2021Q28

CABLING, RESISTIVITY

QUESTIONS

Cables are everywhere! You probably use them to power your computer, charge your phone, and even energize your microwave. At One Energy, we also use cabling, but it's pretty different than the cables that you've likely seen before. The cables we use are huge, sometimes being multiple inches in diameter. This helps us put thousands of volts through these cables while they keep their integrity and stay safe buried in the ground. All cables have a certain resistance to them, which means they'll change some of the electrical energy sent through them into heat energy. We can find the resistance of a cable with the following equation:

$$R = V / I$$

The resistance, R, is the voltage passed through the cable, V, divided by the current passed through the cable, I. Resistance is measured in ohms (Ω).

Generally, we try to minimize resistance to maximize the energy provided to our customers. We can minimize the resistance of a cable by changing a few properties of the cable: the resistivity of the cable, the length of the cable, and the cross-sectional area of the cable.

The resistivity of the cable can be changed by changing the material; resistivity is a property of that material. For example, the resistivity of copper is 0.00000001 Ω-m, but the resistivity of air is 1,000,000,000 Ω-m!

The length of the cable makes a difference as well; if we have a longer cable, that means the electricity must flow through more and more material. Any amount of material resists electrical flow, so adding more of it means adding more resistance.

The cross-sectional area has an inverse relationship to resistance; a big cross-sectional area means less resistance. Think of it like a highway. A wide highway allows for more cars to flow through, and a wide cable allows for more electricity to flow through. The following equation relates all these factors:

$$R = \frac{\rho L}{A}$$

Here, ρ, the Greek character rho, is the resistivity of the material. L is the length of the cable, and A is the cross-sectional area of the cable.

Level 1: We have a cable made of copper. It is in the standard shape of a long cylinder i.e. the cross sectional area is a circle with diameter 5 centimeters. We are only doing a short run with this cable; it only needs to connect two points 40 meters apart. Can you calculate the resistance of this cable?

Level 2: Two cables of the same length are laid in front of you. One cable is made of aluminum and has a cross-sectional shape of a circle with radius 7 centimeters. The other cable is made of copper and has a cross-sectional area that is approximated as an equilateral triangle with side length 8 centimeters. Which cable is going to provide less resistance? The resistivity of aluminum is 0.000000027 Ω -m.

Here is an image of example cable that One Energy has for demonstration. You can see all the complexities that go into transmitting the energy that our turbines produce in a safe, efficient way!