A systematic literature review on the safety and risk assessment of alternative fuels in inland waterway transport

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1. Introduction

А systematic literature review on the safety and risk assessment of alternative fuels, i.e. hydrogen, ammonia, and methanol in inland waterway transport is given in this paper. This review is based on three types of relevant sources: EU policies and regulations, publications, guidelines and methodologies of classification societies as well as outcomes of research projects. European Green Deal [EC, 2021a], belonging to the European Union's ambitious decarbonisation policies, aims to achieve net zero greenhouse gas emissions by 2050 and a 55% reduction by 2030 (as formalized in the European Climate Law [EC, 2020a]). Further, the European Commission’s Fit-for-55 legislative package [EC, 2021b] and the Sustainable and Smart Mobility Strategy [EC, 2020b] underscore the commitment to reducing greenhouse gas emissions in the transport sector, including inland navigation, by promoting alternative, low-emission fuels. The NAIADES III initiative [EC, 2021c], central to the EU's strategy for inland navigation, emphasizes the need for zero-emission vessels, the development of an EU energy index to assess carbon intensity, and funding opportunities for vessels utilizing alternative fuels. Furthermore, recent EU regulations, such as Regulation (EU) 2023/1804, mandate shore-side electricity infrastructure at core inland waterway ports by 2024 and comprehensive ports by 2029, while the Renewable Energy Directive (RED III) [Directive (EU) 2023/2413] sets renewable energy targets for transport, promoting a 29% share of renewables by 2030. Additionally, the EU's Alternative Fuels Infrastructure Facility (AFIF) provides financial support for infrastructure that enables alternative fuels like methanol, ammonia, and hydrogen, enhancing compliance with the Alternative Fuels Infrastructure Regulation (AFIR) objectives [Directive (EU) 2023/2413].

Methanol, ammonia, and hydrogen are considered technically promising for inland waterway vessels due to their potential for reducing emissions, though they present unique safety and technical challenges. This review includes an evaluation of safety guidelines and risk methodologies published by classification societies, alongside the European Commission's alternative fuel regulations. Further insights from the research projects, such as PLATINA3 [PLATINA3 project D2.1, 2021; D4.2, 2022; D1.5, 2023; D2.7, 2023] and SYNERGETICS [SYNERGETICS project D1.1, 2024; SYNERGETICS project 2024a and 2024b], emphasize the need for robust safety standards and regulatory harmonization to enable the sustainable integration of these alternative fuels into the inland waterway sector.

This study aims to identify and highlight gaps in safety standards and regulatory harmonization and therefore to offer insights into the current EU regulatory landscape for safe and sustainable fuel transitions in inland waterway transport.

Acknowledgements

The authors wish to thank the financial contribution of the EU through the Interreg IPA ADRION program 2021-2027, project: IPA-ADRION073- Sustainability of Alternative Fuels in the ADRION area – SUPERALFUEL”.

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