2 VLSFO

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Objectives

Test mechanical recovery of two VLSFO (fresh and emulsified) collected by the project partners with two different skimmers

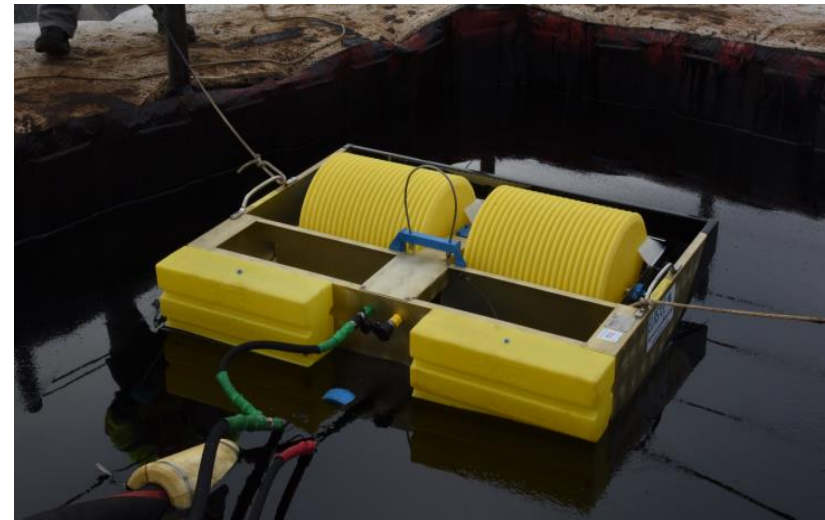
Improve our knowledge on those products and recovery systems

VLSFO tested

		Pour point (°C)	Water content (%)	Temp.(°C)	Density	Viscosity (10s ⁻¹ , in cSt)	Slick layer Homogeneity (7.5 cm)	Note
IM-15	Fresh	+3	0	8.5	0.954	9 144	YES	Very sticky and dark blackish color
				11.3	/	7 145		
	Emulsified	/	57	7.5	/	68 198	YES	Less sticky with a brown color
			48	11		28 677		
IM-14	Fresh	+30	0	8	0.944	26 768	NO (frozen aspect)	Dark blackish colored slick frozen in contact with the cold water
				8.3	/	33 625		
	Emulsified	/	55	7	/	42 022	YES	Brown colored slick more or less homogenous. Appears elastic
			50	7.7		35 149		

Oleophilic drum skimmer:

- made of two oleophilic grooved drums.
- configured with the recommended centrifugal screw pump and hydraulic unit.
- discharge hose diameter is 3 inches.
- maximum oil recovery rate announced by the manufacturer : 20 m³/h.
- **annular water injection was added to the pump in order to help the pump transferring the oil.**



Chosen for the tests because part of French stockpiles



Oleophilic brush belt skimmer

- made of an oleophilic stiff-brush conveyor belt.
- configured in association with the integrated volumetric screw pump and recommended hydraulic unit.
- discharge hose diameter is 4 inches.
- water suction propeller forcing oil to the brush conveyor system.
- according to the skimmer data sheet, it has an oil recovery rate of 30 m³/hr.



Chosen for the tests because part of French stockpiles

Test area



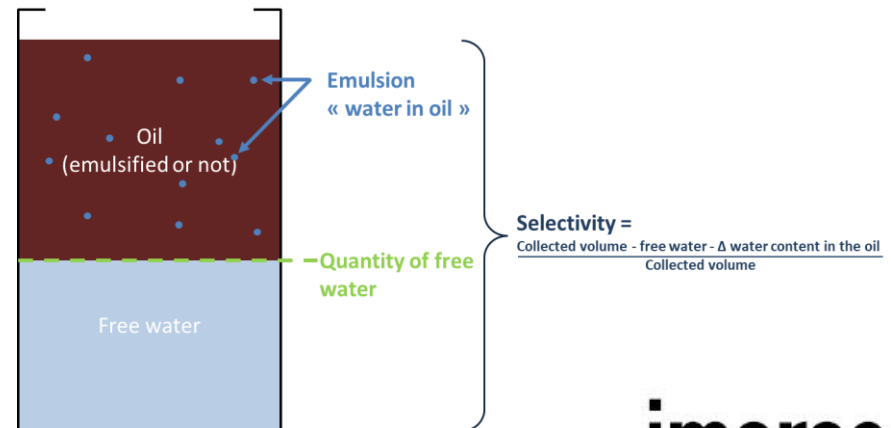
- ①: Spill area (16 m² area in which the oil (1.2 m³) is spilled);
- ②: Hydraulic unit;
- ③: Discharge pipe (10 m long, 3" or 4" diameter);
- ④: Discharge tank allowing the recovery and quantification of the product;
- ⑤: Sampling beakers: allowing to determine the selectivity.

*NF T 71-500 (Oil spill response equipment -
Skimmers - Performance test methods in
controlled environment)*

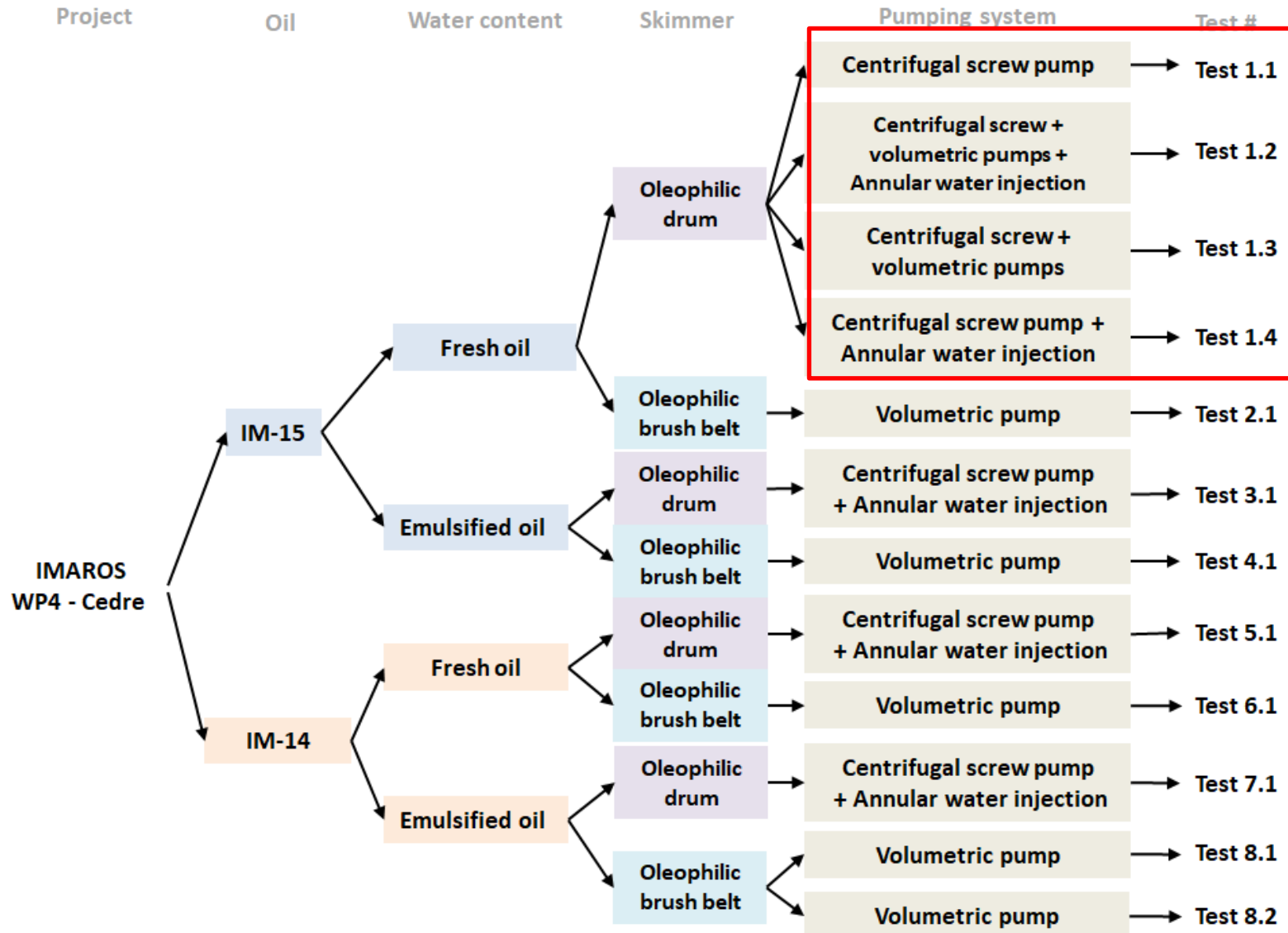
motion of the slick: observed qualitatively by the operators (setting in motion or splitting of the slick by the skimmer).

recovery rate: measured according to the volume recovered and the selectivity.

selectivity: measured according water content in the recovered flow. Takes into account the emulsification of the oil and the quantity of free water.



Tests grid = 12 trials



Fresh IM-15

- General observation

Very sticky

Viscosity : 9 144 cSt (10s^{-1}) at 8°C

Oil layer : 7.5 cm (homogeneous thickness layer in the test area)

- Tests 1

- Test 1.1: skimmer + centrifugal screw pump;
- Test 1.2: skimmer + centrifugal screw pump + annular injection + volumetric pump;
- Test 1.3: skimmer + volumetric pump;
- Test 1.4: skimmer + centrifugal screw + annular injection.



skimmer



centrifugal
screw pump



annular injection



volumetric pump

Trials with *Oleophilic drum skimmer*

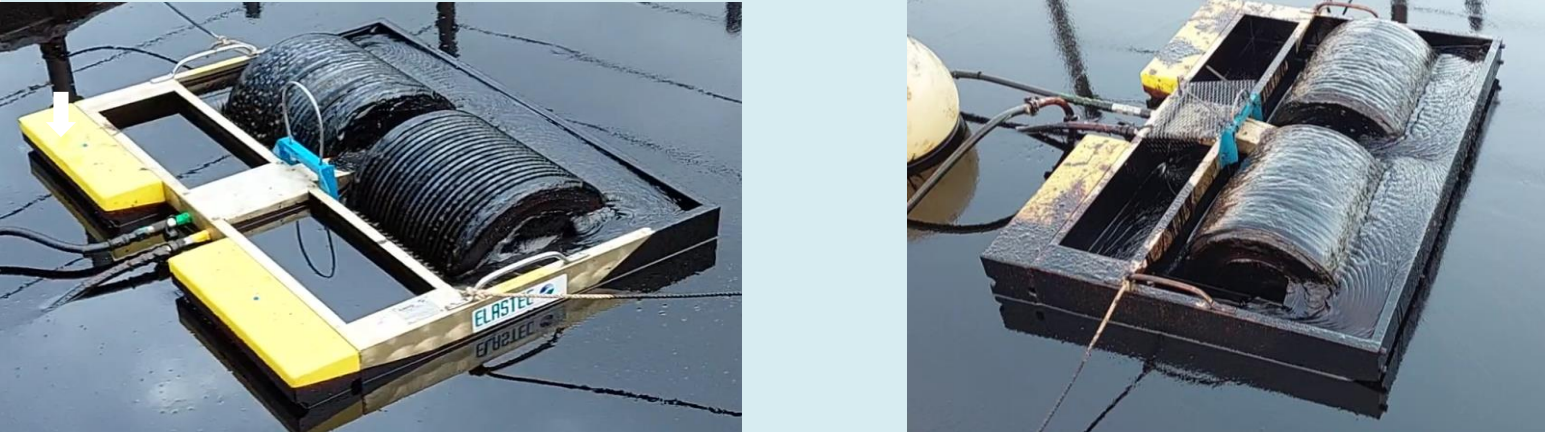
Fresh IM-15

Drums very efficient ;

Need to remove the metal grid protecting pump against marine litter (flow restriction)

For the test 1.1, the skimmer recovered more oil than the pump could transfer;

For the test 1.2 and 1.4 pump system “upgraded” with water injection able to transfer recovered oil.

Tests	<u>Test 1.1</u>	<u>Test 1.2</u> (Water injection)	<u>Test 1.3</u>	<u>Test 1.4</u> (Water injection)
Oil slick stay in direct contact with the skimmer	Yes: the oil flows naturally towards the skimmer			
Selectivity	98%	89%	95%	72%
Oil recovery flow rate	0,70 m ³ /h	6,56 m ³ /h	1.96 m ³ /h	2,97 m ³ /h
Illustrations				

Emulsified IM-15

- *General observation*

Less sticky than the fresh oil

Viscosity : 68 198 cSt (10s^{-1}) at 7.5°C

Oil layer : 7.5 cm (homogeneous thickness layer in the test area)



skimmer



centrifugal
screw pump



annular injection

Trials with *Oleophilic drum skimmer*

Emulsified IM-15

Drums very efficient

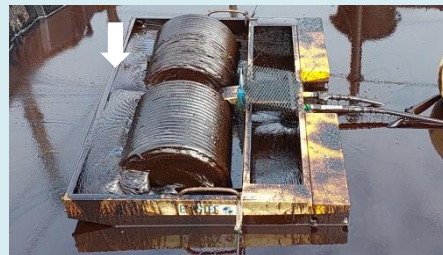
Need to remove the metal grid protecting pump against marine litter (flow restriction);

Centrifugal pump shows difficulties. Works thanks to water injection (prototype);

Gutter is not wide enough and not enough slope. Pipes could be wider (4" instead of 3")

Tests	<u>Test 3.1</u>
Oil slick in direct contact of the skimmer during the test	Yes : The oil flows naturally toward the skimmer, except at the end of the test (small quantity = patches of oil instead of continuous thin layer). At the end of the test, setting in motion by the operators (paddle) because of non homogeneous layer (patches) of the slick
Selectivity	58%
Oil recovery flow rate	2.22 m ³ /h

Illustrations



Fresh IM-15

- *General observation*

Very sticky



Viscosity : 7 145 cSt (10s^{-1}) at 11.3°C

Oil layer : 7.5 cm (homogeneous thickness layer in the test area)



Fresh IM-15

The skimmer and pump were very efficient but the propeller disseminates HC in the basin.

Tests	<u>Test 2.1</u>
Oil slick in direct contact of the skimmer during the test	<p>Yes : The oil flows naturally toward the skimmer, except at the end of the test (small quantity = patches of oil instead of continuous thin layer).</p> <p>After 10 minutes, setting in motion by the operators (paddle) because of patches instead of thin layer.</p>
Selectivity	94%
Oil recovery flow rate	3.41 m ³ /h
Illustrations	 

Emulsified IM-15

- *General observation*

Less sticky than the fresh oil


Viscosity : 28 677 cSt (10s^{-1}) at 11°C

Oil layer : 7.5 cm (homogeneous thickness layer in the test area)



Emulsified IM-15

Skimmer and pump very efficient
Propeller disseminates HC in the basin
Reduced rotation speed compared to fresh recovery

Tests	<u>Test 4.1</u>
Oil slick in direct contact of the skimmer during the test	Yes : The oil flows naturally toward the skimmer, except at the end of the test (small quantity = patches of oil instead of continuous thin layer). At the end of the test, setting in motion by the operators (paddle) because of non homogeneous layer (patches) of the slick
Selectivity	95%
Oil recovery flow rate	2.51 m ³ /h
Illustrations	

Fresh IM-14

- *General observation*
 - Less sticky than fresh IM-15
 - Viscosity : 26 768 cSt (10s^{-1}) at 8.9°C
 - Oil layer : 7.5 cm



skimmer



centrifugal
screw pump



annular injection

Trials with *Oleophilic drum skimmer*


Fresh IM-14

Drum efficient

Water injection needed

Dense slick: product in contact with the skimmer is collected.

The skimmer tends to create a "hole" in the slick: need to feed the skimmer with a paddle

Tests	<u>Test 5.1</u>
Oil slick in direct contact of the skimmer during the test	No: the skimmer "digs" a hole. Need to push the slick with paddles
Selectivity	85%
Oil recovery flow rate	2.48 m ³ /h (with paddle and water injection)
Illustrations	

Emulsified IM-14

- *General observation*

Chewing-gum behaviour of the oil

Viscosity : 42 022 cSt (10s^{-1}) at 7°C

Oil layer : 6.8 cm



skimmer



centrifugal
screw pump



annular injection

Emulsified IM-14



Drums were very efficient

Need to remove the metal gate protecting against marine litter.

Pump shows difficulties. Works thanks to water injection.

Gutter is not wide enough and not enough slope.

Pipes could be wider (4" instead of 3")

Tests	<u>Test 7.1</u>	
Oil slick in direct contact of the skimmer during the test	The skimmer “digs” a hole into the part of the slick in direct contact, after the oil doesn’t flow towards the skimmer. Need to push the slick with paddles	
Selectivity	52%	
Oil recovery flow rate	0.5 m ³ /h	
Illustrations	 <p>Without annular injection</p>	 <p>With annular injection</p>

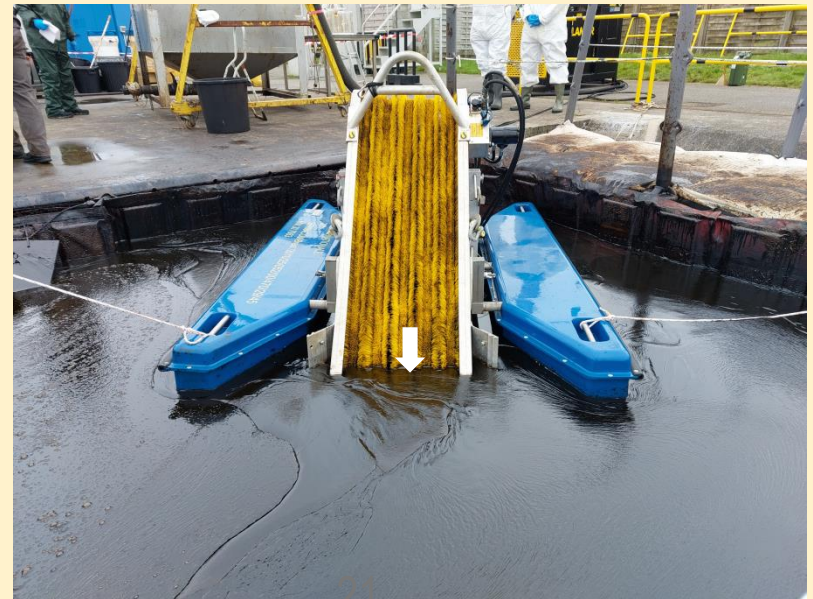
Fresh IM-14

- *General observation*

Less sticky than fresh IM-15

Viscosity : 33 625 cSt (10s^{-1}) at 8.3°C

Oil layer : 7.5 cm (not homogenous because HC freezes on contact with cold water)




Fresh IM-14

- *Results*

Pump were very efficient.

The skimmer tends to create a "hole" in the slick by collecting only the product that is directly in contact with it: as the slick has a frozen appearance, it does not naturally flow back towards the skimmer and the skimmer does not present a sufficient attraction in spite of the presence of a propeller dedicated to this function.

Tests	Test 6.1
Oil slick in direct contact of the skimmer during the test	The skimmer "digs" a hole into the part of the slick in direct contact, after the oil doesn't flow towards the skimmer. Need to push the slick with paddles
Selectivity	94%
Oil recovery flow rate	2.17 m ³ /h
Illustrations	

Emulsified IM-14

- *General observation*

Less sticky than fresh IM-15

Viscosity : 35 149 cSt (10s^{-1}) at 7.7°C

Oil layer : 7.5 cm (homogenous)

Two tests have been performed:

- Test 8.1: static
- Test 8.2: dynamic (pushing oil towards skimmer with paddle)



Emulsified IM-14

brush skimmer and volumetric pump were very efficient when oil is in direct contact of the brushes.

Tend to create a "hole" in the slick by collecting only the product that is directly in contact with it: as the slick has a frozen appearance, it does not naturally flow back towards the skimmer and the skimmer does not present a sufficient attraction in spite of the presence of a propeller dedicated to this function.

Tests	<u>Test 8.1</u>	<u>Test 8.2</u>
Oil slick in direct contact of the skimmer during the test	The skimmer "digs" a hole into the part of the slick in direct contact, after the oil doesn't flow towards the skimmer.	The skimmer "digs" a hole into the part of the slick in direct contact, after the oil doesn't flow towards the skimmer.
	<u>No paddle</u>	<u>Need to push the slick with paddles</u>
Selectivity	79%	99%
Oil recovery flow rate	0.21 m ³ /h	4.96 m ³ /h

Illustrations



Results

		IM-14 Fresh	IM-14 Emulsified	IM-15 Fresh	IM-15 Emulsified
Motion of the slick		Need dynamic conditions (skimmer in motion on the slick or skimmer feed)		Oil flows naturally to the skimmers	
Recovery	<u>Oleophilic</u> drum skimmer	Efficient	Efficient	Efficient	Efficient
	<u>Oleophilic</u> brush Belt skimmer	Efficient	Efficient	Efficient	Efficient
Transfer	Centrifugal pump	Need water annular injection			
	Volumetric pump	Can be appropriate in dynamic conditions	Cannot be appropriate	Can be appropriate	Can be appropriate
Selectivity		Between 52 % and 99 % : No difference between the oils <u>Oleophilic</u> brush belt skimmer more selective			

- Recovery should be possible for the 2 fresh and emulsified VLSFO
- Dynamic conditions (skimmer in motion in the slick, or slick moving towards the skimmer) could be considered to recover this kind of products in order to feed the skimmer and avoid the creation of a gap between the skimmers and the oil slick.
- Necessary to modify the process to improve the recovery operations:
 - With the oleophilic drum skimmer used, a volumetric pump instead of the centrifugal one could enhance recovery rates;
 - A discharge hose diameter of 4" instead of 3" would reduce frictions, especially for longer discharge hoses;
 - Water annular injection option could be interesting if the pump has difficulty in transferring such oils ;

Thank you for your attention



Questions ?



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