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OPTIPOWER™ – FACTS, MYTHS and RATINGS

This brief discussion is intended to clear up a few terms and concepts around electricity as it applies to electric airplanes and helicopters.

Think of electricity like water. Volts = pressure Amp's = flow

Volts is like pounds per square inch, psi. Says nothing about how much water is flowing, just how hard it is being pushed. You can have 100 psi with zero water flow.

Amp's is flow, like gallons per hour. You can have flow at low pressure and you can have flow at high pressure. Amp hours is how much flow can be sustained for how long. It is used as a way of measuring how much electricity is in the battery. Like how many gallons of gas in your tank. It is a capacity number. Says nothing about flow or pressure, it is about capacity.

Amps and mili-amps? We are just moving the decimal point around.

1 amp (short for ampere) = 1000 miliamps (mili means 1/1000 amps)

Examples

So a 7 cell NIMH or NICD pack provides 8.4V (pressure).

The motor will draw electricity from the pack at a certain flow rate, or amps.

If you have a have a 650 mili amp hour pack, it can deliver a flow of .650 amps' (650 miliamps) for one hour. If you draw it out faster, it doesn't last as long. So your motor might pull 6.5 amps for 1/10 of an hour, or about 6 minutes. An 1100 mAh pack has double the capacity of the 650 mAh pack, so it should last "about" twice as long.

What is C in relation to batteries?

C ratings are simply a way of talking about charge and discharge rates for batteries.

1C, = 1 time the rated mAh capacity of the battery. So if you charge your 650 mAh pack at 1C, you charge it a 650 miliamps, or .650 amps.

1C on an 1100 pack would be 1.1 amps.

2 C on your 1100 pack would be 2.2 amps

Motor batteries are often rated in Discharge C and charge C. So an 1100 mAh pack

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(1.1 amp hour) might be rated for 10C discharge, so you can pull 11 amps (flow) without damaging the battery. Then it might be rated at 2C charge rate (flow), so you charge it at 2.2
amps (2200 mAh)

How did I do? Things clearing up?

If you have a 500 mAh pack - any kind - and it is rated at 16C that means it can deliver 8 amps.

If you have a 1000 mAh pack - any kind - and it is rated at 8C that means it can deliver 8 amps.

If you have a 1000 mAh pack - any kind - and it is rated at 12C that means it can deliver 12 amps

If you have a 1500 mAh pack - any kind - and it is rate at 8C that means it can deliver 12 amps

If you have a 1500 mAh pack - any kind - and it is rated at 20 C that means it can deliver 30 amps.

If you have a 3000 mAh pack - any kind - and it is rated at 10 C that means it can deliver 30 amps.

So, if you need 12 amps you can use a pack with a higher C rating or a pack with a higher mAh rating to get to needed amp delivery level.

One last point. Motor batteries vs. receiver batteries

Some batteries can sustain high discharge rates. Others cannot. Those used as transmitter/receiver packs typically are made for low flow/amp rates while those made for motor packs can sustain higher rates.

Having a 600 mAh pack does not tell you if it is a motor pack that can put out 6 amps, or if it is a transmitter/receiver pack that would be damaged if you tried to pull power at 6 amps. It is enough to say that they are different.

Clearly a motor pack could be used for a transmitter/receiver job, but a transmitter/receiver pack should not generally be used as a motor pack.

It is best to size your battery packs so they run somewhat below their maximum C rating. You will stress them less and they will last longer. For example, if your motor needs a pack that can deliver 10 amps, getting a 1000 mAh pack that is rated for 10C (10 amps) will meet the spec, but it is running at its limit. A 15 C rated 1000 mAh pack would be better, or perhaps a 1300 mAh 10 C pack. In either

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of these cases, the pack will be less stressed and should handle the load much better over the long term.

Other considerations:

How does the manufacture derive the C rating?

The C ratings on cells can be very misleading as some manufactures put C Ratings on cells that are clearly inaccurate when used as a *'PACK'.* The C ratings are derived from a single cell connected to test equipment by single very large copper connections to reduce the connection resistance. The cell is also in a forced airflow device so cool air is passed over it whilst the test discharge is executed. This derived a C rating for the cell, the really important issue here is THE CELL. Plainly the majority of real life applications are a set of cells connected together with very small connections internally to make a PACK. The majority of flight packs are 3,4,5 and 6 cell virtually none are single cell except modern micro models where C ratings are of less relevance.

What is burst C Ratings and is it relevant?

A burst C rating is the rating derived from a single cell mounted as mentioned above and discharged for a very short period of time usually less than 10 seconds and typically somewhere between 3 and 8 seconds. There is not approved way of doing this so no convention as such. The lithium cell is capable of very short very high discharge bursts if sustained the wires would fuse and/or the cell explode. An example of one manufacture on a 2150 3S LIPO rated at 35C does a 3 to 5 second burst test and can achieve 312C? Not really a meaningful number and of course it's one cell out of the 2150 3S not the pack.

Is a high C better?

The C rating on a PACK needs to be realistic and is often not and is misleading. Very often the pack limiting factor is in fact the silicon wires rating not the pack rating. As with burst C ratings, AWG gauge wire ratings are measured at the current required to fuse the wires over a 10 second period but are normally reported at 8 Seconds. Therefore the following would be true:

12AWG silicon wires on LIPO packs would fuse at 235A on a 10 second burst.

A 6S 5000 pack with a rating of 80C burst or 400A, would clearly have an issue here as the wire would fuse at this level. The theoretical maximum burst for 12 AWG on a 5A pack would be 50C (rounded slightly the actual figure is 47C) but this is for 10 seconds, this being the case and most manufactures report at 8 seconds you could safely put 60C Burst on the pack (based on 8 seconds).

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The next wire size down often used on LIPO's 14AWG wire, which is rated to 166A. So a 2650 pack rated at burst 80C or 212A would have an issue here, 60C would be a safer number (159A) for a manufacture to use.

The next size down is 20AWG and this is used on many 850mAh packs and RX packs of various sizes. 20AWG has a max rating of 58.5A, a typical 850 pack is rated at 80C or 68A, a manufacture can probably safely state 70C here. ***See FIG 1 for other AWG sizes.***

The RX/TX packs have stupid ratings for burst, for the larger pack sizes as they all only have 20AWG including the 2S 5000 and burst is entirely unimportant for an RX/TX pack.

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Reference data:

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Ashley Davis

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FIG 1

AWG	Diameter		Turns of wire		Area		Copper resistance[6]		NEC copper wire ampacity with 60/75/90 °C insulation (A)[7]	Approximate stranded metric equivalents	Fusing Current (copper)[8][9]		
	(inch)	(mm)	(per in)	(per cm)	(kcmil)	(mm^2)	(Ω/km) (mΩ/m)	(Ω/kFT) (mΩ/ft)			Preece (~10s)	Onderdonk (1s)	Onderdonk (32ms)
0000 (4/0)	0.4600	11.684	2.17	0.856	212	107	0.1608	0.04901	195 / 230 / 260			31 kA	173 kA
000 (3/0)	0.4096	10.404	2.44	0.961	168	85.0	0.2028	0.06180	165 / 200 / 225			24.5 kA	137 kA
00 (2/0)	0.3648	9.266	2.74	1.08	133	67.4	0.2557	0.07793	145 / 175 / 195			19.5 kA	109 kA
0 (1/0)	0.3249	8.252	3.08	1.21	106	53.5	0.3224	0.09827	125 / 150 / 170		**1.9 kA**	15.5 kA	87 kA
1	0.2893	7.348	3.46	1.36	83.7	42.4	0.4066	0.1239	110 / 130 /		**1.6 kA**	12 kA	68 kA

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									150				
2	0.2576	6.544	3.88	1.53	66.4	33.6	0.5127	0.1563	95 / 115 / 130		**1.3 kA**	9.7 kA	54 kA
3	0.2294	5.827	4.36	1.72	52.6	26.7	0.6465	0.1970	85 / 100 / 110	196/0.4	**1.1 kA**	7.7 kA	43 kA
4	0.2043	5.189	4.89	1.93	41.7	21.2	0.8152	0.2485	70 / 85 / 95		**946 A**	6.1 kA	34 kA
5	0.1819	4.621	5.50	2.16	33.1	16.8	1.028	0.3133		126/0.4	**795 A**	4.8 kA	27 kA
6	0.1620	4.115	6.17	2.43	26.3	13.3	1.296	0.3951	55 / 65 / 75		**668 A**	3.8 kA	21 kA
7	0.1443	3.665	6.93	2.73	20.8	10.5	1.634	0.4982		80/0.4	**561 A**	3 kA	17 kA
8	0.1285	3.264	7.78	3.06	16.5	8.37	2.061	0.6282	40 / 50 / 55		**472 A**	2.4 kA	13.5 kA
9	0.1144	2.906	8.74	3.44	13.1	6.63	2.599	0.7921		84/0.3	**396 A**	1.9 kA	10.7 kA

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10	0.1019	2.588	9.81	3.86	10.4	5.26	3.277	0.9989	30 / 35 / 40		**333 A**	1.5 kA	8.5 kA
11	0.0907	2.305	11.0	4.34	8.23	4.17	4.132	1.260		56/0.3	**280 A**	1.2 kA	6.7 kA
12	0.0808	2.053	12.4	4.87	6.53	3.31	5.211	1.588	25 / 25 / 30		**235A**	955 A	5.3 kA
13	0.0720	1.828	13.9	5.47	5.18	2.62	6.571	2.003		50/0.25	**198 A**	758 A	4.2 kA
14	0.0641	1.628	15.6	6.14	4.11	2.08	8.286	2.525	20 / 20 / 25		**166 A**	601 A	3.3 kA
15	0.0571	1.450	17.5	6.90	3.26	1.65	10.45	3.184		30/0.25	**140 A**	477 A	2.7 kA
16	0.0508	1.291	19.7	7.75	2.58	1.31	13.17	4.016	— / — / 18		**117 A**	377 A	2.1 kA
17	0.0453	1.150	22.1	8.70	2.05	1.04	16.61	5.064		32/0.2	**99 A**	300 A	1.7 kA
18	0.0403	1.024	24.8	9.77	1.62	0.823	20.95	6.385	— / — / 14	24/0.2	**83 A**	23 7A	1.3 kA

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19	0.0359	0.912	27.9	11.0	1.29	0.653	26.42	8.051			**70 A**	189 A	1 kA
20	0.0320	0.812	31.3	12.3	1.02	0.518	33.31	10.15		16/0.2	**58.5 A**	149 A	834 A
21	0.0285	0.723	35.1	13.8	0.810	0.410	42.00	12.80		13/0.2	**49 A**	119 A	662 A
22	0.0253	0.644	39.5	15.5	0.642	0.326	52.96	16.14		7/0.25	**41 A**	94 A	525 A
23	0.0226	0.573	44.3	17.4	0.509	0.258	66.79	20.36			**35 A**	74 A	416 A
24	0.0201	0.511	49.7	19.6	0.404	0.205	84.22	25.67		1/0.5, 7/0.2, 30/0.1	**29 A**	59 A	330 A
25	0.0179	0.455	55.9	22.0	0.320	0.162	106.2	32.37			**24 A**	47 A	262 A
26	0.0159	0.405	62.7	24.7	0.254	0.129	133.9	40.81		7/0.15	**20 A**	37 A	208 A

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