Wŏrd Pow´ẽr

Renewable Energy Terms

Conductor—Material with Moveable Charges

Ian Woofenden

Derivation: From Middle English conducten*, from Latin* conducere, *to bring or lead together, to induce, to employ.*

In my last column, I mentioned that an electric current is the flow of charges, and that charges are part of matter. When there is an energy input on one end of an electrical circuit, charges flow and carry energy to other parts of the circuit.

But why do the charges, and therefore the energy, flow *in* the circuit? Why don't they flow from the wiring in your house into the framing, plumbing, and insulation? These things are full of charges too, but we don't use fiberglass or lumber to transmit electricity around our homes.

The answers lie in understanding what "conductors" are. All matter is made up of charges—charged particles. But some types of matter have charges that are more moveable than others. And I mean moveable within the matter, not across the room.

Basic chemistry theory says that electrons (charged particles) orbit around an atom's nucleus. There are a number of orbits or "shells," and each can hold a specific number of electrons. The outer shell (called the valence shell) holds the key to how moveable the electrons are. It can hold no more than eight electrons. If the outer shell is fully populated, the material will tend towards stability—that is, not to gain or lose electrons. But if the outer shell has only a few electrons, they are easily bumped out, forming an "electron sea" of very moveable charges.

So good conductors have only a few valence electrons, and the charge within them is very moveable. Metals are the best conductors, with silver, copper, and gold high on the list. Silver is actually a somewhat better conductor than copper, and you see it used on circuit boards, in solders, and in special wiring applications. Copper is significantly cheaper, so it is widely used for house wiring. Aluminum is another step down, but still a good conductor.

The conductivity of metals is rated on a scale that puts copper at 1.0. On that scale, silver is 1.08, gold is 0.725, and aluminum is 0.625. So aluminum is almost 40 percent less conductive than copper. But economics come into play again, and aluminum is often used for long or large wire runs because it is much cheaper and lighter. Thicker wire must be used because of the lower conductivity.

Other metals have much lower conductivities, and some are used specifically for this reason. Nichrome is a metal alloy used in heating elements. Its conductivity rating is 0.016, so it is 60 times less conductive than copper, size for size. It resists the flow of charges, and much of the electrical energy is converted to heat.

So why is conductivity important? The point of electrical wiring is to distribute electrical energy around your home, to power your appliances. And unlike in a heating element, we are trying to avoid losing energy as heat in our house wiring. As an analogy, consider a highway system. Its purpose is to distribute people from their homes to their jobs to their shopping malls and back.

If the roads are built with rough materials that slow down the vehicles, you get traffic jams, and hot tempers. Similarly, if a conductor isn't made of a conductive material, the resistance will be too high, and it will be harder for the charges to flow. Things heat up there too.

Fortunately, we don't really have to think too much about the technical details of conductors, conductivity, and conductivity ratings. Charts and spreadsheets are readily available to size wires appropriately for the job. See the "Solar Power" section on the downloads page of *Home Power's* Web site for charts and a spreadsheet. If you know the voltage of the system, the maximum amperage (charge flow rate) that the wire will see, and the distance, the chart or spreadsheet will give you the proper size wire to use.

Once you size the conductor properly, you're all set. The moveable charges in the wire will carry the energy where you need it. The wire's insulation keeps the charges from flowing where you don't want them. I'll talk about this and other materials in my column on insulators in our next issue.

Access

Ian Woofenden, PO Box 1001, Anacortes, WA 98221
Fax: 360-293-7034 • ian.woofenden@homepower.com