Full-Scale Application of Hull Vane® on a 108m Holland-Class OPV of the Royal Netherlands Navy: Confirming Predictions and Tactical Benefits

Authors: **Julian Hofman**, Senior Project Lead Hull Vane B.V., **Niels Moerke**, CEO, Hull Vane B.V.

Figure 1 – HNLMS Groningen in dry dock with Hull Vane®

ABSTRACT

This paper presents the results of the full-scale application of the Hull Vane® on a 108m Offshore Patrol Vessel (OPV) of the Royal Netherlands Navy. Building on previous Computational Fluid Dynamics (CFD) studies, this study validates the anticipated improvements in fuel efficiency, operational range, and tactical performance. Full-scale trials confirmed a 10% efficiency gain across the operational range, with a peak fuel consumption reduction of 16% at 17.5 knots, leading to increased top speed and reduced energy dependence. These findings highlight Hull Vane®'s contribution to modern naval efficiency and sustainability.

1. INTRODUCTION

The Royal Netherlands Navy prioritizes innovation to maintain operational superiority and sustainability. The Hull Vane®, a patented hydrofoil appendage, was retrofitted onto a Holland-class OPV following extensive CFD studies and structural evaluations [1]. This study validates prior predictions through full-scale operational data, emphasizing tactical and sustainability benefits. The results reinforce the navy's commitment to cost reduction, enhanced mission performance, and improved fleet endurance.

Figure 2 - HNLMS Holland (P843) in dock

2. BACKGROUND AND PREVIOUS RESEARCH

Hull Vane® has been extensively studied for its hydrodynamic benefits in reducing wave-making resistance and fuel consumption. Initial CFD studies estimated a 12.5% annual fuel savings, with a 15.3% resistance reduction at 17.5 knots [2]. Further research indicated improved seakeeping, reducing vertical accelerations by 13% and extending range capability by 17%[3]. These findings supported the decision for full-scale implementation to verify real-world performance improvements.


Figure 3 - Tank test model Holland-Class © Dutch Ministry of Defence

3. TEST VESSEL AND PERFORMANCE ASSESSMENT

The Holland-class OPV (108m length, 3,750-ton displacement) was selected for Hull Vane® integration [4]. The retrofit required removing the trim wedge to optimize flow conditions. Performance assessment included extensive sea trials, fuel consumption monitoring, and comparative analysis with prior CFD predictions.

Figure 4 - Hull Vane® installed

4. RESULTS & VALIDATION

Sea trials confirmed:

- Resistance reduction: 16% decrease at 17.5 knots, validating CFD predictions.
- Efficiency gains: 10% overall fuel efficiency improvement.
- Operational range: Extended range from 5,000 to 5,850 nm at 15 knots.
- Speed increase: Improved top speed, enhancing operational flexibility.

5. TACTICAL & OPERATIONAL BENEFITS

The Hull Vane® enhances operational range and reduces fuel dependency, an increasingly critical factor in modern naval operations. A 16% efficiency gain at 17.5 knots translates to a speed increase to 18.55 knots without additional fuel consumption. This reduces transit time for long-range missions, improving mission flexibility. Additionally, reduced stern wave generation minimizes the vessel's detectability by drones and surveillance systems, offering strategic advantages in low-observability operations.

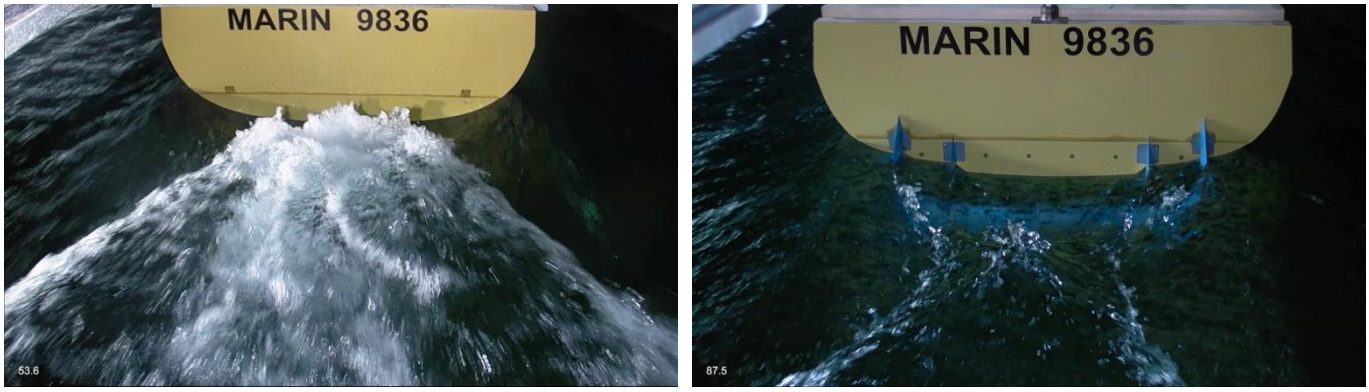

Figure 4 - Suppressed stern wave comparison, left w/o Hull Vane®, right w Hull Vane® © Marin

6. RETURN ON INVESTMENT (ROI) ANALYSIS

Operational fuel savings amount to approximately $425,715 per year, yielding an estimated payback period of 2.5 years [3], [5], [6]. Given the OPV's expected service life until 2036, cumulative savings exceed $4.25 million, demonstrating the financial viability of Hull Vane® as a long-term investment.

7. STRUCTURAL CONSIDERATIONS

Integration required reinforcement due to increased load conditions. A cast steel T-joint was developed to enhance structural rigidity, reducing material stress and optimizing durability. This engineering solution ensured compliance with naval safety standards while maximizing performance benefits.


Figure 5 - T-connection inner struts

8. CONCLUSION

The full-scale implementation of Hull Vane® on a Holland-class OPV validated CFD-based predictions, confirming its role as a transformative enhancement for naval efficiency. With a 16% fuel savings at operational speeds and a verified 10% annual reduction, it extends range and improves stealth. Hull Vane® proves to be a critical addition for future naval combat vessels, with financial viability, operational advantages, and sustainability benefits positioning it as essential for modern fleets.

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