Static versus Dynamic Power Consumption In Winged RC Aircraft

Background:

At a meeting I asked if anyone knew the difference in power consumed while holding an airplane back versus letting it ascend. No one could answer and so I completed experiments that I will present here. It would seem holding the airplane stationary would require more power than on ascent.

Experiment Setup:

I used my Yellow Jacket with an RCTimer 2208-12 1800kv motor and a 7.5x4 prop. The battery is a 3S 950mAHr and the throttle was set to control the power to 155 watts maximum delivered from the battery in all tests. I let the CAM run the motor for 20 seconds. The one battery used was initially at full balanced charge before each test. After the 20S run the battery was recharged and the charge taken to refill noted.

Test Results:

I performed two ascents to somewhat below the 80M cutoff and the motor ran 20S each time. The resulting charge consumed was 0.079 and 0.081 A-Hr.

I performed two static (stationary) tests and the motor ran 20S each time. The resulting charge consumed was 0.077 and 0.081 A-Hr.

The battery voltage started at 11.4 and ended at 10.6 while the motor was running. Initial current was 14A. Power was 155 to 144 watts.

Interpretation:

The results can be considered identical. While one might expect lower consumed energy for ascending the tests do not confirm that. I propose that the reason is that with the 1800kv motor and small prop that the air speed exciting the blades is very high, higher than if a more robust prop with a lower kv motor would have, set to the same thrust. Since it is a high speed on one side a difference of 25MPH (a guess) going in on ascent versus 0 on the ground makes little difference to the thrust and thus the energy consumed. Please anyone with a better theory or facts let us know. One might say charge is not the same as power. True, so battery voltage would be a multiplier with consideration of time as well to get power. I argue that since all discharges used nearly the same charge, that the starting voltage was identical and that the time was always 20S, the voltage discharge profile would be nearly identical for all cases and therefore the same conclusion would be had.

Equivalence of Energy Measurement Methods:

Here I'll show that measuring energy consumed directly with a watt meter and indirectly via battery charge are nearly equivalent.

The 80mAHr of consumed charge should correlate to an average of 150W power consumption for 20S.

Energy delivered from the battery according to measured input power to motor:

P=150W=150J/S

where P=power in watts(J/S), V=volts(J/C), A=amps(C/S), C=coulombs of charge (AxS), S=seconds and J=joules of energy (PxS or VxC).

J=PxS=150x20=3000J

Energy used according to battery recharge:

Convert to A-S then to C: 0.08A-Hrx(3600S/Hr)=288A-S=288(C/S)xS=288C

Convert to J: Energy=PxS=VxAxS=Vx(C/S)xS=VxC)=11*288=3170J

11 is the average battery voltage on discharge.

The battery charger indicates charge delivered to the battery, some of which is converted to heat due to internal battery resistance. On discharge the same and so the energy delivered to the motor is somewhat less than what the above equation indicates.

If you got this far I thank you for your time.

Dave Laude