"Polished props -- the smoother way to greater economies"

Smooth propellers save money is the message ship operators are being told. But owners must be able to weigh the cost of propeller roughness against the expense and timing of maintenance schemes -- an equation requiring detailed understanding of blade roughness and its measurements.

EXTENSIVE STUDIES carried out by the British Ship Research Association (BSRA) have shown that a power loss of up to 6% can result from a roughened propeller. Although it is well known that hull roughness causes serious energy loss, it is perhaps surprising that, according to the BSRA research, the propeller with its small surface area, can generate energy losses amounting to half that of the hull. In BSRA's latest paper on propeller roughness, prepared by D. Byrne, P. A. Fitzsimmons and A. K. Brook, propeller maintenance and its role as a cost-effective energy-saving measure was examined. Data on propeller roughness was drawn from BSRA records compiled over the last 30 years involving over 130 propellers of varying ages.

Propeller deterioration rates and maintenance savings

Case	Maintenance standard	Ten-year roughness (μm) R™ (2.5)	Equivalent annual value ($'000) with fuel inflation of: 10%	15%
1	Poor	100	52.5	87.6
2	Average	60	34.0	56.7
3	Good	30	21.6	36.0
4	As new	5	0	0

R™ (2.5) = peak-to-valley roughness height

The information was combined with roughness measurements taken recently, both with a purpose-built gauge and proprietary equipment on propellers in dry-dock and on replicas of propeller blades. The objective of the paper was to determine whether any extra investment in improving propeller conditions is warranted when balanced against the expected reduction in operating costs. The percentage of power lost due to a roughened propeller was computed for a 39 000dst single-screw containership from which model and full-scale data was calculated; at the speed of 23 knots the power loss varied from 0-6%. Data from the BSRA records also suggested that many other propellers in service could be resulting in a power loss of up to 4.5%.

The two main methods of roughness measurement are peak to valley roughness height (Rtm) and center line average (Roughness average or Ra). When working on hull roughness, a characteristic of new or smoother hulls suggested that measures of height alone might be adequate to estimate hull roughness effect. But analysis of many propeller roughness records has shown that roughness measurements based on height scales alone are insufficient -- a texture parameter, in addition to height scales, is necessary to classify a blade surface.

If no corrective actions is taken ship propellers appear to deteriorate fairly rapidly initially. There are several causes of propeller roughness in service which include electrochemical action and cavitation erosion while the process causes are the finish of a new propeller, unskilled repolishing and paint spatter or overspray during application. It appears from the analyses that changes in roughness occur most rapidly on the outer half of the blades with back affected more than the face. The greater part of any available power saving, therefore, can be obtained by polishing only the outer half of the blade. The authors warn, however, that unless skillfully employed abrasives are used in propeller polishing they are likely to introduce a worsened texture. And, if the texture is downgraded by low standard polishing procedures, then savings due to a reduction in profile height can be offset.

A ship owner is, of course, principally interested in the potential savings associated with a smooth propeller. The cost can then be weighed against the expense and timing of alternative maintenance schemes. Costs arising from various rates of propeller deterioration over a period of 10 years were computed. The amount represented the discounted cost of propeller roughness over and above the new propeller condition. This can also be seen as the amount of capital available over the period for maintaining the propeller in the 'as new' condition.

By these calculations, the amount available at biennial dry dockings to maintain the propeller 'as new' is over $100 000 for Case 1 and about $50 000 for Case 3 -- (see table). These sums increase by about 65% if a higher rate of 15% full escalation is assumed. In the latter case the price of maintenance closely approaches the price of propeller replacement every two years. Typical costs for polishing a propeller such as that used in the study, would range from $6-$12 000. However, if only the outer half of the propeller is polished then only 65-70% of the total costs would apply.

In their conclusions the authors point out that because of the relatively small surface area and the potentially large power loss per unit area due to roughening, quite large sums of money are available per unit -- for every $1/meter² could be spent on propeller smoothness. They emphasize that regular roughness measurement monitoring of both hull and propellers is necessary to achieve maximum financial benefit.

In a Stone Manganese Marine (SMM) technical paper entitled 'The contribution of the propeller to energy conservation in ship operation', Dr G. Patience also points out that propeller blades should be polished as often as the opportunity allows. And if possible the blade tips should be polished afloat since dry docking periods of two to four years are now accepted practice. This means, however, much more regular checking of propeller surfaces. Like the BSRA, Patience is aware of the confusion that exists in defining roughness itself. It is all very well considering different measurements of roughness but it is no good if the superintendent engineer does not know what 10 microns means. The superintendent needs a simple yardstick. Not only this, but if polishing needs to occur more often, checking ultimately must be done afloat where complicated electronic roughness analyzers are unsuitable.

Esso Petroleum, UK, has recognized the need for a simple comparison device which anybody could use when measuring propeller roughness' and which would eliminate the complexity of the interpretation of roughness standards. The scale comprises six specimens representing exact replicas taken from actual propeller blades undergoing repair and reconditioning in the workshops of SMM which was also closely associated in the development of the scale.

The specimens are lettered A to F. Specimen A has a nominal surface of 1 micron Ra taken from a blade surface finished to a very high standards. Specimens C to F have values ranging from 4 to 30 microns Ra representing various stages in the deterioration of the blade surface condition. According to the developers, blade-roughness values found equivalent to 8 microns Ra or more should be treated by polishing.

The two versions of the scale, one for land use by superintendent engineers and the other for divers, only require the matching of blade surfaces with the six specimens to assess propeller condition. The comparison is made by visual and tactile means and the result referred to only by letter, while examination can be made during normal loading and unloading periods. Esso Petroleum has widely adopted the system. 'It is quicker and easier than using electronic equipment' said John Hutchinson, marine technical adviser. It was also less expensive than having a rep flown over or just leaving the propeller to deteriorate, he said. Rubert & Co, believes one of the most important advantages lies in the fact that the scale 'elevates assessment above personal opinion' enabling the correct cost effective decision to be made.