The Automotive Battery

OBJECTIVES

- Describe the different types of batteries
- Discuss the precautions of working on batteries
- Discuss methods of testing of batteries

INTRODUCTION

Contrary to popular belief, the automotive battery does not provide power to a vehicles electrical circuits while the vehicle is operating. In fact, in a properly designed system, the battery provides energy only when the vehicle is starting up. Once the engine is running and the charging system is operational the alternator actually provides all of the energy required by the vehicle to operate.

Battery Categories and Types

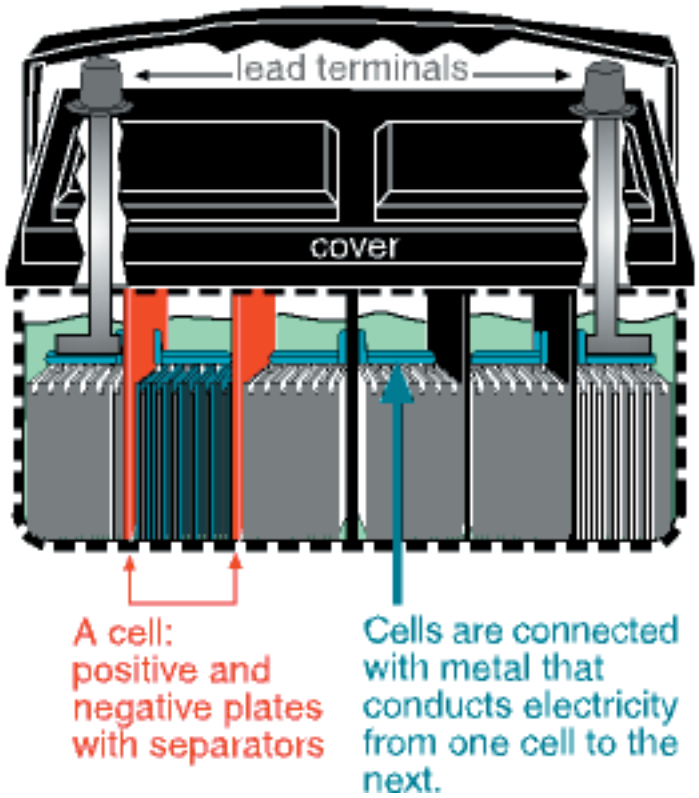
Within the world of batteries there are two different main categories, Primary and Secondary batteries.

Primary Batteries are batteries that cannot be recharged. They are typically a one time use type of battery and are typically thrown away once dead. Batteries that we use in our flashlights and remote controls usually are Primary types batteries. These batteries can range in physical sizes as well as voltages. They can also be made of single cells or multiple cells depending on the application.

Secondary Batteries are batteries that are intended to be discharged and recharged multiple times. The automotive battery falls into the secondary battery category.

The typical automotive battery (often called a 12 Volt battery) actually consists of six (6) separate 2.1 Volt cells. These cells are connected in series and the individual cell voltages add up to create a total voltage. In the case of the automotive battery, six 2.1 Volt batteries in series make up a total voltage of 12.6 Volts.

The automotive battery is composed of several metal plates suspended in a fluid solution called the Electrolyte. This combination of metal and chemical solution stores voltage when a current is passed through the battery. The battery's output potential is based on the surface area of the plates within, and the internal resistance.



Two main types of secondary batteries exist for the automotive environment and many other industrial batteries follow the same philosophies.

- Cranking batteries are used for starting the vehicle. They provide higher current bursts on a short-term basis but do not withstand being totally discharged. These batteries can be "deep cycled' (voltage reduced by 25%) only a couple of times before the battery loses its ability to filter noise and its reliability becomes questionable. Any time a cranking battery has been deep cycled it should be considered damaged and have it known that it will never be able to reach its full potential again.

- Deep cycle batteries have thicker internal plates, which allow them to be discharged many times without significant damage. While their design makes them less susceptible to damage they do tend to produce current at a slower rate than the cranking battery. Because of this they are not usually a good choice to use in place of a cranking battery. Deep cycle batteries are typically a good choice for the second battery option in an audio system as it can be run dead and recharged multiple time.

Another choice to be made in the realm of automotive batteries is what construction type to use. Aside from the standard lead-acid type of battery there are also other types such as the gel-cell and absorbed glass matt batteries

Absorbed Glass Matt or AGM style batteries are similar to a sealed type of battery with one big difference. Instead of the conductive plates suspended in an acid solution, the electrolyte is actually suspended in the glass matt separators. This close proximity to the plates helps to enhance both the discharge and recharge efficiency.

Gel Cell batteries are similar to AGM batteries in that their electrolyte is suspended but unlike the AGM battery it is not considered a wet cell battery. A gel cell batteries electrolyte has a silica additive in it that causes it to set up or stiffen. The big advantage of these types of batteries is that they can be mounted in multiple positions without worry that the electrolyte will leak out. One main drawback is that they typically require lower recharge voltages and longer recharge times so as not to produce too much gas too quickly causing the potential for rupture or explosion.

Specifications

Batteries are normally measured in Cold Cranking Amperes (CCA) and Reserve Capacity (RC). The CCA test is performed with the battery chilled to 0°F or -18°C and connected to a load that will force the voltage to fall to 7.2 volts when measured at the battery posts. The current that is produced at 7.2 volts is the CCA rating.

Ampere-Hours is a now defunct method of rating but still may be used to approximate the length of time until a battery will require charging. A 200 AH battery could provide 200 amps for one hour or 100 amps for 2 hours or 50 amps for 4 hours, and so on.

Reserve Capacity is the amount of time in minutes that a battery can supply 25 amps without the voltage falling below 10.5 volts. Based on the amp-hour idea, if a battery had a 180 minute reserve capacity, it could be called upon to deliver 50 amps for 90 minutes and 100 amps for 45 minutes.

The Battery as a Filter

This task of filtering has to do with the voltage arriving from the alternator to the vehicle electrical system. Voltage from the alternator is actually AC voltage that is rectified to a DC signal. This rectified signal if left unfiltered by the battery would introduce incredible noise to most audio systems. The concept of "rectification" will be discussed in greater detail as we discuss alternators.

Precautions When Working Around Batteries

There are several potentially hazardous conditions that can occur when working on or around batteries. Mobile electronics installers must take precautions when performing duties that involve the automotive battery.

Electrolyte

The fluid contained in an automotive battery contains Sulfuric Acid. This powerful corrosive can cause serious injury when it comes in contact with exposed skin or your eyes. Use the following precautions when exposed to battery fluids:

- Always wear safety goggles and rubber gloves when working with battery fluids. This is especially important when removing or replacing batteries.
- Any electrolyte spilled on exposed skin should immediately be rinsed with water.
- Any electrolyte that comes in contact with your eyes should be thoroughly rinsed out with water, get medical attention as soon as possible.
- If you ingest any electrolyte , immediately ingest a large amount of water or milk. Seek medical attention immediately.

In addition to the potential for bodily injury, electrolyte is also a hazard to your clothing, vehicle painted finishes, and will act as a corrosive to virtually any metal surfaces in the vehicle. BE CAREFUL!

Hydrogen Gas

Hydrogen gas is a by-product of the chemical reaction taking place in the battery. All automotive batteries produce Hydrogen gas all of the time. Hydrogen gas levels increase when the battery is being charged whether by the alternator or an external battery charger. Hydrogen gas is extremely flammable, use the following precautions when working around automotive batteries:

- Always ensure that you are working in a well ventilated area. Gases produced by the battery must be able to vent away from the engine compartment.
- Never expose devices that may serve as an ignition source for the gas to come near the battery. Cigarettes, soldering guns, propane torches or other ignition sources should never be operated near the battery.
- Never remove battery terminals while the engine or any vehicle electrical systems are operating. A spark could be caused between the terminal and the connector if current is moving through the vehicles electrical system.

General Precautions When Working On a Battery

- Keep metallic tools away from battery terminals when working on a battery. Any metallic object that comes in contact with both the positive and negative terminals will cause a dead short and could result in injury or damage to the electrical system. This can also occur if a metal object comes in contact between the batteries positive terminal and the chassis of the vehicle.
- Do not wear any metal jewelry when working on batteries. Rings or necklaces that come in contact between the positive and negative terminals could cause injury and damage.
- Protect vehicle finishes when moving automotive batteries.

Testing the Batteries Voltage

This activity involves locating and checking the batteries voltage levels under different operational conditions.

Step 1 - Put on your safety glasses. Locate the vehicles battery by opening the vehicles engine compartment and examining the area for an automotive battery. If you can not find the battery consult the vehicles owners manual to find the batteries location. While most vehicles house the battery in the engine compartment some foreign vehicles locate the battery in the trunk area, under one of the seats or in the case of rear engine vehicles the battery may even be located in the front of the vehicle under the hood.

Step 2 - Identify the batteries positive (+) and negative (-) terminals. These terminals should be labeled on the battery as (+) and (-) symbols. Set your multimeter to read DC voltage of 14 volts or higher. Attach the multimeters negative probe to the batteries negative (-) terminal. Connect the multimeters positive probe to the batteries positive (+) terminal. Reference the chart below for the appropriate battery voltage readings based on the battery's internal temperature and State of Charge (SoC).

Electrolyte Temperature (Fahrenheit)	Electrolyte Temperature (Celsius)	100% SoC	75% SoC	50% SoC	25% SoC	0% SoC
120°	48.9°	12.663	12.463	12.253	12.073	11.903
110°	43.3°	12.661	12.462	12.251	12.071	11.901
100°	37.8°	12.658	12.458	12.248	12.068	11.898
90°	32.2°	12.655	12.455	12.245	12.065	11.895
80°	26.7°	12.650	12.450	12.240	12.060	11.890
70°	21.1°	12.643	12.443	12.233	12.053	11.883
60°	15.6°	12.634	12.434	12.224	12.044	11.874
50°	10.0°	12.622	12.422	12.212	12.032	11.862
40°	4.4°	12.606	12.406	12.196	12.016	11.846
30°	-1.1°	12.588	12.388	12.178	11.998	11.828
20°	-6.7°	12.566	12.366	12.156	11.976	11.806
10°	-12.2°	12.542	12.342	12.132	11.952	11.782
0°	-17.8°	12.516	12.316	12.106	11.926	11.756

Step 3 - Leave the multimeter connected as in "Step #2". Using the ignition key, switch the vehicles ignition to the ignition (RUN) position. Do not start the motor. With all of the vehicles electrical components turned ON (radio, heater/AC, wipers, etc.) take a second voltage reading at the battery. Under load the battery voltage should not drop below the indicated voltages on the table below.

Electrolyte Temperature Fahrenheit	Electrolyte Temperature Celsius	Minimum Voltage Under LOAD
100°	37.8°	9.9
90°	32.2°	9.8
80°	**26.7°**	**9.7**
70°	21.1°	9.6
60°	15.6°	9.5
50°	10.0°	9.4
40°	4.4°	9.3
30°	-1.1°	9.1
20°	-6.7°	8.9
10°	-12.2°	8.7
0°	-17.8°	8.5

Another option to testing a battery is using a battery load tester. This device is used to simulate a high current load on the battery for a short period of time.

Based on what the voltage level drops to under load you can tell if the battery can be considered good or not. The main different between testing the voltage in the car under load and using a separate load tester is that the battery must be isolated from the vehicles electrical system prior to testing. This means that before using the load tester you should remove both battery cables from the battery terminals.

If you suspect a battery is defective, it can also, be tested with an inexpensive device called a hydrometer. Each of the six cells in a 12 volt automotive battery should be within .050 of each other and the specific gravity of a fully charged battery should be about 1.270 when the battery is at 80°F. This method will not work however on either the sealed case or gel cell type batteries. This test however should not be attempted within 15 minutes of charging since the electrolyte will not be stable. Refer to the chart below for specific gravity levels at various battery temperatures.

Electrolyte Temperature (Fahrenheit)	Electrolyte Temperature (Celsius)	100% SoC	75% SoC	50% SoC	25% SoC	0% SoC
120°	48.9°	1.249	1.209	1.174	1.139	1.104
110°	43.3°	1.253	1.213	1.178	1.143	1.108
100°	37.8°	1.257	1.217	1.182	1.147	1.112
90°	32.2°	1.261	1.221	1.186	1.151	1.116
80°	26.7°	1.265	1.225	1.190	1.155	1.120
70°	21.1°	1.269	1.229	1.194	1.159	1.124
60°	15.6°	1.273	1.233	1.198	1.163	1.128
50°	10.0°	1.277	1.237	1.202	1.167	1.132
40°	4.4°	1.281	1.241	1.206	1.171	1.136
30°	-1.1°	1.285	1.245	1.210	1.175	1.140
20°	-6.7°	1.289	1.249	1.214	1.179	1.144
10°	-12.2°	1.293	1.253	1.218	1.183	1.148
0°	-17.8°	1.297	1.257	1.222	1.187	1.152

Typically prior to testing a battery you should also remove what is known as the surface charge. This involves turning on the high beam headlights for five minutes and the letting then battery rest for ten additional minutes prior to testing or you can use a battery load tester by applying half of the battery's CCA rating for 15 seconds and then letting it rest for ten minutes.