Your Car Battery-What's inside and How It Works

What you can't see

Automotive batteries come in many shapes and sizes, but their operating principles are remarkably similar. The modern automotive battery is a lead-acid storage design. In short, it's an electrochemical device that converts chemical energy into electrical energy. When the battery is placed under a load, such as when the ignition is switched on, the device converts stored chemicals into electricity, and the current flows through the wires to its destination.

A standard 12-volt, lead-acid battery is made up of six cells connected in series. Each cell produces approximately two volts.

The cells are filled with an electrolyte. An electrolyte is an ionized bath — in this case, sulfuric acid (H_2SO_4) diluted with water — that generates an electrical current when called upon.

Each cell also contains plates (grids of active material), which are both positive and negative. Typically, the positive plates contain lead dioxide (PbO_2), while the negative plates are composed of straight lead (Pb).

The plates are formed into a plate group, which holds a number of plates of the same polarity (for instance, all positive or all negative). The like-charged plates are welded to a post strap. The plate groups are then alternated within the battery — positive, negative, positive, negative. There is usually one extra set of negative plates to balance the charge. To ensure that the different plate groups don't touch each other, non-conductive sheets called separators are inserted between them.

The battery case, which holds all these components, is made from molded polypropylene.

A maintenance-free battery, similar in design to a conventional automotive battery, is really just a heavier-duty version of the same arrangement. Many of the components have thicker construction, and different, more durable materials are typically used. For example, the plate grids often contain calcium, cadmium or strontium, to reduce gassing (which causes water loss) and self-discharge. This design is called a lead-calcium battery. The heavier-duty parts ensure that fluid loss is kept to a minimum and that components have a much longer life, making it a closed system.

How it works

The charge of a conventional 12-volt automotive battery is actually 12.6 volts. This can vary slightly, depending on the concentration of the electrolyte in solution. Ideally, for optimum battery performance, the sulfuric acid/water bath should have a specific gravity of 1.265 at 80 degrees Fahrenheit. Specific gravity refers to the weight of a solution, with water having a reference rating of 1.000. The electrolyte in an automotive battery is therefore just slightly over one-and-a-quarter times the weight of regular water.

Battery power rating is measured by two standards. The more popular of these, cold cranking power, determines the amount of current (amps) a battery delivers for 30 seconds at zero degrees Fahrenheit while maintaining a minimum terminal voltage of 7.2 volts: the higher the number, the stronger the battery.

The second standard is called reserve capacity rating. This is a warm weather rating (80 degrees Fahrenheit), which estimates the amount of time it takes the terminal voltage of a fully charged battery to dip below 10.2 (or 1.7 volts per cell) at a continuous discharge rate of 25 amps. The rating is expressed in minutes. For example, a rating of 120 means the battery will run for two hours (120 minutes) before ceasing to function.

A battery has two main cycles, the charge and discharge cycles.In the discharge cycle, a chemical reaction takes place inside the battery in which the lead (Pb) of the negative plates combines with the SO_4 of the sulfuric acid to produce lead sulfate ($PbSO_4$). In this cycle, the electrolyte becomes weaker — specific gravity lessens — and the positive and negative plates become more like one another. Since the voltage, or charge, of a battery depends on the difference between the two plate materials and the concentration of the electrolyte, and since this difference decreases during discharging, the battery loses power. To anyone who has sat in a non-starting car and cranked away as the battery grew weaker and weaker, this scenario will be immediately recognizable.

In the charge cycle, the reverse is true. Electrical current, generated by the car's alternator, passes through the plates, forcing SO_4 back into the electrolyte bath and elevating specific gravity. Voltage increases.

Speaking of charging, there are several different methods used to recharge a depleted battery. The most gentle of these is called trickle-charging. Other methods include quick-charging and slow-charging. See your battery's owner's manual to decide which method may work best for your situation, or talk to your mechanic.

Battery Maintenance

The following tips apply to all batteries, including maintenance-free.

- To ensure good connectivity, clean the terminals periodically with a wire brush.
- When removing a connector from a terminal, twist it from side to side and pull gently upward. Refrain from excessive tugging or prying.
- When reconnecting a connector to a terminal, seat it down firmly on the post. A few gentle whacks from a rubber mallet will do it. Don't over tighten and strip the nut.
- If you keep having electrical problems (battery dies, car won't start, power is intermittent or weak), it's not necessarily the battery. It could be in the charging system, normally either a bad alternator or voltage regulator. A mechanic can test the system to isolate the problem.

These general maintenance tips will extend the life of your battery.