DUNNRITE PROPELLERS

PROPELLER TIPS TWO

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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.
This information is written for inboard applications with fixed prop shafts covering the importance of correct propeller sizing and a tachometer (rev counter), propeller balancing, and three blades versus four. Tips on removing and refitting a propeller on a Ski-boat, Launch or Yacht fitted with a basic propeller shaft assembly.
Propellers of the wrong size are often the reason for increased fuel consumption, motor and gearbox expenses on motors, gearboxes and 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. Some trailer 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 boats tachometer is not just important. It is absolutely critical! An incorrect reading, of as little as 200RPM 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 manufacturers 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.

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 in some cases the 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.

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 an optimum 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.

REMOVING A PROPELLER from a SKI-BOAT, LAUNCH or YACHT

In general you require the following tools to remove a propeller from the prop shaft on an inboard powered ski-boat, launch or yacht with a basic propeller shaft assembly.

I. A pair of side cutters or pliers to remove the old cotter pin (split pin).
II. A tool to undo the prop shaft nut. Preferably use a suitable ring spanner or a socket set although an adjustable wrench used with care will do the job.
III. A piece of wood to pack between the propeller blade tips and the boat hull to stop the prop shaft from turning when you undo the prop nut. Ensure the piece of wood is big enough to spread the load against the bottom of your boat.
IV. A suitable prop puller for your prop shaft and propeller. If you are hiring a prop puller you will need to know the diameter of the prop shaft and number of blades on the prop. Dunnrite Propellers have prop pullers for hire, or if you prefer and your vessel is in Tauranga, we can remove your propeller for you.

If you have the above you should not require a gas-torch, axe or sledgehammer, or any other instrument that may damage your boat, prop shaft, bearings, propeller or cause personal injury to yourself or a helpful friend.

HOT TIP!

An Electric Jug is handy!

Removal Procedure

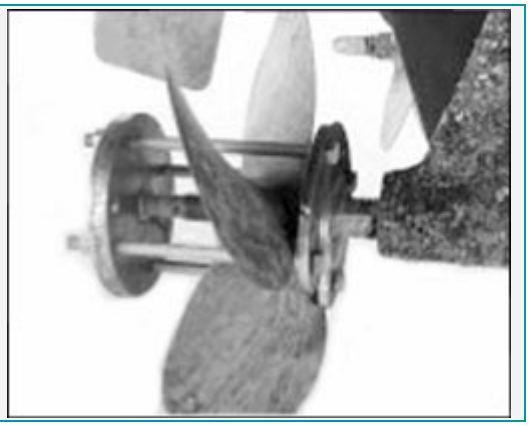
1. Remove the old cotter pin.
2. Place your piece of wood between the hull and the blade tips of your propeller to stop the prop shaft from rotating when you undo the prop nut against the propeller.
3. Undo and remove the prop nut. Look for the keyway on the propeller and rotate the prop shaft until the keyway is at the bottom (the 6 O'clock position).
   Refit the prop nut winding it back past the end of the prop shaft so it will not interfere with the prop puller, leaving the loosened prop nut still on the prop shaft. This will stop the propeller and the prop puller assembly from falling when you "pop" it off the prop shaft. If your prop shaft is fitted with a set of jam nuts (two nuts together) you should remove the first prop nut before removing the second nut to avoid damaging the threads.
4. Without turning the prop shaft (keyway at 6 O'clock), fit the prop puller to the propeller and prop shaft. There are various prop pullers around but they should all pull against the hub of the propeller, (between the prop and the rear prop shaft bearing carrier or strut) and the end of the prop shaft itself. If your puller uses two or more assembly bolts drawing two plates together, tighten the bolts evenly keeping the two plates square to each other.
   CAUTION: The plate pulling against the prop hub should not touch or pull against the blades of the propeller.
5. After you have tightened the prop puller assembly bolts, tighten the centre bolt against the end of the prop shaft and the prop should "pop" off the prop shaft taper. If anything should need a "tap" with a hammer it should be the center bolt of the puller. Avoid striking the propeller. After the prop has "popped" off the prop shaft taper, remove prop puller; remove loosened prop nut and then the propeller.
   NOTE: You should remove the key from the prop shaft and check it for wear while you have the prop off.

HOT TIP!

With the keyway in the 6 O'clock position, quickly pouring boiling water over the top of the propeller boss (where the metal is thicker) while the prop puller is tightened will also assist the removal of a tight fitting prop. At the keyway the propeller boss is thinner and this becomes a 'hinge' when the boss expands due to the boiling water.

Propeller Puller – 3 Blades

There are many types and designs of propeller pullers. The important feature of any type or design is that they pull on the hub or boss of the propeller and not on the actual blades.



REFITTING A PROPELLER on a SKI-BOAT, LAUNCH or YACHT
In general you require the following to refit a propeller to the prop shaft on an inboard powered ski-boat, launch or yacht with a basic propeller shaft assembly.

I. If the old key is damaged - a new key, cut to fit both the propeller and the prop shaft.
II. Perhaps a little “never-seez” or “anti-seize compound” for the key and prop nut before the final fitting of the propeller. The tapered parts must be clean and dry.
III. A tool to do up the prop shaft nut. Preferably use a suitable ring spanner or a socket set although an adjustable wrench used with care will do the job.
IV. A new stainless steel cotter pin (split pin) and a pair of side cutters or pliers.

If you have changed the propeller, or the prop shaft, or you are fitting a new key you need to take extra care that all the parts fit together correctly.

1. Push propeller snugly onto the prop shaft taper WITHOUT the key in either keyway (propeller or shaft).
2. Make sure the propeller is snug and there is no side-to-side movement by gently moving propeller back and forth.
   Ensure there is sufficient clearance between the propeller hub and the rear prop shaft bearing carrier or strut.
   Ensure the propeller does not travel up the prop shaft exposing the prop shaft taper. The prop nut and washer has to push the propeller on to the prop shaft.
3. Make a line on the shaft with a non-graphite marker at the forward end of the propeller where it stops up against the shaft taper.
4. Remove propeller.
5. Put key into keyway on shaft taper with chamfered corners (down) in shaft keyway (if propeller shaft keyway has chamfered corners).
6. Put propeller onto shaft taper.
7. Check to see that the propeller moves back to the forward line made in Step 3. If it does and the propeller is not ‘riding’ on the key, skip down to Step 8. If not perform the following:

   a) Remove propeller and key from shaft.
   b) Place a file on a flat surface area or workbench.
   c) Run opposite side of chamfered key back and forth over file (to remove any burrs) with a downward pressure on key until side being filed is clean.
   d) Install cleaned key in shaft keyway with chamfered corner side down in the shaft (the cleaned filed side facing up in keyway).
   e) Replace the propeller on the shaft and fit snugly on taper. Check to see if propeller reaches the line made as in Step 7. If it does not line up the key is too thick and you will have to repeat “Steps a). thru to e).” until the propeller stops ‘riding’ on the key.
   NOTE: A vice can be used to hold the key when filing but care must be taken not to tighten too much, causing burrs and irregularities on the key.

8. When you have the propeller hub fitting to the correct position, apply a thin coat of “anti-seize compound” to the prop shaft threads.
9. Reassemble key and propeller, fit prop washer & nut. Tighten nut to seat the propeller on prop shaft taper. Install the torque jam nut (2nd nut) if your prop

shaft is so equipped.
CAUTION: If you require a piece of wood placed between the hull and the propeller to stop the prop shaft from turning, take care not to damage the blade tips on the propeller.

10. Install the new cotter pin and the jobs done.

PROPELLER ROTATION

Many people get confused about propeller rotation.
Asking some people whether their propeller is Left or Right Hand, Clockwise Rotating or Counter Clockwise Rotating can often generate a blank look.

The following works and even better, it is not too hard to remember.
Place the propeller on the ground in front of you and between your two feet.
Try placing your Left foot on any blade left of the centre of the propeller. If your foot sits on the blade like it were a footrest, the propeller is Left Hand or Counter Rotating.
NOTE: The Right foot will not be able to rest on any blade right of centre of the propeller, but will kick into the edge of the propeller instead.

Conversely if you can place your Right foot on any blade right of the centre of the propeller like it were a footrest, the propeller is Right Hand or Clockwise Rotating.
NOTE: The Left foot will not rest on any blade left of centre of the propeller, but will kick into the edge of the propeller instead.

Try it. It works and it does not matter whether the propeller is sitting on the ground face up or face down.

HOT TIP!

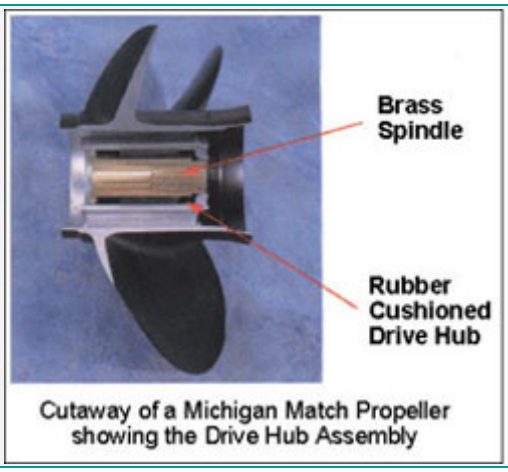
You can't substitute a LH propeller for a RH propeller without making some other changes. In many instances you will require a different rotation in the gearbox. This can be somewhat expensive. It is better to buy the correct rotation propeller.

DRIVE HUBS

The overall performance of stern drives (and outboards) 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 devise 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 lifetime drive hub warranty to the detriment of the gear case components.
Stern drive and outboard 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 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.

XHS drive hub assembly kits and replacement sleeves are available direct from the importer 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 particular tip, my wife and I thank you as every little bit helps when you are in business.

SUMMARY

If you are after extra performance tweaking and tuning of propellers is one way to get it. 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 a stern drive, ensure any replacement propeller is fitted with a quality drive hub of similar quality to the original propeller to protect the internal components of the gear case.

I look forward to assisting you further in the near future

Cheerz

Ric Dunn