In-vacuum Ampacity of Cooner, CZ1105-FEP wire

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Richard Abbott, Samuel Abbott

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1. **Overview and Background** - For in-vacuum wiring requiring the most mechanical flexibility and lowest mass, LIGO has adopted a 28awg Teflon insulated biomedical wire, part number CZ1105-FEP, manufactured by Cooner Wire Company. CZ1105 is commonly used to transmit electrical signals up and down the LIGO suspension chains, where its physical flexibility doesn't adversely impact the isolation of the suspension system. Typically, the wire is loosely grouped together in bundles that can have up to 24 individual wires. The temperature rise of the wire as a function of current has been the topic of some interest. As the current flowing in the wire increases, the average temperature of the wire will rise. The worst case heat transfer mechanism is purely radiative, and this is the assumption of the following measurement.

2. **The Measurement** – Using a small vacuum chamber, a loose coil of CZ1105 wire was formed into an approximately 8.5 inch circle. A total of 50 feet, and 25 turns form the coil. A square yellow cardboard form prevents the wire from touching the metal surfaces of the vacuum chamber. Figure 1 shows a view of the test setup looking into the top of the vacuum chamber.

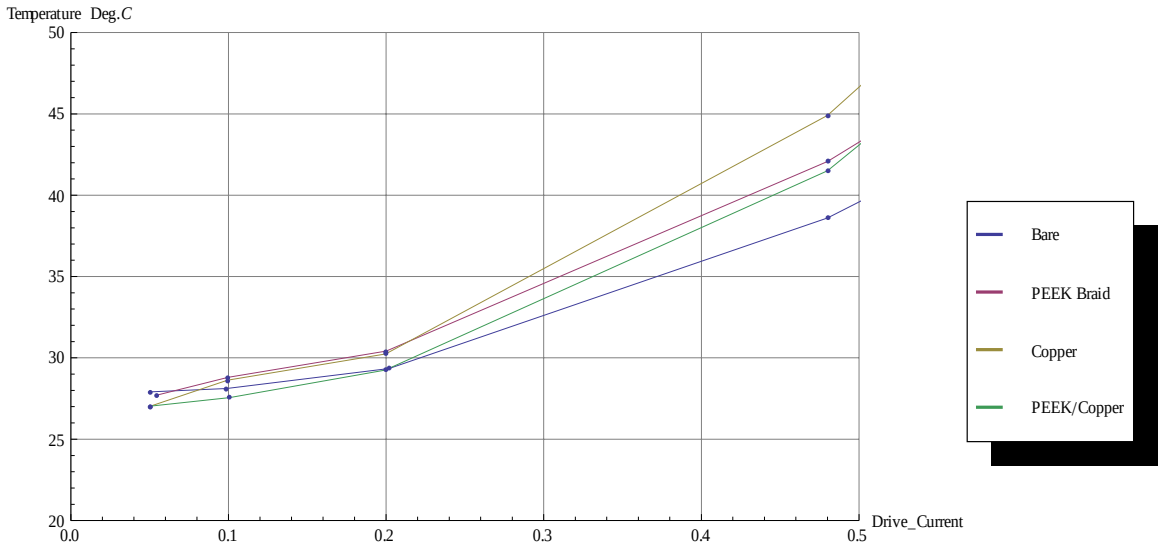
Figure 1

The pressure in the chamber was reduced to about 1 Torr, and the initial resistance of the wire was measured by applying a known current to the coil and measuring the voltage drop. The coil current was then incremented and measured; the voltage dropped across the coil was recorded at each current setting after allowing the temperature of the wire to equilibrate.

By knowing the temperature coefficient of resistance for copper, the average temperature of the in-vacuum wire can be obtained. Figure 2 shows the average temperature of the wire as a function of current for the radiation cooling mode that dominates the wire temperature in this experiment. Pay particular attention to the increase in temperature above the starting temperature asymptote rather than focusing on the absolute temperatures.

Figure 2, In-vacuum Temperature vs. Current for CZ1105. The zero current asymptote corresponds to the ambient temperature.

Figure 2



3. **Conclusion –** A loose wire bundle consisting of twenty five strands of CZ1105-FEP, 28awg wire with only radiative cooling will experience an average temperature rise of less than 10 degrees C if each conductor is simultaneously carrying a current of 400mA or less. Lower temperature rises will result if there are conductive cooling paths present or if fewer conductors are carrying current.