Analisis Ship Resistance Propulsion Oil Tanker 17500 DWT dengan Energy Saving Device (ESD) Fin Menggunakan CFD dan Slender-Ship Theory = Analysis of Ship Resistance and Propulsion 17500 DWT Oil Tanker with Energy Saving Device (ESD) Fin using CFD and Slender-Ship Theory

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Abstrak

Emisi dari industri pelayaran berkontribusi sebesar 2,89 persen dari total emisi CO2 global. dimana jenis kapal container, kapal curah, dan kapal tanker menjadi kontributor terbesar yaitu lebih dari 80% dari total emisi. Bagi kapal existing dapat melakukan strategi untuk menurunkan nilai EEXI sehingga memenuhi standar nilai EEXI yang disyaratkan salah satunya dengan Optimized hull design pengurangan konsumsi bahan bakar dengan mengurangi hambatan yang timbul dari lambung kapal. Penggunaan metode Computational Fluid Dynamics (CFD) dan metode berbasis Slender-Ship Theory saat ini telah banyak digunakan untuk menganalisis seakeeping kapal. Penelitian ini bertujuan untuk mengoptimalkan lambung kapal Tanker 17500 DWT dengan pemasangan ESD jenis fin secara full scale untuk mengevaluasi pengaruhnya terhadap efisiensi dan emisi. Referensi yang digunakan untuk menghitung dan melakukan simulasi adalah MARPOL Annex VI and EEXI relevant guidelines/guidance dengan estimasi speed-power curve dari tank test. Selanjutnya dilakukan penelitian hambatan pada lambung kapal dengan metode CFD pada kondisi calm water yang akan divalidasi dengan metode Holtrop dan Maxsurf Resistance. Setelah itu akan dilakukan simulasi CFD Openwter untuk mendapatkan karakteristik performa kapal dan divalidasi hasilnya menggunakan metode regresi polinomial B-series profiling. Kemudian akan dilakukan self-propulsion test dengan CFD Resistance with Actuator Disk dalam kondisi calm water untuk mendapatkan nilai power operasional desain kapal. Dengan adanya optimasi ESD fin nilai Thrust deduction factor meningkat akibat nilai thrust meningkat dan resistance kapal menurun. Nilai Wake factor juga meningkat karena nilai Va menurun, tetapi nilai Relative Rotation Efficiency menurun. Nilai wake factor menyebabkan nilai efisiensi juga meningkat, hal tersebut terbukti pada nilai Hull Efficiency dan Propulsive Efficiency meningkat. Dilakukan juga simulasi seakeeping dengan Metode Slender-Ship Theory dan CFD untuk mendapatkan nilai added resistance yang dialalami kapal berdasarkan titik resonant frequency kapal di wavelentgh ratio 1-1.25. Nilai EHP karena penurunan hambatan yang dialami kapal sebesar 2.55% sehingga nilai BHP juga menurun, hal itu menunjukkan bahwa daya output main engine untuk menggerakkan kapal maju pada kecepatan servis yang tetap akan semakin berkurang sehingga mengurangi fuel consumption main engine. Hal tersebut berpengaruh kepada hasil perhitungan nilai EEXI attained yang disebabkan oleh peningkatan nilai referenced speed yang dialami kapal. Optimasi pemasangan fin di lambung kapal mampu menurunkan nilai EEXI kapal hingga memenuhi standar dengan penurunan nilai EEXI sebesar 9.5%. Setelah adanya optimasi lambung dengan fin total fuel consumption dan CO2 emission kapal berkurang sebesar 8.6%, tetapi belum bisa memenuhi standar CII yang dibutuhkan oleh kapal.
......Emissions from the shipping industry account for approximately 2.89 percent of total global CO2 emissions, with container ships, bulk carriers, and oil tankers being the largest contributors, representing more than 80% of these emissions. Existing vessels can implement strategies to lower their Energy

Efficiency Existing Ship Index (EEXI) values to comply with the required EEXI standards, one approach being the optimized hull design to reduce fuel consumption by minimizing the resistance generated by the ship's hull. The use of Computational Fluid Dynamics (CFD) and Slender-Ship Theory-based methods has become prevalent for analyzing ship seakeeping. This study aims to optimize the hull of a 17500 DWT Tanker by installing a fin-type Energy Saving Device (ESD) on a full scale to assess its impact on efficiency and emissions. The references used for calculations and simulations include MARPOL Annex VI and EEXI relevant guidelines/guidance, with an estimation of the speed-power curve from tank tests. The research involves analyzing the hull resistance using the CFD method in calm water conditions, which will be validated with the Holtrop method and Maxsurf Resistance. Subsequent CFD Open water simulations will be conducted to determine the ship's performance characteristics, validated using the polynomial regression method of B-series profiling. A self-propulsion test with CFD Resistance and Actuator Disk will also be performed in calm water conditions to ascertain the operational power design of the ship. With the optimization of the ESD fin, the Thrust Deduction Factor increases due to the rise in thrust and the decrease in ship resistance. The Wake Factor also increases as the Va value decreases, but the Relative Rotation Efficiency decreases. The increase in the Wake Factor leads to improved efficiency, evidenced by the enhanced Hull Efficiency and Propulsive Efficiency. Seakeeping simulations using the Slender-Ship Theory and CFD methods are also conducted to determine the added resistance experienced by the ship based on the ship's resonant frequency point at a wavelength ratio of 1-1.25. The ship's resistance decreases by 2.55%, resulting in a reduction in Effective Horsepower (EHP) and Brake Horsepower (BHP), indicating that the main engine's output power for propelling the ship forward at a constant service speed will be reduced, thereby lowering the main engine's fuel consumption. This impacts the calculation of the attained EEXI value due to the increase in the ship's referenced speed. The optimization of fin installation on the ship's hull successfully reduces the ship's EEXI value by 9.5%, meeting the standards. After the hull optimization with fins, the total fuel consumption and CO_2 emissions of the ship decreased by 8.6%, but it has not yet met the required Carbon Intensity Indicator (CII) standards.