XXXII Неделя науки СПбГПУ. Материалы межвузовской научно-технической конференции. Ч.I : С. 7-8, 2004.

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OIL POLUTION IN THE ARCTIC SEAS: OIL IN THE ICE SLUSH

The objective of this work is to obtain information regarding the oil discharging in the Arctic seas on to the new ice formation (slush ice), and experimental test of such problem. A lab simulation of the process is presented together with initial results from this work.

The exploration and development of the Arctic as an important petroleum-producing region has resulted in a significant number of research programs pertaining to the presence of oil in the Arctic environment. The problems which can occur when oil discharged into the see in summer or winter conditions due to research or exploration programs, were intensively study over the past twenty years. There are different opinions and estimations of ecological subsequences of oil pollution in Arctic Seas. The main question of oil pollution is its period of existence and fate. Some scientists suppose that the oil spills in the polar seas will cause negative subsequents as well as changes of water and ice albedo for long period. Therefore, the Arctic radiation balance may be changed and, as consequence, may change the ice quantity.

A lot of combat techniques against oil spills have already been developed and used in open water. However, the technology to fight with oil spills in the ice covered regions are still under development. The main problem is that the influence of oil layers on the ice formation under arctic conditions is not well understood. Several oil ice processes can take place when oil released into the ice-covered regions depending of atmospheric conditions, agitation of sea, type of ice and properties of oil. These processes can be easily studied isolated in small laboratory investigations.

New ice formation in open sea water under the arctic conditions begins from the slurry of the crystals known as frazil ice. The turbulent actions at the Seas will break out the slurries of the crystals and mix them in the upper part of water column forming ice slush. For the preparations for the experiments it has been prepared artificial salt water with salinity 36 ppt. The experiment was conducted in a rectangular aquarium with dimensions 25 cm deep, 34 cm length, 24 cm width, which was installed in cold room at temperature –18 C. After 4 hours, when the first formation of the ice appeared on the surface of the water, this was mixed to produce ice slush. The next step done was to add amount of oil to the slush. For this purpose it was used 50 ml of Norwegian oil NORNE, which properties are described in table 1. Due to the oil high pour point (when it begins to be semisolid), it was warmed up before using, in order to get a more liquid status. To simulate turbulent conditions the oil was added while stirring the ice slush. The frozen samples of oil plus slush were taken after 49 hours (figure 1).

Table 1

Properties of NORNE oil

Oil	Density (g/mL. 15^{0}C)	Flash point (^{0}C)	Pour point (^{0}C)	Wax (%)
NORNE oil (200^{0}C +)	0,877	79	27	15.2

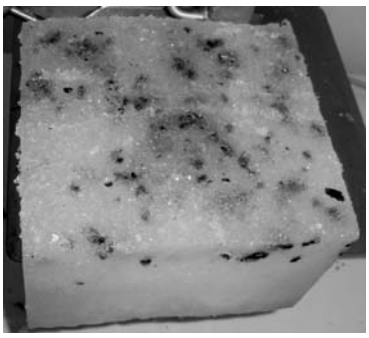

Figure 1. Oil included in the ice slush.
Sample of oil in ice slush frozen together

Figure 2. Holes on the top
of ice due to oil drops

When oil reached the surface of the ice slush, it was noticed that it changed quickly from liquid to semisolid state. The shape of the oil in the slush looked as "three dimensions oil drops". The oil drops were not penetrating trough the ice slush mixture. They were seeping down through the ice slush. Some oil drops were on the surface while others were sink down together with slush. The wave simulation broke oil droplets producing different sizes.

The horizontal spreading was hindered by slush mixture. The oil drops on the surface did not allow the ice slush particles freeze together, thereby forming some kind of holes (figure 2). The oil droplets were seeping down in the water column and kept stable positions during the process of growing ice around.

In this paper it has been observed the process of freezing of oil in an ice slush mixture. The firsts observations done are a first attempt to find suitable conditions for the future experiments to come. These will include tests with different types of oil and analysis of the crystallographic structure of the oil ice thin sections. The previous experiment presented in this paper try to simulate the behaviour of the oil spreading in ice slush cover regions in the open seawater. The experiment shows that oil drops seep down some centimetres in the water column if the mixture is done agitating the slush. This agitation may simulate the action of waves in the sea. The drops kept its position after stopping the agitation process and during the complete ice formation process. The deepness reached by the drops may depend of the oil properties and waves conditions in the surface. The horizontal spreading of oil was hindering by slush.

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