

OIL RESPONSE IN ARCTIC WATER – DIFFERENT POSSIBILITIES FOR RECOVERING OIL IN ICY CONDITIONS

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Abstract The aim of this article is to introduce methods for protecting environment in ice-covered waters in possible oil spill situation. The future trends predict increasing marine business activities in the environmental sensitive Arctic Sea areas, which establish demands for development of vessel's operational safety procedures and creates new challenges for protecting these untouched waters. Many means of mechanical oil recovery solutions have been developed and research have been active during decade's but still a lot of improvement and considerations need to be done.

Vessels operating in the Arctic Sea areas meet many risky situations, which are related for instance to rough weather conditions, limitations of nautical charts and publications or activities in isolated territory where vessels have to manage on their own without any outside help. In addition, organizing rescue and environmental cleaning operations are demanding in these areas.

Oil spill finding, observing and planning of cleaning operations in iced areas differs from open water cleaning operations due to properties of oil. Because of mentioned reason, techniques of preventing of oil spill, which are used in normal open water condition or in the warmer sea areas, may be ineffective or useless under cold and icy circumstances.

The main purpose of effective oil recovery is to choose and implement combination of different techniques, which are preventing short- and long-term effects to the sea environment. Generally known strategies are mechanical, combination of in situ burning and dispersion and normal natural extinction. Finnish are a pioneer in the matter also in regard to the development of collecting techniques and that is a part of our export industry, of research and innovations. This article covers the mechanical methods and use of vessels in arctic oil recovery.

Keywords: Arctic region, marine environment, oil recovery, oil-cleaning methods

Introduction

The shipping and marine business activities in polar areas will increase in volume in the long term due to decreasing of ice fields and exploitation of natural resources in the area. (Haaslahti, 2015) In addition, trends of growing arctic tourism and passenger vessel cruises are starting to show in these remote icy areas.

There is a number of unique risks ships are exposed to like for example harsh weather conditions, limited communication systems, lack of good nautical charts and publications as well as the remoteness of rescue and environmental clean-up operations. When ships are operating in cold air temperatures the functionality of equipment such as deck machinery and life saving appliances can be reduced. The cold and icy conditions increase extra loads on the ship hull, propulsion and have effects on vessel's stability. (IMO, 2017)

The growing activity in arctic areas creates remarkable risk for the sensitive sea and coastal environment in the arctic areas. At this moment there is lack of adequate infrastructure, search and rescue as well as oil spill preparedness in these regions. (Husebekk, et al., 2015)

Oil response in icy conditions

The primary goal of the efficient oil destruction is to choose and implement a combination of response techniques, which would be as effective as possible to prevent or minimizing short and long term influences of the oil spillage for the sensitive sea and the coastal areas.

The usual strategies for responding oil spills in icy waters are the same general suite of counteractions seen elsewhere in the world. The methods are:

- mechanical containment
- a combination of strategies to concentrate the oil and burn it *in-situ*
- dispersants
- detection and monitoring while conceivable planning a subsequent response
- natural attenuation through evaporation and dispersion (Council, Arctic, 2015)

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A collectively known term “weathering” means the physical and chemical changes that spilled oil undergoes. When determining the accessible windows of opportunity for various response strategies, weathering rates play a major role in that respect. One example for this is

usage of dispersant, which will become much less efficient as the oil spreads and as oil viscosity increases. The time available for applying dispersant can be limited - hours to days because of increased oil viscosity. Similarly, if mechanical collection methods are used, there might be need for changing the type of pumps or skimmers as the oil weathers and viscosity grows. There can be difficulties with in situ burning and has need of a greater starting oil thickness as the oil emulsifies and weathers. Weathering starts instantly when the oil is released from its container such as a tank, pipeline or vessel through multiple processes of:

- Biodegradation
- Dissolution
- Dispersion
- Evaporation
- Emulsification
- Oxidation
- Sedimentation (Council, Arctic, 2015)

In the arctic, ice covered areas emergency response is especially demanding due to many reasons. Among other things coping with the dynamic nature and unforeseeability of the ice; the remoteness and long distances that adds challenges in responding to accidental spills; effect of cold temperatures, icy and inhospitable working environment on response personnel and equipment; and the lack of shore-side infrastructure and communications to support and maintain a major response effort. (Council, Arctic, 2015)

Mechanical means of recovering oil from ice

Along with use of dispersants and in-situ burning, mechanical recovery is a method for responding to on oil spill on water. When collecting oil from icy sea, the basic principle is in mechanical oil recovery to get the spilled oil in reach of recovery equipment. The skimmers of the big capacity has also been developed to operate in oil spill response in icy conditions. (Arctic Response Technology JIP, 2015) For example, Finnish company Lamor has developed solutions such as skimmers (Figure 1.) for oil clean-up operations and oil spill equipment have been delivered for all over the world. (Lamor Oy, 2017)

In the mechanical process, oil is removed from the surface of the water with skimmer or with the help of the direct suction and the collected fluid will be stored. Usually skimmer supports the operation with containment booms, which directs oil towards the skimming system. The

comprehensive mechanical collecting operation contains the extermination or recycling of collected material. (Arctic Response Technology JIP, 2015)

When oil is trapped under drifting ice floes, mechanical recovery is a significantly demanding case. At the moment, there are no proven technologies or techniques for managing with scenario where there would be medium or large spill involved. In addition, there is still lack of technological inventions to position and track the oil from icy waters (new sensors are under development but not yet functional). (Council, Arctic, 2015) The developed arctic skimmers (Figure 2) are able to process larger numbers of a cold oil and ice mixture. The heating of critical systems is important to prevent freezing. In addition, oil pumping equipment and techniques have been developed to be suitable for cold conditions. (Tammiala, 2017)



Figure 1 Brush bucket skimmer (Lamor)



Figure 2 An oil skimmer

There is some additional challenges in mechanical recovery in ice-covered waters versus to open waters. When the ice coverage go beyond 10 -20%, it is difficult to operate with booms while the ice itself can act as a boom to border the oil. In icy waters, skimmer needs to be capable of deflecting the ice to reach the approach to the oil. (Sørstrøm, et al., 2010)

The experience of the decades of the mechanical oil destruction in the cold circumstances has developed the understanding of the collecting process and has led to the developing of special equipment and tactics. Ice-strengthened vessels are used in the arctic areas where there can be ice. (Tammiala, 2017) The vessels that have been equipped with the Azimuth (ASD) propeller equipment are especially valuable due to their maneuverability, the ability to support of the collecting and the ability to dispersant spreading. (Sørstrøm, et al., 2010)

In situ burning

Controlled in situ burning (ISB) (Figure 3) is a safe, environmentally acceptable and proven technique in open water, snow and ice-covered conditions already used since 1958. (Arctic reponse technology JIP, 2015) There is many applications in extensive-range field research and experience from accidental spills from several decades. (Arctic Response Technology JIP, 2015)

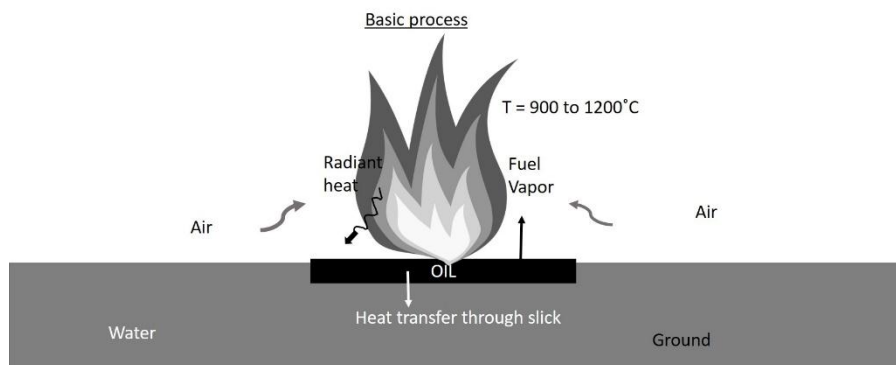


Figure 3 In-situ burning of oil process

There must be three components existing in order to ISB to be effective: fuel, oxygen and a source of ignition. (Arctic reponse technology JIP, 2015) Furthermore, subsequent circumstances should be observed: slick thickness, wind speed, wave height, emulsions, igniters and fire-resistant containment booms. (Tammiala, 2017) The ISB method is suitable especially in the Arctic areas because ice forms the block for oil to sustain the required oil thicknesses for firing, without the necessity for restrict the spill with booms. The primary restriction governing the success of ignition and burning is appearance of a minimum oil foil thickness for the certain kind of oil. In addition, there can be other influences that affect the total efficiency, like the grade of emulsification, swell, forceful winds and slush or crushed ice blended with the oil. The use of the aerial adoption of verified herding agents and igniters is a new swift response measure for spills in open drift ice where the ice concentrations are not enough to sustain a burnable foil thickness. (Council, Arctic, 2015)

A wide range of research indicate burning to be environmentally safe as regards to smoke particulates and fumes, carcinogens (PAHs) and remainder harmful substances in the water. However, in situ burning is not approved as allowed or anticipated response tool by every Arctic countries. (Council, Arctic, 2015) Burning of crude oil is valued to generate 12% water and 75% carbon dioxide. The leftover fume substances are from oil, which is passed to black carbon and carbon monoxide. From imperfect combustion, there will remain residue, which can be collected on land. (Arctic reponse technology JIP, 2015)

ISB method needs less human resources and equipment than other recovery techniques. The benefits are that method is more diversify in its application and it can be applied in the district where infrastructure is undeveloped. When using ISB method, oil is taken out from environment, the need for gathering of oil, storing and delivering of recovered oil is significantly diminished. (Arctic reponse technology JIP, 2015)

Effectiveness of ISB method varies based on ice situation. Fire resistant booms can in open sea conditions be tugged by vessels to thicken slicks for combusting. An area where there is 40-60% ice cover, ice in the sea will lessen slick diffusion, but cannot fully constrain it. Using booms and towing vessels can be risky and probability of boom failure is increased because of interference by ice. Thicker ice concentrations can work as a boom to efficiently control a slick. The concern in this kind of situations is still how to reach the slick to fire it. (Arctic reponse technology JIP, 2015)

Dispersion of oil

Dispersants are generated to boost normal dispersion by lessen the tension of the surface at the oil/water confluence so that it's easier for waves to form little oil droplets that are fast thinned in the water column such that usual levels of nutrients are able to maintain microbial degradation. Dispersants work as an efficient spill response tool when used correctly. With this method, oil can be fast removed significant amounts from the sea surface by transferring it into water column where natural processes will broke it down. (Council, Arctic, 2015)

Environmental and economic advantages can be achieved with dispersants when other spill response techniques are less usable options due to weather conditions or the accessible of resources. (Council, Arctic, 2015) The advantage is that dispersants can remotely applied from aircraft and there is no need for personnel on the water surface. The response time will be the shorter. (Arctic reponse technology JIP, 2015)

Nevertheless, like with other response methods, dispersants have also their weaknesses there have to take consideration the chemical properties of the oil dealt with, state of sea and weather conditions and environmental issues. In every situation, each response method should be considered taking into account factors such as salinity, currents, water depth, and profiles of temperature and species in danger. (Council, Arctic, 2015)

Dispersion of oil is widely applied as the most prioritize means of combatting open water spills but in an Arctic environment, the usage of dispersants is still strongly controversial. The potential to unfavorable effect to fisheries in these sensitive sea areas such as Greenland,

Barents Sea and the Bering Sea need careful consideration when deciding to use dispersants. (Council, Arctic, 2015)

Conclusions

When activity in the Arctic regions increases, there is need for development of an infrastructure to improve the safe operation. The changing activity in the Arctic areas require also simultaneous efficient development of measures of support. For example, oil drilling, oil transports and increasing vessel traffic need effective and improved means for oil spill response. The arctic environment is vulnerable and increasing activity in the areas have to meet the requirements for responsible and sustainable development. The primary concern at moment is that there is a lack for the readiness for environmental protection in the sea and at the coasts.

There are many methods and innovations developed for responding oil spill such as using dispersants, in situ burning technique or various ways of collecting and storing the oil. The numerous research and development projects about the topic have been done during decades and means of responding oil spills have been generated. Researchers have found many promising practical solutions for cleaning the oil from sea even in icy conditions. It is in vital to consider the most efficient method in every incident.

The ice-strengthened vessels or icebreakers are needed for mechanical oil response in icy areas and there is a requirement for ship crew have acknowledgement of ice management, operations in cold conditions and how to protect sensitive sea areas.

References

Arctic reponse technology JIP. 2015. *Summary report of : Spill response in the arctic offshore*. 2015. pp. 10-13.

Arctic Response Technology JIP. 2015. *Mechanical recovery in ice, summary report*. 2015. pp. 5,109.

Council, Arctic. 2015. *Guide to oil spill response in snow and ice conditions in the arctic, ”, EPPR Emergency Prevention Preparedness and Response*. s.l. : A working group of the Arctic Council, 2015. pp. 73, 85-86, 103.

Haaslahti, Simo. 2015. *Polarworthiness*. Rauma : Satakunta Univercity of Applied Sciences, 2015. p. 7.

Husebekk, Anne, Andersson, Magdalena and Penttilä, Risto E.J. 2015. *Growth from the north*. s.l. : Finland Prime Minister's Office Publications, 2015. p. 31.

IMO. 2017. Shipping in polar waters. 2017. [Cited: 5 26, 2017.]
<http://www.imo.org/en/MediaCentre/HotTopics/polar/Pages/default.aspx>.

Lamor Oy. 2017. [Cited: 5 28, 2017.] <http://lamor.com/about-us/>.

Sørstrøm, Stein Erik, et al. 2010. *Joint industry program in oil spill contingency for Arctic and ice-covered waters summary report*. 2010. p. 25, Summary report, Report no.:32.

Tammiala, Sampo. 2017. *Arctic oil recovery*. Rauma : Satakunta University of Applied Sciences, 2017. pp. 6-7, 15, 17.