DUNNRITE PROPELLERS

PROPELLER TIPS FIVE

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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 for competitors in IRB Surf Rescue so they may better understand how boat performance can and will be affected if a propeller of the wrong size is fitted to a boat for any given application.
Propellers of the wrong size, propellers not fitted with an approved drive hub, and damaged or out of balance propellers if repeatedly used are often the reason for increased motor and gearbox expenses on outboards. The same applies to motors & stern drives in all other boats.

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 & inboard engines, and IRB's.
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.
It goes without saying 2 persons in an IRB is probably a lighter load than 3 persons.
If you change the weight of the crewmembers, you have changed the normal load. In an IRB or "Thundercat" the inflation pressure is critical to overall boat performance and can affect the RPM at WOT.
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, and/or worn gears.
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.

Example
A Tohatsu 30hp - the recommended RPM is between 4800-5500 at WOT. There is every chance 30hp will be at 5150RPM.
If the tachometer is accurate and reads only 4500RPM at WOT, the engine will never develop 30hp 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 6000RPM at WOT, the engine may have developed a little more than 30hp, but at the risk of doing serious damage to the engine during the time it exceeds the recommended maximum of 5500RPM.

The accuracy of your boats 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. Equally if you use an out of tune motor or one that requires maintenance to do your prop testing you will waste time and money. If you are not careful the propeller may be altered beyond repair for when it is fitted to a properly maintained and tuned motor. Dunnrite Propellers can supply small digital tachometers suitable for IRB racing.

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 10% 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.

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 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.
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

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.

PROPELLER TERMINOLOGY

Propeller Size:
The size of a propeller is usually described by a set of numbers. Two numbers indicate the sizes of diameter and the pitch respectively. Hence, we express the size of a propeller diameter x pitch (D x P).

Diameter:
Propeller diameter is twice the distance from the centre of the hub to the tip of the blade as a propeller rotates.

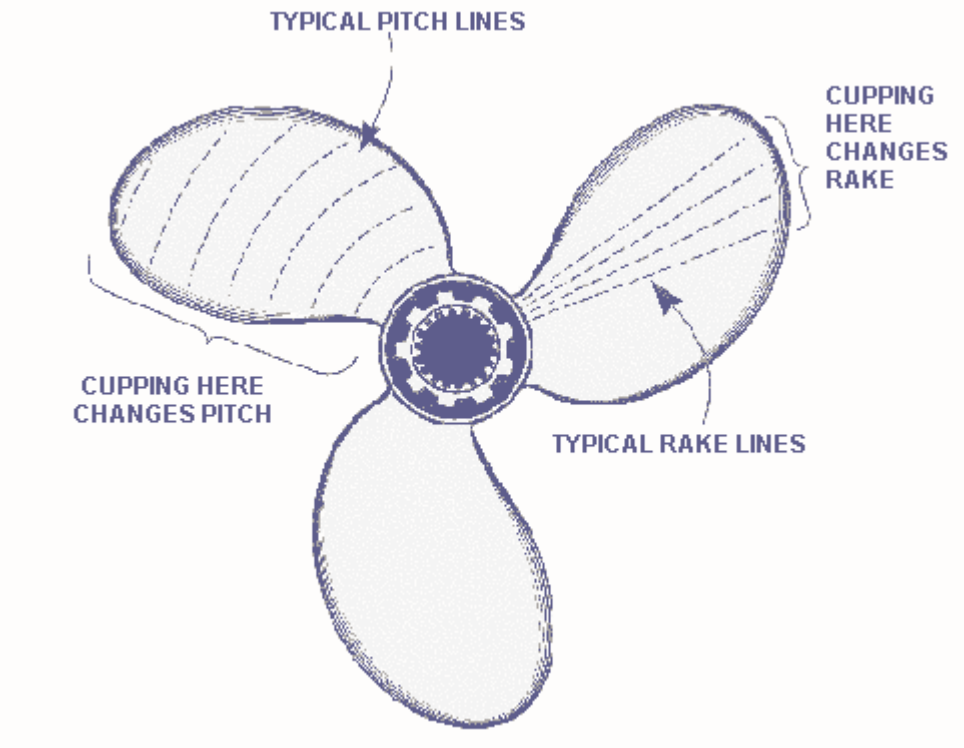
Pitch:
Pitch is the theoretical forward movement that a propeller travels during one revolution. Because of slip the actual distance a propeller travels is about 10 to 20 percent less than the design pitch. Slip is the difference between actual and theoretical movement. It varies from boat to boat for various reasons such as the weight of the boat and blade surface area of the propeller.

Cupping:
A propeller is said to have a cup if the trailing edge of the blades is formed or cast with the edge curled. Cupped blades improve the grip of the propeller into the water, reduce cavitation and allow the boat to reach higher top speed. Cupping benefits are so desirable that almost all modern recreational, high performance propellers have some degree of cup. Compared with an un-cupped propeller with the same pitch, the cupped one will reduce Wide Open Throttle engine speed. Single cup/100-200rpm. Double cup/300-400rpm.

Ventilation:
Ventilation is the introduction of exhaust gases into the propeller. Ventilation can be useful in the bottom end acceleration by allowing the propeller to slip a regulated amount, allowing the engine to rev higher during initial acceleration. Usually achieved by ventilation holes at the base of each blade on thru-hub exhaust propellers. Can also be achieved by fitting a propeller that has a smaller diameter propeller barrel than the original propeller, commonly referred to as a thru hub over hub propeller.

CAUTION: Ventilation of propellers should not be confused with a "ventilating propeller". A ventilating propeller sucks air from the surface, causing the propeller to slip and the boat to loose drive.

Rake:
Blade rake is the angle of attachment of the blade to the hub of the propeller. Higher rake can improve performance in higher engine elevation and/or ventilating or cavitating situations. Lower rake is typically used in heavier boats with fully submerged propellers. Rake should not be confused with pitch.



SUMMARY

If you are after extra performance from an IRB then the tweaking and tuning of propellers is one way to get it. Most propellers run on IRB's and "Thundercats" fitted with prop guards will benefit from tuning and additional cupping.

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"?

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". If you have an outboard or stern drive, ensure the 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