WHY AC CURRENT RATHER THAN DC CURRENT

THANK NIKOLA TESLA FOR OUR CURRENT LIGHTS

The Answer Follows:

Any source of electric energy must get its energy from somewhere. The battery gets its energy from the chemical reaction within the battery. The generator gets its source from turning coils wrapped around a magnet. Any source can be rated in terms of the electric energy it produces for each unit of charge separated. This quantity - the energy per unit charge converted from some other form to electrical - is called the emf of the source. These letters stand for "electromotive force", but this is a very poor name since this term was left over when electricity was not well understood.

The emf of a source is not a force; it is a potential, a value of energy. It is measured in jules per coulomb (Volts) and expressed as:

emf = Ed/q

The common zink - carbon dry cell battery or the newer alkaline cell, produces an emf of approx., 15 volts regardless of its size. A large cell produces more energy by separating more charges, but the energy added to each coulomb separate depends only on the kind of chemical reaction that does the job. If your calculator uses a 9-volt battery, is made up of six dry cells, each adding 1.5 joules of electric energy to each coulomb that passes through it.

A battery with a concentration of electrons at one terminal and excess of positive charge at the other, is a storehouse of electric energy. If a metal wire is connected from the one terminal to the other, electrons will run off the negative terminal into the wire, and out of the wire into the positive terminal. All the electrons in the wire will shift position, drifting toward the higher potential. As they travel, they lose of electric energy, which is converted into random motion of molecular electrons made inside the wire. As a result the wire will get hot. REMEMBER, ONE CAN NOT MAKE OR DESTROY ENERGY, IT ONLY GETS CONVERTED.

AC power has replaced DC chiefly for one reason: the transformer. This is a device that can use electric power at one potential to produce an equal amount of power at another potential. Your electric utility company ships energy to you at 7,000 volts and changes (steps) it down to the 120 volts you use at home by means of a transformer near our home, either on a utility pole or underground.

It was the transformer that made possible the power grid that carries electricity to the most remote parts of the country. Without the transformer and the AC generator that feeds it, we would still need a DC powerhouse no more than ½ mile from our homes, and we would still not get very much power. When Thomas Edison developed his incandescent light bulb it ran on DC current. However, when Edison began lighting the city of New York he needed to build hundreds of power stations producing DC current to light the bulbs. Nikola Tesla developed (invented) the transformer, where AC power could be sent for several hundreds of miles.

To see why this is so, consider a modest home that needs, from time to time, 10kW of power to keep the inhabitants happy and comfortable. To keep the numbers simple, let's assume that we will supply this power at a potential difference of 100V. Then from the Equation:

I=P/v = 10,000 w / 100 v = 100A [A = Amperes] [W = Watts] // Reading my other web sites, you will learn W = A x V.

So we have to send 100A to the house.

Let's send the current through some good-sized aluminum wire. If we assume it is about 1 cm thick and 1 mile long, each wire will have a resistance of about 0.5Ω [Ohm]. The two transmission wires and the house now constitute a series of current connected to the powerhouse. This current of 100A has to flow through the generator and the wires, as well as through the house.

As the current flows through the aluminum wires, it losses power; the wires have resistance which converts electric energy into heat. The power loss in the wire is:

P = 12 R

P = (100A)2(20.5Ω) = 10,000 W

We are using just as much energy to heat the transmission lines as the house is using, and this is terribly wasteful.

There is a way out of this problem Suppose we supply the 10kw [k = kilo or 1,000 W] to the house at 1,000v instead of 100v. Then the house will get the same power by drawing only 10A of current from the generator. The power loss in the lines will not be (10A)2(1Ω) = 1100 w We have saved 99 percent of the waste power.

The catch to this scheme is that no one wants a potential difference of 1,000v in his electric outlets. It is too dangerous. The transformer must come to the rescue. Power companies use very high potentials-and thus all currents and small like losses -in sending the electric over long distances. Locally, the transformers reduce the potentials and increase the current for safer conveyances of power for short distances, where wire resistance is small.

Let’s trace you electricity from the generator where it is made to the fuse (breaker panel) when it enters your house.

In principle, the generator is no more than loops of wire rotating in a magnetic field. But a generator that produces large amounts of energy with high efficiency is a large and complex machine. Every detail must be carefully designed so that the last joule of energy can be squeezed out of the precious oil that runs the generator.

The field magnets of typical large generators are electromagnets energized at about 25,000 volts by some of the current produced by the generator itself. Instead of spinning the armature, the steam turbine is attached to the magnetic field magnets. It is more convenient to keep the armature stationary because the potentials in it are much higher. A field magnet usually has four poles (North South North South) - so each time it goes around once it induces two AC cycles in the armature.

There is no reason why the armature should contain only one loop of wires. There are three -or perhaps several groups of three. In each group there are three coil sets at an angle of 120 degrees to each other. AC current is carried out of the armature on three wires.

Typically, the generator produces AC on three phases at 18,000 volts for each phase. This current passes to a large transformer, where it is boosted to 345,000 volts. This is the electricity that is sent over those giant steel skeletons you see marching across the countryside, bearing wires on their arms. Note that the wires are in groups of three-identical current differing in phase by 120 degrees. The wires are not insulated. No conceivable covering could confine potentials that large. The wires are suspended from the towers by means of ceramic insulators 1 meter or so long. Another wire runs along the tops of the towers, connected to the steel framework. This is the "neutral" wire, electrically grounded through the steel to the earth. If lightning strikes the system, it will hit the neutral wire and pass harmlessly to the earth.

Somewhere in your community there are transformer substations that receives 345,000 volts of power and steps it down to about 13,800 volts. This current travels locally for short distances either on overhead poles or underground. It may wind up in a factory, where the whole three-phase AC is used to run a large motor either at 13,800 volts or transformed down to something a little more modest. Alternatively, it may end up in a small transformer on your block. There one phase is taken off, transformed down to 240 volts, and sent over a short distance wire into your house.

There will be three wires going into your house. Each of the two"legs" carries 120 volts for a total of 240 volts when both "legs" are connected to the main breaker or fuse. From there each leg will send power to our wall outlets. Both legs will be used for your electric dryer or your electric stove which both require 240 volts. The third wire is the neutral or ground wire which mst be connected to an earth ground at your home as well as the service panel.

RETURN TO HOMEPAGE