Basic Electric Theory and Water

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While electricity and water are never a good combination, I often use the similarity to the flow of water when explaining the basics of electricity. There are few things you can do with electricity you can't do with water. Water is a tangible that we see and feel; so if you understand how water flows, you can also understand how electricity flows through wires, something we can't see and feel.

Most people think of electricity as some sort of phantom – something that can kill you. The statement that is most misleading is; Electricity is energy. This is not correct. Water-flow is energy, but water is water, not energy. Whenever something moves or exerts force, that is energy. The substance flowing is not energy, the flow is.

Electricity is a flow of electrons. While you can't actually see them, electrons are solid particles possessing volume and weight. They flow through wires much the same way water flows through pipes. While I use the simile of water, there is one important difference between water and electron flow. You can't compress water in a space; you can compress electrons.

There are three primary measurements of water energy: pressure or force (measured in pounds per square inch – psi), volume or intensity of flow (measured in gallons per minute – gpm), and the resistance to that flow. I don't know what is used to measure resistance to water, but I'm sure you understand the concept.

In electrical theory, voltage is the measurement of electrical pressure or force. As psi is a measurement of water pressure, voltage (or volts) is a measurement of *ElectroMotive Force,* or EMF.

Many have heard the old adage: Volts won't kill you, amperage will. This is true because volume of electrical flow is what you feel. Static electricity generated in your body by walking across a carpet can build to several thousand volts, yet it doesn't knock you dead when you touch a doorknob. This is similar to the water stream from a squirt gun. There is high pressure but little substance. Conversely, a high voltage has the ability to push more electrons through a given resistance.

The current flow in an electric circuit is measured in amps or amperes and is the same as gallons per minute (gpm). It is the measurement of the volume of electrical flow. As larger diameter pipes are needed to transport more water, larger wires are used to carry more current. For that reason most electrical devices are rated in amperes.

As no water flows before a valve is turned on, there is no current flow until something is switched on. Similarly, only so much water can flow through a pipe, and only so much electricity through a wire. This is one instance where electrical characteristics are more like airflow. Because you can compress it, you can squeeze more air through a duct. But, any time you try to move excess volume through something that resists flow, it will heat from friction. Ohms is the measurement of electrical resistance. It is the same as pressure drop in a water piping system. Anything water moves through resists its flow. This is also true of electrical conductors.

Resistance converts energy from one form to another. It reduces both voltage and amperage, creating heat, light, sound, magnetism, and several other waves. Efficient use of electricity or any other form of energy amounts to channeling most of the total power spectrum into the attempted work.

A very important basic relationship among these three unit has been established and is called Ohm's Law. This law states that the current flow is proportional to voltage, but is inversely proportional to resistance. Stated as an equation; $V = I \times R$, where V is voltage, I is current and R is resistance.

Power is the rate of doing work or the amount of work electromotive force and current intensity produce together. Watts is a measurement of *power* or ($P = V \times I$).

Direct and alternating current are different forces to provide electrical energy. Electrical flow in DC power is in one direction and electrons flow from negative to positive. A battery is common sources of DC power. Since the battery is produced by a chemical reaction, the voltage produced would not change for a given load. The current flow as a result of this voltage would not change its value.

Alternating Current (AC) is energy similar to the waves on a beach. They are continuously moving in and out, doing a lot of work, but don't really go anywhere. Alternating current drives electrons one way, then stops and drives them back again. Starting from zero, the voltage rises to a positive peak, returns to zero, rises to a negative peak, then returns to zero again, creating the sine wave. This is called a single cycle. Sixty cycles per second, also known as 60-Hz, repeats this cycle with 60 positive peaks, 60 negative peaks, and 120 points at which the wave crosses the 0-voltage level – per second. The number of times a voltage goes through its cycle of change per unit of time is called the frequency of the system.

As you can see, AC voltage is constantly changing. It isn't constant like DC. The rated voltage measured as an average of the peaks and valleys. Since AC electricity flows in both directions, going from positive to negative peaks, there is no positive or negative connection.

If you think of electricity in terms of something we can see and feel such as water pressure, it will help you visualize flow through wires and other devices. Remember that as with water, nothing happens until there is a pressure difference; and nothing significant happens unless there is sufficient flow volume.