The Use of Chemical Dispersants in Oil Spills

The use of chemical dispersants in oil spills has been contravertial over many years. Some studies show that they are effective and other studies show they are not, some show they are toxic to marine organisms, others demonstrate that they are not toxic. The main reason for the differing conclusions is that many of the studies on chemical dispersants do not take into effect realistic doses, timing, type of oil etc. Finally a definitive study was released last week by the US National Academy of Sciences, Engineering and Medicine (NASEM) which provides more clarity on the use of dispersants. (https://www.nap.edu/catalog/25161/the-use-of-dispersants-in-marine-oil-spill-response). The Committee report made up of scientists from the Oil Industry and Academia came up with specific recommendations. "Field and modeling studies show that dispersants can be a useful tool for oil spill response, says The Use of Dispersants in Marine Oil Spill Response. Dispersants can reduce the amount of surface oil, thereby reducing response personnel's potential exposure to hazardous compounds in oil and lessening the extent of surface oil encountered by marine species. Dispersants may also reduce the fouling of shoreline habitats by reducing the amount of surface oil that is blown ashore.

What are chemical Dispersants and how are they used?

Surfactants reduce oil-water interfacial tension, which helps waves break oil into small droplets. A mixture of oil and water is normally unstable, but can be stabilized with the addition of surfactants; these surfactants can prevent coalescence of dispersed oil droplets. The effectiveness of the dispersant depends on the weathering of the oil, sea energy (waves), salinity of the water, temperature and the type of oil. Dispersion is unlikely to occur if the oil spreads into a thin layer, because the dispersant requires a

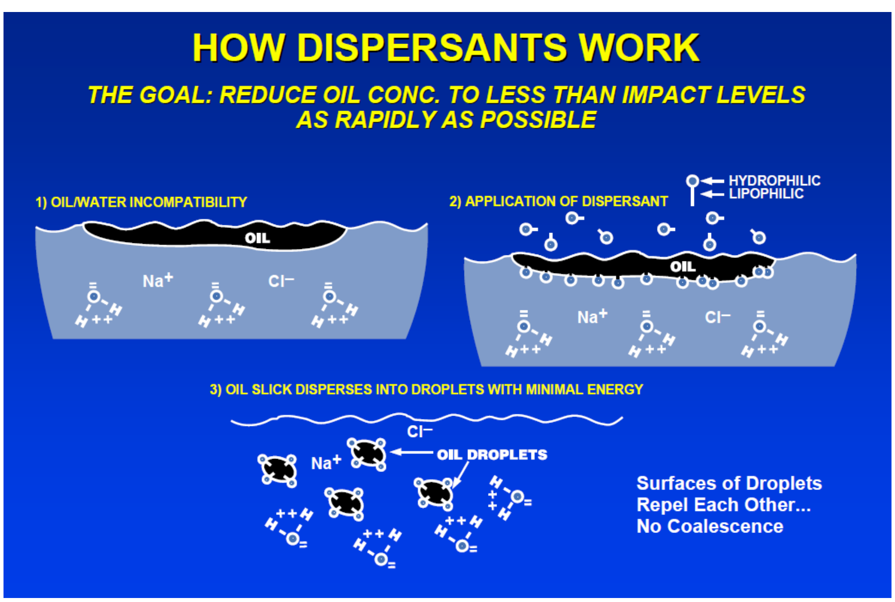

Figure 1: Description of how oil dispersants work

particular thickness to work; otherwise, the dispersant will interact with both the water and the oil. More dispersant may be required if the sea energy is low. The salinity of the water is more important for ionic-surfactant dispersants, as salt screens electrostatic interactions between molecules. The viscosity (stickiness) of the oil is another important factor; viscosity can retard dispersant migration to the oil-water interface and also increase the energy required to shear a drop from the slick. Over the years dispersants have significantly changed in formulation and are now less toxic than they were originally.

Fig. 2: Dispersant use by aircraft versus dispersant use by ship.

They are usually sprayed over the oil slick in specific conditions, generally from a ship or by aircraft in a ratio of about 1 part dispersant to 20 parts oil. The spills also have to be dispersable which has to do with many environmental conditions and generally on fresh oil of a specific type. Some oils are not dispersable and aged oils are generally not dispersable. Some of the failures of knowledge of dispersant use has come about by dispersing during wrong conditions. During the Deepwater Horizon Spill (DWH) in the Gulf of Mexico in 2010 it was decided to add dispersant to the oil well-head at 1500 m depth thus dispersing the oil at the source. An estimated 2.5 m litres of dispersant was used at the wellhead.

Perhaps one of the most concerning incidents in dispersant use was during the Torrey Canyon spill in 1967 on the southwest coast of England where approximately 10 million litres of alkylphenol surfactants were used to treat 119 million litres of spilled oil. These dispersants were not developed for oil spills but was a degreaser that proved more toxic than the oil itself and gave dispersant use a bad reputation. Industry worked hard to form better dispersants, which were more effective and less toxic than these original dispersants as well as developing more useful systems to deliver the dispersants to the environment.

On March, 1989, the Exxon Valdez hit Bligh Reef in Prince Willam Sound, Alaska and spilled approximately 40 million litres of oil. There were many different factors which complicated the response to the spill as it was a lot of oil in a relatively inaccessible area with many small coves and bays which were really only accessible by boat or helicopter. The main forms of cleanup were booms and skimmers, coldwater washing and then even hot water washing which killed many organisms in its own right. Dispersants were tried as well using helicopters but there were few waves and mechanical energy but proved to be were ineffective.

The use of dispersants and when to use them depends on a term called Net Environmental Benefit Analysis (http://www.oilspillresponseproject.org/wp-content/uploads/2017/01/NEBA_2016-2.pdf). There are a number of questions to be answered the first is which tool will be the most effective to removing most of the oil. Which tool can be physically and safely executed? Which tool will minimize the impact on the environment and the community? Which tool will the environmental regulations allow?

Perhaps one of the most important NEBA studies was called the TROPICS experiment in Panama. This was a study which involved spilling oil in a tropical environment and using chemical dispersants (Figure 3) on one site and oil not

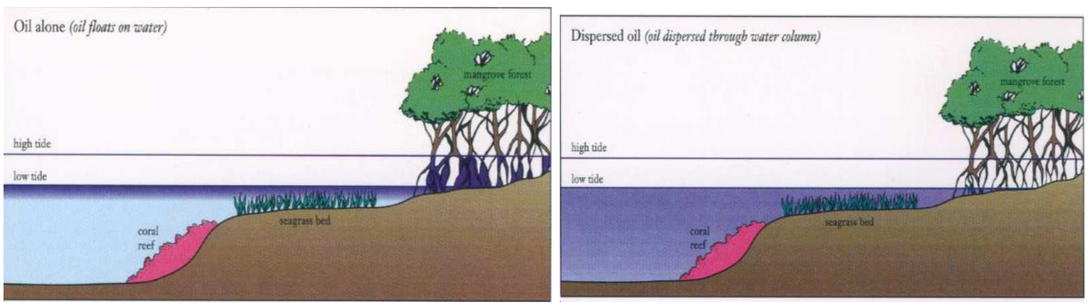

Figure 3: The Tropics experiment scenario. On left just oil is not treated and floats on the surface coasting mangrove roots. On right shows chemically dispersed oil evenly dispersed and prevents oil from coating the mangroves.

treated at the other site. The sites were monitored for 32 years and even after all that time the site which was treated with dispersants was more healthy than the site where oil got into the environment and destroyed the mangroves. In many places if there is risk to Mangroves then it is prudent to chemically disperse the oil. The main point is that each spill has different criteria and different responses. The NASEM report provides clarity in regards to dispersant use and the conclusion that it is an important tool for spill response and can be used where warranted using NEBA.