CHEMICAL DISPERSANTS

BACKGROUND

Since the 1980s, chemical dispersants have been available for oil spill clean-up. Typically, they are used in combination with more traditional techniques, such as oil containment booms and skimmer vessels that collect the corralled slick. Early dispersants were essentially highly toxic solvent. Today's approved dispersants are far less toxic and can be beneficial when applied to oil slicks in deepwater and heavy seas.

The United States federal government has established some standards for decision-making regarding dispersant use, and throughout the U. S., certain zones are "pre-approved" for the use of chemical dispersants--usually at a distance of 3 nautical miles (approximately 5 km) from shore and a depth greater than 10 m (about 30 feet). When faced with a spill, whether or not to apply chemical dispersants can present one of the most difficult choices response authorities make. Dispersant use in shallow water is usually not an option. Fisheries organisms in the relatively shallow estuaries could be exposed by dispersed oil, as opposed to undispersed oil, which floats on the surface. The decision is a weighing of which alternatives will reduce, not eliminate the damage.

HOW DISPERSANTS WORK

Given the right conditions and adequate time, oil will naturally disperse in water through wave activity. Chemical dispersants are designed to accelerate that process by affecting the natural resistance of oil to mix with water. Dispersants do not reduce the amount of oil in the water; rather, they transform it into tiny droplets that can be suspended below the surface in deep water, preventing the droplets from reforming an oil slick. This greatly increases the area that natural microbes can access and "feed" on the oil, resulting in a quicker reduction of the more toxic fractions of petroleum. The effects of turbulence and wave actions can cause the droplets to spread rapidly and travel long distances.

There are three main components in typical chemical dispersants-- surfactants, additives, and solvents. A surfactant is a surface-active chemical compound with molecules containing both water-compatible (hydrophilic) and oil-compatible (lipophilic or hydrophobic) groups. The surfactant molecules accumulate at the interface between oil and water, where the hydrophilic groups interact with water phase and the lipophylic groups interact with the oil phase, reducing the tension and helping form small oil droplets that are distributed in the water column (the vertical section of a body of water, from the surface to the bottom) through wave activity.

Barataria-Terrebonne National Estuary Program
P.O. Box 2663, Thibodaux, LA 70301
1 (800) 259-0869
For media inquiries : 1 (985) 227-1923
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Additives can promote stability and longevity of the dispersant, and along with solvents can enhance its solubility in a spill. Solvents also help mix the additives with the surfactant and can affect how much water can be pre-mixed with the solution for application.
Chemical dispersants have little effect on "weathered" oil (oil that has been in water for long periods of time) because it is more viscous from evaporation and emulsification. Therefore, application should take place as quickly as possible, within 48 hours.

DISPERSANT TOXICITY

In the past, some dispersants were linked to disorders in humans and animals, but in 2005, the National Research Center (NRC) released a report, *Understanding Oil Spill Dispersants: Efficacy and Effects* (National Academies Press) stating that today's dispersants are much less toxic than those used several decades ago. In fact, it cites numerous direct comparison studies in which dispersants themselves were found to be less toxic than oil or dispersed oil (although this finding was not universal). And in deep, open water, where dilution is rapid, the toxic impact of dispersants is likely to be lower. Nevertheless, many factors can cause wide variations in the sensitivity of organisms to dispersants and dispersed oil. These include species, age, stage of development, and previous exposure to toxins.

USE OF DISPERSANTS AND TRADE-OFF'S

Use of dispersants offshore is generally thought to be more effective and safer than use in or near shore (in less than 30 m of water). Offshore, the wave energy is higher which aids the dispersants in breaking the oil into individual droplets, surrounding the droplets with the dispersants, and spreading the oil droplets throughout the water column where it can better photo degrade and be digested by micro-organisms. Once the oil is spread throughout the water column, currents will drive the direction the oil moves, which is usually lateral to the coastline, rather than toward the coast. If the oil remains as a slick on the surface of the water offshore, wind direction will influence the direction of the slick movement more that ocean currents. Also offshore, there is usually a lower density of fishes, birds, and marine life, many of which are adults that are less susceptible to toxins, therefore leading to overall lower impacts to fisheries.

Use of dispersants inshore has far more potential to impact fisheries in shallow waters and are usually restricted from use inside of 30 meter water depths. Fisheries inshore, within barrier islands, bays and marshes, are generally at higher densities and are younger in age than offshore fisheries. They are more susceptible to toxic effects than offshore fisheries. If dispersants are used inshore, then the toxicity of the oil and dispersant is spread throughout the water column, affecting benthic (bottom dwelling) organisms, such as oysters, and larvae and fishes in the water column. In this case, it is usually better to allow the oil to move as a surface slick over the top of these organisms in order to decrease the severity of impacts to these fisheries.

UNRESOLVED QUESTIONS

The decision of whether or not to use chemical dispersants is a particularly difficult because responders must consider the benefits vs. the risks of introducing dispersed oil to a variety of ecologies. The NRC report asserts that there is not even adequate research on the widely held assumption that chemically dispersed oil will have significantly less impact on aquatic animals and seabirds than untreated oil--one of the most critical decision points--and there even is some indication from available data that the toxicity of dispersed and untreated oil to those animals is comparable (p. 255).

For example, there is the potential trade-off, frequently cited, of dispersant use reducing the impact of oil on aquatic animals and seabirds, but possibly increasing oil exposure to fish, corals and other organisms in the water column.

DISPERSANT USE FOR NEARSHORE SPILLS

Many oil spills occur within 3 nautical miles of the shoreline, but little assessment is available for spills in these waters. Dispersants can be effective on nearshore spills, because longer contact time is possible and conditions can allow better dispersant penetration. However, according to the NRC report, in these areas organisms may have significantly varying sensitivities to dispersed oil, which decision-makers would have to weigh carefully.

CONCLUSION

Clearly, the decision of whether or not to utilize chemical dispersants for an oil spill is a complex one and involves trade-offs that require careful impact assessment on nearby ecologies. Each spill is unique, and each ecology that it affects is unique. At present, the long-term, full effects of using chemical dispersants is simply not known.

The decision-making process can be improved by obtaining more reliable study results and information and by implementing more unified oversight. These, in turn, can help develop and improve standards, plans, and proactive strategies for making appropriate spill recovery choices in the future. Spill response is always a weighing of alternatives. Which alternative is least damaging? "The decision is a weighing of which alterative will reduce, not eliminate the damage caused by the oil," said Kerry St. Pé, director of the Barataria-Terrebonne National Estuary Program.

References:

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Understanding Oil Spill Dispersants: Efficacy and Effects; Committee on Understanding Oil Spill Dispersants: Efficacy and Effects, National Research Council (National Acadamies Press, 2005).

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