Laboratory study of oil slick behaviour in sea water in cold weather conditions:
Improving the oil spill response system for the Barents Sea

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Introduction

Volumes of oil transported in the Barents Sea, Kola Bay and through the North-East Sea Route increase every year and will continue to grow several times. The increased number of oil carrier vessels will escalate the risk of oil spills. In 2006, the Murmansk State Regional Centre for Standardization, Metrology and Testing (MCSM), in cooperation with Statoil, established a laboratory to determine chemical characteristics and analysis of weathered oil. The laboratory is outfitted with equipment for the determination of physico-chemical parameters of oil and a "cold room" to research the interaction of oil with sea water in the temperature range of 5-15° C.

Objectives

The objective of this research is testing samples of different oil types, study their physical and chemical properties when released into sea water, the oil slick behaviour depending on weather conditions, and the interaction of dispersants with different types of oil. The aim of the project is to establish a database of oil samples, which will ultimately aid in devising an optimal clean-up strategy in case of accidental oil spill. The test performance data of oil samples will be further used to create a computer model in order to forecast changes in oil properties under a particular weather condition. This will allow forecasting how a particular type of oil will behave during the spill.

RESULTS

Flash point temperature

The samples used in this study were collected from oil terminals and tankers carriers. Oil spill be collected safely only when the flash point temperature is below 60⁰C, otherwise as it can result in explosion in the holding tanks of oil vessels. Figure 1 illustrates that the light oil can start inflaming within 30 minutes after the initial time of the oil spill.

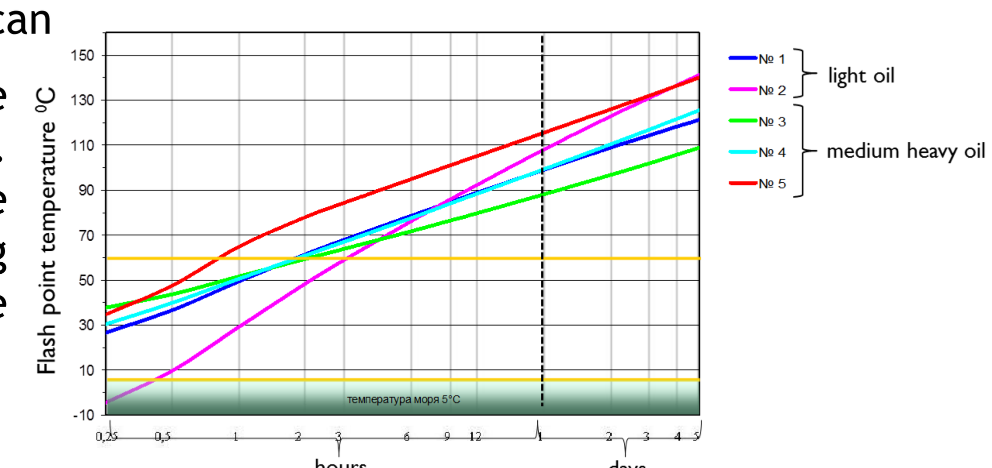

Figure 1 *Flash point temperature*

Residuals of oil on sea surface

Natural processes such as evaporation and dispersion will reduce the amount of oil spill over time.

Figure 5 illustrates what percentage of crude oil will remain on the sea surface from total amount of oil initially spilled at the temperature of +5ºC and wind velocity of 10m/sec.

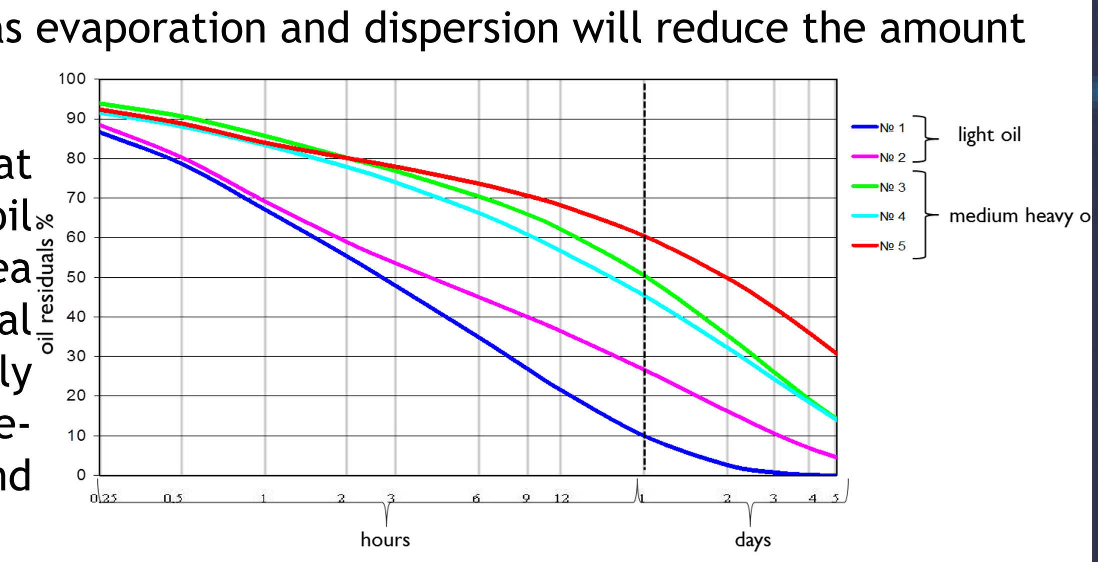

Figure 4 Residuals of oil on the sea surface after natural evaporation and dispersion

Emulsion viscosity

Measuring viscosity allows forecasting possible leak from harbour boom and choose the optimal oil skimmer type. There is a risk of leak from boom fencing for oil emulsion with viscosity under 1000mPa. A mop skimmer is used for oil emulsions with viscosity from 1000mPa to 20 000mPa.

For oil emulsions with higher viscosity, vane type skimmer is recommended. Figure 2 shows that, for 2 - 2,5 hours after the oil spill, emulsions from oil samples Nos. 2, 3, 4 can escape from boom fencing and, after that period, the emulsion can be cleaned with a mop skimmer.

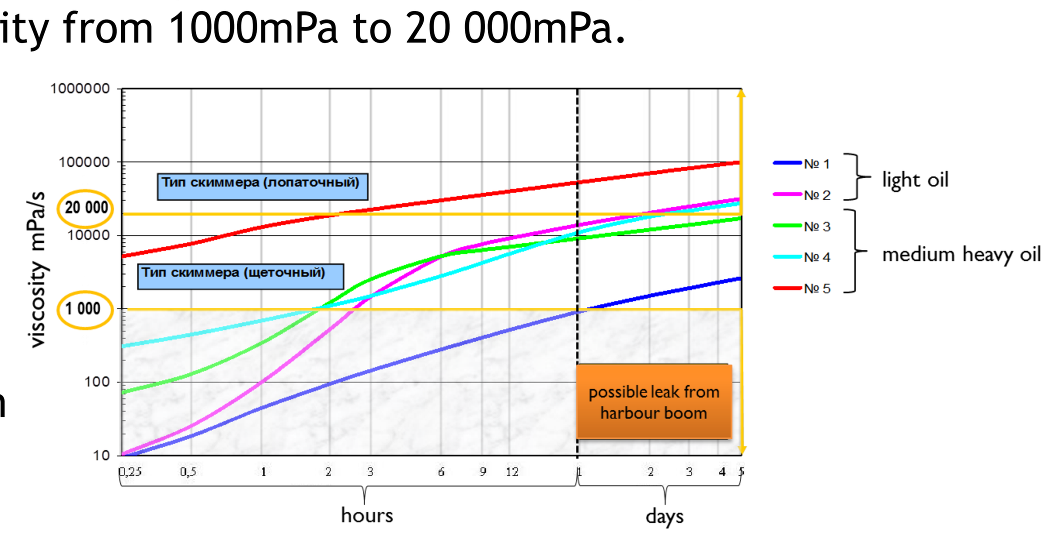

Figure 2 *Emulsion viscosity*

The ability of oil to hold water

The ability to hold water is crucial when collecting the emulsion. Figure 5 shows the stability of emulsions and the effectiveness of the demulsifying agent. There is a remarkable difference between light oil types 1 and 2. Also, we can see that, after 5 days, the demulsifying agent is not effective for sample 5 anymore.

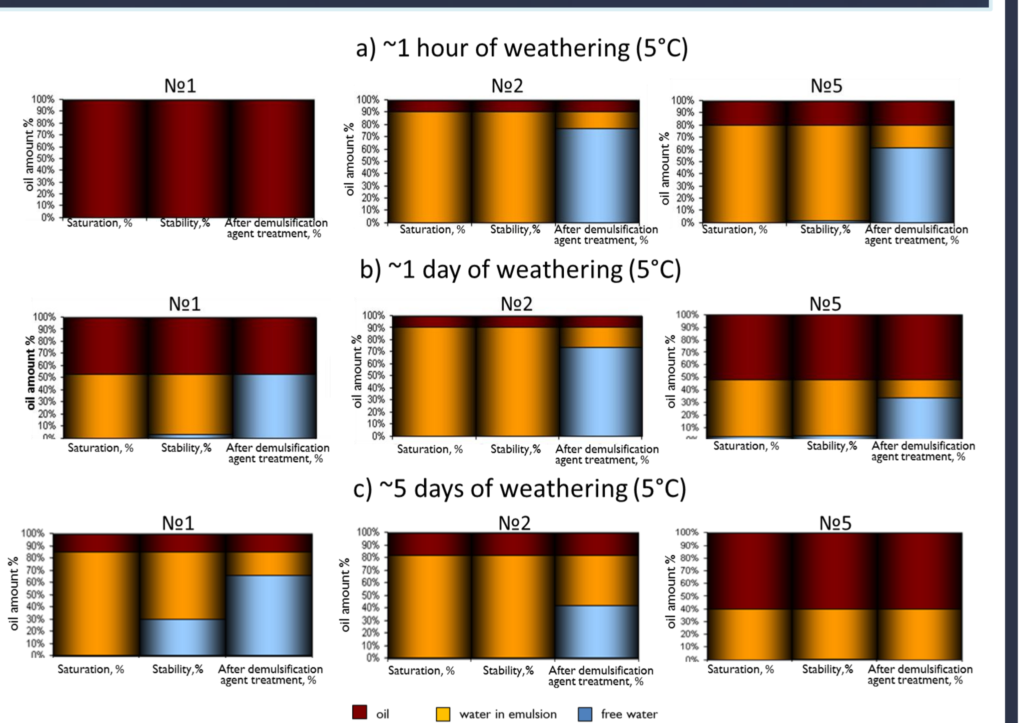

Figure 5 *The saturation rate and stability of oil-water emulsion and the effect of demulsification*

Water saturation

Mixing of oil with seawater spill increases volume. Fig.3 shows the amount of water saturated by oil. During the first day, samples Nos. 2&3 saturate 80% of seawater, sample No.1 saturates 73%, No.4 53%, and sample No.5 only 17% of seawater.

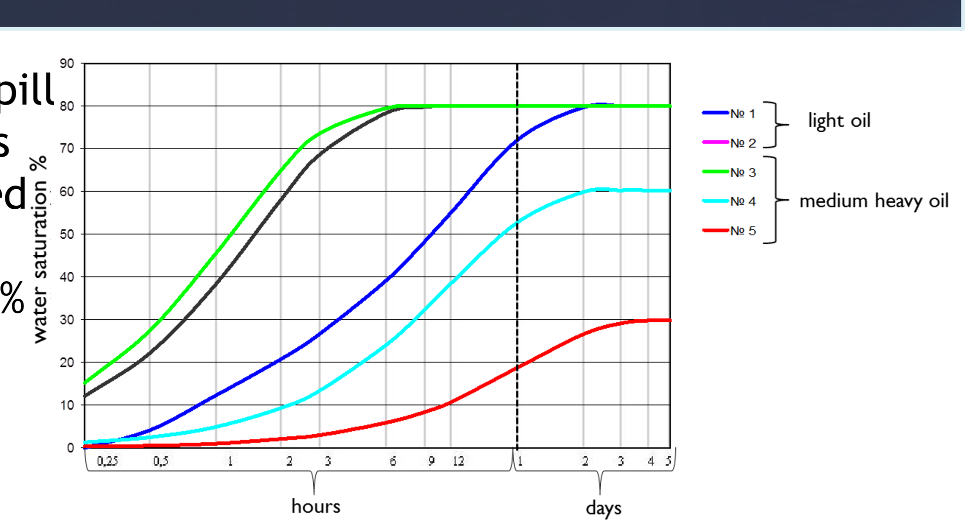

Figure 3 *Water saturation*

The efficiency of dispersant use

The efficiency of dispersant use depends on oil viscosity, pour point temperature and wind velocity. Figure 6 illustrates the window of opportunity for two medium-heavy oil samples Nos. 3 and 5.

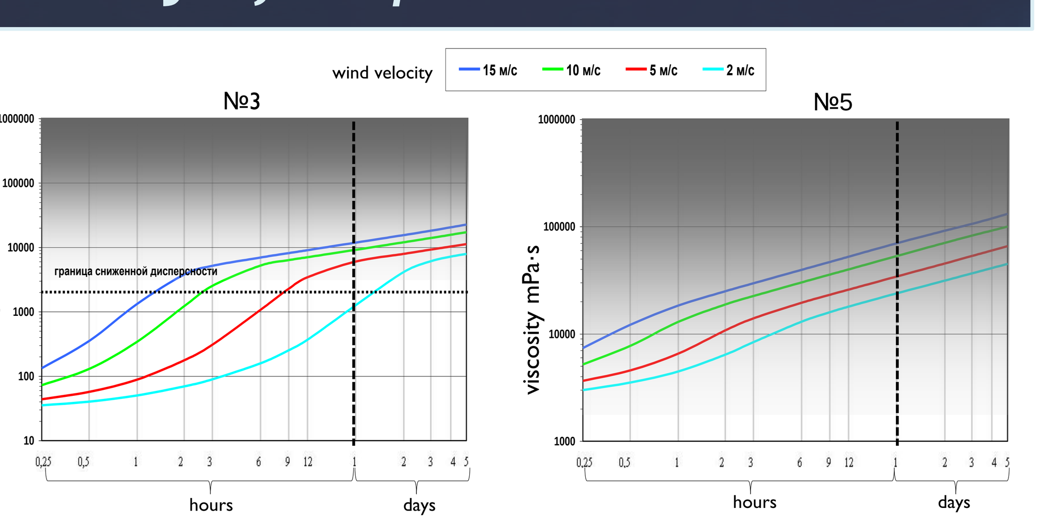

Figure 6 *The efficiency of dispersant use*

The relevance of research

This study will aid in devising a strategy for oil spill clean-up in the Barents sea. In case of accident, the databank will forward oil specific data to Hydrometeorology to determine rescue services, instruments, force and means to react adequately and work efficiently in oil spill elimination.

Acknowledgements

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