Dispersing Oil Slicks: Impact of Droplets on a Floating Oil Layer

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Oil slicks, resulting from oil spills, are often sprayed with chemical dispersants. Ideally, the sub-millimeter scale dispersant droplets will gently land on the oil slick and gradually mix into the oil. Herding, when large dispersant droplets with a high speed break through the oil slick and split it into patches, disturbs the process of oil dispersion. The purpose of this test is to better understand the physics of dispersant droplets impacting an oil slick in order to calibrate the ideal droplet size relative to oil slick properties. In order to perform the experiment, dispersant droplets (Corexit 9500A) and a dispersant substitute (water) impacting on oil slicks of various thicknesses were filmed at high magnification at 1000 frames per second. ImageJ software was used to measure the impact speed and diameter of the recorded droplets for various cases (oil slick thicknesses and droplet material). The droplet impacts were categorized into five behaviors: coalescence, bounce, ripple, crown, and bubble (listed by increasing impact energy). The Weber and Froude numbers were used to analyze the data collected. Plotting Weber versus Froude allowed classification of droplet impact behavior and comparison among different cases. It was found that, as the droplet impact energy increased, meaning droplet diameter and droplet speed increased, the impact behavior transitioned from coalescence to bubble formation. Coalescence was the ideal behavior because coalescing droplets were most likely to gently fall on top of the slick and mix into the oil. Using Weber and Froude number, the ideal droplet size to achieve coalescence on a thick slick was calculated to be approximately 270 microns for water and slightly smaller for dispersant droplets.

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