

## COPPER VS. ALUMINUM WINDINGS

Transformers wound with aluminum or copper coils have similar losses and performance. Losses in the transformer's coil are a function of the current carrying capacity of the wire or foil used to wind them and the actual current. Therefore, a larger wire is used when winding aluminum coils to make up for the lower current carrying capacity and efficiency of aluminum.

- Aluminum wound coils are larger than an equivalent copper coil. Some applications requiring very tight dimensions require copper coils. Aluminum wire requires approximately 1.6 times as much cross section as copper to carry an equivalent amount of current.
- Aluminum's perceived problem dates to the 1960's when connection problems caused several fires. There were never any problems with the actual aluminum wire. Modern, secure methods for connecting aluminum wire have been developed and are widely used. Connections must pierce the aluminum oxide layer in such a way that they remain gas tight to prevent further oxidation.
- Copper corrodes less than aluminum in salt water applications and is recommended. Aluminum corrodes more when it comes in contact with water. While some marine specifications allow aluminum wire, marine rated units are recommended to be copper.
- Aluminum is susceptible to more rapid attacks by halide ions, of which chloride (CL<sup>-</sup>) is the most frequently encountered.
- Copper is susceptible to more rapid attack in oxidizing acids, oxidizing heavy-metal salts, sulfur, ammonia (NH<sub>3</sub>), and some sulfur and NH<sub>3</sub> compounds. HPS's Vacuum Pressure Impregnation (VPI) process can help prevent either copper or aluminum corrosion in most environments.
- Copper has a higher tensile strength than aluminum. Thin aluminum wire is brittle. Smaller transformers, generally 5kVA and under, are wound with copper to avoid breaking or damaging the wire during winding. Copper wire is more flexible and smaller than aluminum wire. Once a transformer approaches one to three MVA, copper wound coils become more practical to wind.
- Certain high efficiency applications can also be more economically achieved using copper units, especially with high harmonics where larger wire sizes can cause more losses and skin effect.
- Aluminum transformers tend to be less costly than copper transformers. A pound of aluminum has about twice the current carrying capacity of copper but costs ½ to ¼ as much.
- Since both aluminum and copper transformers use the same insulation systems and have similar temperature rises, they have similar lifetime ratings.