Brushes for Aircraft Applications

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Several times a year I receive a call or letter asking where one obtains "aircraft" grade brushes for an alternator or generator. One of my readers called recently to say he had been verbally keel-hauled by an engineer with an alternator manufacturing company. The reader had confessed to considering a plain vanilla brush for use in the alternator on his RV-4.

There's a lot of "hangar mythology" about what constitutes aircraft ratings in components. We all know that much of what is deemed "aircraft" today are the same products certified onto airplanes 30-50 years ago. Many developers and suppliers consider aviation a "dying" market; few are interested in researching and qualifying new products. However, automotive markets continue to advance in every technology. It is sad to note that many products found on cars today far exceed the capabilities and quality of similar hardware found on certified airplanes. Alternators, motors and components thereof are striking examples!

First, know that brushes for aircraft generators, motors and alternators come in many grades which are neither "aircraft" nor “alternator” in makeup, just different grades. When "high altitude” operations are anticipated (where moisture in the air is lacking) a brush rated for altitude may indeed be advisable. Know also that "high altitude” usually means 25,000 feet and UP! When a product requiring brushes is designed, it will be tested for adequate performance, first in the lab and then in a working environment. Real-world testing ultimately ensures whether a given brush is suited to a task.

It’s not uncommon to discover that a brush grade which worked well in one application may not perform as well in a similar application. Brushes are subject to many stresses which include but are not limited to: velocity of conductor surface under the brush, current, magnetic characteristics of the machine, spring pressure, altitude, humidity, vibration, duty cycle, etc.

To automatically assume that brushes for aircraft products should also be rated for high altitude ignores design and testing efforts done when the product was certified.

Often, brush requirements are imposed arbitrarily to the extent that they are grossly unreasonable. For example, in about 1980, an AD was placed against all 20-series Learjets for poor trim speed control. I was working on a new, electronically regulated trim system for Model 55 Lears. I was confident we could develop an expedient fix for the older airplanes. The program went well until we began testing for a requirement by Lear that brush life on the primary and secondary trim motors be 1000 hours or more of continuous motor operation! We were hard pressed to demonstrate more than 600 hours from any grade of brush. This little motor runs at 22,000 rpm! There were simply no brush products available that would last 1000 hours at those commutator surface speeds.

The program was nearly scuttled when project managers became fixated upon reaching the 1000-hour goal. We researched our service records for the same motor supplied in other forms for over 10 years.

Clutches and brakes turned out to be the #1 service problem. Brake problems occurred at 300 to 500 flight hours, not motor operating hours. Given that trim operations might run a pitch trim actuator perhaps 3 minutes total per flight cycle, 1000 hours of flight on a Lear might put less than 50 hours operation on the trim motor. Not once did we receive a motor back for repairs because of worn brushes! Brushes were automatically replaced on every overhauled unit; the overhaul shop's scrap brush box was full of brushes ranging from like-new to very serviceable.

In the real world, brushes were never a service issue. I can tell you that the brush grade which ultimately performed best in that application was neither rated for "high altitude" nor recommended by its manufacturer for "aircraft" service. This was in spite of the fact that trim motors in Lears are exposed to outside ambient conditions.

Some folks are adamant in their beliefs about brush ratings. I’ll suggested that brushes are never properly applied by ratings alone, testing in a service context is the only true qualification of a product. A brush is but one component of a complex system. Experience in the field is a better judge of capability than all the analysis in the world.

Most certified “aircraft” alternators are serviced for shorted diodes and worn bearings, worn belts and drive couplings with a good sprinkling of broken attach brackets.

Getting back to the "upset" engineer: without seeing his test and field experience data, I cannot judge the propriety of his actions. It is entirely possible that some altitude rated brush performed better for him in a low altitude aircraft application than one which was not rated. Irrespective of the facts in this one incident, understand that it is unwise to discuss and perhaps make decisions about components of an airplane (or any other machine) without having ALL the facts and data surrounding its application in the flight SYSTEM. Worthless,

perhaps even bad decisions, can be made from "hangar engineering."

For over 15 years, I've observed field service history on modern automotive alternators fitted to amateur built aircraft. These have provided exemplary service with the same slip ring brushes as supplied for ground vehicle duties. There has never been the slightest hint of a design or installation problem with brushes, or for that mater, any other component. Should the topic of altitude rated brushes come up in your travels about the aviation community, know that there's a long demonstrated service history that shows this is simply not an issue.

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