Choosing & Using Propellers

Notes about propellers follow the tables.

Charts specific to Glow and Petrol Engines

Prop Chart for 2-stroke Glow Engines

Engine Size	Starting Prop	Alternate Propellers
.049	6x3	5.25x4, 5.5x4, 6x3.5, 6x4, 7x3
.09	7x4	7x3,7x4.5,7x5
.15	8x4	8x5,8x6,9x4
.19 - .25	9x4	8x5,8x6,9x5
.20 - .30	9x6	9x7,9.5x6,10x5
.35 - .36	10x6	9x7,10x5,11x4
.40	10x6	9x8, 11x5
.45	10x7	10x6,11x5,11x6,12x4
.50	11x6	10x8,11x7,12x4,12x5
.60 - .61	11x7	11x7.5, 11x7.75, 11x8,12x6
.70	12x6	11x8,12x8,13x6,14x4
.78 - .80	13x6	12x8,14x4,14x5
.90 - .91	14x6	13x8, 15x6, 16x5
1.08	16x6	15x8, 18x5
1.20	16x8	16x10, 18x5, 18x6
1.50	18x6	18x8, 20x6
1.80	18x8	18x10, 20x6, 20x8, 22x6
2.00	20x8	18x10, 20x6, 20x10, 22x6

Prop Chart for 4-stroke Glow Engines

Engine Size	Starting Prop	Alternate Propellors
.20 - .21	9x6	9x5,10x5
.40	11x6	10x6,10x7,11x4,11x5.11x7,11x7.5,12x4,12x5
.45 - .48	11x6	10x6,10x7,10x8,11x7,11x7.5,12x4,12x5,12x6
.60 - .65	12x6	11x7.5,11x7.75,11x8,12x8,13x5,13x6,14x5,14x6
.80	13x6	12x8,13x8,14x4,14x6
.90	14x6	13x6, 14x8, 15x6, 16x6
1.20	16x6	14x8, 15x6, 15x8, 16x8, 17x6, 18x5, 18x6
1.60	18x6	15x6, 15x8, 16x8, 18x6, 18x8, 20x6
2.40	18x10	18x12, 20x8, 20x10
2.70	20x8	18x10, 18x12, 20x10
3.00	20x10	18x12, 20x10

Prop Chart for 2-stroke Petrol Engines

Engine Size	Break-in Prop	2 Bladed Propeller Choices	3 Bladed Propeller Choices	4 Bladed Propeller Choices
17cc	14x6	13x6, 14x7	NA	NA
20cc	16x8	15x10, 16x10, 17x8	16x10	NA
26cc	18x6	16x12, 18x8, 20x6	16x10	16x8 Mustang
30cc	18x10	18x12, 20x8	17x10	17x8 Mustang
40cc	20x8	18x10, 18x12, 20x10	18x10, 19x10	18x10
50-55cc	20x10	18x12, 20x10, 22x8, 23x8	19x10, 20x10, 21x11.5	19x8 Mustang
60cc	22x10	20x12, 22x12, 23x10, 24x8	21x10	20x10
70cc	24x8	24x10, 26x8	22x10, 22x12	22x10
80cc	24x10	24x12, 26x10	22x12, 23x12, 24x10	22x10
85cc	26x10	26x12, 27x10, 28x10N	24x12, 25x10, 25x12	22x10
100cc	26x10	26x12, 27x10, 28x10	25x10, 25x12	24x10
111cc	26x10	26x12, 27x10, 28x10	25x12, 26x12	24x10
120cc	26x10	26x12, 27x10, 28x10	25x12, 26x12	24x10
150cc	30x10	30x12, 32x10, 32x12	28x12, 28.5x12	26x10 Mustang
160cc	32x10	30x12, 32x12	28.5x12, 29x12	NA
170cc	32x10	32x12, 33x11	29x12, 30x12	NA
200cc 4 cyl	32x12	32x12	30x12, 31x12	NA
210cc	34x12	34x14, 35x10, 35x12, 36x12	31x12, 32x12	NA
222cc 4 cyl	32x12	32x14, 33x11	31x12	NA
320cc 4 cyl	36x12	36x16, 39x12	34x10, 34x12	NA
420cc 4 cyl	39x12	36x18, 38x16	36x16	NA

Prop Chart for 4-stroke Radial Engines

Engine Size	Break-in Prop	2 Blade Propeller Choices	3 Blade Propeller Choices	4 Blade Propeller Choices
150cc	26x16	28x12, 30x10	26x14, 27x10	23x14, 24x10
215cc	32x12	32x14, 32x18	32x12, 32x14	28x14, 28x16
250cc	32x14	32x18, 32x22	32x14, 32x16	28x16, 28x18
400cc	40x22	40x22	36x16	NA
800cc	48x22	50x22	40x26	NA

Propellers

Breaking in an Engine

The following information has been extracted from articles published by RC Airplane World *with their permission. Much of it is generally applicable to whatever power source you use, but some extra considerations for Electric Motors are included as a footnote to the extract.*

Breaking-in a new engine will lightly load the engine. During the first few hours of running a new engine there is more friction between the piston, piston ring, and cylinder wall as well as all other moving components like bearings.

During this time it is important to keep the heat down in the engine due to other factors such as running a large prop and flying at low airspeeds or hovering. If you don't break in the engine properly, it will never perform well. Using a small prop and keeping the plane moving is best.

For petrol engines, do not break-in the engine on the ground. Make sure the engine runs reliably first! This can take as long as is required, but don't run the engine on the ground in an effort to break it in. There is not enough air to cool the engine.

Glow engines have 20% oil in the fuel which cools the engine tremendously. Petrol engines don't use a lot of oil, so they need really big cooling fins. That's the main

reason petrol engines are so heavy, they need much bigger cooling fins than glow engines.

Use a petroleum based oil for break in, then switch to the more slippery synthetic oils later. Synthetics are too slippery and don't allow the parts to wear in quickly so compression will be low which causes poor idle, transition and top end power.

Keep in mind the following

Balance the prop. Yes, they should be factory balanced, but are you going to take their word for it? Remember balancing the hub is not a big concern. Put the heavy side of the prop down when the piston is at the top so that it acts like a counterweight. Many engine manufacturers use too small a counterweight to keep the overall weight of the engine down. The prop can help.

Don't tighten the prop so much that you crush it. Neither wood nor CF can hold up to over tightening. When the prop starts to crush, you are tightening it too much. Check the prop after the first flight, and if it is loose, check it after every flight until it needs no further tightening. All that vibration will seat the prop. If the prop is loose, it is not good!

Drilling holes in the prop for the 2, 4, 5 or whatever screws can weaken the prop. The prop can fly apart, so don't let anyone stand in front or to the side of the prop when running the engine. If you run the engine in a garage, it might go right through your Ferrari, so it's best to run in out of doors.

Don't throw anything into the engine (like a rag) to kill it. You could do serious damage.

If the prop has tip damage, you can sand the damage off and make it even in some cases. Balance the prop when you are finished. If the prop is wood, and it is split, discard the prop. Don't let the spinner cone contact the prop. It will gouge it.

The subject of RC propeller size selection can be a bit of a minefield, but hopefully this page will show you some generally accepted guidelines and recommendations for choosing the right prop.

It goes without saying that selecting the correct propeller size for your rc airplane is very important if you want to get the optimum performance from your glow engine/ electric motor and plane.

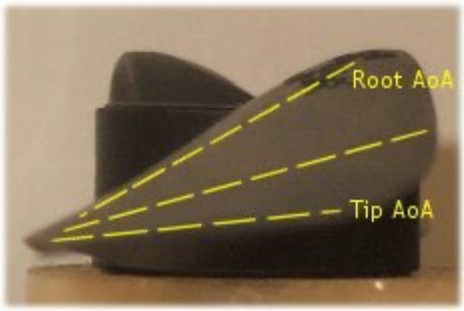
In the worst case scenario, the wrong prop can cause serious damage to components and this is especially true for electric powered rc airplanes.

The first and foremost plan of attack is to follow the **engine/motor manufacturer's recommendations** for the engine or motor that you have. The manufacturer of the plane might also give a recommended prop size, but it's more common for the recommendation to come with the engine or motor.

Understanding RC plane propellers

You'd be forgiven for just seeing your airplane's prop as the thing at the front of the plane that spins round very fast, but understanding a bit about how propellers work is no bad thing.

Propellers for rc airplanes are nothing more than vertically mounted rotating wings. Their job is to convert the engine power into **thrust**, to pull/push the plane through the air. Thrust is generated in exactly the same way as lift is generated by the wing, and that's why props have a profile airfoil section.

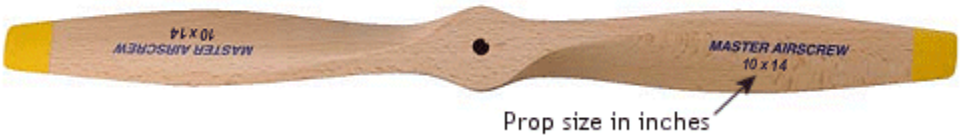


The 'twist' in the propeller is there to create the essential Angle of Attack of each blade, just like a wing has an AoA. The twist is greater towards the hub of the prop because of varying airspeeds along the length of the blades, and hence varying thrust generation.
This difference occurs because the tips of the prop blades move faster than inner portions of the blades, so the AoA has to change accordingly along the length of the blades.

The picture approximately illustrates how the Angle of Attack varies along the blade length.

Prop size labelling

All rc propellers are designated two measurements.



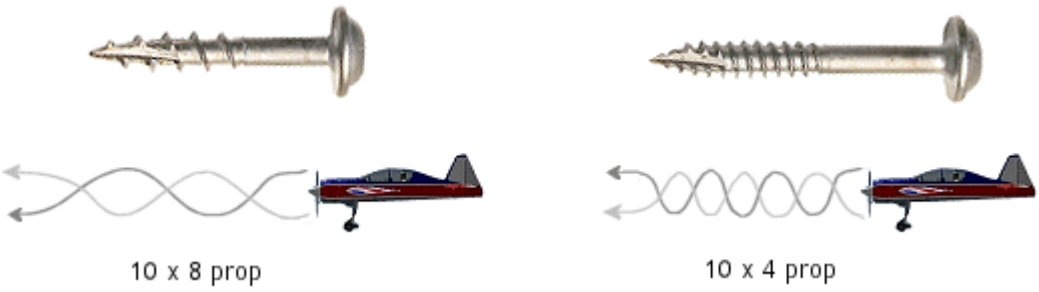
The first number is the **diameter** of the imaginary disc ('arc') created by the spinning prop *i.e.* the length of prop from tip to tip. The second number is the **pitch** and this is the harder of the two to understand - but we'll give it a go...

The pitch measurement of a prop indicates how far that propeller will move through the air per single revolution of the engine (*i.e.* every single complete turn of the prop). However, the pitch measurement of your prop must only be taken as a guideline because real-life factors come in to play to influence this distance *eg* the material of the prop, its condition, efficiency, air density on the day etc.etc...
So, pitch measurement is really only a *theoretical* value but it is good enough to help you choose the right size propeller for your airplane and your needs.

Essentially, the higher the pitch, the faster your plane will go. One way to understand it is to imagine the gauge of two different screw threads, coarse and fine, and picture both being screwed in to a piece of wood at the same speed. The screw with the coarse thread will cut in to the wood a lot faster than the fine threaded screw will.

It's the same for propellers 'cutting' through the air (hence the reason why propellers are sometimes called *airscrews*).

In the illustration below, the two arrow lines represent the path of each propeller tip. You can see that the higher pitch prop (*eg* 10x8) takes only one and a half turns to cover the same distance that the lower pitch prop (*eg* 10x4) takes 3 turns to accomplish. So, with both engines and props spinning at identical RPM, the higher pitch prop will travel further in the same amount of time - hence a faster flying plane.



So you can see that selecting a different propeller pitch size is going to significantly change your airplane's performance, with speed being the primary factor.

The **diameter** of the propeller (10" in the example above) will also effect how the airplane flies, but also how the engine runs and, again, following your engine manufacturer's recommendations is the place to start.

Roughly speaking, diameter influences the amount of thrust generated but an ever-increasing and non-performance related issue these days, linked to prop diameter, is that of **noise**.

A faster turning propeller (and props can easily turn in excess of 10,000 RPM) generates a lot of noise as the tips cut through the air. In fact, when you hear an rc airplane flying it's more than likely the propeller that you're hearing more than the engine.

So a larger diameter prop *reduces* the engine's RPM at any given power setting, because there is more for the engine to turn over and hence more work to do. And slower turning props generate less noise - therefore, larger diameter props run quieter than smaller diameter props, all else being equal.

Footnote about Electric Flight

The last paragraph does not hold true for an electric motor*. Electric motors are designed to rotate at a given speed. Increasing the prop size merely increases the workload of the motor…it only reduces the rotation speed when the motor is overloaded - and that will have damaging effects! Generally choose a lower Kv value motor for larger props.*

Some basic rules for electric motor propellers:

- *The rpm of an electric motor is the Kv [the rpm per volt] x the number of volts supplied. Motor manufacturers specify the Kv, range of cells usable and maximum current rating of the motor. They often quote suitable prop sizes.*
- *If you are using a battery at the lower voltage of the given range, choose the larger prop option. If you choose a battery at the higher end of the range, use the smaller prop suggested.*
- *If you want more speed from the same motor/battery combination, reduce the prop diameter by 1" and increase the pitch by 1".*
- *Use props designed for electric powered flight. IC props can fit, but they are heavy and introduce unnecessary load on the motor.*
- *Not all props behave the same - different makes & materials can have different results. Experiment.*
- *Use a wattmeter to ensure you are getting the best out of your motor, and not exceeding the maximum power rating of the motor.*

- *If your Tx has the facility, set up a motor off switch. If you use Spectrum this is straightforward, but always bind you Rx with the motor switched on to ensure the failsafe is set correctly.*

Andrew Gibbs has done extensive research and sells a number of valuable guides to electric flight. His website, gibbsguides.com, also includes a number of very useful articles.

Safety

- Install the prop with the curved side of the blade facing forward and tighten the prop nut or bolt with the proper size wrench.
- Recheck the tightness of the nut or bolt often, especially on wood props which tend to compress and loosen more often.
- When starting the engine, keep spectators at least 20 feet clear of the model and out of the path of the propeller.
- Keep hands away from the prop as much as possible. Use a chicken stick or and electric starter.
- Keep face and body out of prop arc as engine is started and run.
- Make all adjustments from behind the prop except on pusher prop installations.
- Never throw anything into the prop to stop the engine. Use a kill switch or pinch off the engine's fuel supply.
- Discard any prop with nicks, scratches, splits, cracks or any other sign of damage. Never attempt to repair, alter or bend a prop.
- Don't run an engine in areas of loose gravel or sand for the prop can throw such material into your face and eyes. It's not a bad idea to wear eye protection.
- Keep loose clothing, shirt sleeves, and other such items away from the prop and avoid carrying objects that can fall into the prop such as pens, screwdrivers, etc.
- Be sure to keep the glow driver wire out of the prop path.
- If a spinner is used, be certain that it's edges are not in contact with the propeller blades.