Propeller Design & Selection - notes from Mike Lucas

PROP WIZARDRY

Much has been written about propellers and how to select the optimum propeller for boat and engine. One of the most informative books is the Propeller Handbook by Dave Gerr and it is probably one of the best reference books on the subject.

Prop manufacturers, engine suppliers and boat builders will all have their methods for calculating the correct prop to put on the boat. In practice, there are so many variables, that the decision taken in this way is rarely right first time and a degree of experimenting has always been found to be necessary. I can certainly concur with this view, when thinking of my time at Marine Projects building Moodys and Sigmas, and also later with Sadlers.

Having said all this, there is a huge fund of knowledge on the subject and I have acquired a fair amount of historical data as regards props fitted to the various Sadler boats. I should stress at this stage, that none of the data appearing in this document should be taken as absolutely reliable and should be treated only as a helpful indication. Before taking a decision on a prop change, it is always worthwhile seeking a second opinion, which is reassuring if nothing else!

KEY POINTS

1. Diameter. It is broadly accepted that the largest diameter of propeller that can be used will be the most efficient, although this is of course limited by the proximity of prop shaft to the bottom of the hull. In calculating maximum diameter, allowance should be made for sufficient tip clearance between the top of the blade and the bottom of the hull and this should ideally be 15% of diameter and certainly not less than 10%. Should there be insufficient tip clearance, this will result in undue turbulence and a rhythmic "knocking", as the water is powered upwards against the bottom of the hull.

2. Pitch. The second variable is the pitch of the propeller and this can be best understood as the length through which the propeller would turn in one revolution and thus the extent to which the boat would move forward were it acting as a screw in a solid material. The limits of pitch are determined by achievement of designed maximum engine revs and optimising boat speed. If the pitch is too great, then the engine will not be able to achieve the maximum revs under load. This is of the order of 2,800 r.p.m with a Bukh engine and 3,200 r.p.m with a Volvo. Precise figures need to be determined from the engine manufacturers specification. Should the pitch of the propeller be more than required, then the engine will be unable to achieve the revs it should and will be "labouring" and producing black smoke to demonstrate its disapproval. If this is the case, then the pitch should be finer.

At the other end of the scale, if the pitch is too fine, then the engine will acquire peak revs too soon and before such time as the maximum hull speed achievable is attained. This of course is determined by waterline length and speed/length ratio from the well-known formula V = SL ratio x square route L.

The SL ratio depends upon a number of variables (mainly relating to power and displacement) and will vary between about 1.25 for a Sadler 26 to 1.45 for a Starlight 39.

If in doubt, it is probably better to err on the side of having a propeller that is slightly over-pitched, rather than under-pitched. The reason for this, is that with a cruising yacht you will seek optimum driving conditions at comfortable engine revs, which would be perhaps 2,200 to 2,500 r.p.m. Should there be no real intention to use peak revs, then it would not matter greatly if the boat is slightly over-pitched. The converse is most unsatisfactory, because there will be insufficient drive from the propeller and at modest revs, you will not achieve the required waterline speed.

As mentioned, this is a very brief and superficial summary, which is written to interest Sadler owners in some of the issues relating to propeller design and is certainly not intended to be a treatise on the subject. However, much has been learned about engines and propellers in Sadlers

over the past decade and I have noted some propeller data and performance criteria during the period. The following notes refer briefly to the various sizes of Sadler, engines selected and propellers used.

We have supplied a number of propellers over the years and these have generally come from either Teignbridge Propellers, Hamble Propellers, or Lake Engineering, all of whom are familiar with the various props supplied to Sadlers, but needless to say I have found differences of opinion on many of the issues, even amongst the trade suppliers. Propellers from different manufacturers do produce different performances for given diameter and pitch, which makes it even more confusing!

3. Right-hand and left-hand. Almost all props supplied to Sadlers were right-hand, but this matter is worth checking when ordering a new propeller. When afloat, you can check this for yourself, because the prop-wash emerging from a right-hand propeller will push the stern to starboard when going in ahead and pull the stern into port when going astern. Generally speaking with a Sadler, it is better to berth portside to, for this reason. When departing from the berth in astern, give the stern a little push outwards, which compensates for the initial thrust of the prop pulling the stern to port. When manoeuvring in ahead, a tighter turn is possible to port, than to starboard, if you have the standard right-hand prop. This is the "prop-wash" effect.

It is possible that you may have a left-hand propeller with a Volvo engine, but the linkages would then have been be reversed. Certainly with the Volvo engine, it is possible to change the linkages, so that the final output shaft can be reversed. I am advised by Volvo that the reduction ratio is exactly the same in ahead, when driving clockwise or counter clockwise.

4. Folding or fixed. There is no doubt that performance under power is better with a fixed propeller, and it is certainly more responsive in astern. There is of course more drag when sailing and many Sadler owners now appear to opt for a folding propeller to reduce drag, accepting less efficiency under power. It is highly desirable to have some form of rope-cutter if a fixed prop is installed, being either Ambassador or Spurs.

SADLER PROPS

1. Sadler 25. This boat has had a number of engine selections, with the Petter Mini 6 being the most commonly found on earlier boats. This was followed by the BMW 7hp and new installations now seem generally to be the Yanmar 1GM 10hp. The propeller most commonly found on the Yanmar engine (with 2.21 reduction ratio) is the 12" diameter x 9" pitch. Prop shaft is ¾" diameter.

2. Sadler 26. Initially, the 26 had the Bukh DV10ME 10hp engine with a 2.5 reduction ratio and was supplied with a 14" x 11" propeller. 14" diameter was the maximum diameter to give reasonable clearance and the pitch at 11" was about right for the gearbox reduction ratio, giving 5.5 knots at about 2,800 r.p.m.

About 1986, Sadlers moved over to Volvo engines (as did most of the UK boat builders) and this brought with it a changed reduction ratio to 2.37, thus giving a faster rotation of the prop in relation to the engine. Clearly, this required a finer pitch, which was subsequently found to be 9". Sadly, this new prop of 14" x 9" was not fitted for some time to the 26 and therefore a fair number of boats were delivered with Volvo engines, which were over-propped. I am still discovering these boats now, where the owner complains he can only get 4 knots maximum speed, when in fact it should be over 5 knots.

Prop shaft diameter is always 1", taper 1:12 and key-way 0.25". These dimensions hold good for all the 1" prop shafts in the Sadler range, which are also used for the 29, 32 and 34.

3. Sadler 29. During the time the 29 had the Bukh DV20ME 20hp engine, the prop fitted was a 16" x 12". When the change came about in 1986 to the Volvo 2002, the reduction ratio reduced to 2.37 (as for the 26) and the propeller then became a 16 x 10.5. This would give maximum speed of about 6.3 knots, smooth water, clean bottom and maximum revs about 3,000 r.p.m

4. Sadler 32. I am less than clear on the correct propeller for the Sadler 32 and have found a number of variations fitted during the period of the Watermota Seapanther installation. However,

once the boat had the Bukh DV20ME 20hp, then the propeller became the 16 x 12. In due course, the engine was changed to the Volvo 2002 and the propeller was changed to a 16 x 10.5.

5. Sadler 34. Initially, this boat had the Bukh DV20ME 20hp and the 34 was certainly under powered with this engine. At that stage, it had a 16 x 12, being the same propeller (surprisingly) as the 29. There was a brief period in about 1985/6 when the engine installed was the Bukh 24hp (max revs about 3,200 r.p.m) and then the change was made to Volvo 2003. At this stage, the prop moved to a 16 x 13, which happens to be the same propeller as used for the Starlight 35 (see below).

STARLIGHT PROPS

1. Starlight 35. The initial engine installed was the Volvo 2003, with the 16 x 13 prop, maximum revs about 3,000 r.p.m. This was used up to boat number 18. From boat 19 to number 34, the Perkins M30 was installed with a reduction ratio 2.05, with higher revs at 3,600 and a 16 x 9 or 16 x 10 propeller.

Interestingly, a 25mm prop shaft was used with the 35 (rather than 1") and this is of interest for shaft anode and Volvo shaft seal. A subsequent change to the Volvo 2030 from boat number 36 onwards, used the 16 x 10 propeller, as I recall.

Maximum revs for the 2030 engine was about 3,200 r.p.m and for the Perkins engine, this was more like 3,600. Maximum speed 7.5 knots.

2. Starlight 39. Initially this yacht had the Mermaid Meteor 2, which with only one or two exceptions, went into all the 39s upto and including boat number 28. This had an 18 x 14 prop generally, although choice of propeller did depend upon gearbox selected and resulting reduction ratio and the 18 x 12 was fitted in some cases.

In due course, this engine was changed to the Watermota Seapanther with effect from boat 29 onwards and this had the 18 x 12 prop. Prop shaft 1¼" for anode and rope cutter. Maximum speed in calm water 8.4 knots with max revs about 3,700.

CONCLUSION

The above notes are written as a general guide and to provide some helpful comments, which will enable owners to discuss this matter with their local engineer, or engine installer. The notes should be interpreted as an aid to discussion, rather than a definitive guide to prop selection.

This whole business is complicated and worthy of deeper investigation. Any further detail should be obtained direct from the prop suppliers. We are in touch with several of the prop experts and are in a position to supply what you require.

It would be interesting if owners with further contributions to make would care to enter this up on our Discussion Forum on the MLY website. This is now attracting considerable debate on technical matters, relating to the whole range of Sadler and Starlight yachts. There is so much knowledge available amongst owners, it would be interesting to contribute further. We shall post this article on our website within the Technical Articles section.

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