WHAT ARE VOLTS, AMPS & WATTS?

Question

OK, correct me if I'm wrong, but as I understand it, volts measure the potential for energy to travel and ohms measure the resistance to the electrical flow, but then what are amps and watts?

Answer

The three most basic units in electricity are voltage (**V**), current (**I**) and resistance (**r**). Voltage is measured in **volts**, current is measured in **amps** and resistance is measured in **ohms**.

A neat analogy to help understand these terms is a system of plumbing pipes. The voltage is equivalent to the water pressure, the current is equivalent to the flow rate, and the resistance is like the pipe size.

There is a basic equation in electrical engineering that states how the three terms relate. It says that the current is equal to the voltage divided by the resistance: **I = V/r**

Let's see how this relation applies to the plumbing system. Let's say you have a tank of pressurized water connected to a hose that you are using to water the garden.

What happens if you increase the pressure in the tank? You probably can guess that this makes more water come out of the hose. The same is true of an electrical system: Increasing the voltage will make more current flow.

Let's say you increase the diameter of the hose and all of the fittings to the tank. You probably guessed that this also makes more water come out of the hose. This is like decreasing the resistance in an electrical system, which increases the current flow.

Electrical power is measured in **watts**. In an electrical system power (**P**) is equal to the voltage multiplied by the current: **P = VI**

The water analogy still applies. Take a hose and point it at a waterwheel like the ones that were used to turn grinding stones in watermills. You can increase the power generated by the waterwheel in two ways. If you increase the pressure of the water coming out of the hose, it hits the waterwheel with a lot more force and the wheel turns faster, generating more power. If you increase the flow rate, the waterwheel turns faster because of the weight of the extra water hitting it.

In an electrical system, increasing either the current or the voltage will result in higher power. Let's say you have a system with a 6-volt light bulb hooked up to a 6-volt battery. The power output of the light bulb is 100 watts. Using the equation above, we can calculate how much current in amps would be required to get 100 watts out of this 6-volt bulb.

You know that **P** = 100 W, and **V** = 6 V. So you can rearrange the equation to solve for **I** and substitute in the numbers: **I = P/V = 100 W / 6 V = 16.66 amps**

What would happen if you use a 12-volt battery and a 12-volt light bulb to get 100 watts of power?

100 W / 12 V = 8.33 amps

So this system produces the same power, but with half the current. There is an advantage that comes from using less current to make the same amount of power. The resistance in electrical wires consumes power, and the power consumed increases as the current going through the wires increases. You can see how this happens by doing a little rearranging of the two equations. What you need is an equation for power in terms of resistance and current. Let's rearrange the first equation: **I = V / R can be restated as V = I R**

Now you can substitute the equation for V into the other equation:

P = V I substituting for V we get P = IR I, or $P = I^2R$

What this equation tells you is that the power consumed by the wires increases if the resistance of the wires increases (for instance, if the wires get smaller or are made of a less conductive material). But it increases dramatically if the current going through the wires increases. So using a higher voltage to reduce the current can make electrical systems more efficient. The efficiency of electric motors also improves at higher voltages.

This improvement in efficiency is what is driving the automobile industry to adopt a higher voltage standard. Carmakers are moving toward a 42-volt electrical system from the current 12-volt electrical systems. The electrical demand on cars has been steadily increasing since the first cars were made. The first cars didn't even have electrical headlights; they used oil lanterns. Today cars have thousands of electrical circuits, and future cars will demand even more power. The change to 42 volts will help cars meet the greater electrical demand placed on them without having to increase the size of wires and generators to handle the greater current.