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REPORT

Oil in Ice - JIP

Report no.: 8

Testing of Lamor GT 185 Skimmer and LRB 150 Skimmer in SINTEF ice basin. Task 3.1: Testing of existing concepts. A technical report.

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SINTEF Materials and Chemistry
Marine Environmental Technology

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Preface

SINTEF has in cooperation with SL Ross Environmental Research Ltd and DF Dickins Associates LLC on behalf of the oil companies AGIP KCO, Chevron, ConocoPhillips, Shell, Statoil and Total initiated an extensive R&D program; *Joint industry program on oil spill contingency for Arctic and ice covered waters.* This program was a 3-year program initiated in September 2006 and finalized in December 2009.

The objectives of the program were;

- To improve our ability to protect the Arctic environment against oil spills.
- To provide improved basis for oil spill related decision-making:
- To advance the state-of-the-art in Arctic oil spill response.

The program consisted of the following projects:

- P 1: Fate and Behaviour of Oil Spills in Ice
- P 2: In Situ Burning of Oil Spills in Ice
- P 3: Mechanical Recovery of Oil Spills in Ice
- P 4: Use of Dispersants on Oil Spills in Ice
- P 5: Remote Sensing of Oil Spills in Ice
- P 6: Oil Spill Response Guide
- P 7: Program Administration
- P 8: Field Experiments, Large-Scale Field Experiments in the Barents Sea
- P 9: Oil Distribution and Bioavailability

The program has received additional financial support from the Norwegian Research Council related to technology development (ending December 2010) and financial in kind support from a number of cooperating partners that are presented below. This report presents results from one of the activities under this program.

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Funding Partners

R&D Partners

Cooperating Partners

SINTEF REPORT

SINTEF

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A technical report

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CLIENT(S)

Agip KCO; Chevron; ConocoPhillips; Shell; Statoil; Total

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ABSTRACT

This report summarises the main findings from the testing of two oil skimmers produced by Lamor Corporation Ab of Finland in the SINTEF ice basin.

The GT 185 Skimmer outfitted with a brush conveyor worked well with no ice present, even with an emulsion of medium viscosity at low temperatures. The ice processing capability was not satisfactory. This will probably be an effective skimmer in open waters even with highly viscous oils, but has less potential in ice-covered waters. Ice had a tendency to block the entrance of the brush conveyor ; however, small ice pieces were recovered by the brushes to some degree. To avoid this problem, reversing the direction of application of the conveyor could be considered so that oil and ice move into downward (not upward)-rotating brushes-; however, implementing this approach was not possible in these tests.

The LRB 150 brush drum skimmer worked well both without ice and in the two ice scenarios selected for testing. The skimmer demonstrated good ice processing capabilities. It was concluded that the LRB 150 Skimmer can be an effective device in low-to-moderate ice concentrations (up to approximately 50 – 60% ice cover) when operated from an adequate crane. The skimmer represents state-of-the-art technology for the recovery of oil in ice covered waters.

The concept of this skimmer and its potential capability were recognised by the project Reference Group as being both interesting and promising. The skimmer was recommended for further testing during the field experiment planned for 2008.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Chemistry	Kjemi
GROUP 2	Oil	Olje
SELECTED BY AUTHOR	Oil recovery skimmers	Oljeopptakere
	Basin testing	Bassengtesting
	Oil recovery in ice	Oljeopptak i is

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1 Introduction

Most mechanical methods for recovering spilled oil are based on technologies developed for open water conditions. They often have serious limitations in ice-covered waters and recovery capabilities can be highly variable depending on a variety of local environmental conditions and logistics constraints. Some of the main challenges of operating skimmers in ice versus open waters are:

- Limited/difficult access to the oil – deflection of oil together with ice
- Limited flow of slicks to the oil recovery mechanism
- Separation of oil from ice and water
- Pressure in the ice field – structural and strength considerations of the skimmer
- Increased oil viscosity due to low temperatures
- Icing/freezing of oil removal and transfer components
- Detection / surveillance of the oil slick, potentially over a long time
- Moving ice of variable size as well as residual currents

It is expected that the largest potential for improving mechanical oil recovery in Arctic and ice-covered waters will be to further improve and adapt existing skimming technologies. Taking into account the remoteness of many of the Arctic areas in question, it is important that equipment for combating oil in ice also can be used in open waters.

In this project, oil spill response equipment manufacturers known to produce equipment with an expected potential for the recovery of oil in ice were asked to "nominate" existing skimmers for testing in the SINTEF ice basin. The manufacturers were required to prepare a short description of the "nominated" equipment for communication with the project Reference Group (RG) and decision by the Steering Committee (SC). Approximately 15 manufacturers were invited and six of them responded to the request. After discussions in the RG, a total of six skimmers from four manufacturers were selected for testing in the ice basin. One of the skimmers was equipped with a centrifugal pump unable to pump the viscous emulsion used in the testing. Testing finally involved a total of five skimmers from three different manufacturers.

Lamor Corporation AB of Finland suggested including their GT 185 Skimmer with brush conveyor and LRB 150 Skimmer in the testing. The testing was performed during week 24/2007.

2 Objectives

The main objective of this project was to document the capability and potential application of commercially available skimmers for recovering oil in ice. Based on this documentation, suggestions should be possible for defining and improving the operational spill response window in ice and cold conditions. The testing should also lead to a better understanding of the potential use of these skimmers in ice-covered waters. The aim was to identify one or two skimmers with potential use in Arctic areas.

3 Test set-up

3.1 The ice basin

The basic ice basin configuration is shown in figure 3.1; some additional minor modifications were also needed.

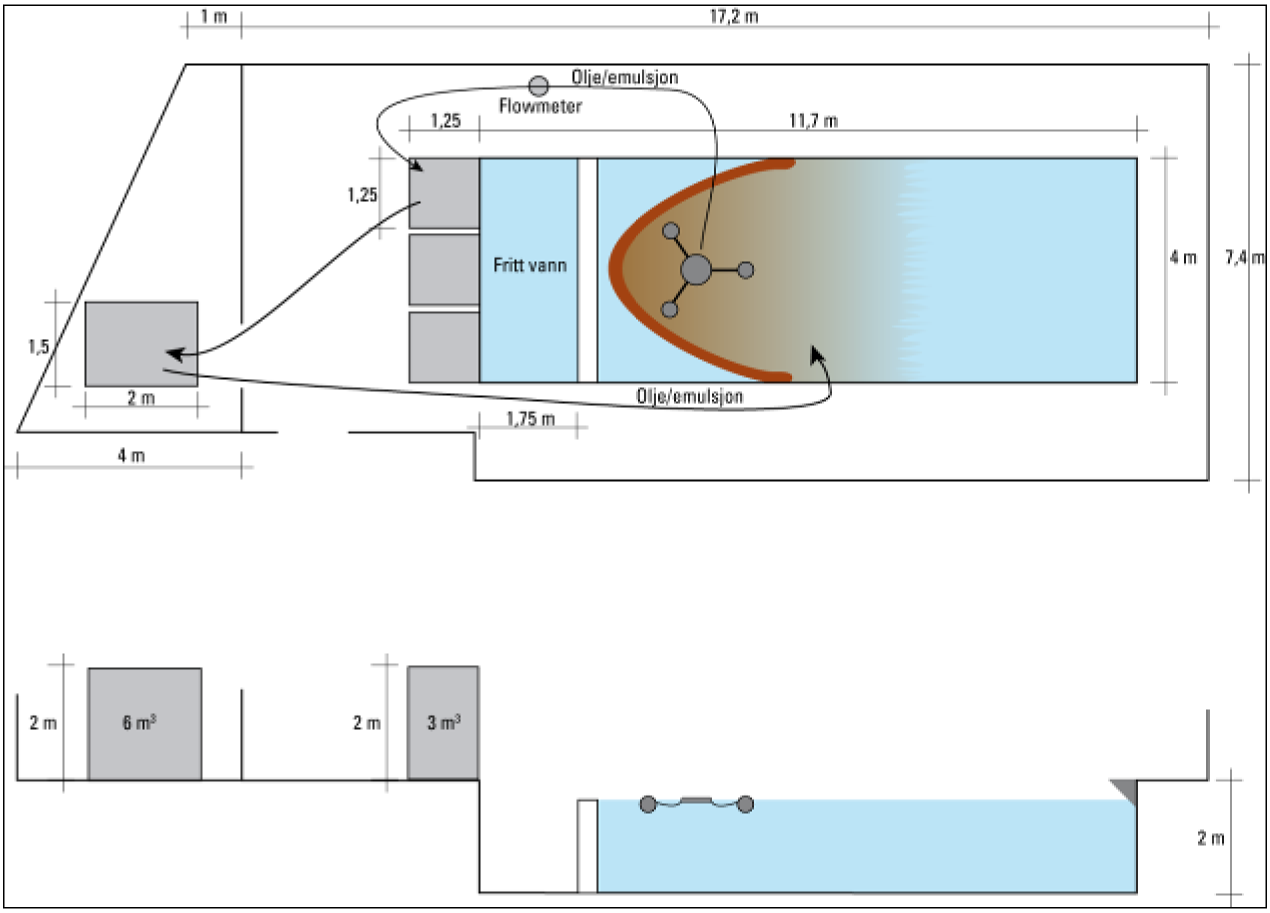

Figure 3.1 Sketch of the ice basin configuration during the testing.

A 5 m^3 tank for storing the original bunker oil was placed outside the building housing the ice basin. Two 3 m^3 tanks were installed in a heated room next to the ice basin for the storage of emulsion for testing and also for use as recovery tanks. One 3 m^3 tank was also installed in the ice basin room for the potential recovery of emulsion. Altogether, four tanks with a total capacity of 14 m^3 were used in the testing.

3.2 Test oil

It would have been desirable to use a weathered crude oil for the testing; however, that would have required distillation of large amounts of crude oil – approximately 6-7 m^3 of fresh oil to yield approximately 5 m^3 of residue. The distillation of sufficient amounts of crude oil would have taken weeks and been quite expensive, so it was decided to use an IF-30 bunker fuel. 5 m^3 of bunker fuel that was purchased from the Slagen refinery and from this oil a 50% water-in-oil emulsion was prepared. The resulting emulsion had the following characteristics:

IF-30 bunker oil – 50% emulsion => viscosity approx. 6-8.000 cP at 0^oC.

An aim was to use an emulsion that did not differ too much in water content and viscosity from test to test. As expected, however, pumping of the emulsion by the skimmer contributed somewhat to increased water uptake and hence increased viscosity. This increase was within acceptable limits and the IF-30 with 50% emulsified water proved to be a good medium for testing under these conditions.

3.3 Ice conditions

The testing was performed in two different ice conditions. The first target ice scenario was approximately 50% ice cover comprised of broken ice pieces and floes with a size up to approximately 1 m in diameter. The ice thickness was approximately 15 cm. This is referred to as the 50% broken ice scenario. The other target ice scenario was a mixture of small ice pieces and slush ice with an ice cover of up to 100%. This scenario is referred to as the slush ice scenario.

3.4 Test parameters

It was important to have good documentation of the emulsion used and the physical parameters in the basin.

For the emulsion, the following parameters were measured between each test:

- Water content
- Viscosity

In the basin, the following parameters were measured:

- Water temperature
- Air temperature
- Emulsion layer thickness
- Temperature in the emulsion prior to testing

In addition to physical-chemical measurements of the emulsion before and after recovery, the amount of emulsion was calculated, recovery rate was measured, and the testing was documented by video recordings and photos.

During testing the following test parameters were recorded:

Parameter	**Measurement/registration**
Flow of oil to the skimmer - access	Visual, photo, video
Deflection of oil/ice	Visual, photo, video
Separation of recovered oil – water - ice	Settling, mixing, draining
Increased emulsion viscosity	Physical/chemical analyses
Icing / freezing of equipment	Leave at low temperature + visual
Recovery effectiveness	Recovery per unit time. Portions of emulsion, free water and ice. Measurements in recovery tanks.
Free water recovered	Settling – measurement in recovery tanks
Water in emulsion before and after recovery	Emulsion breaker and heating/settling
Viscosity of emulsion	Physical/chemical analyses.

4 Skimmers for testing

4.1 The GT 185 skimmer

Figure 4.1 GT 185 Skimmer with brush conveyor, viewed from front

Figure 4.2 Sump for recovered oil and pump on the GT 185 Skimmer

4.2 The Oil Recovery Bucket LRB 150 skimmer

Technical data skimmer:

- Length: 1800 mm
- Overall height (with pump): 1200 mm
- Width: 1500 mm
- Weight: 900 kg

Technical data off-loading pump:

- Type: Lamor GTA Archimedes Screw Pump
- Capacity: 90 m^3/hr
- Discharge pressure: 200 bar maximum
- Hydraulic flow required: 125 l/min maximum

Figure 4.3 LRB 150 Skimmer viewed from the side.

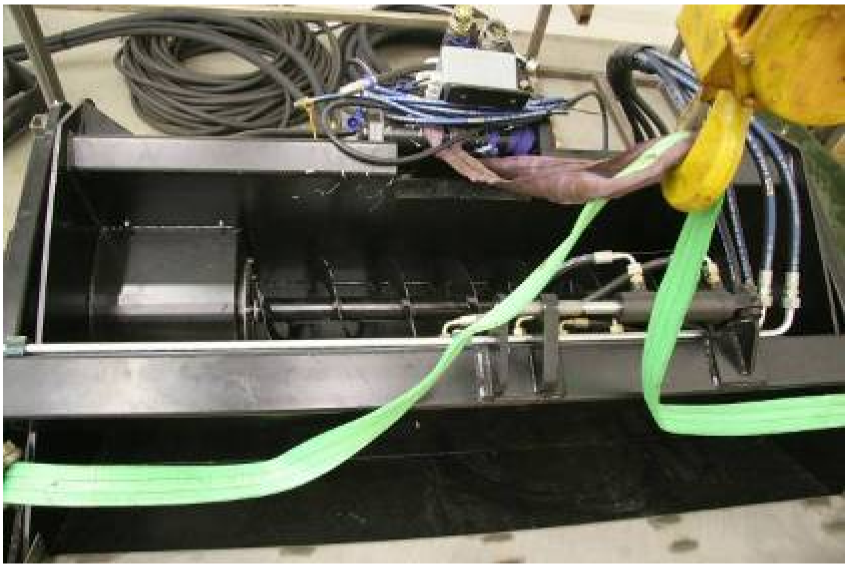

Figure 4.4 Sump of the LRB 150 Skimmer with screw auger transfer system.

4.3 Diesel hydraulic power supply

Technical data power supply:

- Length: 2000 mm
- Width 1000 mm
- Height: 1250 mm
- Weight: 900 kg (1100 kg full diesel tank)
- Hydraulic flow range: 0 - 160 l/min
- Max. cont. pressure: 210 bar
- Power: 47,6 kW at 2600 rpm (DIN 6271)
  50 kW (DIN 70020)

Figure 4.5 Diesel hydraulic power pack used during the tests.

5 Ice basin testing log

<table>
<tr><th>Testing log</th><th>Illustrations</th></tr>
<tr><td>

13. June 2007.
Test no 1: GT 185 Skimmer in emulsion, no ice:

- 3000 l emulsion pumped to basin
- Air temperature: -10^{o}C
- Water temperature: 1,1^{o}C
- Emulsion temperature: 0,2^{o}C
- Emulsion layer: 10-12 cm.

<u>*Observations:*</u>

The brush conveyer was operated at a speed of approximately 7 – 8 rpm. Due to a malfunction, the pump was unable to deliver the emulsion to the receiving tank. At low speed, the skimmer was able to recover the emulsion well as a continuous layer. At higher speed, it had a tendency to break the emulsion layer, collect only a segment of it, and then work in free water.

Because the emulsion could not be pumped to the receiving tank, the delivery hose was shortened and the emulsion pumped back to the basin. In spite of this procedure, the pump remained the limiting factor. Samples were taken from the delivery hose in 2 litre containers to measure free water, water content, and viscosity. The time to fill these 2 litre containers was measured in order to obtain an approximation of recovery rate; however, these measurements should be regarded as rough estimates only.

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Figure 5.1 Recovery of emulsion – no ice

Figure 5.2 Flow of emulsion to the pump

Figure 5.3 Flow of emulsion from the delivery hose

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Figure 5.4 Flow of emulsion to the brush conveyor

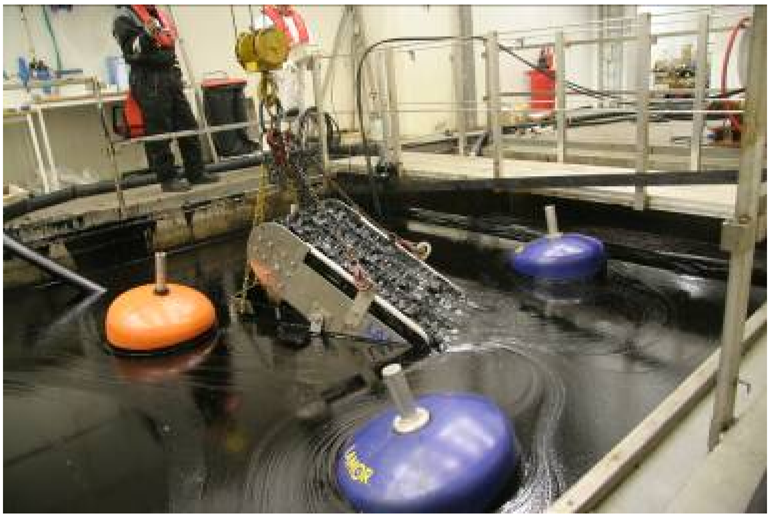

Figure 5.5 Flow of emulsion to the skimmer

<table>
<tr><th>Testing log</th><th>Illustrations</th></tr>
<tr><td>
13. June 2007.
Test no 2: LRB 150 in emulsion, no ice:
• Approx. 3000 l emulsion released to the basin
• Air temperature: -9^oC
• Water temperature: $1{,}2^oC$
• Emulsion temperature: $0{,}2^oC$
• Emulsion layer: 10-12 cm

<u>Observations:</u>

The brush drum was operated at a speed of approximately 5 – 8 rpm. At the start of the experiment, the skimmer was immersed too deeply in the water. For optimal recovery, the skimmer depends on the free flow of emulsion under the skimmer towards the brush drum. This is clearly shown in figure 5.7 where emulsion can be seen flowing into the brush drum only from each side of it leaving a broad section in the middle exposed to a relatively lower encounter rate of the emulsion.

The skimmer was lifted slightly allowing the free flow of emulsion under it (figure 5.8). The skimmer worked well after this adjustment was made and it recovered the emulsion effectively.

The emulsion was pumped to the 3 m^3recovery tank. Recovery time was 14 minutes.
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Figure 5.6 Recovery of emulsion – no ice

Figure 5.7 Little flow of emulsion under the skimmer – too deep in the water

Figure 5.8 Skimmer lifted – free flow of emulsion under the skimmer
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<tr><th>Testing log</th><th>Illustrations</th></tr>
<tr><td>

13. June 2007.
Test no 3: LRB 150 Skimmer in emulsion, 50% broken ice.

- Approx. 1700 l emulsion in the basin
- Air temperature: -10°C
- Water temperature: 0,8°C
- Emulsion temperature: 0,2°C
- Emulsion layer: 20-25 cm

<u>*Observations:*</u>

The brush drum was operated at a speed of approximately 7 – 8 rpm. This skimmer worked well also in broken ice. It was able to drag the small ice floes and emulsion under the recovery bucket and towards the brush drum. There were limitations in the basin because the ice floes were stuck in front of the skimmer thus limiting the flow of ice/emulsion after some time. This situation was improved by manoeuvring the skimmer around the basin by the crane.

Under these oil and ice conditions, this skimmer seems to be quite adept at processing the ice floes.

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Figure 5.9 Recovery of emulsion in broken ice

Figure 5.10 Flow of emulsion and ice under the skimmer

Figure 5.11 Effective recovery of emulsion

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Testing log	Illustrations
14. June 2007. **Test no 4: GT 185 Skimmer in emulsion, 50 % broken ice.** • Approx. 1800 l emulsion pumped to the basin • Air temperature: -7^{o}C • Water temperature: 0,6^{o}C • Emulsion temperature: 2^{o}C • Emulsion layer: 10-15 cm <u>*Observations:*</u> The brush conveyer was operated at a speed of approximately 7 – 8 rpm. This skimmer was much less effective in ice than the LRB Skimmer. The ice floes blocked the flow of emulsion to the skimmer. The skimmer was able to lift the front end of the ice floes (see figure 5.12) but could not take them further up to the brush conveyor. In this way, ice floes prevent emulsion from contacting the brush conveyor; however, some small ice pieces are recovered by the conveyor. Due to malfunction of the pump, it was not possible to measure any recovery of emulsion in this experiment. It is expected that the pump on this skimmer will not be able to pump ice pieces to a receiving tank.	 *Figure 5.12 Ice floes blocking the brush band*  *Figure 5.13 Low recovery of emulsion*  *Figure 5.14 Water in front of the skimmer due to reduced flow of emulsion*

<table>
<tr><th>Testing log</th><th>Illustrations</th></tr>
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14. June 2007.
Test no 5: GT 185 Skimmer in emulsion with slush ice.

- Approx. 2700 l emulsion pumped to the basin
- Air temperature: -4°C
- Water temperature: 0,8°C
- Emulsion temperature: 2°C
- Emulsion layer: ca. 10-15 cm

<u>*Observations:*</u>

The brush conveyer was operated at a speed of approximately 7 – 8 rpm. The skimmer was able to recover emulsion shortly after start-up, but oil recovery decreased rapidly. After that, much water was observed together with ice in front of the skimmer. There was low flow of emulsion to the skimmer. Due to malfunction of the pump, it was not possible to measure any recovery of emulsion in this experiment.

The refrigerating system in the basin room was not working properly this day and the air temperature increased. There were some associated problems with thawing of the ice in the basin.

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Figure 5.15 Small ice pieces recovered by the brushes

Figure 5.16 Water in front of the skimmer due to reduced flow of emulsion

Figure 5.17 Ice pieces collected in the pump

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Testing log	Illustrations
14. June 2007. **Test no 6: LRB 150 Skimmer in emulsion with slush ice.** • Approx. 2700 l emulsion in the basin • Air temperature: -4^{o}C • Water temperature: 0,8^{o}C • Emulsion temperature: 4^{o}C • Emulsion layer: 10-15 cm *Observations:* The brush drum was operated at a speed of approximately 5 – 6 rpm. It worked very well, almost as effectively as in ice-free conditions. Slush ice and emulsion were drawn to and under the skimmer towards the brush drum (or wheel). It did not recover any ice. Because the temperature in the basin room and hence the water temperature were too high, the ice was relatively soft and the viscosity of the emulsion relatively low. Plans were made to repeat this test the next day at lower temperature; however, the next morning, the air temperature was -11^{o}C and the temperature in the emulsion were between -3^{o}C and 0,7^{o}C. Consequently, the skimmer brushes were found to be frozen to the “scraping” board which was damaged when starting the brush drum. Further testing was cancelled.	 *Figure 5.18 Recovery of emulsion in slush ice*  *Figure 5.19 Ice and emulsion drawn under the skimmer*  *Figure 5.20 Effective recovery of emulsion in slush ice*

6 Test Results

Table 6.1 presents the key results from testing of the LRB 150 Skimmer and the GT 185 Skimmer in the ice basin. Table 6.2 indicates the viscosity and water content in the emulsion measured during the testing. Figure 6.1 presents the recovery rates calculated for the LRB 150 Skimmer. Due to malfunction of the pump, it was not possible to accurately measure recovery rates for the GT 185 Skimmer; only rough estimates were made without ice.

Table 6.1 Results from the basin testing of the LRB 150 Skimmer and the GT 185 Skimmer.

		Recovered liquid				Recovery rate calculated		
Skimmer and ice conditions	**Recovery time, min**	**Total amount, l**	**Free water, l**	**Free water, %**	**Water in emulsion, %**	**Total m3/hr,**	**Emulsion m3/hr,**	**Oil m3/hr,**
LRB skimmer, No ice	14	2342	0	0	45	10	10	5.5
LRB skimmer, Broken ice	19	1090	55	5	50	3,4	3,3	1,6
LRB skimmer, Slush ice	14	2163	108	5	50	9,3	8,8	4,4
GT skimmer, No ice	N/A	N/A	N/A	N/A	N/A	1,2-1,8	N/A	N/A
GT skimmer, Broken ice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GT skimmer, Slush ice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 6.2 Viscosity and water content of the emulsion measured during testing. Measured viscosity at 0^oC and at a shear rate of $10\ s^{-1}$.

Sample ID	Sample from	Viscosity, mPas	Water content, %
LA1	Pumping skimmer, day 1 –GT skimmer, No ice	8.942	51
LA2	Pumping skimmer, day 1 – LRB skimmer, Broken ice	8.518	50
LA3	Emulsion in basin, day 2 –GT skimmer, Broken ice	5.543	43
LA4	Pumping to basin, day 2 – GT skimmer, Slush ice	6.507	45
LA5	Pumping skimmer, day 2 – GT skimmer, Slush ice	10.165	50
LA6	Emulsion in basin, day 2 – LRB skimmer, Slush ice	7.848	49
LA7	Pumping skimmer, day 2 – LRB skimmer, Slush ice	11.522	50

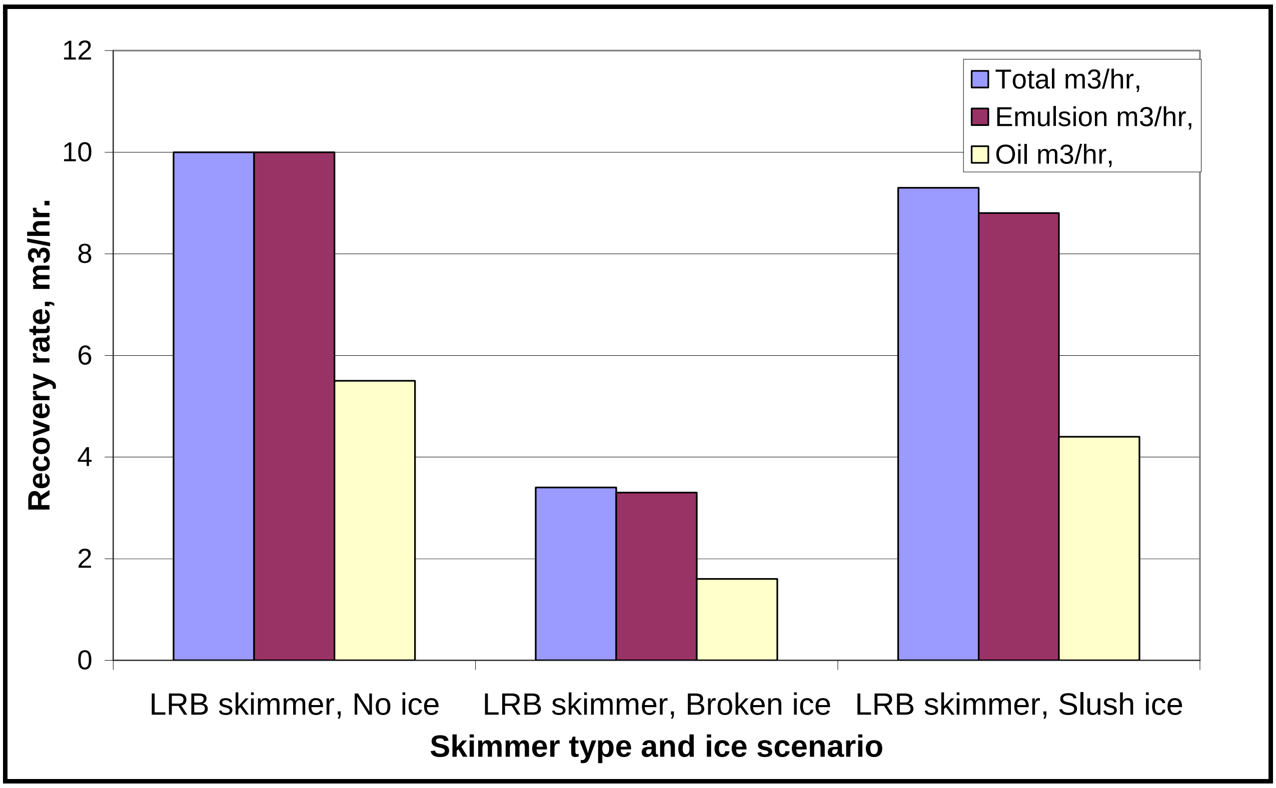

Figure 6.1 Recovery rate for total liquid, emulsion and oil calculated from the testing of the LRB 150 Skimmer.

6.1 Flow of emulsion to the skimmer

Access to the oil is one of the major challenges of recovering oil in ice-covered waters. The following observations were recorded during this testing:

GT 185 Skimmer with brush conveyor:

- There was good flow of emulsion with no ice present.
- With ice present, there was very poor flow of emulsion in both ice scenarios.

LRB 150 Skimmer:

- Very good flow of emulsion to the skimmer with no ice.
- The skimmer bucket needed to be raised so that the emulsion could flow freely under it to the brush drum.
- Good flow of emulsion with broken ice present. Ice floes were pushed under the skimmer by a gentle current created by the brush drum.
- The apparent recovery rate seems to be higher in slush ice compared to broken ice. However, due to problems with the freezing capacity in the lab, the temperature was higher in the testing in slush ice. This might have had an influence on the test conditions.

6.2 Ice processing

In this context, ice processing is defined as the skimmer's ability to deflect the ice for greater access to the oil. The following related observations were made:

GT 185 Skimmer with conveyor brush:

- The ice had a tendency to become stuck in front of the brush conveyor.
- The belt was able to collect small ice pieces, while the larger pieces blocked the entrance to the conveyor.
- Due to malfunction of the pump, it was not possible to determine if this kind of pump has the ability to transfer smaller ice pieces to the receiving tank.

LRB 150 Skimmer:

- The brush drum, rotating downward (on the pump side of the drum) into the emulsion and ice created a movement of oil and ice under and towards the skimmer where ice was deflected and oil was recovered.
- The ice was pressed under the brush drum and surfaced behind it allowing the emulsion to be recovered quite efficiently.
- The skimmer proved to be capable of processing ice both in the broken ice and slush ice scenarios.

6.3 Separation of emulsion, water and ice

Uptake of free water along with emulsion is undesirable for effective recovery. Skimmers with screw pumps are very likely capable of recovering small ice pieces along with the emulsion, but it is not desirable. In this testing, attempts were made to measure uptake of free water and ice. This proved to be difficult since the free water settled very slowly from the emulsion and small ice pieces and slush ice were difficult to find and measure in the viscous emulsion. The following observations were made:

GT 185 Skimmer with brush conveyor:

- The recovered emulsion was pumped directly back to the basin because the pump was unable to deliver the emulsion to the receiving tank. Therefore, it was impossible to measure the recovery of free water and/or ice.

LRB 150 Skimmer:

- Recovered tentatively 5% free water in both broken ice and slush ice scenarios.
- Very low uptake of ice (visually)
- Free water more intimately mixed in with the emulsion than for some of the other skimmers tested. Therefore, samples were left for settling overnight so that free water could be measured. In spite of these procedures, the water and emulsion had probably not settled out in the receiving tank. The measurements of free water in these tests, therefore, should only be considered to be approximate.

6.4 Icing / freezing of equipment

Icing / freezing of the skimmer and auxiliary equipment is a serious challenge in Arctic areas at low temperatures and in strong winds. Winterisation of equipment for use in these conditions is highly recommended. Although this testing did not focus on icing / freezing, some relevant observations were possible:

GT 185 Skimmer with brush conveyor:

- The testing was performed at temperatures down to -10^{o}C.
- The skimmer was left overnight in the basin and worked well the next day.
- It was not subjected to very low temperatures.

LRB 150 Skimmer:

- The skimmer was not subjected to the lowest possible temperatures in the basin (typically -18^{o}C to -20^{o}C).
- The skimmer was left overnight beside the basin at temperatures down to -11^{o}C. The brushes had frozen to the “scraping” board and when the skimmer was started the next morning the “scraping” board was damaged.
- The skimmer needs to be modified with protection and possibly heating for operations in cold conditions.

6.5 Recovery effectiveness

GT 185 Skimmer with brush conveyor:

- Because the pump was unable to deliver emulsion to the receiving tank, it was not possible to measure recovery effectiveness for this skimmer.
- In open water, the skimmer appeared to recover the emulsion quite effectively.
- In broken ice and slush ice, oil recovery was relatively good when starting the experiment but decreased significantly as ice blocked the conveyor.

LRB 150 Skimmer:

- The skimmer was capable of a high relative recovery rate with no ice present (estimated to be approximately 10 m^3/hr), the low speed of the drum taken into consideration.
- In the broken ice scenario, the oil recovery rate decreased, as expected, but still was relatively high (approximately 3–4 m^3/hr).
- In the slush ice scenario, the recovery effectiveness was determined to be quite high (approximately 9 m^3/hr). This result might be unrealistic due in part to problems with the air cooling system and, the temperature that was too high during testing.

6.6 Skimmer effectiveness related to oil type

As mentioned a 50 % water in oil emulsion of a IF-30 bunker oil was used in this testing. One reason for choosing this oil was practical because it was fairly easy to prepare stable emulsions. If we should have used a crude oil it would have been necessary to evaporate (top off) the light components to be able to prepare a stable emulsion, which would have been very time consuming and expensive.

Another reason for using IF-30 is that we have used it as reference oil in previous skimmer testing (Singsaas *et al.*, 2000). This testing was performed with a rope mop skimmer (Foxtail) and the recovery rate using the IF-30 oil was very close to the maximum recovery rate as given by the manufacturer of the skimmer. The IF-30 proved to have good cohesion and adhesion properties related to this skimmer type. Figure 6.2 shows the results from this testing, all results normalised to the IF-30 as the reference oil.

This testing indicates that IF-30 and emulsions of IF-30 can be close to optimal testing oil for skimmers that are dependant on good adhesion between the emulsion and the skimmer brushes and strong cohesion forces within the emulsion. However, for logistic and economic reasons it has not been within the scope of this project to do testing with several oil types. Even if ice processing seems to be the main challenge recovering oil in ice, the oil type and weathering degree still has a significant impact on the recovery effectiveness of different skimmer types.

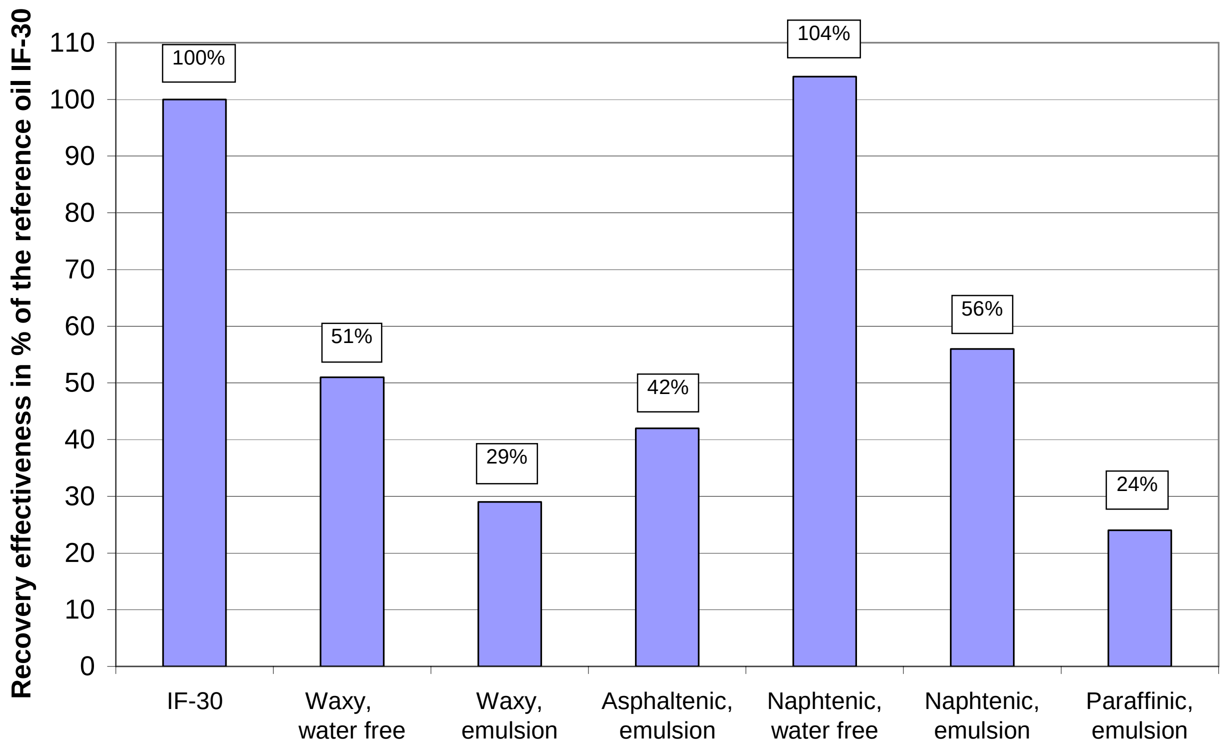

Figure 6.2 Testing of previous rope mop skimmer testing in the SINTEF basin, using IF-30 as reference oil (Singsaas et al., 2000).

7 Conclusions and recommendations

Based on this testing it was concluded:

The GT 185 Skimmer with conveyor brush worked well with no ice present, even with an emulsion of medium viscosity at low temperatures. The skimmer likely depends on a relatively high oil thickness for effective recovery. The ice processing capability was not satisfactory. This device will probably be an effective skimmer in open water even with highly viscous oils, but has less potential in ice-covered waters. The pump had a malfunction or was not sufficiently powerful enough to deliver this medium viscosity emulsion to the receiving tank. Changing the pump should be considered. Ice had a tendency to block the entrance of the brush conveyor; however, small ice pieces were recovered to some degree by the brushes. To avoid this problem, reversing the application of the skimmer could be considered so that oil and ice approach the downward-moving side of the brush conveyor rather than as presently configured, i.e., from the side of the conveyor that leads into upward-moving brushes; This configuration whereby oil moves into a pickup mechanism and ice is deflected downward was not tried nor possible in these tests because of the location of the hopper and pump. Based on the findings from the testing and discussions with the manufacturer and the project Reference Group, it was decided not to plan any further testing of this skimmer in this project.

The LRB 150 Skimmer worked well both without ice and in the two ice scenarios. It demonstrated good ice processing capabilities. It was tested at oil thicknesses of approximately 10-20 cm. In ice-covered waters at ice concentrations where booms are not expected to be used (i.e., greater than 20-40 %), the oil thickness can be much lower. Whether or not this skimmer can actually function under these conditions has not been tested but the cold basin work indicates that the skimming principle is very promising in oil and ice

This skimmer incorporates the same oil recovery principle as the Lamor Arctic skimmer, the only difference being that the Arctic Skimmer has two brush drums. However, this skimmer's ability to draw the ice and emulsion toward and under the skimmer so that the oil is collected and the ice is deflected remains to be verified for the Arctic Skimmer.

The concept of this skimmer and its potential capability were recognised by the project Reference Group as being both interesting and promising. The skimmer was recommended for further testing during the field experiment planned for 2009.

The LRB 150 Skimmer recovery and transfer components are not enclosed and are therefore exposed to low temperatures and wind. To be able to work under extreme conditions it is recommended that the skimmer be protected against freezing by a shield or protective cover and that heating is supplied.

Operation of this skimmer is dependent on a crane. Application of the complete skimming system from Lamor calls for deployment of the skimming head by an excavator type of crane from which it can be controlled and operated very effectively, including the adjustment of the angle and position of the recovery bucket and rotational speed and submergence depth of the brush drum.. Also, and quite possibly, this skimmer concept could be built into a frame with integral buoyancy or other means of deployment. For example, the brush drum could be built in to a catamaran or other type of vessel and thereby function independently of a main vessel and a crane. The problem often observed when operating skimmers close to a vessel is that the vessel itself opens up the ice field spreading the oil to a thinner layer.

It was concluded that this skimmer can be an effective device in low-to-moderate ice concentrations (up to approximately 50 – 60 % ice cover) when operated from an adequate crane. The skimmer very likely represents state-of-the-art technology for the recovery of oil in ice-covered waters.

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9 References

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