



Renewable Energy Terms

Electrons—Charged Particles

Ian Woofenden

©2002 Ian Woofenden

Derivation: From the Greek word for amber, “elektra.” Amber is petrified tree resin, which when rubbed with a cloth, builds up an electric charge. This phenomenon led to the word “electricity,” and Irish physicist G. Johnstone Stoney coined “electron” in 1891.

When we talk about electric currents in wires, we’re talking about the movement of electrons. But what are electrons? To understand that, we have to look at some chemistry basics.

All matter is made up of “elements,” materials that cannot be broken down further by chemical means. Hydrogen, oxygen, nitrogen, carbon, and copper are all elements. The complete list of currently acknowledged elements can be found in the Periodic Table of the Elements.

The single unit of an element is called an atom. An atom is made up of three major components—protons, neutrons, and electrons. Protons and neutrons form the “nucleus” or center of the atom, while electrons surround the nucleus.

Protons have a positive charge, electrons have a negative charge, and these opposite charges are attracted to each other. (Neutrons have no charge.) The electrons are racing around the proton, and are repelled from each other. A simplified model is a tiny solar system (and I don’t mean a solar-electric system), with the protons acting like a sun, and the electrons acting like planets. In fact, electrons may be more like clouds moving around the nucleus.

The electrons travel in “shells” similar to orbits—each a specific distance from the nucleus. Each different element has a specific number of shells in its atom and

a certain number of electrons in each shell. In its neutral state, an atom has the same number of electrons as protons. When there is an imbalance, electrons begin to move in an effort to regain the balance of charge.

If you pick up a piece of copper wire and walk across the room, you’ve moved the electrons in the wire. Is this movement an electric current? Of course not. The electron movement that we use to power our appliances is the electrons moving while the protons don’t. This is what we call an electric current or “amperage.” An amp is one coulomb per second, and a coulomb is about 6 billion billion electrons.

Heat, friction, pressure, light, magnetism, and chemical activity can all move electrons through a circuit. In PV modules, light dislodges electrons. In alternators, magnetism in motion moves electrons. And lead-acid batteries move electrons via a chemical reaction. The other three ways are less common. Piezoelectricity (pressure) is used in stove and grill igniters. Thermoelectricity (heat) is used in the safety shutdown mechanism of some on-demand water heaters. And friction is mostly used for shocking yourself on doorknobs.

When you flip a light switch, the bulb lights up almost instantaneously. So you may think that the electrons are traveling very quickly. In fact, an electric current is quite slow, like “a river of warm putty,” as science misconception maven Bill Beaty says. The electrons may travel less than an inch per minute in DC; in AC, of course, they just wiggle back and forth.

It’s the energy transfer that’s nearly instantaneous. This is easier to imagine when you remember that electrons are not something that we have to fill our electrical pipe with. Electrons help make up the pipe—they are part of the metal in the wire. We’re simply jostling them along in the wire when we flip the switch and energize the circuit.

Think about what happens when you pull on a rope. Your pull is felt at the other end almost immediately. The rope is like electrons, which move slowly. The “pull” is like energy, which moves almost instantaneously.

So electrons are charged particles that are a basic part of all matter. When they move in relation to protons, an electric current results. Electrons are tiny—one coulomb of electrons in copper is about the size of a grain of salt. But their movement powers our homes. In future columns on conductors and insulators, I’ll cover how they behave in different materials.

Access

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

