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The effectiveness of chemical herders as oil spill response tool in ice-infested water

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Abstract

The effectiveness of the chemical herding of crude oil, a tool for handling of oil spills, was studied in ice-infested waters to evaluate the applicability to oil spills in Arctic waters. The average slick thickness, surface distribution of the slicks, as well as the burning efficiency of a North Sea crude oil were studied after herding to determine the herder effectiveness as a function of the ice coverage, basin size and herding direction. Experiments were performed in a small scale laboratory setup, featuring a 1.0x1.0x0.5 m³ water basin (1 m² surface area), and an intermediate scale outdoor setup, featuring a 4.0x4.0x0.1 m³ water basin (16 m² surface area). Crude oil was spread from a corner of the basin on open water and in 3/10, 5/10 and 7/10 brash ice coverages, using the same open water surface to oil ratio in all experiments. The chemical herder (50 µL/m²), which is a surfactant that spreads to form a monolayer, was then applied in the opposite corner to compact and thicken the oil slick. Post-herding slick thicknesses varied between 3.0-5.7 mm and reached a maximum thickness for the 3/10 ice coverage. The post-herding surface distribution of the oil strongly depended on the ice coverage. Several tens of slicks were formed for an ice coverage of 3/10, whereas coverages of 5/10 and 7/10 resulted in several hundred small slicks. The burning efficiency was not significantly affected by the presence of ice and only depended on the scale (40-50% and 65-75% for respectively the small and intermediate scale), which is in line with previous studies. The results showed that the herding process is effectively thickening the oil slick to an ignitable thickness and the burning efficiency was independent of the ice coverage. However, the formation of multiple oil slicks complicated the ignition procedure and post-burn clean-up process which could reduce removal efficiencies in full scale operations.