HYDROFIL TECHNOLOGY IN MARITIME ENGINEERING: A COMPREHENSIVE OVERVIEW

Kadir Beytulllah GÜNDÜZ[1], Yasemin ARIKAN ÖZDEN[2]
[1]Yıldız Technical University, kgunduz@yildiz.edu.tr,
[2]Yıldız Technical University, yarikan@yildiz.edu.tr,

ABSTRACT

This paper outlines the historical evolution, theoretical background, and engineering applications of hydrofoil technology in the maritime domain. Emphasizing hydrodynamic lift and drag reduction, it examines how various hydrofoil configurations influence vessel performance, including speed, stability, and fuel efficiency. Key design considerations—such as structural integrity, environmental adaptability, and manufacturing feasibility—are discussed in light of current literature. The findings underscore the potential of hydrofoils to enhance maritime transportation through improved efficiency and operational safety[1].

Keywords: *Hydrofoil technology, maritime energy efficiency, sustainable Ship Design*

Introduction

Hydrofoils are hydrodynamic surfaces designed to lift a vessel's hull above the water at sufficient speeds, thereby reducing drag and enhancing performance. Originating in the late 19th century, hydrofoil technology has evolved through advancements in materials, control systems, and CFD, enabling broader applications in high-speed, electric, and autonomous vessels[2]. This study reviews the historical progression, design typologies, and performance benefits of hydrofoils, emphasizing their growing relevance in sustainable maritime transport.

Materials and Methods

This study conducts a comprehensive analysis of hydrofoil profile types and structural configurations, emphasizing the performance differences between symmetric and asymmetric sections through CFD simulations and experimental data. Additionally, various foil geometries (e.g., T-, L-, V-type) and control strategies (e.g., flap, pitch) are compared, revealing how tailored combinations of design and control can enhance lift, reduce drag, and improve stability in dynamic marine environments. The findings underscore the importance of profile selection and active control systems in optimizing hydrofoil performance across varying sea states and operational conditions[3].

Results and Discussion

This section emphasizes the significant advantages of hydrofoil technology in enhancing vessel speed, fuel efficiency, and stability by reducing hydrodynamic resistance through hull elevation. The integration of active control systems further improves performance in dynamic sea states, while recent advancements support its role in environmentally sustainable maritime operations[4]. Despite structural complexity and cost-related limitations, hydrofoils—especially when combined with modern propulsion systems—demonstrate substantial promise for the future of efficient and eco-friendly vessel design.

Conclusion

This conclusion highlights hydrofoil technology as a transformative approach for enhancing maritime efficiency, reducing emissions, and supporting sustainable vessel operations. The study underlines the potential of integrating hydrofoils with electric and AI-supported systems, while also acknowledging that broader adoption depends on economic and regulatory factors. Continued research into optimized control systems and tailored foil designs is essential for realizing the full potential of hydrofoils in future maritime transport.

References

[1]H. Liang and Z. Zong, "A lifting line theory for a three-dimensional hydrofoil," *Journal of Marine Science and Application*, vol. 10, no. 2, pp. 199–205, Jun. 2011, doi: 10.1007/s11804-011-1038-5.

[2]L. Yun and A. Bliault, "Hydrofoil Craft," in *High Performance Marine Vessels*, Springer US, 2012, p 161–202. doi: 10.1007/978-1-4614-0869-7_5.

[3]Y. Liang and A. Bliault, "High Performance Marine Vessels."

[4]"The Stability Analysis Of Hydrofoils Boats," *Scientific Bulletin of Naval Academy*, vol. 19, no. 2, Dec. 20 doi: 10.21279/1454-864x-16-i2-022.