Recent testing of Oil-In-Ice Skimmers

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Objective

- Overall objective;
  - To improve and develop technology for oil recovery in ice-covered waters in cooperation with suppliers of equipment

- The project shall
  - Document the capability and limitations of selected mechanical recovery concepts
  - Make recommendations for improvements
  - Carry out further testing of improved units
  - Initiate development of new oil spill recovery concepts
  - Give recommendations for the generic oil spill recovery guide.

JIP testing scope

Laboratory / Basin / Svalbard / Field trial

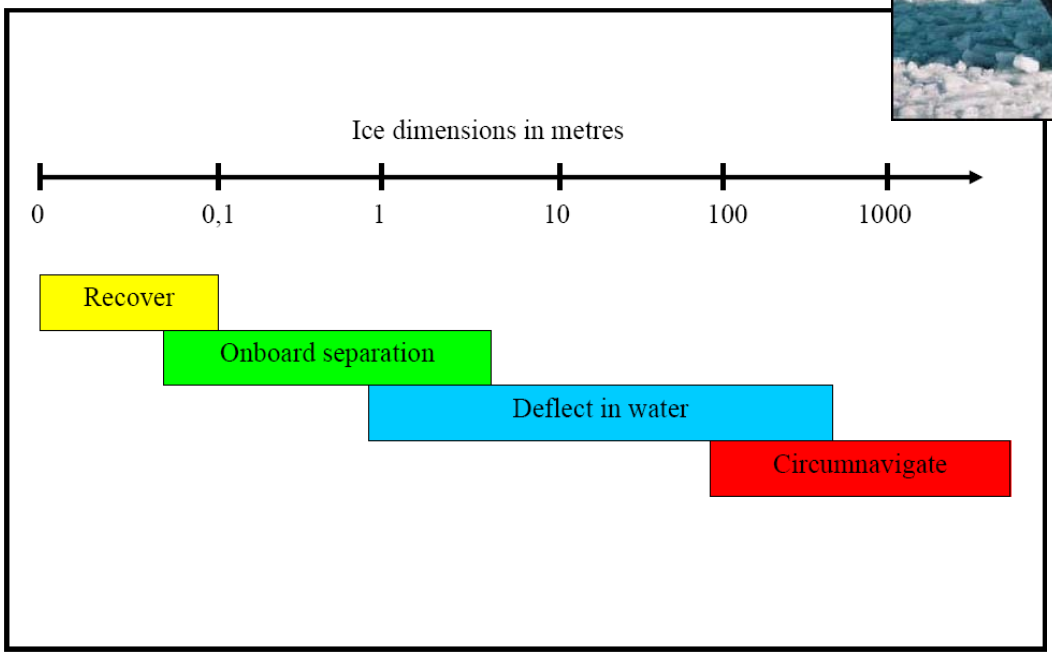
2006	2007	2008	2009
	Laboratory	Laboratory	Basin
	Basin	Basin	Field trial
	Svalbard	Svalbard	
		Field trial	

Mechanical recovery in ice-covered waters

- Totally different problems than in open waters:
  - Limited flow of oil to the recovery device – limited access
  - Deflection of oil together with ice
  - Separation of oil from ice
  - Increased viscosity
  - Icing /freezing of equipment

Ice processing

- Recovery of ice
- Ice deflection
  - Submerging (Lamor LOIS)
  - Lifting (Morice concept)
  - Lateral displacement
- Non ice deflection



R&D basis

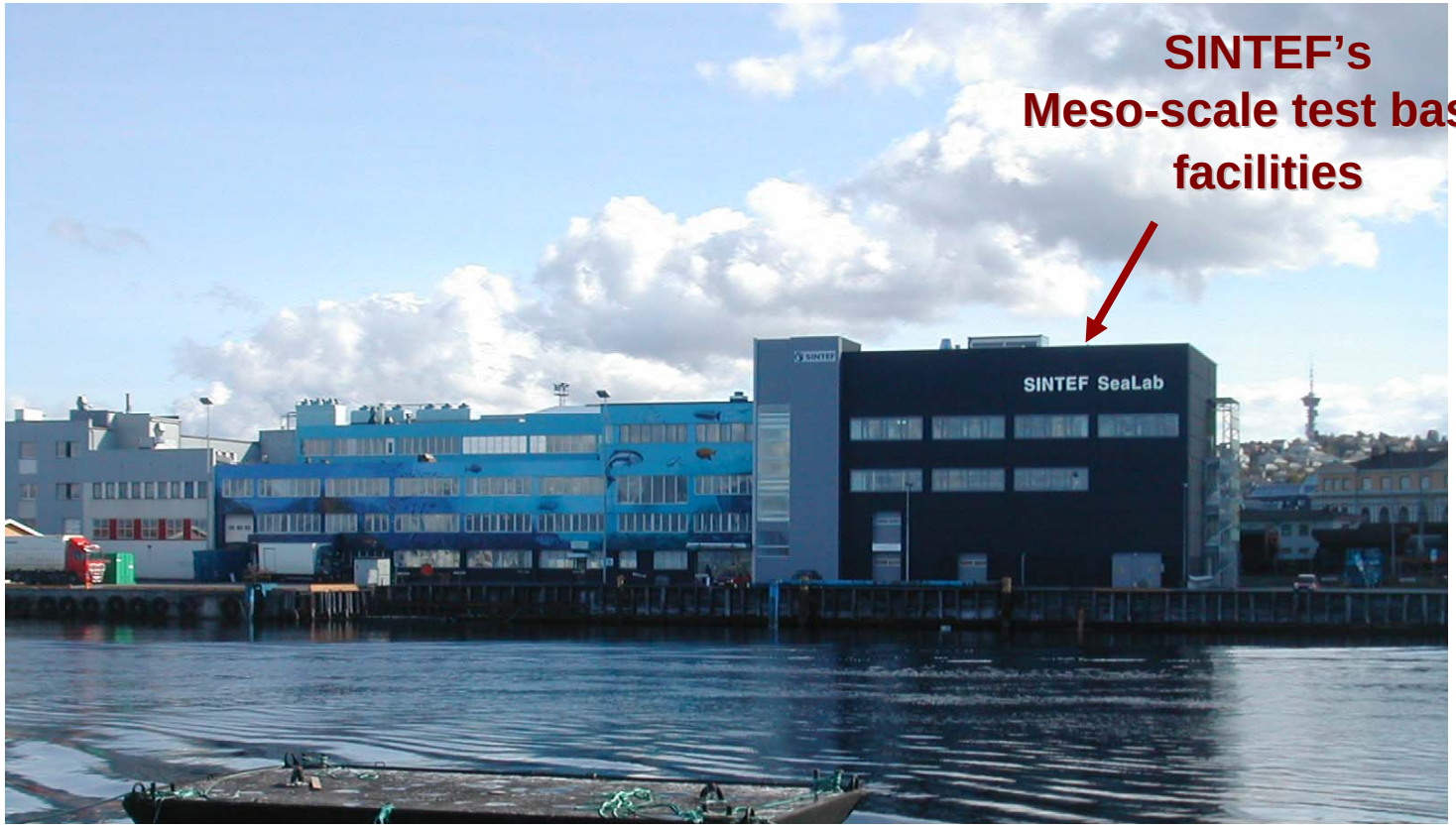
- 1992: Canadian Petroleum Association: State of the Art Review: Oil-in-Ice Recovery (Solsberg *et al.*)
- 1996: MORICE Phase I; Report published by SINTEF
  - Summary of suggested technical solutions to oil-in-ice recovery

Concept	Function	Potential
Lifting Grated belt	Ice processing	M
Submerging Grated belt	Ice processing	M
Large/lightweight Drum	Oil recovery	L-M
Brush and Brush-Drum	Oil recovery/Ice processing	H
Air Conveyor	Oil recovery	M
Grated Plough Shaped deflector	Ice processing	M
Rope Mop	Oil recovery	H
Auger Deflector	Oil recovery	L-M
	Ice processing	M
Archimedean Screw Vehicle	Operating platform	H
Lifting Plane with induced overflow	Oil recovery	L-M

Existing skimmers for testing

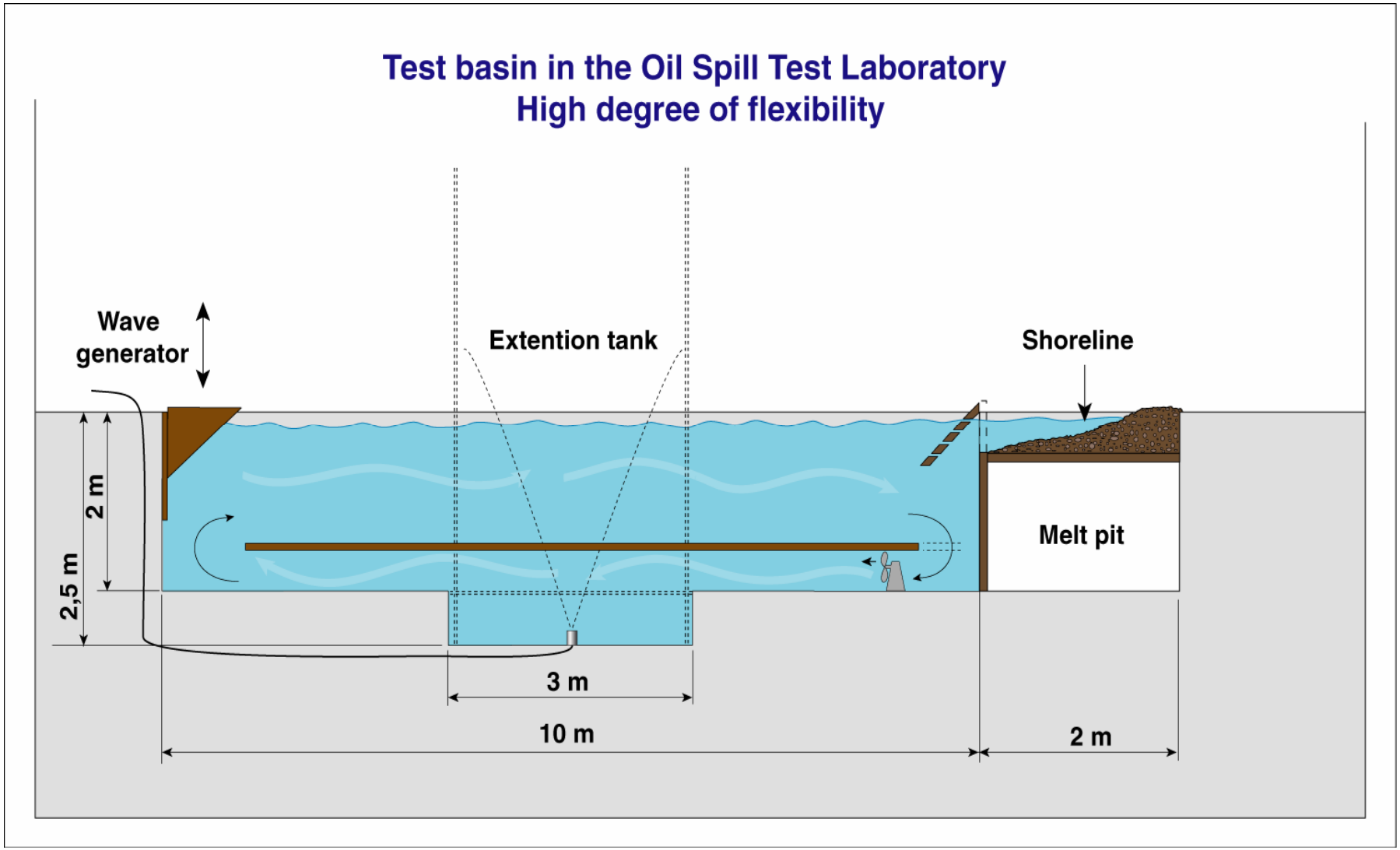
- Nominations by equipment suppliers/manufacturers
- Invitations to approximately 15 suppliers/manufacturers
- Response from 4 suppliers/manufacturers
- Basic skimmer concepts for testing:
  - Brush drum skimmer
  - Brush chain skimmer
  - Brush helix skimmer
  - Shovel drum skimmer

SINTEF Marine laboratory (at Trondheim Harbour) (Completed 11/2005)



Upgrading of laboratories is kindly supported by Statoil

SINTEF's New Wave-Current-Oil-in-Ice Basin



Testing at – 18ºC

Testing set-up and parameters	Visual/photo/video	Measured
Prior to testing:		
Air temperature		Typically -10 to -18^{o}C
Water temperature		Typically -1,5 to 1^{o}C
Emulsion viscosity @ shear rate 10s^{-1} & 0^{o}C		Typically 6-20.000 cP
Emulsion layer thickness		Typically 10 to 15 cm
Emulsion temperature		Typically -0,3 to 1^{o}C
Under and after testing:		
Flow of oil to the skimmer	X	
Ice processing / deflection	X	
Separation of recovered emulsion – free water		Settling/heat
Increased emulsion viscosity		Phys-chem analysis
Icing / freezing of equipment	X	
Recovery effectiveness		Recovery per time unit
Free water recovered		Draining
Water in emulsion		Phys-chem analysis

Brush helix skimmer

Brush drum skimmer

Results from testing without ice

Testing performed at only one pre-set speed – recovery rate are therefore only used to study the decrease due to the presence of ice. It should not be used to evaluate the maximum recovery rate of the skimmers.

	Recovered		Recovery rate	
Skimmer type	**Total amount, l**	**Free water, %**	**Total, m^3/hr**	**Emulsion, m^3/hr**
Brush drum 1	2.342	14	10	8.6
Brush chain*	N/A	N/A	Ca. 1-2	N/A
Brush drum 2	2.342	24	7.6	5.7
Brush helix	N/A	N/A	N/A	N/A
Shovel drum	2.675	44	26.8	15

* Unable to pump the emulsion to the receiving tank. Explained by a malfunction of this particular pump and not a general short-coming for this skimmer

N/A: Not measured or tested

Results from testing Broken ice, 50 %

Testing performed at only one pre-set speed – recovery rate are therefore only used to study the decrease due to the presence of ice. It should not be used to evaluate the maximum recovery rate of the skimmers.

	Recovered		Recovery rate		
Skimmer type	**Total amount, l**	**Free water, %**	**Total, m^3/hr**	**Emulsion, m^3/hr**	**Oil - ice separation**
Brush drum 1	1.090	15	3.4	3.0	Very good
Brush chain*	N/A	N/A	N/A	N/A	Poor
Brush drum 2	2.040	26	4.2	3.2	Poor
Brush helix	1.167	12	1.3	1.2	Good
Shovel drum	N/A	N/A	N/A	N/A	N/A

* Unable to pump the emulsion to the receiving tank. Explained by a malfunction of this particular pump and not a general short-coming for this skimmer

N/A: Not measured or tested

Results from testing Slush ice/ice pieces

Testing performed at only one pre-set speed – recovery rate are therefore only used to study the decrease due to the presence of ice. It should not be used to evaluate the maximum recovery rate of the skimmers.

	Recovered		Recovery rate		
Skimmer type	**Total amount, l**	**Free water, %**	**Total, m^3/hr**	**Emulsion, m^3/hr**	**Oil - ice separation**
Brush drum 1	2.163	5	9.3	8.8	Very good
Brush chain*	N/A	N/A	N/A	N/A	Poor
Brush drum 2	735	76	2.9	0.7	Poor
Brush helix	1.314	0	5.3	5.3	Very good
Shovel drum	2.776	56	14.5	6.4	Poor

* Unable to pump the emulsion to receiver tank. Explained by a malfunction of this particular pump and not a general short-coming for this skimmer

N/A: Not measured

Conclusions
Brush drum skimmer

- Good ice processing capabilities
- Low uptake of free water
- Should be “winterised”
  - Protected by shield
  - Heating capability
- Crane operated – need vessel with excavator
- Candidate for further testing/verification during field trial

Conclusions
Brush helix skimmer

- Good ice processing capabilities
- Low uptake of free water
- Not constructed for “Arctic” conditions – modifications necessary
- Should be “winterised”
  - Protected by shield
  - Heating capability
- Crane operated from vessel
- Candidate for further development, basin testing and verification during field trial

Further work

- Task 1: Testing of existing concepts
  - Testing and verification of 2 concepts in field trial 2008

    Candidates: The brush drum skimmer + Rope mop skimmer

- Task 2: Development of new concepts
  - Development of 1-2 concepts - cooperation manufacturers and SINTEF

    Candidates: Modified Helix skimmer + self-operating brush drum skimmer
  - Deliverable: prototype
  - Testing in ice basin
  - Verification in field trial 2009

Potential Field sites

Acknowledgement

Thanks to the oil companies sponsoring the “Oil in Ice JIP, from which this work is a part-study