BY CARL BAER

Tips For Converting RC Gas Engines To Electric Motors

- How To Determine Motor Size
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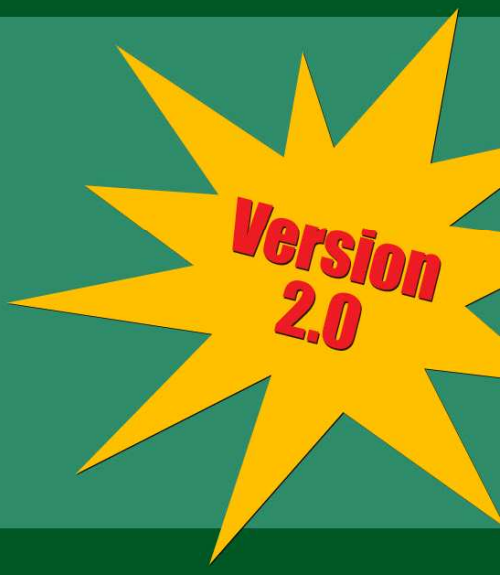

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Tips For Converting RC Gas Engines To Electric Motors.

By Carl Baer – Version 2.0 2008

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Introduction

Deciding to convert a gas engine from your already built radio control airplane used to be a lot more difficult, for the simple reason that technology had not yet caught up to the power to weight ratio of gas engines. That is not the case anymore. Now we have brushless motors (which means there aren't any internal parts that are touching one another, causing less friction and heat generation, which equaled more battery consumption). Another huge factor is battery technology. With Lithium Polymer batteries, it is possible to power giant scale aircraft with results that rival glow engines.

However, one of the biggest reasons to consider converting your glow engines to electric motors has nothing to do with technology or the aircraft themselves. It has to do with population growth. Simply put, many RC clubs are being threatened to close because of land development. This is leading these clubs to switch their rules and only allow electric motors to fly, so that they can conform to the newly enforced noise abatement laws that homeowners are demanding.

Regardless of the reasons, it is good to remind ourselves that this is a hobby where we are all interested in trying out new fangled technologies that can make flying our models even more fun, and converting our gas engines to electric motors is just as good a reason as any ☺.

Things To Consider Before Converting Your Glow Fuel Engine To An Electric Motor

What you should consider before converting your rc airplane gas engine to an electric motor system.

With the changes in rc electric motor technology it is possible to fly ANY size model using rc plane electric motors. The biggest leap in making this possible has been two fold. First we have model airplane electric engines that are powerful enough, not to mention much more efficient, that they rival or even surpass gas/slimers/smokers/nitro hogs, or whatever else you may call rc airplane gas engines.

In fact you can expect to see an increase in the performance of a model airplane in several areas. Your take-off is shorter, climb rate will increase and you can now fly in areas that have noise restrictions.

The debate between the benefits of rc plane electric and gas motors are as controversial as those between pc and Mac users. It will continue for as long as they are both in existence.

Some questions you might be asking before you convert your rc model airplane's gas engine to an rc electric motor...

How long will the battery allow me to fly? With today's Lithium Battery technology, you can easily expect 10, even 20 minute flights, even in bigger aircraft. The days of overheating the batteries and fire hazards are almost non-existent. There are many add on features that you can now purchase that all but eliminate battery hazards. Such as temperature monitors and voltage indicators.

Here are a few questions that will help determine what components to buy.

1. What is the radio control plane that you want to convert? Is it a trainer, sport plane, 3D etc.. This is important because you will need to determine the electric motor based on your models capabilities, and what you want it to do.

Example: Hangar 9 Arrow with a .40 size gas engine.

Would require an electric rc motor equivalent to an AXI 2826/12 External Rotor Brushless.

This motor would allow this model to perform basic aerobatics with its semi-symmetrical wing.

Specs of the Hangar 9 Arrow

You will need these numbers to help determine the motor, battery, and prop requirements.

Wingspan: 63 in

Overall Length: 52.5 in

Wing Area: 710 sq in

Flying Weight: 5.7 lb (as a radio controlled gas plane)

Engine Size: converting a standard .40 size rc gas engine to an rc electric motor.

Now you need to determine what type of batteries you will need. This is based mostly on your budget and time till land variable. In other words, how long do you want to fly for and still get performance.

The most obvious choice is going to be a Lithium Polymer battery, this is the most advanced battery technology available for rc model airplanes. They are also the most expensive. Other older battery technologies are available, such as, lithium ion and nickel metal hydride. They can do the job, but at a weight cost and flying time consideration. So choose carefully.

In the Arrow Example: We will use a 4200 mAh 11.1V Li-Poly Pack. This was determined based on the flight performance we were after, some aerobatics, but mainly stable easy going flying. Nothing too extreme. (We will go over some figures for how to determine the motor, based on the flight characteristics that we want).

As with any gas rc plane conversion to electric (or any electric radio controlled airplane for that matter), you will have to consider an ESC (electronic speed control). This hooks up to the motor, battery, and receiver. You will need to pick one that can handle the required number of battery packs, servos and have programmable features. This will make life easier for you if you pick one that is feature rich. Of all the components, this is one to spend a little more on. You will be glad you did.

For this example, we used a 40 Amp Brushless Controller with Program features. There are lots of manufacturers of ESC's so take the time to research them.

Prop Selection is an important consideration. You need to be aware that with an electric conversion there is a possibility that your model plane will not have enough clearance when using an electric motor prop. It may need modifications to the landing gear (making them longer) so that the prop has clearance.

For the Arrow example we used an APC 13x10 propeller. Most electric motors now have a table that you can find on their website that will recommend the propeller range to stay within.

One final consideration with rc gas planes converted to electric. You always need to factor in cooling of the battery pack and esc. In fact many modelers, including myself, put the ESC on the outside of the plane, usually I mount it under the engine on the firewall. You also need to make air vents to cool the battery inside the model. Without this, you run the risk of overheating batteries and ESC's.

How To Determine Motor Size For Your Model Airplane

First let's look at what today's electric motors are all about. In the past you had brushed motors, they overheated, were inefficient, and sapped battery power. Usually you would have to add a gearbox to compensate for the inefficiency of the brushed motor (and older battery technology). Lots of motors were melted in those days. That's not to say that you cannot melt an electric motor today, hook up enough batteries to any electric component, and you will be assured to have a melted motor ☺. Anyway, let's look at where motor technology is today.

Brushless motors are exactly what they sound like, no part is "brushing" any other part, less parts creating friction, means less heat, which means equals a more efficient motor. (There is no motor that will ever be 100% efficient, based on the laws of physics and thermodynamics, there is no way for any energy system to be 100% efficient). Today's brushless motors are silent, gearless, and have lots of torque (something to consider when you are taking off, too much torque is not a good thing during take-off, think crashing).

However, because electric motors can produce varying amounts of power (based on the battery configuration, they tend to be more difficult to choose for a particular airplane.

Think of it this way…A larger gas tank will not make your glow engines displacement increase (horsepower), BUT a larger battery will most certainly increase the power of an electric motor. Think about that ☺.

Another important factor to consider with electric motors, they use a larger propeller than their gas counterparts, remember this when allowing for ground clearance for your propeller.

Which leads into the most often asked question. How do I determine the motor size for my rc airplane?

It is based primarily on the individual just not having the basic equations and theory that make the process much smoother. It does not completely remove any error, but it does help to build your confidence when it comes time to do the research to find your proper engine for your particular aircraft. After all, it is not just an electric motor that is required, you have to figure in the ESC (speed control), propeller and proper battery pack that will give you the power requirement that you are after.

JUST A QUICK NOTE: In this day and age, manufacturers of electric motors have finally started to realize that people need an easy way to determine the components that they will need in order to get the most out of their model airplane. No one wants to be an electrical/mechanical engineer in order to determine these figures. Well, they have listened and are now providing motor combo packs, which include the motor and all the components that would be needed to fly a particular model.

On that note….Let's start at the beginning with looking at what power for electric motors is based on… Watts.

A watt is just a measurement of energy, in this case we can equate the power to something we are familiar with…horsepower.

1 Hp (horsepower) is equivalent to 746 watts.

This simple relation makes it clear for most glow engine flyers. Glow engines are based on horsepower (displacement), and this shows the relation with watts, which is the unit of measure used to determine power for an electric motor. See, doesn't that already clear up some preconceived confusion ☺ ?

Now let's look at the Watt even closer and see how it is used to determine power requirements when related to Amps and Volts.

1 Watt = Volts x Amps, and when we are talking about rc electric motors, we usually start at around 30 Watts as the bare minimum to get a basic park flyer into the air. This will change over time as motor and battery technology create even more efficient products.

Now, even though output wattage in relation to the propeller is the determining factor, it is much easier to determine what we will refer to as INPUT Watts (the energy produced when we multiply battery voltage by the applied current in amps, Don't worry about this though). Just remember Input Watts.

Remember this General Rule of Thumb:

Keep Your Input Wattage Between 50 and 100 Watts/Pound (weight of your airplane), and you will be covering most rc models that you will most likely be flying. We will explain more below.

Using this knowledge, we can determine the power requirements when we use these numbers for a particular model.

TIP: Determine the weight of your airplane, without the engine, gas tank, or any other gas engine components, before you start looking at motor needs.

Here are a few guidelines to follow based on the type of aircraft you might be flying. The numbers below will show how many watts are needed per weight of the aircraft in pounds. Remember this when determining your power requirements.

- **60 watts/pound. Usually a trainer or other slow flying plane. In other words low wing loading.**
- **100 watts/pound. Usually good for aerobatic capable planes, will also get more speed at this power level. Once you get above this number, you are looking at larger scale planes.**
- **120 watts/pound. Expert level, we are talking about fully aerobatic capable aircraft with high wing loading.**
- **150 watts/ pound. This kind of watt power is best suited for entry 3D models (super responsive, fast, aerobatic planes, straight up vertical on take-off). Also good for jets with electric ducted fans.**
- **Over 200 watts/ pound. You pretty much don't need wings anymore.**

These figures are based on today's brushless motors. The motors today (as mentioned above), do not "bleed" energy from the battery like older motor technology did. In the "old" days (5 years ago), you needed a gearbox for your electric motor to make up for the loss of efficiency from a brushed motor. That is

not the factor today, and this coupled with amazing battery improvements, makes electric motors a good value.

Taking this knowledge, you can now make an informed decision towards choosing the best fit solution for your models motor size requirements.

Here is a tip to remember when choosing your motor.

a. Motor manufacturers like to rate their motor by relating them to the number of battery cells that are needed, current load (usually continuous), and an on-demand full power load (full throttle).

Make sure that you know ahead of time what type of performance you would like to get out of your airplane. This will help you to avoid being overwhelmed when it comes time to make the purchase decision. It can also help in saving money by avoiding the bigger is better trap that we all fall for when we do not have the proper knowledge ahead of time. Take your time and pick out the components that fit your plane.

As one final note: some electric motor manufacturers are making it even easier to switch out glow engines for electric motors, they are doing this by creating model numbers for electric motors that match their glow engine counterparts. For example, a .40 size glow engine would now be replaced with a Model 40 electric motor, which is what glow converters have been requesting for some time now.

Tips For Improved Performance From Lithium Polymer Batteries

- Always Cycle your batteries when you first get them. Then cycle them at least three more times at a lower charge rate 1/3 less. This seasons the batteries and will give you the best battery life and usage.
- Try not to discharge your packs beyond 80% of their capacity. The reason is that it will keep your battery from heating up too much.
- Do not fly your plane past the point of reserve power, this will affect the performance of the battery in the future.
- Always equalize your batteries after flying for the day. Do not leave them half charged, this will affect their ability to accept a charge, hold a charge and battery life.
- Always, always, always use the proper charger for the type of battery you are using (Nickel Metal Hydride, Lithium Polymer). I don't mention Ni-Cd because they are pretty much obsolete, and they really should not be used anymore anyway.
- Charging your batteries at the slowest charge rate will always give you the best battery performance and utmost life of your batteries.
- Never leave any battery unattended while charging, especially Li-Po's they are the most dangerous to charge, but ironically the best battery technology on the market for electric engines.

What Equipment Will I Need For Flying Electric Motor Planes.

Honestly, the equipment to fly electric planes is not that much different from your glow engine equipment. Obviously you will not need a battery, fuel, or electric starter anymore. These reasons alone seem to be a driving force in more and more people putting their glow engines aside to make room for the convenience of electric motors, and with the advances in electric motor technology, no need to wire batteries in series or parallel for better battery management and the dangers of lithium batteries almost eliminated it is no wonder we are seeing somewhat of a revolution towards electric conversions.

Let's look at the equipment that you will need to get up and flying.

BATTERY: Batteries are like fuel for a glow engine, and usually come in the range of 500 to 2000 mAh cells, the higher the number, the more charge the battery can hold. The weight of the pack is proportional to its capacity.

Electronic Speed Control:

ESCs like the Jeti Advance PLUS line have simplified programming further with the use of a card that stays in your field box. New Lithium cells have eliminated the need to parallel cells and increased safety through being non-combustible at high charging voltages.

WATTMETER

Measures Voltage and current draw. It is good for measuring anywhere in the circuit what is going on with the power system. Where is comes in handy, is verifying how much current is being used in the system and how much the voltage drops as you increase the current.

Charger

Final Considerations With Glow To Electric Conversions.

The biggest factor with converting to electric motors is becoming less of a factor, but it is still worth mentioning here. Weight of your gas powered airplanes were designed with a bulkier airframe to withstand the vibration that was generated with a glow engine. Many large electric motors are comparable in weight to the glow engines they are replacing. For instance a AXI 4130 motor, which is equivalent to a .60 size 2 cycle engine, weighs about 14 ounces. While the glow engine weighs about 18 ounces. So in fact, the electric motor is a little less, but the weight of the batteries (depending on the performance desired) can weigh a little more than a full fuel tank of gas. As we noted, this is changing and soon the weight of batteries will not be a factor. Still, we need to take them into consideration when converting our heavier older models to electric engines.

The final factors to consider are…

Ground clearance and balancing your model. Because electric motor usually turn slower, they require larger propellers to increase the amount of area that is needed to provide the thrust (after all a propeller is essentially the same as the wing of your plane). This increase in size of propeller can mean that you need to change the landing gear to a larger size to accommodate the propeller size increase.

When it comes time to balance the plane with all the new components, you will find the most productive way to balance is by using the battery placement as a way to balance you plane. Moving the batteries around should be all that is necessary to balance your plane. If more ballast or weight removal is required, you can do things like drilling lightning holes in your fuselage or firewall. This will not compromise the integrity of your airframe because the electric motor will not “pound” the airframe the same way a glow engine does.

This covers the majority of issues that you will encounter when converting your model to an electric engine. However, this is still Tips to help you get started. As always I recommend seeking the advice of your rc clubs members for specific help in areas that you are unclear of.

Or, you can contact me and I will be glad to answer your questions about glow to electric conversions.

Good luck and happy flying,

Carl Baer

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