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Risk assessment of methanol-fuelled shipping industry

William Giraud[1], Sonia Belhabib[1], Laura Cotte[1] and Stéphane Le Floch[1]
[1] *Cedre, 715 rue Alain Colas, Brest, France*
Contact: william.giraud@cedre.fr

To reduce particles and greenhouse gas (GHG) emissions, with the global objective to mitigate impact on air quality and climate warming, different initiatives were launched at international level, including in shipping industry. In 2023, the International Maritime Organization (IMO) adopted a strategy to reduce GHG Emissions from Ships by at least 40% by 2030, compared to 2008 levels. In 2021, the European Union adopted the latest Commission proposals to reduce, across all sectors, GHG emission of roughly 55% by 2030, compared to 1990 levels.

Among the different fuels that could be used alternatively to conventional hydrocarbons, e.g. methanol, ammonia or hydrogen; each one requires shipping industry to overcome several challenges. These include for instance the applicability and sustainability in terms of compliance with regulation, economic costs, technical feasibility (Vessel design and propulsion), as well as fuel production, storage, supply and handling.

In the fuelled-vessel energy transition, methanol offers several advantages and is a promising candidate compared to conventional hydrocarbons thanks to a significant abatement of particles and GHG emissions, acceptable energy density or similar use compared to gasoil/diesel fuel. However, incidents might happen with leakage or total losses of methanol from ship storage tanks or bunkering hoses. Methanol is supposed to be fully soluble in water but the question is to verify in which extent it can evaporate and potentially form toxic or flammable cloud (1,2). Thus, it appears necessary for first responders to be able to implement appropriate response strategies and deploy adapted equipment.

To tackle these issues, Cedre has developed an experimental device, a chemical tank, that allows to study the behaviour of a chemical in fresh water or seawater, and under controlled environmental conditions (e.g. solar radiation, water temperature, wind speed and consequently current speed). In addition, Cedre floating pools were used to conduct experimentations at larger scale and under natural environmental conditions. These experiments offered also the possibility to use existing sensors, as well as a new prototype, to monitor methanol concentration in the air and in the water over time.

Different first interesting results were obtained. The primary outcome highlighted by the experimental tool is its capability to track the behavior of methanol, not only over time but also under specific environmental conditions. As far as evaporation is concerned, despite the fact that methanol is fully soluble, vapours were systematically detected at the point of discharge for several minutes after the release in all the tests carried out. It was also shown that current and wind parameters significantly influence the evaporation rate. Concerning dissolution, surface agitation was identified as the main parameter affecting this process. An increase of the water temperature can lead to a faster dissolution of methanol. The findings indicate that methanol dissolves primarily in the subsurface, facilitating its evaporation from the aqueous phase. However, increased water column agitation was found to diminish the evaporation process.

The various results obtained are crucial to better understand the behaviour of methanol spilled on the surface of water and assess associated risks. Thanks to all experimental results obtained, an operational sheet has been created to provide support to decision-makers and responders, to better prepare and respond in case of spill of methanol.

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(2) Schwarzenbach, R. P.; Gschwend, P. M.; Imboden, D. M. Environmental Organic Chemistry, 2nd ed.; Wiley: Hoboken, N.J., 2003. https://doi.org/10.1002/0471649643.