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Influence of Ullage to Cavity Size Ratio on *In-situ* Burning of Oil Spills in Ice-infested Water

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Abstract

This study analyzes the results of meso-scale experiments related to *in-situ* burning of oil spills in ice leads or in close pack ice, which are the two main spill scenarios commonly found in the arctic with the presence of ullage. Alaska North Slope (ANS) crude oil with slick thickness of 0.015 m was burned in ice cavities of sizes 1 – 1.5 m with ullage or freeboard of 0.1 – 0.2 m. Heat fluxes on oil surface and ice wall, in-depth temperature profiles in gas phase, oil-layer and water-sublayer, and average burning rate were experimentally measured to analyze the influence of ullage and cavity size on burning. Significant improvement in the burning dynamics was observed with an increase in ullage to cavity size ratio (*h/D*). This is mainly due to a recirculation zone developed in the cavity causing partial premixing of oil-vapor and entrained air, which promotes a faster burning rate. The implications of experimental findings towards *in-situ* burning operation for oil spills in ice leads and close pack ice are discussed. Both freshwater and saltwater ices were used and differences are examined.

Keywords: *in-situ* burning; ice cavity; ullage; crude oil; burning rate; removal efficiency.

1. Introduction

In-situ burning (ISB) has been considered a primary spill response for oil spills in the Arctic seawater conditions since the 1970s [1]. Many field trials have been conducted to examine and document burning of spilled oil on solid ice, in snow, in pack ice, and brash and frazil ice [2]-[11]. The most up-to-date