

Mechanical dispersion of oil on water

by use of high pressure water jet

A new solution to combat oil spills?

Stein Erik Sørstrøm
CTO

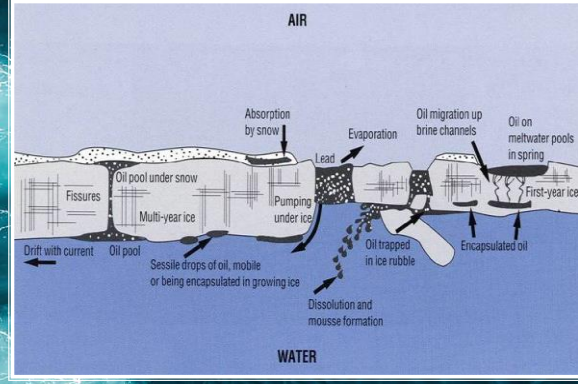
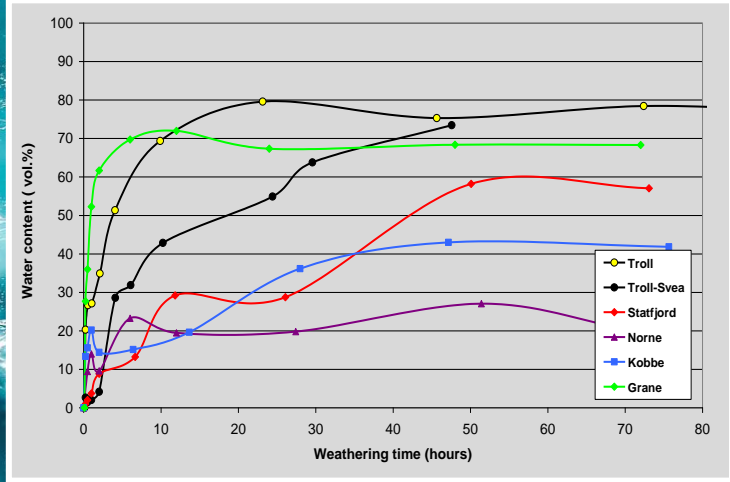
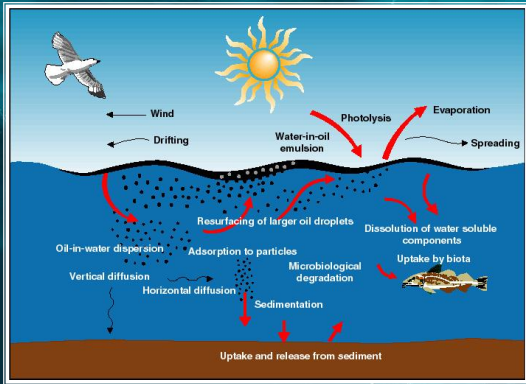
Chemfree AS

www.chemfree.no
Steineriks@icloud.com

TECHNOLOGY FOR OIL SPILL RESPONSE

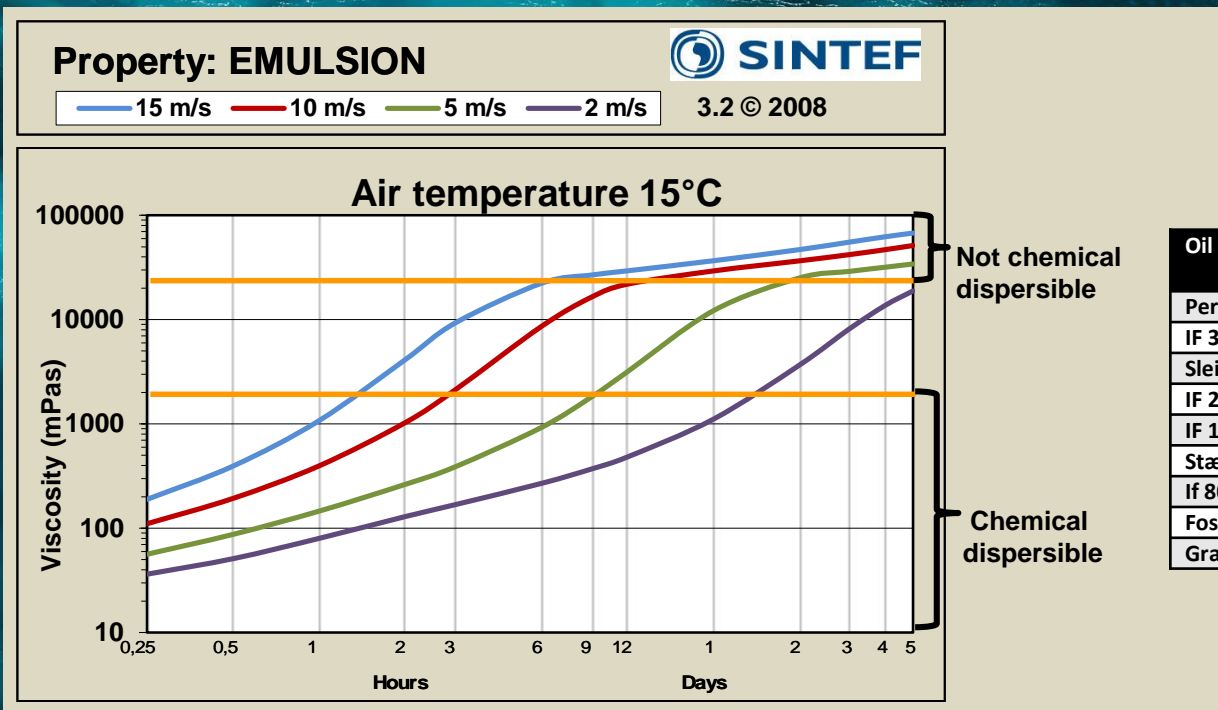


THE WINDOW OF OPORTUNITY



THE WINDOW OF OPPORTUNITY

- for chemical dispersants is short in most cases



Oil type	Viscosity (10 C/10 S ⁻¹)
Peregrino	40.000
IF 380	30.000
Sleipner Vest	15.000
IF 240	12.000
IF 180	7.000
Stær	1.800
If 80	1.300
Fossevall	1.120
Grane	638

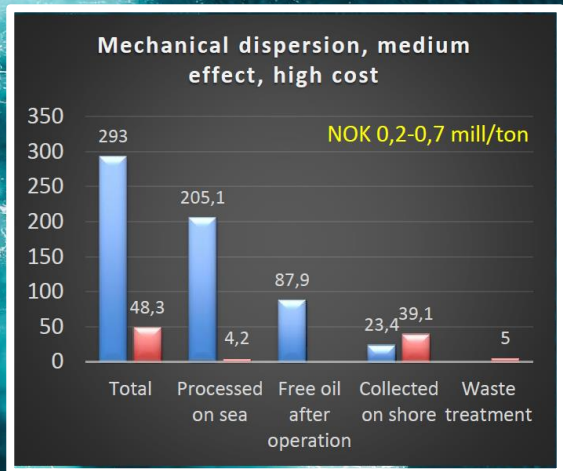
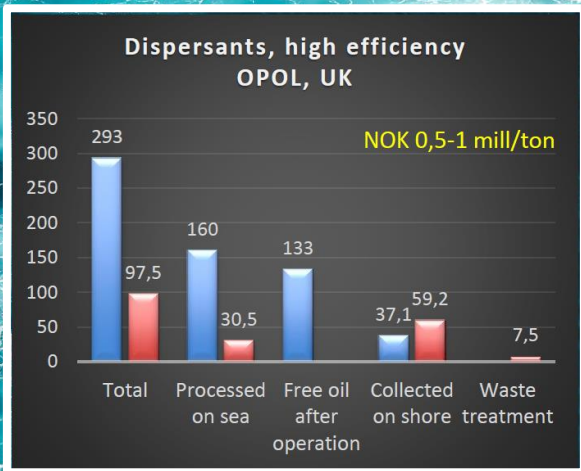
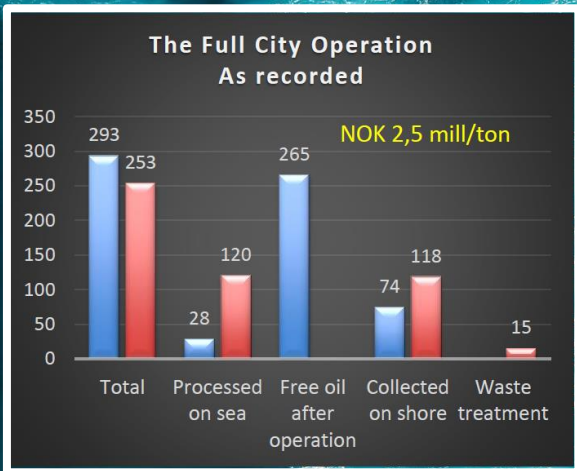
THE COST-EFFICIENCY

Mechanical; Low, Dispersants; OK, Chemfree; Better?



Vol

Cost



191 locations along the shore hit by oil from the release

Assumptions;

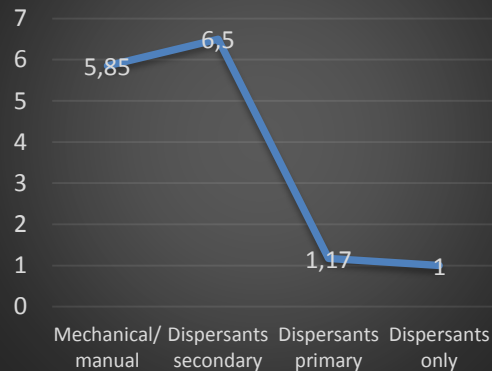
Dispersant cost same as for aircraft spray operation with Hercules aircraft. UK-analysis.

- High efficiency; 160 tonnes removed during 4 day operation

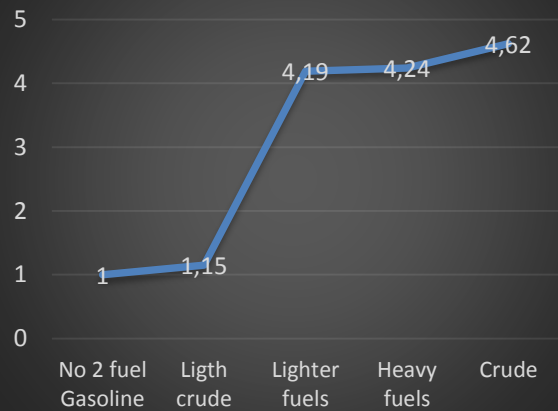
Assumptions;

Medium effect, high cost; 10 small vessels, 2 persons on board. 10 days operation. Each vessel able to treat 2,3 tonnes per day

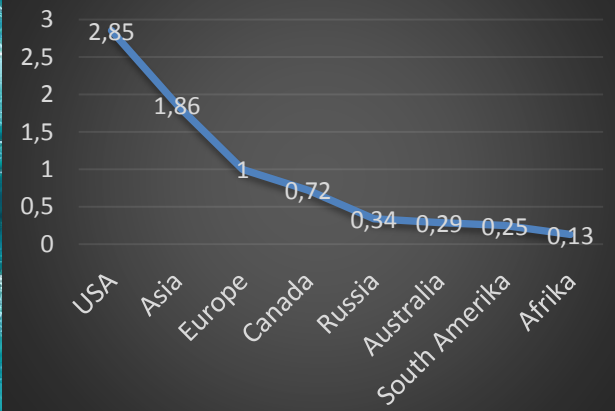
Cost versus method applied



Cost vs oil quality



Cost VS region



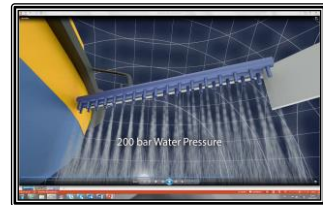
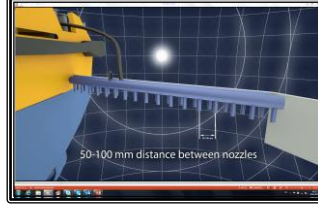
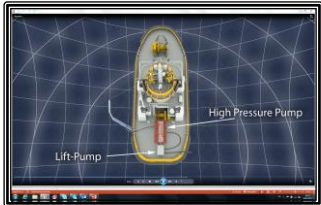
Based on analysis of oil spill cost data in the OSIR – International Oil Spill Database (Dagmar Schmidt Etkin, Oil Spill Intelligence Report 1999)
Relative values

THE CHEMFREE TECHNOLOGY



A quite simple technology;

1. A water intake
2. A high pressure water pump
3. A set of specialized nozzles
4. A vessel that keep the nozzles close to the surface



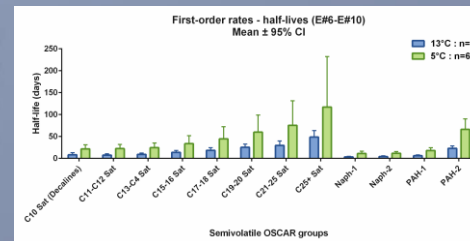
The technology

How it works?

- The water jet crushes the oil slick into microscopic droplets.
- The droplets are mixed into the water column *and stays there if they are smaller than 70 μm*
- **Test results; The oil is crushed into tiny droplets with a medium size of 20-50 μm**

The natural turbulence in the water as well as the energy from the water jet combined with the small size of the droplets causes the oil slick to dissipate into a cloud of oil droplets in the water column

Dissolution, chemical processes and bacterial degradation works fast to reduce the local toxic effect



Patent Situation

2012: Submitted in Norway

- Multitool-patent
- High pressure water dispersion

2013: Application continued in PCT

2015: National application submitted in Australia, Brazil, Canada, EPO (Europe), Indonesia, Mexico and USA

2016: Approved in Norway

- In process in USA ++

We have tested – but still need more tests

- **Proof of principle – 2011**
 - Funded by SINTEF
- **Concept study 2013-2015**
 - Funded by the Norwegian Research Council
- **Product development study 2015-2017**
 - Funded by Norwegian Coastal Administration and Norwegian Clean Seas Association for Operating Companies (NOFO)
- **Verification of functionality and efficiency, 2016 - 2018**
 - Funded by the Norwegian Research Council



Small lab, 2011

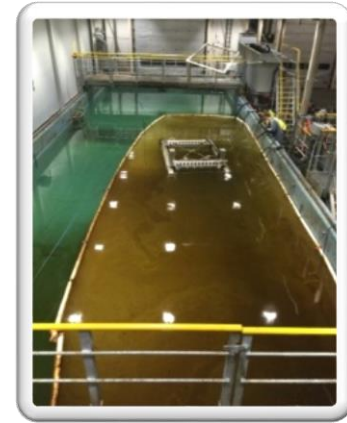
One nozzle, small pump
Promising results



Medium lab, 2013-15

Two nozzles, low-medium pump capacity.

**Droplet size well below the
limits for permanent
dispersion.**



Basin test, 2015-16

10 nozzles, medium - large
pump

Droplet size well below the
limits for permanent dispersion.

Tests consistent with small and
medium lab-tests.

**We believe that we can
disperse all (or at least most)
oil qualities.**

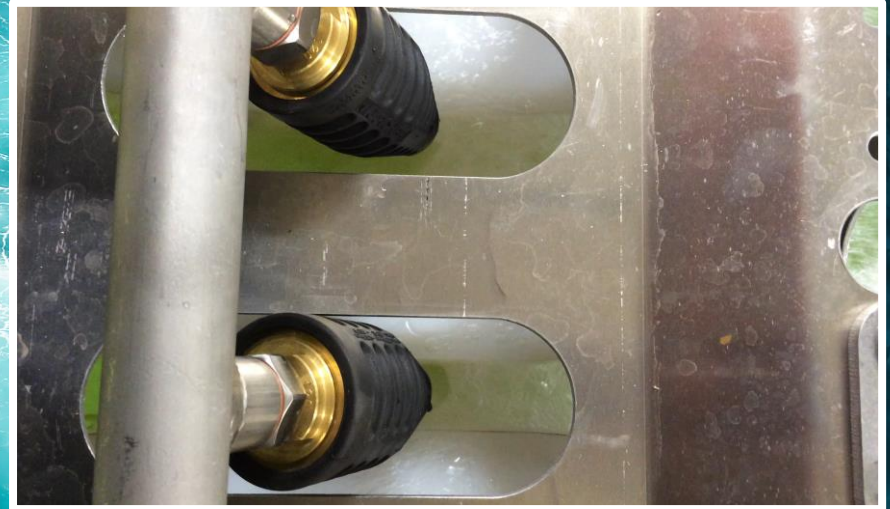
NOZZLES SEEN FROM ABOVE

Narrow beam



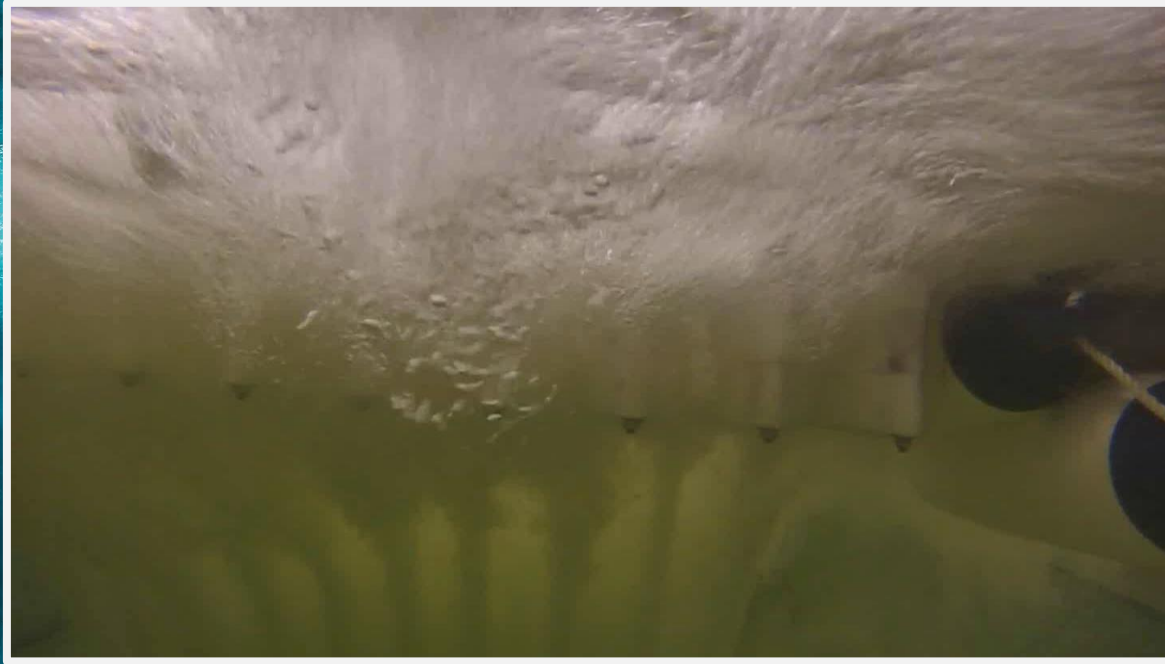
Reach; 1.5-2 m depth

Rotating, wider beam



Reach; 0.5-1 m depth

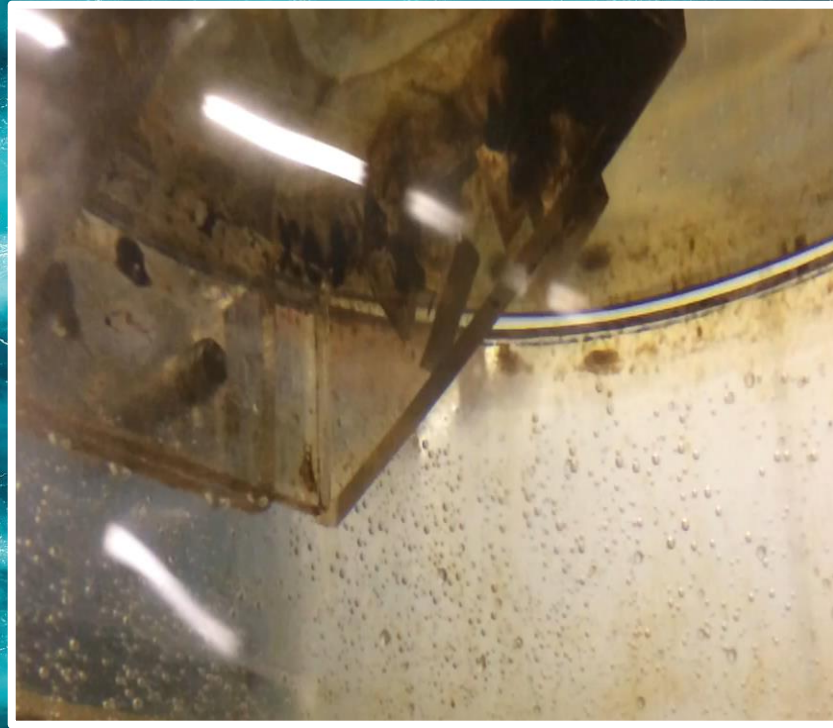
10 narrow water jets, no oil – seen from under water



The jets reaches down to approximately
1.5-2m depth when the raft is moving forward
(towards us)

Black plastic particles added.

1 water jet and oil on the surface seen from underneath



The oil is crushed into small droplets – approximately 20-25 μm diameter.

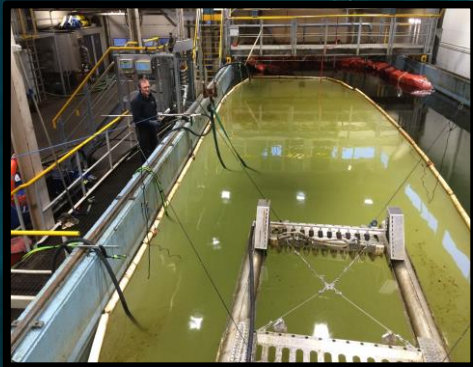
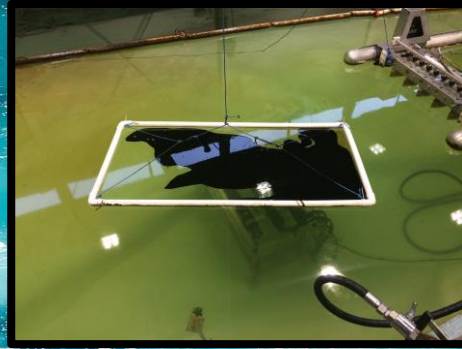
Air bubbles escape to the surface. The oil stays in the water column

BASIN TEST WITH RAFT WITH 10 NOZZLES



Oil was (partly) pushed in front of the raft and escaping between the water jets, but the size distribution of the oil droplets was the same as in lab-test.

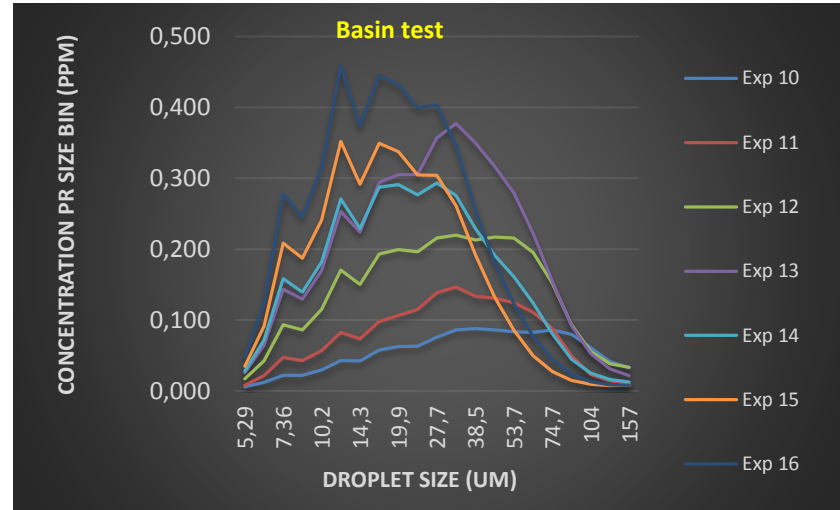
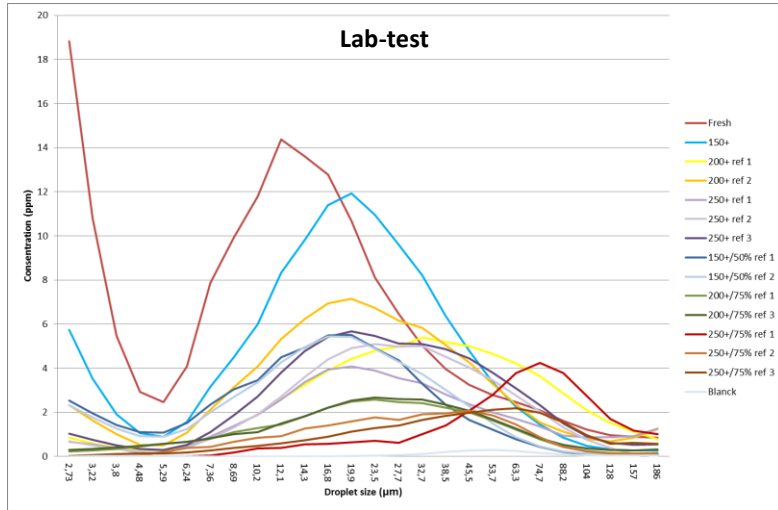
Concentration of oil in the water column increases considerably during test



IT STILL REMAINS TO ESTABLISH HOW WELL THE OIL IS DISPERSED AND HOW TO OPERATE THE SYSTEM IN ROUGH WEATHER AND SEA STATE CONDITIONS

Small droplets - easier to degrade

..seem to be even smaller than with dispersants

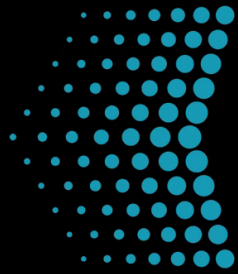


We believe that we can disperse

any oil, any where, any time

- as long as we can create high enough impact energy

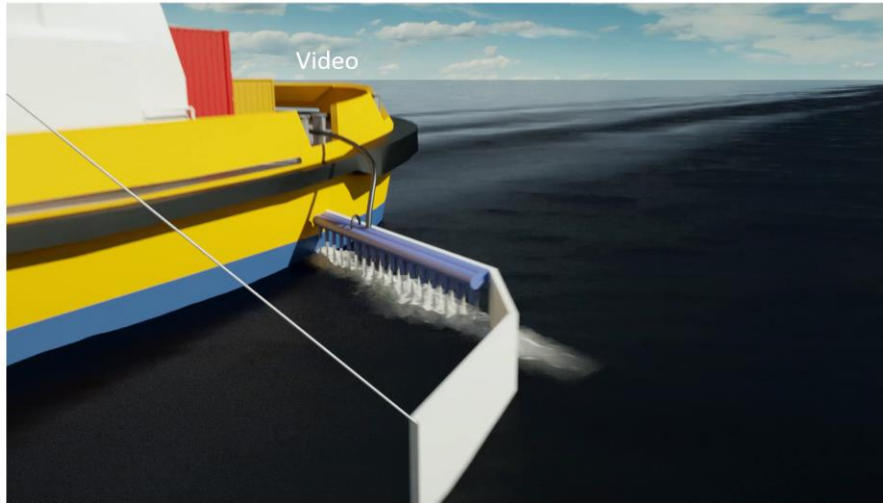
Video



chemfree

OIL SPILL SOLUTION

Snapshot from video



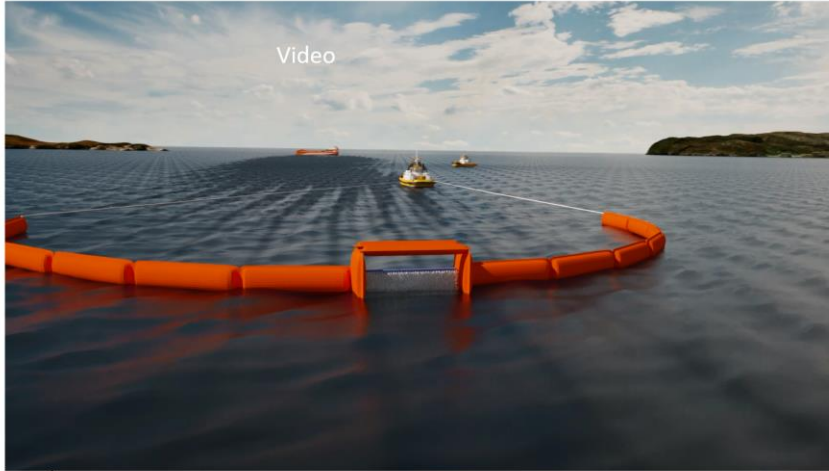
NOZZLE BAR MOUNTED WITH AN
OIL COLLECTING ARM FOR SWEEPING
OPERATIONS CLOSE TO HARBORS AND
CONFINED WATER (BAY AREAS, FJORDS ETC)

chemtree
OIL SPILL SOLUTION



chemtree
OIL SPILL SOLUTION

Snapshot from video



chemtree
OIL SPILL SOLUTION



NOZZLE BAR MOUNTED WITH AN OIL COLLECTING BOOM FOR SWEEPING OPERATIONS IN OPEN WATER, HARBORS AND CONFINED WATER (OFF SHORE, BAY AREAS, FJORDS ETC)

Snapshot from video

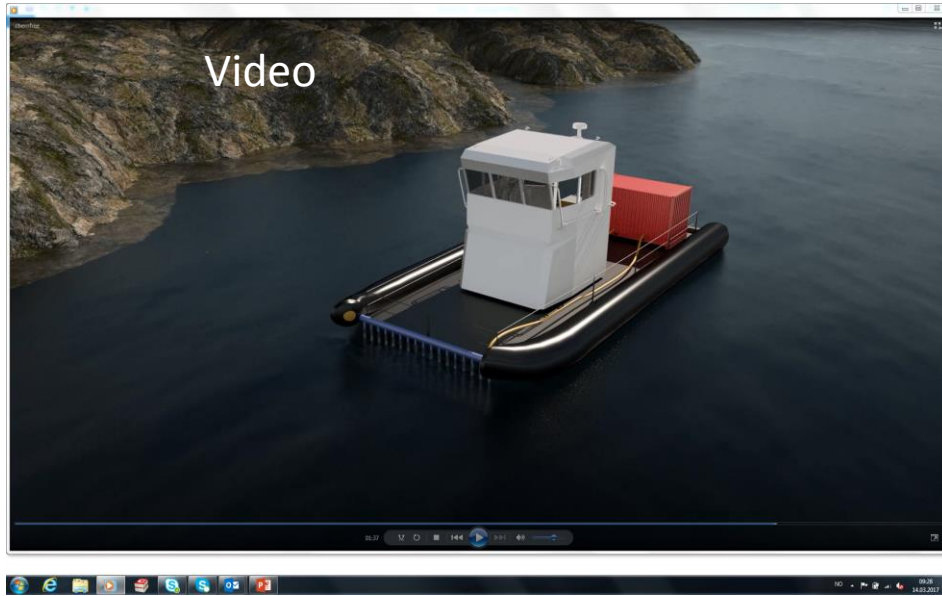


chemfree
OIL SPILL SOLUTION



NOZZLE BAR MOUNTED WITH AN ARTICULATED ARM FOR CLEANING OPERATIONS IN HARBORS AND CONFINED WATER (BAY AREAS, ICE COVERED AREAS, FJORDS ETC). PART OF THE MULTITOOL SOLUTION

chemfree
OIL SPILL SOLUTION



NOZZLE BAR MOUNTED WITH A HIGH SPEED WATER JET DRIVEN RIB FOR CLEANING SMALL DISTRIBUTED PATCHES OF OIL IN HARBORS, CONFINED WATER (BAY AREAS, PARTLY ICE COVERED AREAS, FJORDS ETC).

FURTHER DEVELOPMENT

1. ESTABLISH WINDOW OF OPORTUNITY FOR MECHANICAL DISPERSION BY USE OF WATER JET. MARCH – OCTOBER 2017, SINTEF

a. Goal;

- More than 75 % of the oil efficiently dispersed
- *Any oil – any where – any time*
- First results in May-June 2017

2. OPTIMIZATION OF TECHNOLOGY. SINTEF, KÄRCHER, IKM TECHNOLOGY, CHEMFREE AS

a. Goal;

- highest possible impact over largest possible surface area

3. LARGE SCALE TESTING AND VERIFICATION. SINTEF, CHEMFREE.

a. Build prototype – first product

b. Test

- in basin (at NCA, 2017)
- at Ohmsett New Jersey, USA (2018)
- in full scale field test

EFFICIENCY AND WINDOW OF OPORTUNITY

..as a function of oil type and weathering time (viscosity)

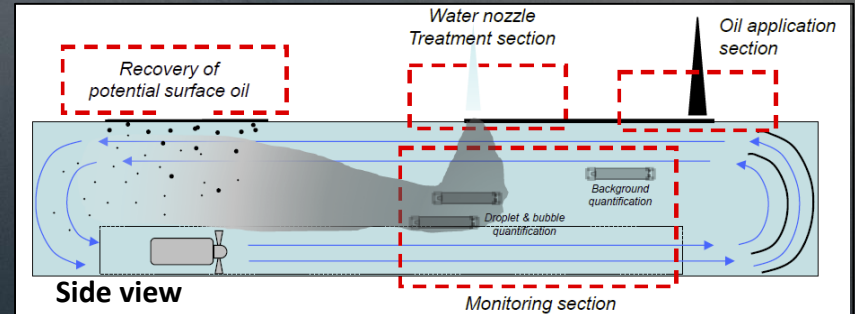
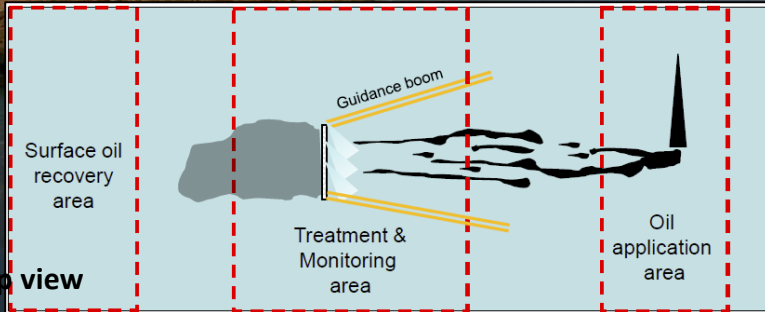
Oil type	Viscosity (10 C/10 S ⁻¹)
Peregrino	40000
IF 380	30000
Sleipner Vest	15000
IF 240	12000
IF 180	7000
Stær	1800
If 80	1300
Fossekall	1120
Grane	638

Any oil – any time – any where?

The key investigation this year

Will it be possible to
disperse "difficult" types of oil?

Experimental set up for laboratory tests by SINTEF. 200 bar / 280 l/min pump



CHEMFREE - PRODUCTS

One technology– Many products

- *Integrate with existing solutions?*
- *Develop our own solutions?*
- *Both?*
- **→ First solution ready for market by the end of 2018**



Chemfree
Coastal Sweep



Chemfree
Sea Sweep



Chemfree
High Speed



Chemfree
Multitool