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Response to spills of alternative fuels and energy products

Condensates

INTRODUCTION

Condensates are low-density, low-viscosity, liquid hydrocarbons that are typically separated out of natural gas at a production field when temperature and pressure drop to atmospheric levels. Condensates are light and volatile. If released subsea, their behaviour will depend on the gas to condensate ratio. Condensates can be blended with heavier crude oil streams or transported separately via pipeline or vessel.

Information common to all the fact sheets in this series is provided here. This fact sheet provides a high-level overview of condensate spill response. A comprehensive guide to condensate spills has been produced by Cedre.

PHYSICOCHEMICAL PROPERTIES

Condensates are very light (Group I) oils predominantly comprising saturated hydrocarbons (alkanes), though aromatics and asphaltenes may also be present. They are defined as 'non-persistent' under the international compensation regime for shipping.

Surface spilled condensates spread rapidly in open waters, where 50–90% will evaporate within 6–12 hours depending on environmental conditions. This volatility includes flammable compounds and potentially harmful monoaromatic (BTEX) compounds and hydrogen sulphide (H_2S).

Although condensates weather, primarily through evaporation and natural dispersion, there is potential for components to remain on the sea surface – albeit likely less than half the spilled volume, depending on the condensate's properties. Furthermore, wave action can create water-in-oil emulsions and asphaltene, if present, may stabilise these emulsions to a limited degree. Generally, condensates with <70% predicted evaporation and >0.1% asphaltene content may form emulsions, which can result in a substantial volume increase of the residue due to incorporated water. At-sea response or shoreline clean-up of non-liquid/waxy residues may be considered under certain circumstances.

The behaviour of subsea releases will depend on release conditions, including gas to condensate ratio, release rate and water depth. It is possible that a significant proportion of the hydrocarbons will dissolve, disperse and ultimately biodegrade without reaching the sea surface.

Real world condensate spill experiences combined with laboratory and flume experiments indicate that most incidents will lead to little or no product remaining on the sea surface after a few days. In the case of a release involving condensates blended with other oils, there may be complicated interactions, including persistence of non-condensate components.

KEY MESSAGES

- The primary concern is health and safety, due to flammability, vapour inhalation and skin contact hazards
- Condensate spills can weather rapidly in open sea conditions with the majority dissipating through evaporation and natural dispersion, typically within a few days
- A subsea well release may not lead to surface oil slicks, depending on the well and environmental/site characteristics
- Knowledge of the condensate characteristics helps to determine whether the product remaining after initial evaporation, which may be a waxy residue, needs active response or clean-up
- Monitoring and surveillance of natural dissipation may be the only action for many incidents but there are scenarios where active response and clean-up can be considered

RESPONDER AND PUBLIC HEALTH CONCERNS

There can be serious health and safety concerns associated with the initial stages of a condensate spill. For the first few hours there are fire, explosion and vapour inhalation hazards. First response will focus on ensuring personnel and public are kept away from the incident location. Note that the product may be colourless, leaving it difficult to determine the extent of spreading slicks.

A suitably wide exclusion area should be implemented; air dispersion modelling can assist in determining this. Prior to any response considerations, it will be necessary to establish air monitoring to ensure safe working and establish exclusion zones. Any persons undertaking air monitoring should wear a suitable respirator or breathing apparatus.

In open, well-ventilated areas, the fire and explosion risks are likely to diminish within 12 hours of the end of the release. If the incident is on land or in an enclosed, unventilated area the vapours can persist for longer.

DETECTION, MONITORING AND SAMPLING

Monitoring of a condensate spill may be constrained by safety concerns in the initial stages of response. Furthermore, condensate may be colourless or quickly spread and fragment making it difficult to detect sheens. For significant scale incidents on water, it is recommended that aerial surveillance is considered to detect and track the product remaining on the sea surface. UV sensors can be useful, particularly if the slick is colourless. In shallow water scenarios and subsea blowouts, when air monitoring allows safe access, water column sampling and analyses for soluble compounds (light aromatics) is recommended.

MODELLING SPILLS

Where the condensate's characteristics are known, the product can be modelled using oil fate and trajectory computer models. In the case of subsea release, modelling of the steady-state underwater hydrocarbon plume and its trajectory could be conducted. These models provide estimations of movement and product weathering under present and forecast environmental conditions (temperature, wind velocity / direction and sea currents). Atmospheric modelling of hazardous vapour dispersion is also possible and may help the establishment of personnel exclusion zones.

Modelled outputs may provide guidance to oil spill contingency planners using probabilistic approaches or incident management teams undertaking response using current and forecast environmental conditions.

RESPONSE AND CLEAN-UP

Pollution response will be secondary to ensuring the safety of personnel in the initial stages of an incident. Active response should only be considered after the evaporation of volatile components and clearance from air monitoring that it is safe to work.

In many condensate release scenarios monitoring and surveillance will be the primary response. If the pollution is in open waters, slicks may spread, dissipate and fragment to an extent that active response is not operationally or logistically feasible by the time it is safe to consider such actions. In the case of subsea releases, water column sampling may be needed.

CONTAINMENT AND RECOVERY

The low encounter rate of containment systems is such that offshore deployment is unlikely to be feasible by the time air monitoring indicates it safe to do so. Remaining components will either be sheens or fragmented to an extent that likely makes containment impractical. At-sea containment and recovery may be feasible for some subsea releases with large volumes of condensates that contain a persistent fraction. Inshore, there may be scenarios where booms might be considered to protect sensitive areas. If containment is feasible and safe, weir or oleophilic skimmers are the likely choice. For relatively small incidents in sheltered situations, sorbents may be effective when access is deemed safe.

DISPERSANTS

Laboratory testing indicates that dispersants may be effective if condensates are predicted to form emulsions at sea. Dispersant application may be suitable for condensates with evaporation levels below 70%, and an asphaltene content greater than 0.1%. Dispersant use should only be considered after the volatiles have gone and be subject to the applicable requirements relating to application windows (while fresh), water depth, mixing energy, and avoidance of sensitive areas. The scale and location of the incident will determine the operational and logistical feasibility of dispersant application, either from vessel or aircraft.

Subsea dispersant injection may be considered for a condensate well. This has the potential to reduce the amount of product reaching the sea surface and evaporating, reducing health and safety related concerns, but increasing dissolved volatile components, and therefore potentially increasing impacts to marine life. The balance of health, safety and environmental concerns with the pros and cons of dispersant should be considered prior to use.

IN-SITU BURNING

On-water in-situ burning using fire-resistant booms may be viable if a safety assessment indicates feasibility. It is also possible that remotely operated vehicles could deploy herding agent and ignite condensate, though rapid spread, dissipation and fragmentation make the operational deployment of this technique unlikely.

Intentional ignition of an uncontrolled well release might be considered, depending on the safety, practical and environmental considerations for a specific incident.

In-situ burning has been used on relatively small inland leaks of condensate occurring within permanently water inundated marsh or swamp habitat, with the product effectively removed and no long-term damage to the wetland systems. This can be preferable to manual or mechanical clean-up options that are potentially invasive and damaging in wetland environments.

SHORELINE CLEAN-UP

Condensate may dissipate prior to the threat of shoreline contamination when spilled at sea. If this threat exists, potential shoreline clean-up will depend on the weathering state of the condensate and the type of shoreline affected. If condensate is fresh, no clean-up will be feasible due to safety concerns. Penetration into sand, gravel, pebble and boulder beaches is possible. This may retard evaporation and require care and assessment prior to considering whether the benefits of clean-up are greater than the impacts of the clean-up itself.

In principle, once a product and working area are deemed safe for operations, the range of documented shoreline clean-up techniques developed for conventional oil spills may be considered, where appropriate. The low viscosity of weathering products is likely to favour flushing with skimmer recovery or sorbents for final clean-up.

OILED WILDLIFE

Fresh condensate may present various threats to wildlife such as birds, mammals, and turtles, including burns to skin and eyes, loss of insulation through saturation of fur/feathers, and inhalation or ingestion effects. These potential impacts will be difficult to avoid during the initial response, due to exclusion of personnel for their safety. The geographic extent of these threats may be limited by condensates' high volatility and natural dispersion. Any remaining product on the sea surface or stranding on shorelines has the potential to affect wildlife in a similar manner to weathered light crude oil. This may require an active oiled wildlife capture and rehabilitation programme.

POTENTIAL IMPACTS ON MARINE LIFE

Whilst freshly spilled condensate may express high acute toxicity in laboratory testing, in most cases, open water surface spills are highly unlikely to have significant environmental impacts. If an incident occurs subsea or near shallow waters, it is possible that acute toxic effects could be observed, particularly if large volumes are involved. Tainting of seafood collected from such areas is also possible due to dispersion, so fisheries closures should be considered.

Direct smothering of shore dwelling animals and plants is possible by residual or emulsified product after evaporation. It is likely that persistence on shorelines will be less than observed for heavier oil, due to the biodegradability of most condensate components and weak emulsion stability.

RELEVANT RESOURCES

Cedre (2021). *Condensates chemical response guide.* wwz.cedre.fr/en/Resources/Publications/Chemical-Response-Guides/Condensates

SINTEF (2021). *Fogelberg condensate. Weathering properties and behaviour at sea in relation to oil spill response report.* https://sintef.brage.unit.no/sintef-xmlui/bitstream/handle/11250/2732990/Final+Report_Weathering+Fogelberg+%28002%29.pdf?sequence=2

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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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