Oil Spill Dispersants – Myths & Mysteries Unravelled †

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The subject of oil spill dispersants has attracted greater attention in recent years as more countries have sought to develop legislation permitting their use. Claims about the improved effectiveness of 'new generation' dispersants coupled with concern about possible toxic effects have created a confused and emotionally charged arena in which to debate this topic. On occasion, potential spillers have been accused of trying to promote dispersant use because it is seen as a convenient 'out of sight, out of mind' alternative to mechanical recovery. However, the benefit of the appropriate use of dispersants was clearly demonstrated during the response to the 'SEA EMPRESS' incident in 1996. In this case, it was estimated that chemical dispersants prevented at least 17,000 tonnes of crude oil from hitting the environmentally sensitive coastline of south-west Wales.

ITOPF regularly receives questions on the subject of dispersant usage from our ship-owning members and from government and industry responders all over the world. Some of the more commonly asked questions are addressed in this article.

- ***What is dispersion?***

When oil is spilt into the sea it tends to form a slick on the surface, as its density is usually less than seawater. The chemical force that resists oil and water mixing is known as the 'interfacial tension' and this varies from oil to oil. Natural dispersion takes place when the breaking waves are sufficient to overcome the mechanical resistance caused by the viscosity (consistency) of the oil and the chemical resistance caused by the interfacial tension, usually at wind speeds greater than 10 knots. When this happens, the oil breaks up into droplets of varying sizes. However, the larger droplets are buoyant and may resurface. If this occurs before the sea has diluted the droplets, a slick may reform. Chemical dispersants are used to enhance the rate of natural dispersion by reducing the interfacial tension and promoting the formation of smaller oil droplets which do not resurface, but stay in the water column.

- ***What are chemical dispersants?***

Chemical dispersants consist of a blend of surfactants in a mixture of solvents, which work together to promote the formation of small oil droplets. The size of the resultant oil droplets is important, as they need to be small enough (i.e. 50 microns) to prevent them from re-surfacing and re-forming a slick before they are carried away and diluted by the sea. The surfactant is the 'active' ingredient and comprises a *water-loving* (hydrophilic) head and an *oil-loving* (oleophilic) tail. The solvent acts as a means of delivering the surfactant to the oil-water interface. Once the oil droplet has formed, the surfactant remains at the interface and prevents them from re-coalescing. Contrary to frequent misconception, the application of a chemical dispersant does not cause the oil to sink. Instead, the droplets are rapidly diluted by the vast volume of seawater and, because of their large surface area, are quickly biodegraded.

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- ***Are dispersants toxic?***

All substances are potentially harmful to living organisms. Whether or not a substance actually causes harm depends upon a combination of the inherent toxicity of the substance, the concentration to which the organisms are exposed and the duration of that exposure. Most modern dispersants are no more toxic than the oil itself. Consequently, any observed toxic effect is most likely to be associated with the dispersed oil and not with the dispersant *per se*. This might occur if the dispersed oil plume has not been sufficiently diluted by the sea, for example, in shallow bays with limited water exchange. Ironically, the most effective dispersants may also be perceived a being the most 'toxic' as they introduce a higher concentration of oil into the water column. Consideration of the dilution potential of the dispersed oil plume and the resources most sensitive to dispersed oil will be important when deciding whether dispersant use is the most appropriate response option.

- ***Which is the best dispersant to use?***

The majority of oil spill dispersants are manufactured for use in the marine environment and their effectiveness is considerably reduced in freshwater. Nowadays, most dispersants that are used to treat oil slicks offshore differ only in the way in which they are applied. Some are usually diluted prior to application (1 part dispersant: 9 parts water), whereas others are used undiluted. Experience has shown that applying the dispersant undiluted, usually from aircraft, is the most effective. The choice of whether to use one product over another typically depends on availability and price. Some products are two or three times more costly than others although there is currently insufficient evidence to suggest that, in practice, any one of the more commonly used dispersants is significantly better than another.

A list of the dispersants approved for use in the UK, which includes many of those used commonly elsewhere, can be found on the following web-site (http://www.defra.gov.uk/environment/marine/oilspill/). Similarly, other countries have lists of approved products.

- ***What are the limitations affecting chemical dispersion?***

When oil is spilled at sea, it undergoes a number of physical and chemical changes, some of which lead to its disappearance from the sea surface, whilst others cause it to persist. These processes are known, collectively, as weathering. The viscosity of the oil is the most critical parameter governing the effectiveness of chemical dispersants. The greater the viscosity of the oil, the more difficult it is to disperse. Evaporation of the lighter components of the oil can occur very quickly, particularly in warm climates, and this leads to a gradual increase in viscosity.

Another important process is that of emulsification. Many oils tend to absorb water to form a 'water-in-oil' emulsion, increasing the volume by 3 or 4 times. These emulsions may become extremely viscous and stable within a short period of time. In some situations, dispersants may be able to break an emulsion and promote effective dispersion, although stable emulsions tend to be resistant. The more quickly dispersants can be applied, the more chance there is of them being effective. Often this 'window of opportunity' is very short, ranging from only

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hours to a few days depending on the type of oil involved and the environmental conditions.

- ***Can Heavy Fuel Oils (HFO) be dispersed?***

In general terms, provided that the oil is still relatively fluid, it may be dispersible. Temperature is an important parameter affecting the viscosity (and hence, fluidity) of the oil. Obviously, if an oil spill occurs in a cold climate, the oil will be more viscous. Indeed, if the sea temperature is lower than the pour point of the oil, the oil will be effectively solid. If the freshly spilt oil is highly viscous to start with or the oil has weathered appreciably, the effectiveness of the dispersant will be severely compromised. Given the high viscosity of most heavy fuel oils, it is highly unlikely that dispersants will be an effective response, especially if the sea temperature is much below 15°C.

- ***How much dispersant should be used?***

For the purpose of planning a response, the dispersant is normally applied undiluted in a ratio of 1 part dispersant to 20 parts spilled oil. By targeting the thickest parts of the slick, over-dosing with dispersant is avoided. Recently, there have been suggestions that the amount of dispersant applied can be reduced, thus making savings on the cost of the response and the cost of storing stocks of dispersant. However, attempting to modify the optimum application ratio is a subtlety that is lost when considering the enormous variation in slick thickness. Whilst it might be true that less dispersant will be required to treat fresh slicks of light oil, emulsions and slicks of more viscous oil will require several applications resulting ultimately in more, rather than less, dispersant being used. In reality, accurately targeting the thickest patches of oil is easily the most important variable to improve upon.

- ***How is it possible to tell that dispersants are working?***

If the oil is readily dispersible, chemically enhanced dispersion may be very rapid. In these circumstances, the formation of a coffee-coloured plume of oil droplets may appear shortly after application of the dispersant. It is also easy to tell when dispersants are not working. Often the dispersant merely runs off the oil, leaving it untouched and forming a milky-white cloud in the sea. However, if the onset of dispersion is delayed slightly, perhaps because the oil is more viscous or the sea temperature is low, evidence of dispersion may be more difficult to observe. Ultra-violet fluorimetry (UVF) has been used to provide 'real-time' data on the concentration of dispersed oil in the water column during the application of dispersants. Typically, the variation in concentration is measured about 1 metre under the slick using a fluorimeter that is towed behind a sampling boat. However, when used operationally, this method does not provide a quantitative guide to the amount of oil that is actually being removed from the sea surface. Experience suggests that if dispersants are working sufficiently well to make their use worthwhile, it should be possible to observe a change in the appearance and behaviour of the slick within a reasonable time-scale.

As with any oil spill response method, the decision to use chemical dispersants in preference to mechanical recovery or some other method involves careful balancing of the advantages and disadvantages of each and comparing them with the option of allowing natural processes to take their course. There will be occasions when using

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dispersants offers a clear benefit, such as protecting flocks of birds on the sea surface or important tourist beaches. In other circumstances, dispersants may increase the risk of oil-tainted seafood and their use should be avoided.

The factors that are most likely to influence whether chemical dispersants will be an effective response are not those associated with the choice of dispersant or the dose rate. Instead, it will be issues such as the type of oil spilled, the sensitive resources at risk, priorities for protection and whether or not a particular country has a clear policy and plans in place for the use of dispersants. Conflicts and even fines may result when a facility or ship spills oil and uses dispersants without prior consent or regard for the policy of the country involved. However, ITOPF is continuing to work with governments and industry to tackle some of the issues that arise during consideration of their policy on dispersant use. We hope that an unbiased and educated debate will ensure that chemical dispersants get a 'fair hearing'.

† The views here expressed are those of the author and do not necessarily reflect those of the individual directors and members of ITOPF.

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