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On the evaporation kinetics of volatile HNS: A key challenge for Marine Pollution response

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Release of volatile Hazard Noxious Substances (HNS) at sea can lead to the formation of toxic, flammable or even explosive gas plumes that can travel large distances and pose risks over a wide area in relatively short timescales.

Yet, when an emergency is declared, key information is not always available for all the needs of responders. A case in point is the lack of knowledge and data to assess the risks that responders or rescue teams could take when intervening, or those that could impact coastal communities when allowing a shipping casualty to dock at a place of refuge. Evidence-based decisions are thus needed to inform maritime authorities in terms of detection and monitoring in order to protect crews, responders, coastal populations as well as the environment.

When maritime accidents occur, knowledge about any chemical released in open sea (e.g. physical and chemical properties and behaviour in the environment) is essential to predict potential environmental consequences and to adapt first-response. For light chemicals, one critical parameter that should be systematically predicted and/or assessed is the evaporation kinetics: this would warn first-responders against toxic or explosive gas clouds that might originate from the surface slick. The MANIFESTS project aims to address these knowledge gaps by developing modelling tools and providing new experimental data on evaporation and dissolution kinetics of volatile HNS as well as gas cloud fate^[1].

Here we present new experimental data obtained at lab-scale on the evaporation kinetics of 6 pure chemicals along with 7 liquid mixtures. The final objective is to assess mass fluxes at the sea-air interface due to evaporation process and to compare it to analytical models. The chemicals studied included acrylonitrile, aqueous ammonia, cyclohexane, petroleum benzene and vinyl acetate. They were chosen to reflect key groups of HNS routinely carried at sea or reportedly involved in spills. Liquid samples of 2-5 component systems were prepared by mixing each chemical in equal volume ratio. Evaporation rates of pure chemicals and mixtures were then assessed by following the weight loss fraction (Okamoto et al. 2010). All pure chemicals except ammonia showed a linear mass loss over time with a full evaporation observed between 2,5 and

30h after the beginning of the experiment. However, the same chemicals spilled at the surface of seawater generally presented a non-linear mass loss over time, i.e. different and longer evaporation rates. An intermediate behaviour was also observed for mixtures. Given that, these new data could be used to adapt the equations routinely used to model evaporation, particularly on addressing the variations observed for the evaporation rates. This will offer crisis management stakeholders more precise information regarding the formation of toxic, flammable or explosive gas clouds (Go/No Go decision).

Okamoto, K. *et al.*, 2010. Evaporation characteristics of multi-component liquid. *Journal of Loss prevention in the process Industries*, 23(1), 89-97.

^[1] MANIFESTS (MANaging risks and Impacts From Evaporating and gaseous Substances To population Safety) is co-funded by the European Union Civil Protection Mechanism of DG-ECHO (call UCPM-2020-PP-AG – Prevention and preparedness for marine pollution at sea and on shore.