

Technical Brief

Advancing Scavenge Drain Oil Analysis for Modern Marine Engines

A Real-time Cylinder Condition Monitoring Solution

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TB030

Controlling wear rates and preserving cylinder health are essential for extending marine engine components' service life and lengthening overhaul intervals. Scavenge drain oil analysis (SDA) has proven to be one of the most effective tools for achieving these goals, enabling ship operators to monitor engine performance and make data-driven decisions. Consistent monitoring delivers insights into the wear behaviour and alkalinity reserves of cylinder lubricants, ultimately helping reduce operating costs and enhance engine reliability.

In the dynamic landscape of marine engineering, SDA continues to serve as the foundation of engine condition monitoring. It enables early detection of potential issues, supports timely corrective actions, and aligns with the industry's focus on sustainability and operational efficiency.

Role of SDA in Cylinder Condition Monitoring

SDA involves the analysis of used cylinder oil, or drain oil, scraped from the cylinder liner and collected from the scavenge air space. It serves as a reliable indicator of engine health by analysing key parameters such as residual Base Number (BN) and iron (Fe) content. Residual BN measures the alkalinity reserve, while the iron content reflects wear levels and the type of wear — corrosive, abrasive, or adhesive.

Effective use of SDA allows ship operators to understand wear behaviour and optimise cylinder oil feed rates. This optimisation



Ensuring engine reliability and supporting maritime sustainability

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can significantly reduce operating costs by minimising lubricant consumption and extending maintenance intervals. However, reliable SDA results depend on proper sampling procedures to avoid contamination from system oil, fuel, water, or inter-cylinder leakage. Furthermore, interpreting the results requires expertise, as the data must account for variations in operating conditions and fuel types.

The maritime sector is increasingly exploring advanced SDA practices to address these challenges. By embedding continuous condition monitoring in daily operations, ship operators gain access to accurate and reliable data. These insights are instrumental in achieving better operational control and fostering a culture of preventive maintenance.

The Need for Real-Time Monitoring

Traditional SDA, performed both onboard and in laboratories ashore, has clear constraints. Onboard test kits provide early detection of abnormal conditions but are often time-consuming and involve complex multi-step procedures. Laboratory analyses are thorough yet often delayed by shipping and processing, leaving crews without actionable data for weeks.

To address these challenges, the maritime industry is moving towards real-time monitoring solutions. Real-time sensors capable of measuring Fe content and residual BN onboard can provide immediate feedback, enabling chief engineers to make timely adjustments to cylinder oil feed rates. This proactive approach



Development of real-time monitoring technology

not only enhances engine operability but also reduces the risk of severe wear or damage. This capability becomes even more valuable when operating on alternative fuels, where the impacts on engine components are still being understood.

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Collaboration with SIT for Innovation

In 2025, Gulf Marine partners with the Singapore Institute of Technology (SIT) on a two-year applied research programme. This collaborative effort will bring together SIT faculty members, Gulf Marine researchers, and SIT undergraduates, offering students a valuable opportunity to enhance their applied learning experience.

The objective of the project is to engineer accurate and reliable online sensors for real-time SDA. By integrating state-of-the-art technology, the project seeks to replace cumbersome onboard test kits and reduce dependency on shore-based laboratories. The collaboration will focus on designing sensors that provide instant data on key parameters, such as Fe content and residual BN. These innovations will not only improve operational efficiency but also align with the industry's decarbonisation goals by supporting the use of alternative fuels like LNG, biofuels, methanol, ammonia, and hydrogen.



*Photo credit: SIT and Keng Photography/
Tan Eng Keng*

The collaboration draws on Gulf Marine's operational experience across more than 9,000 vessels worldwide and SIT's strength in sensor design and applied engineering. Together, we aim to create solutions that are technically advanced, practical, and scalable for widespread adoption.

Future-Proofing the Maritime Industry

The adoption of alternative fuels and stricter environmental regulations has introduced new challenges to cylinder lubrication. Advanced SDA solutions, combined with real-time data integration, empower ship operators with actionable insights that optimise engine performance, reduce costs, and contribute to sustainable shipping practices.

Gulf Marine's partnership with SIT underscores its commitment to innovation and sustainability. The insights gained from this project will not only enhance our ability to serve its global customer base but also redefine the future of condition monitoring for marine engines.

Looking ahead, the maritime industry stands at the cusp of transformative change. Real-time monitoring technologies, supported by collaborative research efforts, will pave the way for more resilient and efficient operations. By staying ahead of the curve, Gulf Marine continues to reinforce our position as a leader in marine lubrication and condition monitoring solutions.

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