



PROPELLER TIPS ONE

DUNNRITE PROPELLER SERVICES LTD

61 Freyberg Street
Tauranga 3110
NEW ZEALAND
Phone: 07 570 3339
Mobile: 0274 919 460
Email: dunnrite@actrix.co.nz
Website: www.dunnritepropellers.co.nz

Founded in 1995, Dunnrite Propellers are specialists in supplying, tuning and repairing marine propellers. A personal professional experience is assured when you deal with Dunnrite Propellers.

The following has been put together by Dunnrite Propellers so that boaties may better understand how boat performance can and will be affected if a propeller of the wrong size is fitted to their boat for any given application.

Owners of outboards or stern drives could avoid some serious expenses if they better understood the importance of correct propeller size and a good tachometer (rev counter). These easily understood tips cover prop sizing and tachometers plus propeller balancing, three blades versus four, the importance of drive hubs (propeller bushes), and what props are best. Props of the wrong size are a cause of increased fuel consumption, motor and gearbox expenses on outboards, motors & stern drives.

PROPELLER SIZE

A correctly sized propeller is all-important to the overall performance of any propeller driven boat whether it be a speedboat, runabout, launch, yacht, or other vessel. The same rule applies for both outboard and inboard engines.

Marine engine manufacturers recommend how many RPM (Revolutions Per Minute) their engines should reach at WOT (Wide Open Throttle) with a "normal load". A "normal load" for someone doing a little fishing can be very different to another person with an identical boat who does cruising, scuba diving or water skiing. Many outboard boat owners find they require more than one propeller size because they run their boats with both light and heavy loads.

To confuse the subject further, boats of the same design with similar "normal loads" and the same horsepower can require propellers of different sizes.

This can occur when engines from different manufacturers develop their power at different RPM levels. A more common reason is that not all gearboxes are fitted with the same gear ratio to that of a competitor. The lower the gear ratio the larger the propeller that can be used and vice versa.

If the propeller is too big, and the engine manufacturers recommended RPM at WOT cannot be achieved, the boat is over propped. Continued use will bring about one or more of the following problems, depending on engine type. Excessive carbon build-up, pre-ignition, frequent spark plug failure, scoring of the cylinder walls, burned pistons, worn gears, and black exhaust smoke.

Such overloaded engines never develop the horsepower their manufacturers rated them as having, and the boats to which they belong never perform as well as they should.

If the propeller is too small or worn, and the maximum RPM recommended by the engine manufacturer is exceeded at WOT the boat is under propped and serious engine damage may occur. Fuel economy will suffer, as the maximum boat speed is often less than it should have been.

TACHOMETER (Rev Counter)

A tachometer is the most important instrument for assessing the performance of a boat and its propeller.

An engine will only develop the horsepower stated by the manufacturer if it can reach the recommended RPM. When the engine revolutions are correct at WOT, the load on both the engine and transmission (gearbox) will also be correct and will remain so regardless of the throttle setting.

The accuracy of your boat's tachometer is important. An incorrect reading, of as little as 300RPM with some installations, could guide you to the wrong size propeller for your boat.

Assuming your tachometer is accurate, does the engine RPM in your boat meet the engine manufacturer's specification when the boat is run at WOT?

If not, and you damage the engine or gearbox, you may find any warranty with the manufacturer to be withdrawn, and the expense of those engine and gearbox repairs carried by you, the boat owner.

Example

If an outboard is rated at 90hp and the recommended RPM are between 5000-6000 at WOT, there is every chance 90hp will be at 5500RPM.

If the tachometer is accurate and reads only 4500RPM at WOT, the engine will never develop 90hp and both the engine and transmission will be overloaded, regardless of the throttle setting. Such overloading will increase fuel consumption and reduce the life of both the engine and transmission.

If the tachometer had read 6500RPM at WOT, the engine may have developed more than 90hp, but if run continuously at such revs you may risk serious damage to the engine. Usually in such situations, fuel economy and boat speed would again be compromised.

HOT TIP!

Generally a propeller a size too small does less damage than a propeller a size too big. If your propeller is a size too small - the boat is under propped.

The motor will over rev but the motor and gearbox will only be at risk during the period you over rev it.

If your propeller is a size too big - the boat is over propped.

The motor will not reach the recommended rev range.

If that is so, the motor and transmission are over loaded and are at risk from the time you put the boat in gear regardless of the throttle setting.

BALANCE

The balance of a propeller is important for smooth operation and to eliminate wear and damage to the drive train due to vibration. If one or more blades are different in size, pitch, rake, cup or blade spacing, the balance will be affected and vibrations will usually occur.

Owners of boats fitted with inboard engines and a fixed propeller are less tolerant of vibrations especially if they go cruising for several hours. It is important that propellers on these installations have sufficient clearance between the blade tips and the hull. A good rule of thumb is to allow clearance equal to 15% of the propeller diameter.

If the propeller is running too close to the hull or other appendages, the wash from the propeller can wash back off the hull and onto the propeller. This can cause a vibration. Vibrations do become very tiresome.

A common misconception is that outboard and stern drive propellers do not need to be balanced because they are fitted with a rubber drive hub. The reason for fitting the drive hub was to protect the gears from the shock loads created when shifting to go ahead or astern. The rubber drive hub can dampen vibration, but it can't cure it.

Little vibrations and bad harmonics given time create havoc for bearings, seals, splines and gears. Continued use of a damaged, and out of balance outboard or stern drive propeller may cause the drive hub to fail prematurely. Drive hubs do fail from time to time, even if the propeller is in good condition.

The cause of vibrations in some boats can be very hard to track down. Propellers are a high-risk item for some boat owners and are susceptible to sustaining damage that can cause vibrations. Propeller damage is very often not apparent to the untrained eye and blades can become bent or distorted without showing signs of impact or abrasion. If you have a vibration in your boat, it is a good idea to eliminate the propeller as a possible cause. Remove the propeller, send it to a competent marine propeller technician and have it properly measured for pitch, hydraulic balance, and static balance.

THREE BLADES versus FOUR BLADES

A common question, "what performance advantages are there in running a 4 blade propeller instead of a 3 blade"?

4 blade propellers provide better acceleration or hole shot, better manoeuvrability at low speed, better cruising performance, and run smoother. They will assist in getting a heavily laden boat to plane. I have also found them more user friendly in regard to correct trim on outboards and stern drives when getting a boat to plane or pulling a water skier up.

In many instances on stern drives and boats with fixed propeller shafts there is insufficient clearance between the cavitation plate or hull respectively. In such cases the diameter of the propeller is restricted and the selection of a 3 blade propeller can become a compromise.

A 4 blade propeller of equivalent diameter will have better propeller efficiency than a compromise 3 blade under such operating conditions.

Generally speaking a 4 blade propeller will out perform a 3 blade propeller of similar quality in all departments except top speed. The question is how often do you run a boat at full speed?

Many boat owners with outboards find they require more than one propeller size because they run their boats with both light and heavy loads. You can sometimes overcome that situation by fitting a 4 blade propeller.

A 4 blade propeller is another option and may suit your boat and application.

DRIVE HUBS

The overall performance of outboards and stern drives is greatly affected by the size and shape of the lower gear case. Because of this, lower gear cases are everything but over engineered.

Using information such as the engine horsepower, gear ratio, and the recommended engine RPM at WOT; design engineers calculate the maximum torque at the propeller. Armed with that information, gear case manufacturers determine the loading factor and how strong the gear case and its components need to be to function properly. The quest for performance dictates that gears, shafts, bearings, and housings are kept to a minimum size, but to give the gear case a better chance in life, outboard and stern drive propellers are generally fitted with a dampening device called a drive hub.

The drive hub (prop bush, prop damper, rubber thingy, etc.) actually drives the boat, and protects the gears from the shock loads created when shifting to go ahead and astern.

If the engine cannot rev to the recommended RPM at WOT the torque at the propeller will be greater than calculated by the design engineer and the transmission (gear case and drive hub) will be overloaded. Such overloading can cause excessive wear to gears and bearings, and can be the cause of premature drive hub failures.

The design or weight of the boat should not be a factor, as long as the engine manufacturers recommended RPM at WOT are adhered to.

Outboard and stern drive manufacturers have determined how much dampening is required to protect their gear cases and in turn they have determined how strong the drive hub can be. Obviously if the drive hub is stronger than the gear case, costly gear case repairs would be more common than the less costly drive hub repairs.

It is true that some outboard and stern drive manufacturers use propellers without drive hubs, or with solid hubs. Both the Bravo 111 from Mercruiser and the TRP Hydra Drive stern drive from Yamaha are two that come to mind. Solid hub propellers are often used for high performance applications.

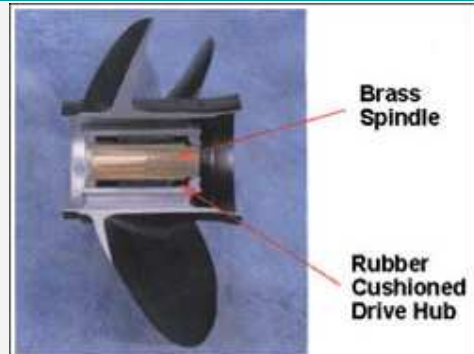
In racing applications where solid drive hubs are used, it is recommended to modify the electrical circuits to allow the engine to be started in gear. This eliminates the problem of shock loads when changing gear.

If you think your drive hub is slipping, stop and check if the propeller is fouled with plastic or weed. If it is clear, try to go ahead and slowly work the boat up to planing speed with the leg or outboard trimmed in. Maximum load on a drive hub is just as the boat goes on to the plane. If you can get the boat to plane, the drive hub is probably not at fault. Take a look at the propeller. If the blades are visibly bent or distorted, you very likely are experiencing cavitation. Cavitation is often mistaken for a slipping drive hub. Get the propeller repaired by a marine propeller technician.

The challenge in drive hub design is to have a hub that will fail, but only when the gear case itself is at risk. Some propeller manufacturers have reduced their manufacturing costs by using drive hubs of inferior design or in one case no drive hub at all but offering a 3 year drive hub warranty to the detriment of the gear case components.

Outboard and stern drive manufacturers (who also want to reduce manufacturing costs) nearly always use propellers fitted with drive hubs to protect their gear cases.

A conventional drive hub has a bronze or aluminium spindle, which has been machined to suit the prop shaft spline of the drive unit. A round damper made of solid rubber is vulcanised around the metal centre to make a one-piece unit. The quality and hardness of the rubber damper is critical to drive hub performance. These hubs are pressed as an assembly into the prop.



Cutaway of a Michigan Match Propeller showing the Drive Hub Assembly

Mercury, Mercruiser, Mariner & Force are users of the above described drive hubs, but they are big users of "their own" Flo-Torq 11 hub system. This system was developed on propellers first marketed under Quicksilver. Those same propellers are part of an extended range offered by the Mercury Marine Propeller Company.

Michigan Wheel Corporation has produced an improved drive hub that will interchange with Mercury's Flo-Torq 11 hub system. Michigan has called their drive hub the XHS. Using a urethane compound that better absorbs the shock loads when an outboard or sterndrive is put into gear has made considerable improvements. XHS drive hub assembly kits and the replacement urethane sleeves are available direct from the NZ agent, Dunnrite Propellers in Tauranga.



NEW from Michigan Wheel the XHS Exchangeable Drive Hub System with the Vortex Aluminium Propeller

Drive hubs do fail from time to time and specialised equipment is required to replace them. The following is recommended:

- Re-hubbed propellers are cured in an oven.
- That engines are operated at idle, shifting from forward to reverse several times during the first three minutes of use, to allow proper seating of a new drive hub.

These two procedures have proven to significantly reduce premature hub failures. Dunnrite Propellers realise many boaties collect their re-hubbed propellers on the way to the boat ramp and not to the kitchen. Dunnrite Propellers stock an extensive range of drive hubs and company policy ensures that all re-hubbed propellers go through the oven procedure prior to leaving the workshop.

HOT TIP!

I should not leave the subject of drive hubs without commenting on the use, or more importantly the lack of use, of spline grease. Most outboard and stern drive propellers will only too readily become permanent fixtures to the prop shaft without the use of premium spline grease. Boat owners could save themselves some money and anguish if only they were prepared to remove the propeller from the prop shaft at least annually, clean the parts, apply a clean film of an approved grease to the spline or prop shaft, and reassemble in the reverse order to the removal procedure.

I cannot recommend the use of general-purpose grease, as it tends to wash out. To boaties who would rather ignore this tip, my wife and I thank you as every little bit helps when you are in business.

WHAT'S BEST, COMPOSITE, ALUMINIUM or STAINLESS STEEL PROPELLERS?

A basic propeller, amongst other things, must be strong enough to withstand the power and loads it is subjected to without breaking or flexing.

In theory, you can improve the performance of a propeller by making the blades thinner. In practice, whenever this is done, the strength of the propeller is compromised in some way.

All aluminium, stainless steel, and bronze propellers are made from an alloy of metals. As technology has advanced, stronger and better materials have been developed, and methods to use them have been found. The propeller manufacturing industry has been a party to developing such technologies.

Stronger alloys have been developed and many of the aluminium propellers manufactured today have thinner blades, without losing the strength required to withstand the power and loads they are subjected to. Regrettably some of the new aluminium alloys are difficult to repair.

Composite propellers on the other hand are generally unrepairable although some are fitted with replacement blades. The replacement blades are not as cheap as you might think but they may be convenient for some boaties.

If a composite propeller is spinning when you damage it, expect to have to replace all the blades.

To date, no aluminium alloy, or composite material, used in the manufacture of marine propellers can equal the qualities found in stainless steel.

Stainless steel allows propellers to be manufactured with thinner and stronger blades, with more complex blade shapes and attention to detail.

Stainless steel propellers flex the least, which can improve the overall performance of a boat. Composite propellers would have the most flex and are generally made smaller in diameter while aluminium would be in the middle.

A stainless steel propeller is capable of withstanding five to ten times the blow or strikes an aluminium propeller can.

Stainless steel propellers can always be fitted with new drive hubs, whereas aluminium propellers have been known to break during re-hubbing. Some of the composite propellers in the market place have no drive hubs at all, just an internal spline to fit the prop shaft.

If there is a disadvantage with stainless propellers over aluminium or composite propellers it is the relative weight. There are people who consider the weight to be a disadvantage when an outboard or stern drive is repeatedly put in, and out of gear. The shock loads inflicted on parts in the gear case when changing gear should not be ignored, but a quality drive hub does address such concerns.

It would be fair to say that excessive wear to gear case components is more attributable to other causes such as:

- Boat owners who try to gently ease their motors into gear,
- Using the wrong size propeller,
- Using a propeller with an inferior drive hub design,
- Poor maintenance and cable adjustment.

Boat owners interested in water skiing were amongst the first to appreciate the performance advantages, and enjoy the additional strength found in stainless steel propellers and have done so without having too many gear case problems.

I will let you the reader draw your own conclusions on the subject of a propellers weight. Although stainless steel propellers are becoming more affordable, they will remain more expensive than aluminium or composite propellers because of the additional labour required at manufacture.

Stainless steel propellers are becoming more common and are now available for more applications than ever before. By fitting a high quality stainless steel propeller to your boat, you will maximise safety, reliability, and economy.

SUMMARY

If you are after extra performance tweaking and tuning of propellers is one way to get it. Remember the stock propeller as supplied with most outboards and stern drives is often a compromise.

Many outboard manufacturers supply their motors with a "standard" propeller but have no idea as to the type of craft it will be fitted to. The size and weight of the craft is unknown. Would one motor or two power it? What will be the "normal load" or "application"?

There is a good chance that if you have never really been happy with the performance of your boat under power, the size and type of the propeller fitted is incorrect for your application.

Regardless of the number of blades, a correctly sized propeller is important to the overall performance of any propeller driven boat or vessel. Always remember, marine engine manufacturers do recommend how many RPM their engines should reach at WOT with a "normal load".

Gearbox & engine repairs do not come cheaply. If you have an outboard or stern drive, ensure any replacement propeller is fitted with a quality drive hub to protect the internal components of the gear case.

I look forward to assisting you further in the near future

Cheerz

Ric Dunn
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