Kamloops Model Airplane Society

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Propulsion (power) Types

Power type

It's probably fair to say that a larger proportion of RC airplanes were internal combustion powered (IC - glow plug, petrol etc.) in the early days of RC manufactured kits, but nowadays electric power (EP) has become equally as popular, if not more so.

It may be possible to say, RC planes originally intended for IC power are being converted to electric power (EP) as electric power-train components become more powerful, readily available and cheaper to buy than ever before. With the price of fuel for IC, electric is become a lower priced alternative. Some plane manufacturers are actually including component options for both power types.

Electric Power for RC Airplanes

In the very early days of EP (pre-mass production), electric RC airplanes were under-powered. Brushed motors and gearboxes were the order of the day, along with heavy nickel-cadmium batteries. It all made for a pretty poor power-train setup, resulting in poor flight performance.

Over the last several years electric power for RC airplanes has made enormous gains on the traditional world of the nitro RC airplane. The reason for this is twofold. Firstly, advances in both electric motor and battery technology have made electric airplanes performance and practicality extremely attractive to serious RC airplane enthusiasts, where cost is an issue Electric Power for RC Airplanes makes very good sense as you don't have to keep buying nitro fuel. Secondly the environmental issues that go with traditional nitro RC airplanes i.e. Noise and pollution, are no longer an issue. Also a lot of the Jet Air Inducted Fan (EP) planes sound good and are easier to get in the air, over the larger and costlier IC Jets.

There will always be a place for the internal combustion engine within aero-modelling,

especially with large scale RC airplanes, however these advances in motor and battery performance are reducing the issue.

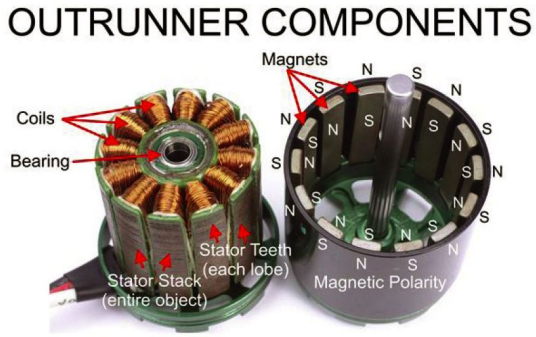
Electric Power for RC Airplanes-No longer Toys

Just a few years ago electric power for RC Airplanes was reserved for only the cheapest RC Models, indeed the phrase “remote controlled airplane” would have been synonymous with electric power. The main reason for this increased practicality and performance is the Brush-less RC motors and Lithium Polymer batteries also known as Li-Po batteries. Electric motors also work really well with ducted fan RC airplanes, these can be an alternative to real RC Jet Engines, so jet appearance models are now available almost ready to fly without the cost of true jet technology.

Brushed & Brush-less Technology

Brush-less motor technology is a relatively newer technology for RC hobbies, but it has gained a lot of traction due to costs becoming more affordable, and the inherent advantages of brush-less motors.

A Brush-less motor does not have the brushes or the commutator that you find in a standard electric motor. The locations of the magnets and the winding's are also reversed. The permanent magnet is placed on the rotor part and the copper winding's are on the stationary part around the rotating rotor. A computerized Electronic Speed Control (ESC) is used to control the electrical fields generated by the winding's which causes the rotor to turn, and also controls how much power is drawn from the battery based on how much torque and speed is needed at any point in time.



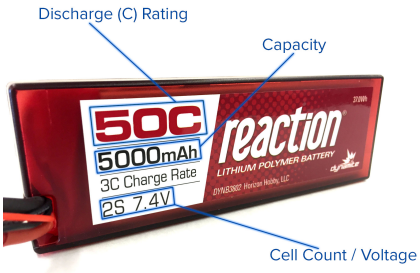
RC Electrical Motor

Voltage

A battery is composed of cells, which are connected in series and/or parallel to make up the battery. The voltage of any battery is determined by the chemical composition of the material within the battery’s cells. Nickel cadmium (Ni-Cd) batteries have a reference, or nominal, voltage of 1.2 volts per cell. Lead-acid batteries have a nominal voltage of 2.0 volts per cell. A typical Li-Po cell has a nominal voltage of 3.7 volts per cell.

A battery's total voltage is given as a multiple of the cell voltage, so six lead-acid cells make up the 12-volt battery we carry in our cars. A three-cell series-connected (3S) Li-Po is labeled "11.1 volts," and a six-cell (6S) battery's label is "22.2 volts." At a state of full charge, a Li-Po battery's voltage will be near 4.2 volts per cell, and the cut off, or minimum allowable, voltage is 3.0 volts per cell.

When purchasing a Li-Po battery for your RC plane, pay particular attention to the number of cells the plane manufacturer recommends. Some allow either a three-cell (3S) or four-cell (4S) battery, but others may specify just a four-cell (4S) and if you plug in a six-cell (6S) battery, you more than likely will experience damage to the electrical components such as the ESC, due to the over voltage.



Li-Po RC Battery

Connectors

Li-Po batteries from your hobby shop for RC planes, will come with a standard JST-XH Balance Connector for connecting to the balance board on your charger. But, the power connector can be a Deans, EC3, EC5, etc. or not come with a connector at all, depending on what you are buying. Check the connector on the ESC on your plane and use the same type on your battery. Most quality chargers come with a variety of interchangeable cables for different types of battery connectors.

Another popular connector – Anderson Power Pole

Charging and C Ratings

Compared to the NiMH and NiCd, the lithium polymer (Li-Po) battery packs have totally altered our definitions for power and flight duration. Where the older types of batteries offered 1.2 volts per cell, (1V under load), Li-Po cells offer a nominal voltage of 3.7 volts per cell, and they provide much larger capacities (C ratings) along with an impressive weight saving. More voltage, more capacity, and lighter wing loading have really improved our airplanes' flight performance.

Unlike other types of batteries, Li-Po batteries can be stored for one to two months without significantly losing charge. Li-Po batteries should not be trickle-charged, and the typical maximum and minimum voltage for Li-Po cells should be 4.23 and 3 volts per cell, respectively.

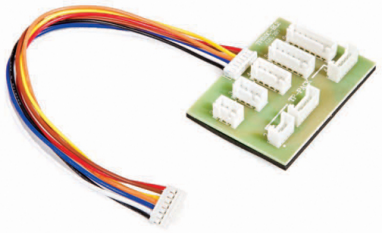
Great care is required when using Li-Po battery packs. Overcharging a Li-Po battery can cause the pack to burst and vent violently and can cause the pack to catch fire. As for over discharging, most speed controls allow you to set a low-voltage cut off or use the default, which varies by manufacturer. Three volts is the absolute minimum anyone should use as allowing Li-Po cells to go below this voltage will damage them.

As with any high-energy electrical equipment and battery packs, you should always carefully follow the manufacturer's instructions for proper use. Li-Po batteries can ignite and cause fires, so care should be taken to where and how you store them. I purchased a fire proof type portable document box, which I keep all my Li-Po batteries in. Thus, it is safe to leave in my car or house. Prior to that I stored them outside, but in the winter cold weather can cause problems with Li-Po batteries.

Li-Po batteries must be properly charged with appropriate chargers to extend their life span and optimize their capabilities. Many manufacturers now produce batteries that can be charged at very high rates and discharged at extreme rates. It's common to see charge rates listed as 5C or higher and discharge rates at 45C continuous and even 90C bursts. For the absolute best service from your packs and to increase their longevity, it's still best to charge at the 1C rate (example: 3.3A for a 3300mAh battery). Discharges are best kept within the continuous discharge rating and bursts only used for emergencies. Proper chargers should provide constant cell monitoring and balance charge capabilities.

Balancing Boards

Never charge a Li-Po pack without the balancing board plugged in. There is no reason to charge without balancing a pack. This keeps all the cells even, allowing them to work together with less stress on each. A balanced battery will always outlast a battery that has never been balanced. Almost every new quality charger has balancing ports for keeping the packs balanced. Also look for a charger that will charge at least two (2) batteries at the same time.



Balanced Board Adapter for Charger

You can also use your charger to check the balance on each cell and just as important, the resistance on each cell. For resistance results, a typical 1300mAh to 1500mAh pack (regardless how many cells), resistance results of under 10 to be great condition, 10 to 15m to be fine, 15 to 20 to be old, and over 20 to be "time to retire".

Pros and Cons of Electric Motor powered RC Planes

Pros:

- Are quiet and therefore should not disturb your neighbours
- Are easier to operate and maintain (better choice if you are mechanically challenged)
- Can be used indoors
- Brush-less products can provide similar or higher speeds than offered by Nitro gas powered products.

Cons:

- Run time or play time is limited to the capacity of the batteries you have. Once all your batteries are depleted your play time is over, unless you have a fast charger. You normally want several batteries to increase your play time.
- If you are not going to use your batteries for a long period of time, you should use your charger to put them in Storage Mode.

Nitro RC Airplanes

In this we are going to look at nitro power and to a degree the larger petrol engines. 2 and 4 Cycle Nitro RC Airplanes.

Most traditional engines used in RC airplanes are 2 stroke glow engines, this means that they operate on the 2 cycle principle, just like a chainsaw engine. However, rather than having a spark plug to ignite the fuel/air mixture, a small glow plug, which is preheated by a battery at start up, continuously glows and burns the fuel. These engines are simple, light and inexpensive so this is why Nitro RC Airplanes are so popular. They are fueled by Nitro-methane/methanol which is mixed with 20% oil for lubrication. Most engines for Nitro RC Airplanes are categorized by their size in cubic inches e.g. 40 size= .40cu in.

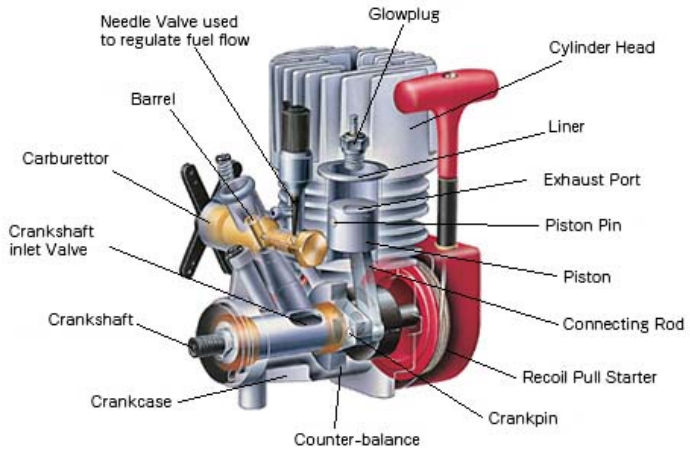
Typical Glow Plug Battery Starter

4 Cycle engines are a bit more expensive and complicated, so are more often used in the larger and more expensive airplanes, where their better low-down power suits this type of airplane. 4 cycle engines are more suited to the more experienced modeller, as they are more complicated to use and maintain, but provide more power.

Glow Plug IC Engines

The typical model airplane engines used for decades, are glow engines using methanol-based fuel and are the gold standard for all sizes of model airplanes. From small .049ci to over 2ci (and larger) displacements, glow engines get the job done. In simple terms, 2-stroke glow engines are popular because they have relatively few moving parts, do not require a separate ignition system, and are easy to start and maintain. When properly broken in and tuned, they produce amazing power. The proper care and feeding starts with the break-in, and this will take several tanks of fuel, depending on the type and brand of engine.

The type of engine you have is usually identified with three letters (ABC, for example), which refers to the kinds of materials that the engine's piston and sleeve assembly are made of. "ABC" means an aluminum piston (A) fitted into a brass sleeve (B) that has been chrome-plated (C). Another popular type of glow engine is an "AAC," which refers to an aluminum engine (A) fitted into an aluminum sleeve (A) that has been chrome-plated (C). Some engines use simple aluminum pistons, while others can be equipped with a steel piston ring, so it is always best to follow the engine manufacturer's recommendations for break-in.



Break-in

Glow engines come in various sizes and setups. The Evolution .60 2-stroke comes with a separate high-end needle valve behind the engine. It is connected to the carburetor with a short length of glow-fuel-compatible fuel line.

Engine break-in is the process of slowly conditioning the internal parts of the engine so that they fit more precisely together. Even though some manufacturers suggest that you can break in your engine while flying your model with a rich fuel mixture, it's a lot safer and you will have more control over the first few initial engine runs—if you run it on the ground with the airplane secured by the tail. Keep your glow engine fed with clean, filtered fuel. Install a fuel filter between the engine and the fuel tank, and use another filter in your fuel-supply container.

At the end of the day, empty your fuel tank and run out the last bit of fuel in the tank by running the engine. Never leave old fuel in the tank for long periods of time. Also, use some after-run oil after the last flight of the day. Adding a few drops down the carburetor and into the glow plug hole will lube the piston and sleeve assembly and prevent corrosion. And if your engine has been running properly and suddenly quits or it won't readily start up, replace the glow plug.

Once your airplane is built and your engine installed, be sure to use a quality fuel and use the same nitro percentage during break-in that you intend to fly with. Regardless of the size or brand of glow engine that you install in your airplane, it is very important to break in the engine before you use it to power your model.

For break-in, use fuel with the same nitro percentage as you plan to fly with. Why? Generally, the more nitro-methane a fuel contains, the higher the cylinder-head temperature will be. Higher cylinder-head temperatures mean greater expansion for the upper cylinder and, to some degree, the piston. If you break in an engine with 5% nitro fuel, it will actually be too loose when 15% nitro is used because the cylinder expands faster than the piston as temperatures increase.

Carburetors

When breaking in an engine, it is important not to run an ABC engine excessively (slobbering) rich. This is because the engine will run far cooler then designed to at normal operation. The engine's internal clearances are tighter when cold. Running the engine below designed operating temperature will promote premature wear. It is best to use a tachometer to read the engine's speed while leaning out the high-end mixture. When you get to a point where further leaning creates no further increase in rpm, stop leaning the needle. Now, turn the needle clockwise to richen the mixture to produce a 200 to 300rpm drop.

If you don't have a tachometer, you can also perform the 'pinch test.' At full power, start leaning out the fuel mixture and then pinch the fuel line. The engine should momentarily speed up. Keep doing this until the engine stops speeding up when you pinch the fuel line. Now richen the needle setting a few clicks richer, and you are good to go. As a last resort, you can raise the nose of the airplane vertical and see if there is any difference in engine rpm. If the engine rpm lowers ('sags') with the nose up, the engine is too lean. Richen the needle a few clicks, and repeat.

Propellers

To minimize vibration, never try to repair or glue a damaged propeller. Vibration increases wear and tear on the engine's bearings as well as the rest of your airplane's parts and radio equipment. Also be sure to select the correct propeller from the recommended range specified by the engine manufacturer. Running a prop that is too big can lead to overheating, while a propeller that's too small can allow the engine to over-rev, further affecting overall performance. Again, follow the instructions, and experiment with size and pitch values to fine-tune your airplane and engine combined performance. For safety while starting your engine, use an electric starter or a chicken stick.

Keep in mind that you are still going to need a battery in an IC plane to power the receiver which in turn, controls servos.

Nitro RC Airplanes verses Petrol and Diesel Engines

The much larger petrol engines are for use with the Large and Giant Scale RC airplanes that have become popular lately. These large engines are normally between 32cc to over 100cc so are clearly serious bits of equipment, with price tags to match. When used with the very large-scale RC airplanes they make for a truly stirring sight. Diesel engines used to be quite popular and work by igniting their fuel using very high compression ratios, these engine were available in a large range of sizes and although were less powerful than similar sized nitro engines they did produce good low-down power, they have however become hard to obtain. So, Nitro RC Airplanes have become the most popular aircraft for more experienced modelers.

Pros and Cons of Nitro Gas powered RC Products

Pros:

- Some RC Hobbyists really like the increased realism of the smoke and noise of a nitro gas or gas powered engine
- A key advantage is that you can run as long as you want, by just adding fuel to the fuel tank
- It provides opportunity to learn some mechanical skills such as engine tuning
- Are more water resistant than many electric powered planes

Cons:

- Nitro gas or gas powered engine noise may disturb your neighbours (they are not that loud, but some neighbours can be fussy)
- Gas powered engines take a bit more work to break-in, tune and maintain. There is an initial learning curve, but they are not difficult to operate
- As you have to purchase fuel, they have a higher operational costs long term
- Cannot be used indoors due to the fumes they generate

- Nitro gas fuel may be difficult to obtain if you are located far from a local RC hobby shop (1/5 scale vehicles often have 2 cycle engines which can use a standard gas-oil mix)
- At the end of the day, you need to empty your fuel tank and run out the last bit of fuel in the tank by running the engine.