

PROPELLER & HULL ROUGHNESS

Hull roughness, surface roughness & Propeller roughness – some definitions. As “roughness” is not just roughness, definitions of some relevant types of roughness might come in handy.

hull roughness

The instrument to measuring hull roughness is The BSRA Roughness Gauge. The instrument measures the Average Hull Roughness (AHR), which is defined as the average of minimum 100 measurements of Mean Hull Roughness (MHR). MHR is the average of highest peak to lowest trough in 50 mm measuring length. MHR is comparable to “Average Rmax” or Rtm.

AHR on newbuildings typically is in the range of 130-160 micron (full A/C and A/F system). A well prepared new steelplate after blasting and shopprimer typically has an AHR of 55-60 micron.

Measurements of hull roughness have nowadays been abandoned by most owners, but had much attendance when the Self polishing Antifoulings were introduced during the mid 1970's to mid 1980's.

It should be noted that it is not possible directly to compare AHR with other definitions for roughness, as the AHR is inevitably linked to the BSRA AHR gauge and stylus.

surface roughness

Surface roughness is closely linked to the paint specification. The specification for the necessary anchor pattern covers at least the roughness (sometimes also the profile). Surface roughness is given as “roughness numbers” according to ISO 1302 with reference to the roughness comparison specimen, Rugotest No. 3, which accords to ISO 2632/IT.

Roughness numbers are related to Ra, the arithmetical term for the deviation of the profile. If a numerical nominal roughness is needed, for instance Ra = 12.5 micron, the specification will be “Rugotest No. 3, N10”.

rugotest #3, n10

Note also that different comparators may be based on different roughness parameters. E.g., the Keane-Tator Surface Profile comparator uses Average Maximum Peak Rz - the ten-point height of irregularities.

Rugotest Roughness Number	Nominal values or Ra Micron
N1	0.025
N2	0.05
N3	0.1
N4	0.2
N5	0.4
N6	0.8
N7	1.6
N8	3.2
N9	6.3
N10	12.5
N11	25

propeller roughness

There are three main choices in technique for measurement of propeller roughness.

1. Stylus instruments in situ.
2. Stylus instruments following replication.
3. Comparators.

Stylus instruments are used in situ for the finishing of new propellers in the foundry. Compact instruments are available with digital readout, but the instrument is considered too delicate for routine dry-dock use.

A variety of laboratory instruments are available some with the addition of microprocessors and associated software and they are designed to measure a large number of roughness parameters such as seen in table 3 (next page). These instruments require a replication technique. Replicas of the propeller surface may be taken using either silicone or cellulose acetate foil. The replicas may then be measured later in the lab. Table 3 also gives the Ra for various ship types and ages.

Comparators or replicas of a variety of surfaces are available from a number of manufactures. One of the principal advantages by using comparators is that the surface condition may be assessed by divers, thereby allowing more frequent and less time consuming inspections.

The most commonly used comparator is the Rubert Propeller Replica Gauges which consists of 6 specimens A, B, C, D, E, and F, which are replicas of surface roughness of propeller blades. Specimens A and B are replicas of the surface roughness of new or reconditioned propeller blades.

The specimens show increasing roughness with "F" being very poor and normally unacceptable. The table below gives the corresponding numerical values of the different grades.

Rubert Grade	Ra (CLA) * Micron	Rz Micron
A	0.65	5.0
B	1.92	12.0
C	4.70	32.0
D	8.24	51.0
E	16.6	97.0
F	29.9	154.0

*CLA - Centre Line Average

Figures are mean values for the specific grade.

It may be noted that values for "Rubert Roughness" may be directly compared to RUGOTEST and Keane-Tator as figures are given both as Ra and Rz -roughness.

It is difficult directly to correlate a given propeller roughness to the influence on fuel consumption, but as a coarse rule of thumb a relationship between the different Rubert roughness grades and percentage power increase may be given.

Grade	Power I Increase
Rubert A	...
Rubert B	Negligible
Rubert C	1.5%
Rubert D	3%
Rubert E	5%
Rubert F	6%

The contribution of roughness to a necessary power increase is very dependent on where on the propeller roughness is positioned. The roughness of between approximately 0.5 or the blade radius and the edges plays a much greater role than the area in the vicinity of the boss because of the

considerably higher rotational velocities. Already, H.V. Lerbs (in Journal of the American society of Naval Engineering, 1951), concluded - based on tests - that loss of efficiency is reduced some 80% in case a "rough" propeller is polished "smooth" between the blade edge and 0.5 of the radius. The leading blade edge is especially important, and has to be kept as smooth as possible. Though roughness on the pressure side of the propeller will cause less increase in resistance compared to a similar roughness on the suction side, it is normally recommended to polish to the same grade on the two sides. On the figure (right) is also indicated some guidelines as to desirable and most cost effective Rubert grades. It is evident that the outer half radius and the leading edge of the blade are the important areas. These areas should be maintained at or near equal to Grade B.

propeller fouling

Part of the "roughness" might be caused by fouling. In spite of being 70 percent copper, most propeller alloys are either designed to resist solution in sea water, or are deliberately made cathodic to the hull by sacrificial or impressed current cathodic protection. As such, they have no antifouling properties. The copper is not active and available as toxicant to the fouling organisms. The incidence of fouling propellers is highly variable, but severe on occasions. Fouling by algae, barnacles and tube worms can be encountered.

However, the assessment of the effect of propeller fouling alone from performance analysis is bedeviled by the fact that it is often accompanied by hull fouling. For the operator it might therefore sometimes be an advantage to combine a propeller polishing with a hull cleaning or if necessary a re-activation of the anti-fouling system.