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Workshop Chronicles

Aluminum: Some History, Facts, and Figures — Part 1

During a recent antenna installation for which I had fabricated some modified parts for the client's Yagis, he asked me about the little numbers stenciled on the aluminum. His remark, "I've always wondered what those meant," inspired this column, as it occurred to me that some readers might wonder about them as well.

This time, I'll provide some general information, and next time, I'll demonstrate and discuss some specific questions arising from fabricating items from this strength-to-weight-ratio miracle metal.

6061-T6 was the designation in question, but before I explain what those numbers signify, let's spend some time learning about aluminum in general. The history of aluminum goes back centuries, with pottery glazes of aluminum oxide having been found in ancient Egypt. The pure form of aluminum was finally isolated in 1827, but it was very difficult to extract, and it became almost as valuable as silver or gold. In 1886, however, American C. M. Hall and Frenchman Paul Herout — while working separately and concurrently — each smelted aluminum from bauxite ore. The Hall-Herout process is followed to this day.

Aluminum is actually the third most common element found in Earth's crust, and the most common metallic element. It blends easily, allowing us to fabricate lightweight but strong alloys. It conducts heat and electricity very well. It is non-magnetic, another useful property for some applications. Now for those alloys.

Other elements are added to pure aluminum, and this changes its properties, typically increasing its strength. Iron, silicon, copper, magnesium, and zinc are some of the typically added combinations. Factors such as strength, density, workability, conductivity, and corrosion resistance can be enhanced by creating different alloys. Different alloys can be combined easily in manufacturing, evidenced by your soft drink can. The shell is 3004 alloy, while the top or lid is 5182 alloy.

Alloy Designations

The aluminum industry has created a four-digit indexing system to describe the various aluminum alloys. The first digit indicates the alloy group, according to the major alloy elements. 1XXX would indicate a minimum aluminum content of 99 percent, with no other elements. The second digit describes impurity limits. If it's zero, for example, there is no control on impurities. Numbers 1 through 9, assigned consecutively as needed, describe special control of other impurities. The last two digits describe specific minimum aluminum content. Although the absolute minimum aluminum content in this group is 99 percent, the minimum for certain grades is greater than 99 percent. For them, the last two digits represent the hundredths of a per cent greater than 99 percent.

Alloys in the 6### series contain magnesium and silicon, making them heat treatable, weldable, and of high strength, along with good corrosion resistance. 6061 is often referred to as "aircraft aluminum," having seen extensive use within that industry. I'd suggest it's the most versatile alloy, considering all of its features together. 6063 is often referred to as the "architectural alloy," considering its extensive use in construction applications. These two alloys are also used extensively for ham radio antenna construction projects and both are sold by various vendors, such as Texas Towers and DX Engineering. They are quite comparable, with the 6061 having slightly better yield strength. Temper designation is the hyphenated suffix following the basic alloy number. Four basic designations are used for aluminum alloy tempering:

F — As fabricated
O — Annealed
H — Strain hardened
T — Thermally treated

So, that "T6" following the series designation simply means the alloy was heat treated, and then artificially aged in a chemical solution. T832 is another heat-tempering process, once again followed by a specific chemical bath.

Obviously, if you're going to build an antenna, you want the aluminum to be hard and strong, so those two alloys are what you'd choose. But then other questions immediately arise, such as: How do I work or machine it? How do I join or otherwise connect things? Are there other factors to consider? Are there safety concerns I should know about?

Fortunately, most common woodworking tools can be used when working with these alloys. This means power tools, of course, and the usual shop safety precautions apply. Eye and ear protection are important. It is also an important consideration not to "mix" the filings or debris from aluminum with sawdust or even iron filings. Indeed, if at all possible, have dedicated tools for fabricating things from aluminum.

Even though we've learned that these alloys are "hard," they are soft in comparison to, for example, iron and steel. Files, saw blades, and other cutting tools can easily clog or "gum up" when working aluminum. Suitable lubricants are required. And while special commercial products are available, there are some common substitutes. Automatic transmission fluid works well for keeping cutting tools clean. Even kerosene is a good lubricant that can be used when drilling aluminum.

And of course, the best part about metal work is the level of precision that's possible. This means using layout fluid, along with scribes or precisely sharpened marking tools, center punches (used properly), and sharp drill bits, preferably in a drill press. This always leads to questions about drilling perfectly centered holes in round tubing — the most common item in antenna construction. Or on how to "join" two pieces of tubing, not only for strength, but for good electrical conductivity.