Renewable Energy Terms

Insulator—Material Lacking Movable Charges

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Derivation: From Latin insula, *island.*

In my last column, I talked about conductors, materials that allow electrons to flow easily. Copper and aluminum are the two most common conductors in electrical systems. They have only a few electrons in their atoms' outer or valence shells, and these are easily bumped out. It is the motion of these electrons or charges that carries electrical energy in wires. (See *Word Power* in *HP90* for more on the anatomy of atoms.)

But since all matter is made of charges, what keeps the flowing electrons in the wires where we want them? The answer is insulators, materials that do not allow electrons to flow easily. In wiring, common insulating materials are rubber and plastic. In other electrical applications, glass, porcelain, resin, Bakelite, and other materials are used.

Conductors have only a few electrons in their valence shell, but insulators have valence shells that are almost or completely full. Insulators also tie up electrons in strong bonds that form between adjacent atoms, making them very stable and not likely to lose electrons. While the electrons in conductors are free to wander about, the electrons in insulators tend to stay put.

A common analogy compares a pipe to a wire and water flow to electron flow. A better analogy compares a wire to a *prefilled* pipe, with the insulation acting like the material of the pipe, and the copper or aluminum conductor acting like the water in the pipe. The pipe (wire insulation) keeps the water (charges) from going where we don't want it, and the water is ready to move when pressure (voltage) is applied. An even better analogy compares the conductor to water and the insulation to ice—charges that are "frozen" and won't flow.

Remember—a wire is not empty and waiting for electrons to fill it; it's already full of electrons, and is waiting for a force to cycle the electrons slowly through the circuit, carrying energy.

The values of conductivity and insulation are variable, depending on the circumstances. For example, while wood is usually thought of as somewhat of an insulator, if it's wet enough and the voltage is high, it can certainly conduct electricity.

Once when I was removing a Douglas-fir tree in tight quarters, I was taking a 30 foot section off the top, across a road from some utility lines. As it went over, the very tip (tiny) hit an uninsulated utility wire. At the same time, the butt of the piece separated from the trunk, and I had my hand on it. I got a goodly shock, since I was the conductor between the top and the trunk, with my spikes into the trunk and my hand on the top. It was enough to teach me that green wood is not a good enough insulator when faced with high voltage...

A variety of wire and insulation types are used in renewable energy systems. Each of these has a specific designation, such as #6 AL USE, #10 CU THHN, etc. These codes describe the characteristics and appropriate uses of each of the types of wire and insulation.

For example, "#12 CU" means a copper American Wire Gauge #12 wire (3.3 mm^2 in metric). The gauge and material description of the wire are primarily concerned with the conductor material. The letters that follow primarily describe the insulation around the conductor.

Different insulations have different voltage and temperature limits, moisture and ultraviolet light resistance, and needs for protective conduit. See John Wiles' *Code Corner* column in *HP76* for a detailed description of different wire types.

Conductors allow charge and energy to flow easily. Insulators inhibit charge and energy flow, keeping them where we want them—not flowing through us! Next time around, I'll talk about materials that have qualities of both conductors and insulators—semiconductors.

Access

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