Estimating ship performance following energy efficiency interventions using in-service data

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Introduction

With increasing environmental and economic pressure on shipping, the uptake of energy efficiency technologies is increasing however minimal efforts are made to measure the effect of such technologies in the operational context. Technology providers and ship owners alike are at a stalemate as the former require evidence from real life applications of their technologies to substantiate their claims while the latter are not willing to go through the expense of gathering the required data for doing so (Rojon & Smith, 2014). This study assesses the use of in-service data following ISO 19030 to evaluate the effect of interventions on vessel performance illustrating the concept with a case study.

Methodology

This study uses speed loss as a performance indicator (PI) for vessel performance as specified in ISO 19030 (ISO, 2015a, 2015b, 2015c). It is currently the only standard method of data collection, filtering and normalisation designed for evaluation of hull and propeller performance. To determine the effects of interventions, data collected before and after implementation is used to establish a reference and evaluation period between which comparisons can be drawn. The two primary measurements required are speed through water (STW) and main engine shaft power (P_s). Additionally, secondary measurements are required for filtering and normalization of operating and environmental conditions. With the normalised data set, ISO 19030 requires use of the design power-speed relation to evaluate speed loss for data points measured a specific main engine shaft power (Equation 1).

$$V_d = 100.\frac{V_m - V_e}{V_e} \qquad (1)$$

Where: V_d = speed loss (%)
V_m = measured velocity at power P_s (kn)
V_e = expected velocity at power P_s (kn)

These speed loss values are averaged out over the reference and evaluation period for the intervention to be assessed. The difference between these averaged values constitutes the PI for the intervention. The uncertainty in the value obtained is dependent on data frequency and quality.

Case study

The methodology described above was applied to a 46,000DWT product tanker for a three year data set gathered at a 10 minute frequency using a continuous monitoring system. The vessel underwent dry docking in mid-2014 which involved spot blasting and new hull coating. The design power-speed curve was not made available by the ship owner thus an average power-speed characteristic was fitted across the filtered and normalised data set which was used to evaluate speed loss.

The resulting speed loss time series (Figure 1) illustrates an improvement in performance after the dry docking (vertical line). The performance indicator was evaluated for this intervention over reference and evaluation periods of 12 months which yielded a 5.1% absolute performance increase. Figure 1 raises a number of questions about uncertainty, and the appropriate duration for the reference and evaluation periods.

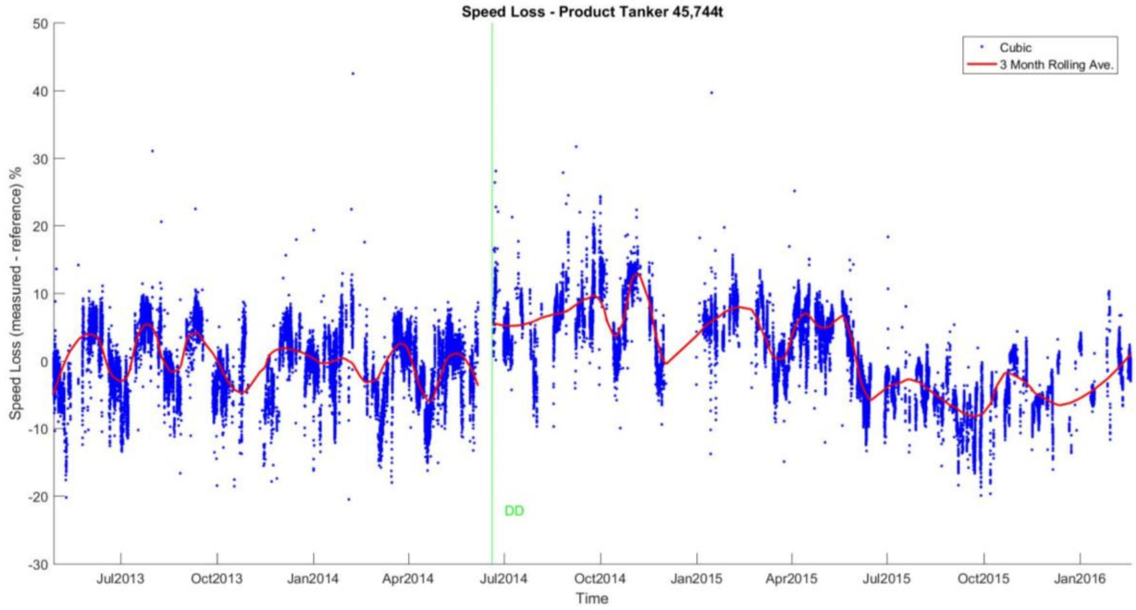

Figure 1 Speed loss time series

Discussion

The study showed potential with this method based on ISO 19030 to evaluate the benefits from retrofits however the results rely directly on the quality of measured in-service data and vessel metadata. In general the quality of data is very poor and only 20% is retained after normalization and filtering. Poor record keeping was also observed with regards to details of interventions carried out. This makes it especially difficult to attribute any observed improvement in performance to a particular intervention as several are usually applied at the same time (especially when a vessel is in dry dock).

The PI value was found to be sensitive to the length of evaluation and reference period. The value in this case ranged from 7.8 % to 5.1% for periods of three, six and twelve months. This needs to be taken into account especially when evaluating the performance of interventions that are expected to deteriorate with time (such as hull coatings). This also highlights the importance of correct evaluation of uncertainty. While ISO 19030 gives guidelines for the evaluation of uncertainty various data quality and frequency scenarios, not all cases are included and the calculation of this value is not trivial.

Further development is dependent on filling in knowledge gaps regarding energy efficiency interventions and clarifying data quality issues. This may allow the development of a method for translating the speed loss PI in terms of fuel consumption, GHG emissions or other metrics of choice based on in-service data for particular retrofits or interventions. This method can also be used to correct or validate existing performance indices or metrics based on operational date rather than design data.

ISO. (2015a). *ISO 19030-1 Ships and marine technology - Measurement of changes in hull and propeller performance - Part 1: General principles*.

ISO. (2015b). *ISO 19030-2 Ships and marine technology - Measurement of changes in hull and propeller performance - Part 2: Default method*.

ISO. (2015c). *ISO 19030-3 Ships and marine technology - Measurement of changes in hull and propeller performance - Part 3: Alternative methods*. London.

Rojon, I., & Smith, T. (2014). *On the attitudes and opportunities of fuel consumption monitoring and measurement within the shipping industry and the identification and validation of energy efficiency and performance interventions*. UCL Energy Institute, London.