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No Juice

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Some owners sure do have cavalier attitudes toward aircraft batteries. I visited a small FBO a few weeks ago and witnessed two hand-propped departures in a row of rental aircraft. When I asked the operator about battery maintenance, he opined,"airplanes in the shop don't make money . . . airplanes in the air do."

I offered to show him a cheap product that promised to reduce battery maintenance and increase performance but he said he was "happy" with the $60 batteries he bought from a local distributor. As I prepared my own rental for flight, I wondered if those two other renters were equally "happy" with his choices. If any of them visited a nearby airport for a pit stop, they'd be inviting catastrophe. What level of experience and skills would be available to prop an engine for the return flight? Maybe plenty, maybe none at all.

Pilot shops are full of gadgets for airplanes and it's not unusual to hear a pilot extol the virtues of some new flight bag gee-ga. But no one gushes much about batteries, for obvious reasons. Batteries are like tires; you gotta have one and the fact of the matter is, no single brand (not necessarily type) seems to perform better than another and we've simply adjusted ourselves to regular replacement. Neither battery nor tire is cheap, but we're accustomed to paying "dues" to an exclusive club for aircraft ownership.

Batteries live a hard life, stuck out there in the tailcone or buried out of sight in a box in the engine compartment. Preflight check lists don't suggest inspection of battery liquid levels so most owners just run the things until they roll over some cold, winter morning. Virtually every annual inspection I've observed included pulling the battery out to clean and check battery box paint to forestall corrosion. However, I've never seen a mechanic capacity test a battery; very few shops (including A&P schools) have the tools to load test a battery.

The prevailing attitude assumes that if the battery starts the engine, it's okay for flight. Yet, unlike other components in your airplane, you can pretty well forecast your battery's impending doom with a couple of simple tests, one of which involves installing an instrument that costs less than $50.

You may think of the battery simply as a device for helping you avoid hand propping but in fact it performs three functions in an airplane. Obviously, it cranks the engine but it also provides electrical inertia, a sort of energy fly-wheel for stabilizing the alternator (most alternators do not run well with a battery off-line). This same inertial effect provides some filtering of electrical noise and surge protection. The third requirement is to supply standby power in flight in case of an alternator failure.

A starter will draw several hundred amps during cranking so starting the engine is indeed a regular load test of a battery. In airplanes and cars, cranking ability is a useful rule-of-thumb for triggering battery replacement. Stabilizing and filtering qualities are intertwined with cranking ability. If your battery is in good shape, it has a very low internal impedance; it will (1) deliver energy fast enough to crank an engine and (2) resist variations in bus voltage due to changing loads and regulator perturbations.

Requirements for standby power are more subtle and hard to predict. Successful performance as a sole source of power is dependent upon a battery's capacity, which is only slightly dependent upon cranking abilities. For example, if your engine is well tuned and starts easily, a very tired battery may get it going even when battery capacity has fallen to a fraction of new. Then, when your alternator fails some dark and stormy night, that sweetly tuned engine will keep on running but the battery may go away real fast.

Accurate testing of battery condition isn't difficult. Indeed, you can build the necessary tools right into your airplane. All it takes is to add an accurate voltmeter to your panel, which should be a relatively simple task. The data displayed is over and above that which was needed for certification and it's not a flight instrument so field approval shouldn't be difficult to obtain. The very best voltmeter for diagnostics is the expanded scale. analog meter. These will have a lower reading on the order of 7 to 8 volts and an upper end of 15 to 16 volts with 8 to 16 being optimum. Westberg makes an 6 to 16-volt, 2-1/4-inch instrument (Part #2A5) with a street price in the $38 range. Their P/N 2A5-2 is a 0-30-volt instrument but then everybody makes meters that go down to zero. (See address box for sources.)

The voltmeter can be mounted in a very out-of-the-way place on the panel, especially if it's an extra meter. It should get its power from as close to the battery as possible. An in-line fuse right at the battery contactor is best; go right to the bus if running the wire is too much hassle.

A number of products such as digital engine monitors and displays, clocks, OAT indicators and so on include some form of bus voltage display. Unfortunately, most are digital displays and while quite accurate, the are difficult to use during dynamic load analysis. If you have room for the meter or want a quick test, will a regular old voltmeter work? Certainly it will, but the larger the scale the better. If your meter runs 0 to 30 volts or 0 to 50, you won't have the resolution to see the voltage drop. For convenience, you can tap the voltage right off a cigarette lighter accessory plug, assuming your lighter socket is wired and works.

Load testing may be accomplished while cranking your engine: observe the battery voltage. In warm weather, the needle shouldn't drop below 8.5 to 9 volts during cranking. Double these values for 28-volt systems. In cold weather, 8 to 8.5 volts is the benchmark.

Even if the engine started as usual, voltages below these target values should be reason enough to do a capacity test. While airborne and after a half hour or so of flight, battery voltage should be in the range of 13.8 to 14.2 volts.

A capacity test is best accomplished using flight loads considered to be minimum essential equipment needed for comfortable completion of the flight. Here's my personal list in order of priority. You should develop your own: (1) minimum-current panel lights (such as the single bulb, overhead flood on a C-150), (2) turn coordinator (needle-ball-and-airspeed works when all else fails), (3) primary nav radio, (4) voltmeter (your battery's "gas" gauge) and maybe (5) transponder and (6) comm radio. Everything else that can be off should be off. On your next day VFR cross country, shut the alternator off along with everything not included on your minimum list. Start a timer and continue flight while observing the voltmeter. When your battery voltage drops below 10.5 volts, its remaining capacity is very small and it will fade fast. Put the alternator back on-line and continue to run on minimum equipment until the alternator has time to bring the battery back up. If the battery can't carry your minimum load for a useful period of time, the loads you picked are too big, the battery is too small and/or it needs to be replaced. I encourage my amateur airplane builders to develop Under no circumstances should you expect the battery to carry a full, night-time cockpit load for very long. Remember, you're after a realistic minimum capacity.

Armed with the knowledge of how long the battery will carry such loads gives you a benchmark from which to judge future battery replacement decisions. In no case would I recommend keeping a battery that cannot carry minimum load for less than one hour; two hours is much better.

One last point: a common abuse of batteries is over-charging. It's something akin to putting on too much fertilizer. The ideal voltage for recharging (but not overcharging) a battery is dependent on battery chemistry and temperature. At 75F, batteries like to be charged at about 13.8 to 14.2 volts (double these values for 28-volt airplanes). As battery temperature goes down, ideal charging voltage goes up. Overcharging a flooded-cell battery results in a loss of water, which can be replaced. Overcharging a gelled or RG battery causes irreparable damage which shortens battery life. An accurate voltmeter is your best monitor of how well your voltage regulator is treating your battery.

Until a very few years ago, battery replacement choices were limited. There have always been a few brands to pick from and other than size and capacity, little difference in the technologies used. Most light aircraft today carry batteries that are direct descendants of the type Charles Kettering bolted onto the first Cadillac fitted with a self starter. These are so-called flooded-cell, lead-acid batteries, characterized by vented caps, a need to maintain water level and the requirements for a semi-tight, corrosion-proof enclosure to prevent a battery's escape by eating its way through the airplane's belly.

Twenty or so years ago, someone figured out how to "gel" the electrolyte in a lead-acid battery and things got a little better in the mess department. But overall cranking performance is lower with gel cells, primarily because of higher internal resistance. In recent years, a relatively new battery has become available under the name "recombinant gas." It's not terribly new technology, since the original patents have already expired. However, the industry's ability to produce reliable RG batteries at a reasonable price is the hot news. Interestingly, some of these advances were fueled by requirements for large quantities of economical, fume free, leak free, energy storage in the un-interruptible stand-by power supplies used for computers. Office workers dislike stinky computers and acid holes in the carpet.

Demand for millions of batteries in the consumer market has made low-cost, high-performance RGs available for a few tens of thousands of airplanes. Here's how they work: Water and acid are wholly contained in a very fine, Fiberglass mat looking very much like a thin stack of tissue. The mat is less than saturated, meaning you'd have to wring it out to extract any liquid. Each cell contains so little liquid that none escapes, even if you punch a hole in the battery side wall.

RG batteries tend to have thinner plates, which translates to more plates of lead per cell. More plates lowers the internal impedance (better cranking) and increases surface area (higher capacity). So, RG batteries tend to be smaller and heavier than their flooded-cell counterparts but the difference in performance is striking. I conducted certification tests on a 25 ampere-hour, RG battery in comparison with a new, 35 ampere-hour flooded-cell battery.

After cold soaking at -20F, both batteries were loaded to 300 amps. The RG battery had a higher terminal voltage after 30 seconds than the flooded-cell battery started with. During the same testing, we substituted a $300 set of 25 AH RG batteries for a multi-kilodollar, ni-cad battery in a C-90 King Air.

A data acquisition system monitored voltage and current during an engine start sequence. The same data was plotted for the ni-cad. When the curves were laid on top of each other, I couldn't tell the difference between the ni-cad and RG battery performance. (Before you run out and look for itty-bitty RG batteries for your turboprop, understand that this particular experiment was to compare the two batteries with respect to cranking performance only. Additional work is needed to prove suitability of these batteries for use on the bigger airplanes.)

RG batteries have another interesting feature with respect to longevity. Their self-discharge rate is about half that of a flooded-cell battery. This means that an RG battery is less likely to self-destruct from inattention than its gray-bearded cousins. I personally fly one airplane with an RG battery installed (now over a year old and cranking great).

I also run RG batteries in my cars: a 25 AH, B&C battery in a Plymouth Voyager and an 11 AH, Concord in my VW van. To date, every indication is that these batteries are going to be exemplary performers. If it were my airplane, recombinant gas batteries would be the only way to go.

The flooded lead-acid battery is a comparative dinosaur; manufacturers will be reluctant to invest in any form of research or manufacturing tools to enhance quality. RG technology enjoys mass consumer market support; it will mature rapidly. I recommend switching to an RG battery at the next opportunity; there's nothing to maintain on this truly sealed battery, just keep an eye on charging voltage. Converting to leak-free, fume-free devices will reduce battery box maintenance to zero as well (homebuilt aircraft don't use battery boxes; RG batteries may be operated in any position by simply strapping them down to the airframe.

At time of this writing, I know of two sources for STC'd RG battery products: Concord Battery Corporation and B&C Specialty Products. Concord can supply an RG battery for virtually any airplane and B&C has STCs on many models. Pricewise, RGs are about 20 to 30 percent higher than flooded-cell models.

But if you order through the catalogs, some of that price difference will be offset by the fact that RGs don't require any additional shipping charges for corrosives, while flooded-cells do. Incidentally, if you'd like to put a super-cranking RG battery in your car or truck at a reasonable price, contact Optima Battery Corporation, Denver, CO. Phone (303) 744-5360. For about $70, they'll sell you a battery that severely abused B&C's 800-amp load tester.

Addresses:

Westberg meters
Aircraft Spruce and Specialty
PO Box 424
Fullerton, CA 92632
800-824-1930

Concord Battery Corporation
2009 San Bernardino Road
West Covina, CA 91790
818-813-1234

B&C Specialty Products
PO Box B
Newton, KS 67114
316-283-8000

April 1998, A follow up . . .

Recent discussions on several Internet forums prompted a small survey of battery distributor's net sites. I was amazed to discover how many sellers are behind the power curve in battery technologies. A number of distributors refer to RG batteries as "gel-cell" products and continue to give advice to their customers as if the products were indeed gel-cell devices. At this time, I can find only two companies that offer any form of true gel-cell battery. Johnson Controls (bought the old Globe line of batteries) and Sonnenschein (a German company that excelled in gel-cell technologies when it was still the battery of choice.

When communicating with any distributor of batteries about their products, be suspicious of their knowledge if they use the words "gel-cell". Unless they've gone out of their way to offer the gel technology it's quite likely that they're selling RG batteries and don't know it. When in doubt, contact the MANUFACTURER . . . most have websites where it's easy to confirm their product's features.

There's still a limited market for gel batteries. At room temperature and above, they are exemplary performers in some deep cycle applications . . . like electric wheel chairs. The fact that gels have not disappeared entirely contributes to distributor's confusion. I suspect most of the problems arise when the sales clerks you speak with on the phone really don't know much more about batteries than their immediate supervision handed them via hearsay. I think it's safe to say that the vast majority of sealed, lead-acid batteries out there today are recombinant gas products and worthy of consideration for your airplane.