Is Greener Cleaner? Spill implications from alternative marine fuels

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With the eyes of the world on reducing human reliance on fossil fuels, the shipping industry is undergoing the largest fuel revolution since the obsolescence of steam-powered vessels in the 1950s. The push for decarbonisation is now not just driven by the Paris Agreement and the International Maritime Organisation's (IMO) goal of reducing total emissions from marine shipping by 50% by 2050 but also by a changing climate of public opinion, investors and charterers demanding a faster energy transition. According to DNV's *Maritime Forecast 2050* released in August 2021, approximately 12% of current newbuilds ordered have alternative fuel systems in place, with biofuels and liquefied natural gas (LNG) as early frontrunners to bridge the gap between current and zero-carbon fuels such as ammonia and hydrogen. With more vessels expected to run on alternative fuels, it is a matter of time until an incident involving these emerging fuel types occurs.

The International conventions in place such as the Civil Liability Convention, the Bunker Convention and the yet to be in force HNS Convention have been widely accepted and praised for providing compensation for those affected by ship-source spills. However with the emergence of these alternative fuels, there is a large liability gap where spills of these substances as bunkers do not fall under any of the relevant regimes. This is something that needs to be addressed in order to ensure that any impacted stakeholders are not left to pick up the pieces without financial recourse. One possible option includes expanding the HNS Convention to allow for bunkers as well as the current cargo liability. Another potential route would be to expand the Bunker Convention to allow fuels other than oil. These future developments will be eagerly awaited by the shipping industry as well as those coastal communities located in close proximity to busy transport routes.

The potential negative effects that we are likely to see in future incidents involving some of these alternative fuels are anticipated to be significantly different to the current negative impacts of oil spills. Some of these fuels will have the benefit of being considerably less persistent in the marine environment and are therefore likely to result in short- to medium-term impacts, rather than some of the longer-term impacts that can characterise oil spills. For instance, liquefied gases such as LNG, ammonia and hydrogen are understood to rapidly volatilise following release and will be lost to the surrounding atmosphere. Additionally, methanol is miscible with water and will disperse, dissolve and biodegrade in a relatively short period of time. In comparison to significant and well-publicised impacts of oiled wildlife, ecological impacts from some alternative fuels are likely to be short-lived. However, they could include mass marine organism fatalities due to cryogenic damage, fire and explosion, fluctuations in local water column temperature and pH, as well as potential seabird fatalities from vapour cloud formation. Instead of the possibility of oil slicks moving with meteo-oceanic conditions over a large area, these impacts are likely to be felt within the immediate vicinity of an incident. However, it should be noted that biofuels come under the umbrella of alternative fuels and although, significantly more similar in composition, fate and behaviour to traditional fuel oils, recent studies have shown that these types of oil tend to be more readily biodegradable and therefore less persistent (depending on the blend ratio) in comparison to conventional petroleum oils.

Although ecological hazards have been one of the most common areas of concern related to accidental spills, the risks to human health with these new emerging fuels are widespread. The incident, although not shipping related, in the Port of Beirut in August 2020 showcased the world what damage can be caused by an explosion ammonia compounds. If this were to occur on an ammonia-

fuelled vessel for instance it could lead to a drastic loss of life and further economic damage from loss of the vessel and, if the incident was located in-port, severe damage to port infrastructures. Alongside fire and explosion risks, there are also significant risks of asphyxiation resulting from formations of vapour clouds and cryogenic risks from liquefied gaseous fuels. While the work undertaken by engine manufacturers, ship designers and regulatory bodies are reducing the risks of these incidents occurring, there is still potential for these systems to fail and how the spill community responds will need to be considered diligently.

When it comes to spill response, low sulphur fuel oils (LSFO) are the most understood fuel type due to their similarities with conventional fuels and the fact that several incidents of this fuel type have occurred since the global introduction of them in January 2020. Although research and development is limited and an insufficient amount of data has been collected to date, ITOPF has noted that the characteristics of LSFOs are highly variable. Following ITOPF's experiences during spill mobilisations (MV WAKASHIO in Mauritius, AM GHENT in Gibraltar and X-PRESS PEARL in Sri Lanka) the oil type tends to have a lower viscosity and density than high sulphur fuel oils but with a higher pour point. This indicates that in cold water environments, there is potential for the formation of semi-solid oil masses if spilled and therefore techniques such as recovery using skimmers are extremely difficult and rudimentary techniques such as nets or buckets may be more efficient. The lower viscosity experienced on-site in warm environments has led to deeper infiltration into mangrove root systems, rip-rap boulders and fine sediments. For these reasons, high-volume low-pressure flushing techniques have been widely used to bring this low viscosity oil to the surface for subsequent recovery using skimmers.

Biofuels are the second most similar fuel type in comparison with conventional fuels. Research has indicated that oil droplets can recoalesce to form a slick of weathered high-viscosity biofuels, allowing weir skimmers or oleophilic skimmers to recover even heavily weathered slicks. Studies have also shown that instead of biodiesel evaporation, pure biodiesel can readily biodegrade with almost the entire volume attenuating within 28 days (Jezequel et al., 2019).

For liquefied gaseous fuels such as LNG, ammonia and hydrogen with potential flammability risks, containment of this type of fuel would be hazardous to human health as well as ineffective. As it is likely that any substance released would volatilise rapidly into the atmosphere, the standard clean-up techniques would not be necessary. More resources may be focused on mitigating human health risks, modelling and evaluating potential vapour clouds and flammability limits and using water suppression systems to divert any vapours drifting towards populated regions or areas of ecological sensitivity. These are all potential mitigation measures that can be employed by spill contractors, however more research and development is required in order to understand how these substances will behave once released.

As the shipping industry moves to decarbonise its global fleet in line with the IMO's emission reduction goals, substantial investments are being made into an array of new and emerging fuel types. However, consideration needs to be given to how these fuels will behave when spilled, how the environment and nearby receptors will be affected and how impacted stakeholders will be compensated. It is evident that further research and development needs to be applied to this topic and following this, the picture will become clearer as to how the spill community can appropriately respond to these types of incidents. There is potential for the focus of ship-source spills to shift from ecological to human health risks and with this, the development and implementation of safety measures and regulations should also be given an appropriate level of investment. Greener may mean cleaner for the reduction of the world's greenhouse gas emissions, but it is paramount that the consequences of using these fuel types are better understood beforehand.