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Response to spills of alternative fuels and energy products

Biomass-based diesel fuels

INTRODUCTION

Biofuels are produced from biomass such as plants, used vegetable oils and animal fats; they can range from ethanol that is blended into gasoline to biodiesels, renewable diesel products and untreated straight vegetable oil (SVO).

This fact sheet examines the properties and characteristics of biodiesel, renewable diesel and vegetable oils; it also suggests methods for their detection and response if spilled. Information common to all the fact sheets in this series is provided here.

DEFINITIONS

Biodiesel: also referred to as fatty acid methyl ester (FAME), usually obtained from vegetable oils or animal fats by transesterification of fats with methanol. Biodiesel is usually blended with fossil-based diesel for retail sales. The 'B' number is typically used to state the percentage of biodiesel in a blend; for example, B10 is 10% biodiesel and 90% petrodiesel.

Renewable diesel: also referred to as hydrotreated vegetable oil (HVO) and hydroprocessed esters and fatty acids (HEFA). This can be a drop-in replacement for fossil-based diesel.

Straight vegetable oil (SVO): an untreated vegetable oil which can be used in suitably modified diesel engines.

PHYSICOCHEMICAL PROPERTIES

Key properties and behaviour of the different biomass-based fuels are shown in Table 1 and Figure 1. The appearance of the different biomass-based fuels before and after mechanically induced emulsification is shown in Figure 2.

KEY MESSAGES

- Spills of biodiesel, renewable diesel and straight vegetable oil (SVO) can pose a significant threat to wildlife and shoreline habitats, primarily through smothering action
- As many biofuels are clear, making visual observation challenging, more advanced techniques of detection and monitoring may be required
- Response and decision-making following spills of biodiesels, renewable diesel and SVOs are similar to those of conventional fossil-based diesel

Table 1: Key properties and behaviour of the different biomass-based fuels

FUEL TYPE	OIL GROUP	VISCOSITY	APPEARANCE	BEHAVIOUR	
BIODIESEL/ FATTY ACID METHYL ESTER (FAME)	Group I/II	Very low	Clear	Spills to water will tend to spread out to form a slick or oily film on the water surface. Depending on wave action, and in the absence of containment measures, the slick may disperse or degrade, typically within a few days, though potentially longer for high volume incidents. Whilst biofuel emulsions can form, it is unlikely they will be stable.	
RENEWABLE DIESEL	Group I/II	Very low	Clear		
STRAIGHT VEGETABLE OIL (SVO)	Group III	Low to medium	Varied		SVOs undergo little or no evaporation and may be prone to oxidise, polymerise and start to sink, or, if the sea temperature is more than a few degrees below the pour point, SVOs may form semi-solid lumps.

DETECTION, MONITORING AND SAMPLING

Like conventional diesel fuels, biofuels and related fuel blends typically spread easily on the water surface to form a thin layer. This makes visual detection and monitoring challenging unless the spilled oil has emulsified or thickened due to the water temperature being a few degrees below its pour point or colder. Detection using radar systems from vessel, aerial or satellite platforms is possible and the introduction of advanced radar processing techniques such as Ku-band (as opposed to conventional X-band) which can detect thin layers of oil even on a flat sea, and Hyperspectral Laser Induced Fluorescence Light Detection and Ranging (HLIF LiDAR), are proving useful. Microwave radiometry may help identify thicker areas of a slick, though operational challenges have been encountered with this technology. Sampling may include water quality parameters and sediment grabs if the spilled biofuel sinks. It is unlikely that air sampling would be needed due to the absence of volatile organic compounds (VOCs).

Figure 1: Fate and behaviour of biofuels when released to water (source: adapted from Oak Ridge National Laboratory, 2021)

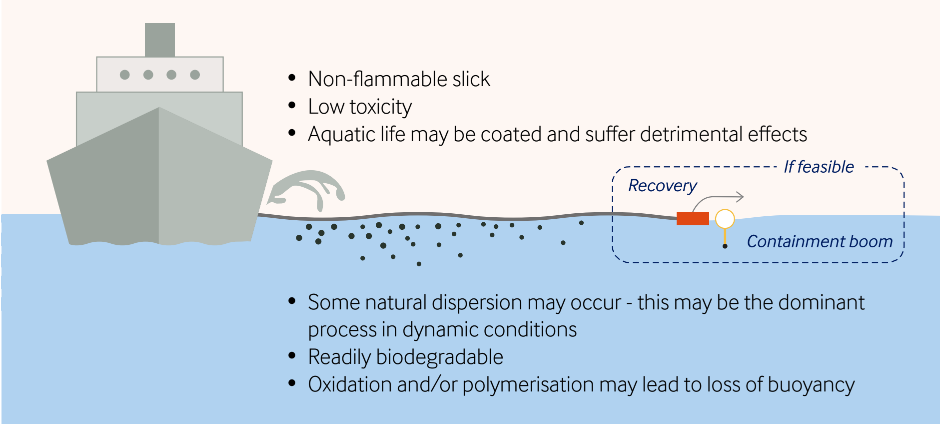
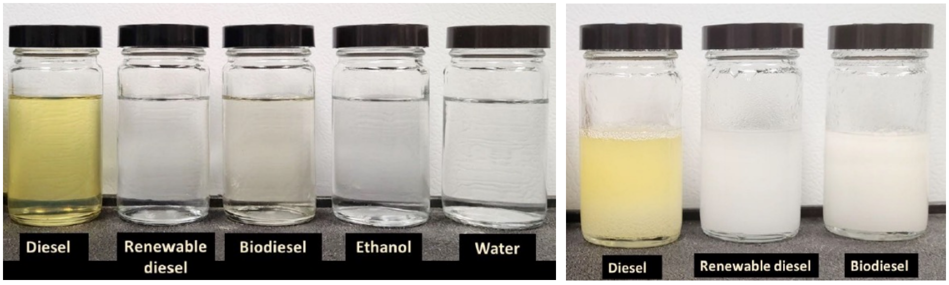


Figure 2: Photos showing different biomass-based products (left) and their mechanically induced emulsions (right) (source: Oak Ridge National Laboratory, 2021)



RESPONSE AND CLEAN-UP

Response techniques for biodiesel, renewable diesel and SVO spills are like those used for conventional diesel spills (Figure 1). If the spill is large and natural dispersion is not appropriate, containment and recovery utilising a light-oil skimmer can be attempted. Use of chemical dispersion is typically not appropriate due to poor performance of dispersants on these products. The use of in-situ burning is not feasible due to ignition challenges. If the temperature of the receiving water is low, SVO may form semi-solid lumps, and removal may be possible using a 'trawl net'.

WILDLIFE

Biofuels can harm wildlife by coating feathers or fur and destroying the insulating properties that keep animals warm in aquatic environments. Excessive ingestion of biofuel by preening or grooming may lead to internal effects. The procedures for wildlife capture and rehabilitation are similar to those for petroleum oil spills; the risks to wildlife responders from exposure to the product will be low.

RESPONDER AND PUBLIC HEALTH CONCERNS

Standard protocols for protecting the health and safety of responders should be followed when responding to fuels that are still floating; however, flammability and the risk of ignition is very low. A product's safety data sheet should provide guidance, including consideration of dermal and other routes of exposure. Where spills threaten shorelines, the public should be excluded to avoid their exposure, and responders deployed with suitable personal protective equipment. Unpleasant odours have been noted on public beaches as a result of decaying SVO spills.

POTENTIAL IMPACTS ON MARINE LIFE

Biofuels lack the aromatics present in petroleum products and therefore toxicity issues are significantly lower. Microbial degradation of biodiesel and renewable diesel may be significant, so there will likely be a rise in local biochemical oxygen demand. This can lead to a temporary and localised depletion of dissolved oxygen, possibly resulting in sub-lethal or lethal effects on aquatic life. SVOs may polymerise and this can retard their biodegradation and lead to persistence for months. Some animals and biologically important nearshore habitats, such as intertidal corals and seagrass, are vulnerable through smothering (particularly in cases of SVO spills) and exposure to naturally dispersed oil (particularly in case of biodiesel/HVO spills).

MODELLING SPILLS

Modelling the fate and trajectory of biofuels mirrors the wind and current vector techniques used to model spills of petroleum oils. Where biofuel spill scenarios are of short duration, the use of modelling is likely to have limited value.

RELEVANT RESOURCES

Cedre (2024). *Chemical response guide: Diesels and biodiesels.* https://wwz.cedre.fr/en/Resources/Publications/Chemical-Response-Guides/Diesels-and-biodiesels

Cedre (2024). *Vegetable oil spills at sea.* https://wwz.cedre.fr/en/Resources/Publications/Operational-Guides/Vegetable-Oil [to be published September 2024]

Fingas, M. (2015). *Vegetable oil spills: oil properties and behavior.* www.researchgate.net/publication/317755663_Vegetable_Oil_Spills_Oil_Properties_and_Behavior

Jezequel, R., Autret, Y., Gueffeier, M., Receveur, J, and Le Floch, (2022). *Fate, behaviour and impact assessment of new generation of biodiesels and biofeedstocks in case of an accidental spill.* https://www.interspill.org/downloads/Fate-Behaviour-and-Impact-Assessment-of-New-Generation-of-Biodiesels-and-Biofeedstocks-in-Case-of-an-Accidental-Spill.pdf

NOAA (2023). *Small diesel spills, 500-5,000 gallons. A guide to responding to conventional diesel spills.* https://response.restoration.noaa.gov/sites/default/files/Small-Diesel-Spills.pdf

Oak Ridge National Laboratory (2021). *Spill behavior, detection, and mitigation for emerging nontraditional marine fuels.* www.maritime.dot.gov/sites/marad.dot.gov/files/2021-05/ORNLAlt_Fuels_Spill_Study_Report_19Mar2021.pdf

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Ipieca was founded at the request of the United Nations Environment Programme in 1974. Through its non-lobby and collaborative approach Ipieca remains the industry's principal channel of engagement with the UN.

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