INVESTIGATION OF INFLUENCE OF MICRO BUBBLE DRAG REDUCTION (MBDR) ON FRICTIONAL DRAG REDUCTION OF A BULK CARRIER

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ABSTRACT

In the situation surrounding the marine transportation business, expectations for the development of energy-saving technologies for shipping are high, with the international need to address shipping costs and environmental issues such as CO_2 emissions. It is reported that, merchant vessels operating at lower speeds, the fluid frictional drag accounts to almost 70%-80% of the total drag, thus there is a strong demand for the reduction in the frictional drag. The air lubrication method or Micro Bubble Drag Reduction (MBDR) is a technology to reduce frictional drag of a hull by injecting air to the bottom of the hull to create a layer of air bubbles between the hull and sea water. Latest developments in this field suggests that, there is a potential reduction of 80% in frictional drag in case of flat plates, which encourages researchers to investigate further. In this study, experimental investigations into frictional drag reduction by microbubbles were carried out for an 8000 Tonnes Deadweight Bulk Carrier for different speeds and for different air injection rates using series of injection holes. The selected hull particularly suits to the investigation as it has shape like a box with wide flat bottom, forcing injected bubbles to stay close to the hull bottom by buoyancy and uniformly distribute over the entire bottom, causing considerable reduction in the drag. 1:23 scaled model of the ship is constructed and is tested for the resistance of ship for both with and without injection of microbubbles in the towing tank. The influence of bubble distribution near the hull, which directly controls the void fraction was also investigated. The design exploration study was carried out for the various sizes of bubbles, flow speeds, injector flow rate and of course for different void fractions. The experimental study was carried out for speed range of 4 knots to 12 knots in the interval of 1 knot and for each speed, effect of six different injection flow rates of 0.5 CFM (Cubic Feet per Minute) to 3.0 CFM in the interval of 0.5 CFM was investigated. From the study, it is concluded that, with the injection of microbubbles, considerable reduction in the total drag and frictional drag of ship was found, which depends on the void fraction, injection flow rate and ship's speed. As the contribution of frictional drag at higher speeds is lesser, MBDR effect at higher speeds was found to be lesser as compared to slower speeds.