Improved methodology for estimating the drag penalty due to hull roughness: Part II Preliminary results from field and laboratory campaigns.

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Abstract

There exists an extensive literature on turbulent boundary layers developing over rough surfaces, dating back almost 90 years to the seminal work of (1). This problem is pertinent to ship operations where fouling on the hull can lead to very large increases in the skin friction drag coefficient (>80%, see 2). However, current engineering approaches to estimate this drag penalty face numerous challenges / roadblocks which influence the efficacy of these methods. Part I of this talk will discuss these challenges and introduce a campaign of field and laboratory measurements that can redress these issues. Part II will present preliminary results.

We present, for the first time, high-fidelity turbulence measurements on the hull of a large tanker, MT. Sinar Morotai (LOA = 95m), in service in Indonesian waters. Through collaboration with Samudera Indonesia, ITS and the University of Melbourne, we have developed a unique research capability aboard this vessel. A Laser Doppler Anemometer (LDA) mounted above a glass window installed in the hull acquires high frequency velocity data in the turbulent flow adjacent to the ship surface. The LDA is traversed via an automated carriage to provide profiles of velocity statistics over the full thickness of the boundary layer. These unprecedented measurements at $Re_\tau \approx 100,000$ display two attributes that are consistent with previous field and laboratory work by our team: i. carefully controlled experiments in the laboratory display similar characteristics to that in the field, such as a logarithmic dependence of the mean velocity profile; ii. a clean, freshly painted ship is never perfectly smooth and, in fact, can incur more than 20% higher drag than a truly smooth hull would.

These velocity statistics are collected over the course of 12 months while also monitoring the hull state using our unique, custom-built, underwater 3D scanning camera. The camera allows us to measure the surface roughness of the hull with sub-millimetre accuracy; examples of which will be provided in the presentation. Those surface scans are replicated in the laboratory and used to determine the hydrodynamic roughness length, k_s, which in turn, allows us to predict the drag of the full-scale ship using the method of Monty *et al.* (2016).

References

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