HISTORY OF DISPERSANT DEVELOPMENT: A DISPERSANT TIMELINE

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ABSTRACT

Initial experiences with oil spill dispersants were less than positive somewhat due to the fact that dispersants began their evolution as chemical substances that were perhaps more toxic than the oil that they were intended to disperse. Through time, however, dispersants were formulated to become less toxic. Beginning with caution, testing and evaluation though the U.S. national science community, then through public workshops and hearings, the US began the process of integrating dispersant usage into its repertory of response technologies.

DISCUSSION

The United States began it's exploration of the use of dispersants in oil spill response recognizing that the primary value of using dispersants is to move oil away from the water surface and away from near-shore habitats where the vast majority of sensitive marine resources reside. The secondary benefit of dispersants was seen as the reduction of threats to birds and marine mammals that feed on the surface and rise to the surface to breathe. Additionally, dispersants provide a response option when other techniques such as mechanical response and in-situ burning are not available due to remote locations or rough sea states.

Dispersants are solvents which reduce the surface tension of water allowing the oil to disperse into small droplets in the water column. Dispersants are made up of several components, the most important of which is surfactants. Surfactants bind to both oil and water to produce finely dispersed droplets of oil-surfactant molecules. There are two commercially available types of dispersants; the first is primarily hydrocarbon solvent and 10-25% surfactant; the second is alcohol or glycol based solvents which contain a larger components of surfactant. This concentrate self mixes when it is applied to the oil spill. (WA Dept of Ecology, 1993)

Dispersant History

Before 1970, dispersants were degreasing agents that were developed to clean tanker compartments and engine rooms.

The *TORRY CANYON* spill off Cornwall, England in 1967 resulted in the use of 6,000 barrels of chemical used to treat a spill of 85,500 barrels of oil. Many of these chemicals were degreasing solvents and were more toxic than the oil itself. The denser surfactants did not evaporate, mix with, or dissolve in water. Instead, they formed a stable "oil-detergent" emulsion that had a negative synergistic effect causing more harm to the environment than had they done nothing. There was a significant impact to the marine and coastal environment with resulting massive kill off of fish and intertidal invertebrates. Over 10,000 tons of detergents were sprayed on the floating oil. The news this as indiscriminate dumping of solvents to disperse oil along the shoreline this perception was widely broadcast on American TV news. The result of the negative media attention was a poor public image of chemical dispersants.

In the United States at this time, the National Contingency Plan (NCP) allowed the Environmental Protection Agency (EPA) and the U.S. Coast Guard to oversee pollution preparedness and response. The same plan severely restricted the use of dispersants and other chemical counter measures, while stressing mechanical recovery of oil.

Future dispersant usage saw increasingly better results. In 1979 the Ixtoc 1 spill released more than 3.5 million barrels of oil. Almost 500 aerial missions were flown applying the dispersant COREXIT 9527 to 1,100 square miles of slick. While dispersants were not used in the US waters, there was successful application of dispersants seen.

Dispersant Reformulations

While dispersant application was becoming increasingly more successful, dispersants were being reformulated to address concerns for efficiency and toxicity.

COREXIT products are the principle US dispersants. In 1967 EXXON produced COREXIT 7664. This weak-water based product was the first that was specifically formulated for the marine environment. This product was not used during the TORREY CANYON. In 1972 EXXON produced the first "self-mix" concentrate, COREXIT 9527 This was the first product that could be applied by aircraft. In 1992 EXXON developed COREXIT 9500, which was effective on heavy, weathered and

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emulsified oils. (Exxon-mobil, 2004) By the third generation of formulas, dispersants consisted of surfactant with little solvent. These were designed to be mixed with water.

Testing Experience

The U.S and Canada, along with several European countries participated in a number of dispersant evaluations. Canada ran tests with dispersants in 1978 in Victoria, BC, in 1981 in St. John's, the next year in Halifax and with the Bedford Institute of Ocean Science (BIOS), and in 1986 in the Beaufort Sea. The United States tested dispersants at sea in with the American Petroleum Institute (API) on the East coast and in southern California in 1978 and 1979. The United States had also followed the work of the UK in 1978, France in 1979-83, and Norway in 1984 where field trials were conducted as part of the research on dispersants. The results of these research efforts were better information on toxicity and biodegradation. This showed spiked exposures, which were less toxic than anticipated and weathered oil, which was less toxic than anticipated. Additionally, important observations were made at actual spills including the Braer, North Cape, and Sea Empress that showed the potential for dispersant use.

By the early 80's interest in dispersants was beginning to build. There was some experience in spill response, which tempered assumptions about how effective mechanical response actually was. There were also advances in understanding of the fate and effects of spilled oil and improvements in dispersant formulation to provide greater efficacy and less toxicity. The Gulf of Mexico and Alaska regions began exploring potential net environmental benefits of dispersant use.

In 1986 and 1987, the Marine Industry Research Group sponsored a series of dispersant-use decision-making workshops in Florida, Louisiana, and Texas. State and federal resource management officials attended these workshops. This effort highlighted the potential benefits of dispersant use, and attitudes began to shift. (Belore, 2004)

By the late 80's the Regional Response Team on the US Gulf Coast was actively discussing dispersant pre-authorization. The Alaska Region established limited pre-authorization zones offshore.

This increasing interested culminated in the February 1989 publishing of "Using Oil Spill Dispersants on the Sea," by the National Research Council, the academic consulting body of the US Congress. This review indicated that the primary environmental concern was from dispersed oil, not the dispersant alone. However, the study found that both dispersants and dispersed oil has been shown to be toxic to aquatic organisms in the laboratory, but that more recent formulations of dispersants were less toxic than earlier versions. In fact, the toxicity of dispersants was found to be low compared to crude and refined oil products. The study suggested that toxicity testing protocols needed to be carefully considered when interpreting the results of dispersant tests. This included the preparation of media, the exposure profile and the analytical chemistry. (National Research Council, 1989)

Among the possible benefits acknowledged by the study was the prevention of shoreline oil stranding, the protection of birds and marine mammals, the enhanced degradation of oil, and reduction of chronic impacts. Possible risks included the potential expansion of the expansion of the surface slick, the effects on the water column organisms, and the facts of dispersed oil entering shallow, coastal habitats.

Several critical issues were raised by the study review. First, the report's conclusions were based primarily on offshore areas with rapid mixing and dilution. A conservative estimate of such areas was used to develop "pre-authorization zones." However, this application is generally not where oil spills occur, because oil spills occur primarily in shallow water near the shore or in estuaries. Proponents of dispersant use would lead to more controversy. For example, there was disagreement on the definition of such areas and how to define the potential risks and benefits.

The report made selected research recommendations. For example, it recommended improved toxicity testing (especially exposure) protocols, additional effort to integrate laboratory and field studies, additional studies on biodegradation of dispersed oils, and additional studies on the interaction of dispersed oil droplets and sediments.

The report concluded by saying "The committee recommends that dispersants be considered as a potential first response option..." and "dispersion of oil at sea, before a slick reaches a sensitive habitat, generally will reduce the overall and particularly the chronic impact of oil on many habitats." (NRC, 1989)

Thirty days later, in March 1989, the Exxon Valdez grounded on Bligh Reef in the Prince William Sound of Alaska spill overwhelmed local, regional and national spill response assets. Suddenly, all response technologies were needed and dispersants were tried.

COREXIT 7664 was applied at Ingot Island followed by a warm water wash with little effect on the beach. EXXON tested the dispersants BP 1100X and COREXIT 9580 in Prince William Sound. However, a recommendation was made against broad applications because efficacy was not demonstrated in light of possible adverse effects.

With time, however, the National Research Council report was lost to the public conscious and mechanical recovery again rose to predominance. The Oil Pollution Act of 1990 was passed and the US Coast Guard regulations, which followed in 1993, required extensive mechanical recovery but no dispersant capabilities. There was a call for withholding dispersant capability decisions until further study was done and greater public acceptance achieved.

However, the requirements of responding to unexpected spills ensured that since 1989, dispersants were used in a variety of situations particularly in the Gulf of Mexico and included such incidents as the T/V Mega Borg in 1990 where dispersants were tested; the West Cameron Block 168 spill in 1995; the High Island Pipeline System Spill in 1998; the T/V Red Seagull spill in 1998 which included a fire monitor demonstration; the BP-Chevron Pipeline spill in 1999; the Blue Master spill of 1999 (IFO0180 fuel dispersed); and the Poseidon Pipeline spill in 2000.

National Contingency Plan

In 1994 the National Contingency Plan (NCP) was updated to reflect the oil spill revisions of the Oil Pollution Act of 1990. (U.S. EPA, 2004) The NCP required that local Area Committees and Regional Response Teams decide on when and where to use chemical countermeasures including dispersants. This was a critical though subtle change. Earlier, the NCP had only allowed for the consideration of these dispersant measures, an open ended approach which resulted in no decisions being made. Now the NCP was requiring a decision to be made. This raised the question as to when appropriate pre-authorized use of dispersants and other chemical countermeasures should be permitted. However, no government, industry or academic consensus had been developed, making the question difficult to address.

Joint Chemical Countermeasures Workshop

Given this challenge in 1995, government and industry response personnel convened with national resource trustee agencies to discuss potential net environmental benefits of 8 different chemical countermeasures. The consensus was that given the current state of technology, only dispersants had the potential to mitigate large volumes of oil effectively. The participants recommended future efforts focusing primarily on determining the dispersant role in response. In 1996, a joint government and industry national

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workshop examined dispersant effects in the upper 10 meters of the water column.

Joint Government and Industry Risk Communication Project

In addition, a joint government and industry risk communications project assessed the stakeholder perceptions and conceptions regarding the use of dispersants. Spurred by the NCP mandate and the Countermeasures workshop model of stakeholder analysis of dispersants, Regional Response Team VI began work on the Situational Monitoring of Advanced Response Technologies (SMART) protocol to monitor dispersant effectiveness in a real time environment. (USCG, 1998) Monitoring of dispersants effectiveness was achieved by giving a rough estimate of oil parts per million (ppm) in the water column. Any toxicity estimate is entirely qualitative based on the ppm.

Others were also involved in this issue. The Minerals Management Service (MMS) and Environment Canada have assessed the efficiency and properties of dispersants. The OHMSETT facility, a 2.6 million gallon freshwater tank in Leonardo, New Jersey, has been used for testing. Laboratory effectiveness testing has also been done. The National Oceanographic and Atmospheric Administration also has conducted research and published HAZMAT summary documents on dispersants. The U.S. EPA is developing an improved dispersant testing protocol. (Sorial and Weaver, 2004)

By 1988, every region in the United States had some form of dispersant use pre-authorization in place. In addition to pre-authorization, some areas had the alternative of expedited approval arrangements for dispersant use. The United States Coast Guard recognizes these pre-authorization and expedited agreements in giving credit for spill response preparedness and the NCP directs regions and areas to engage in pre-spill planning for response countermeasures in accordance with establishing and using these determinations. (USCG, 1998)

Government Infrastructure

The policy of the United States Government is that spill response, including the use of dispersants, will be the responsibility of the private sector. To that end, regulatory requirements have been developed which establish mechanical recovery capabilities limits with the private sector and permit credit against these requirements for dispersant capability.

Current US Dispersant Usage

Currently, dispersant pre-authorization exists in some form in all coastal US states except Oregon and Washington. (USCG, 2004)

Presently, dispersants are tested for toxicity and efficacy and listed along with other spill response resources in the NCP National Product Schedule. For use in the United States, a product must be tested and listed in the NCP. As of May 2004 the following dispersants may be authorized for use on oil spills in designated areas according to the RRT plan: COREXIT 9527, NEOS AB 3000, Mare Clean 200, COREXIT 9500, Dispersit SPC 1000, JD-109, JD-2000, Nokomis 3-F4, Biodispers, Sea Brat #4, and Finasol OSR 52. (EPA, 2004)

CONCLUSION

Initial experience was dispersants was less than positive and raised many concerns among responders and the public. As a result, dispersant usage was limited, despite the fact that some oil spill responses continued to involve dispersant usage.

Over time, however, dispersants were formulated to be less toxic. The toxicity derived from dispersing oil is primarily caused by the dispersed oil itself and not the chemical dispersants. Additionally, dispersant delivery systems are designed specifically to apply the chemical evenly at the proper doses and with the correct aerosol or droplet size. Given this evolution, dispersants have come to be considered a viable response option in the United States and other countries, particularly in the open ocean.

Beginning with caution, testing and evaluating through our national science community, then through public workshops and hearings, the United States began the process of integrating dispersant usage into its repertory of response technologies. Dispersants are now seen as viable tools in the proper situations and with stakeholder support.

Oil spill dispersants can work at sea, but not every time and in all conditions. Sea state, oil properties, dispersant brand and dispersant treatment influence effectiveness. With this experience we have come to perceive dispersants as one tool among others to be used with caution.

BIOGRAPHY

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