

Study on Types of Batteries Used In Electric Vehicles

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Abstract

An electric-vehicle battery (EVB) or traction battery is a battery used to power the propulsion of battery electric vehicles (BEVs). Vehicle batteries are usually a secondary (rechargeable) battery. Traction batteries are used in forklifts, electric golf carts, riding floor scrubbers, electric motorcycles, electric cars, trucks, vans, and other electric vehicles.

Electric-vehicle batteries differ from starting, lighting, and ignition (SLI) batteries because they are designed to give power over sustained periods of time. Deep-cycle batteries are used instead of SLI batteries for these applications. Traction batteries must be designed with a high ampere-hour capacity. Batteries for electric vehicles are characterized by their relatively high power-to-weight ratio, energy-to-weight ratio and energy density; smaller, lighter batteries reduce the weight of the vehicle and improve its performance. In this paper different types of electric car batteries are studied and it is found that lithium ion batteries are most useful for electric vehicle car.

Keywords: BEV, EVB, SLI, lithium ion batteries.

INTRODUCTION

The heart of an electric car is its battery. Unlike the batteries in most cars, which primarily serve to start the engine and run accessories like the radio or air

conditioner, the battery in an electric car runs everything. Most importantly, it runs the electric motor -- or, more precisely, it runs a controller which in turn runs the electric motor -- so it needs to be powerful

and long-lasting enough to take drivers where they need to go with a minimum of recharging. Until recently, no reliable, mass-producible batteries have been manufactured that could make electric cars competitive with gas-powered cars. A battery is a device for storing chemical energy and converting that chemical energy into electricity. A battery is made up of one or more electrochemical cells, each of which consists of two half-cells or electrodes. One half-cell, called the negative electrode, has an overabundance of the tiny, negatively charged subatomic particles called electrons. The other, called the positive electrode, has a deficit of electrons. When the two halves are connected by a wire or an electrical cable, electrons will flow from the negative electrode to the positive electrode. We call this flow of electrons electricity. The energy of these moving electrons can be harnessed to do work running a motor, for instance. As electrons pass to the positive side, the flow gradually slows down and the voltage of the electricity produced by the battery drops. Eventually, when there are as many electrons on the positive side as on the negative side, the battery is considered 'dead' and is no longer capable of producing an electric flow. The electrons are generated by chemical reactions, and there are many different

chemical reactions that are used in commercially available batteries. In a rechargeable battery, electrical energy is used to reverse the negative and positive halves of the electrochemical cells, restarting the electron flow.

Automobile manufacturers have identified three types of rechargeable battery as suitable for electric car use. Those types are lead-acid batteries, nickel metal hydride (NiMH) batteries, and lithium-ion (Li-ion) batteries.

Lead-acid batteries

Lead-acid batteries were invented in 1859 and are the oldest form of rechargeable battery still in use. They've been used in all types of cars -- including electric cars -- since the 19th century. Lead-acid batteries are a kind of wet cell battery and usually contain a mild solution of sulfuric acid in an open container. The name comes from the combination of lead electrodes and acid used to generate electricity in these batteries. The major advantage of lead-acid batteries is that, after having been used for so many years, they are well understood and cheap to produce. However, they do produce dangerous gases while being used and if the battery is overcharged there's a risk of explosion. Lead acid batteries have seen used in

conventional petroleum driven vehicles and are relatively inexpensive. However, this type of battery has a poor specific energy (34 Wh/kg)

Nickel metal hydride (NiMH) batteries

Nickel metal hydride batteries came into commercial use in the late 1980s. They have a high energy density that is, a great deal of energy can be packed into a relatively small battery and don't contain any toxic metals, so they're easy to recycle. NiMH batteries are considered to be superior, as they can have up to double the specific energy (68 Wh/kg) compared with lead acid batteries. This allows electric vehicles that utilize NiMH batteries to be significantly lighter, leading to reduced energy cost for propelling the BEVs. Similarly, NiMH batteries also have greater energy density compared to lead acid batteries, which will allow the battery system to be contained within a smaller space. Though, NiMH batteries do have some drawbacks, such as having lower charging efficiencies than the other batteries. There is also a major issue with self-discharge (up to 12.5% per day under normal room temperature conditions) that is exacerbated when the batteries are in a high temperature environment. This makes NiMH batteries less ideal for hotter environments. [4]

Lithium-ion batteries, which came into commercial use in the early 1990s, have a very high energy density and are less likely than most batteries to lose their charge when not being used a property called self discharge. Because of their light weight and low maintenance requirements, lithium-ion batteries are widely used in electronic devices such as laptop computers. Some experts believe that lithium-ion batteries are about as close as science has yet come to developing a perfect rechargeable battery, and this type of battery is the best candidate for powering the electric cars of the near future. A variation on lithium-ion batteries, called lithium-ion polymer batteries, may also prove valuable to the future of EVs. These batteries may eventually cost less to build than lithium-ion batteries; however, at the present time, lithium-ion polymer batteries are prohibitively expensive. There are many types of Li-ion batteries that each has different characteristics, but vehicle manufactures are focused variants that have excellent longevity. Compared to other mature battery technologies, Li-ion offers many benefits. For example, it has excellent specific energy (140 Wh/kg) and energy density, making it ideal for battery electric vehicles. Li-ion batteries are also excellent in retaining energy, with a self-discharge rate (5% per month) that an

order of magnitude lower than NiMH batteries. However, Li-ion batteries also have some drawbacks as well. Comparatively, Li-ion batteries have been a very expensive battery technology. [5] There are also major safety concerns regarding the overcharging and overheating of these batteries. Li-ion can experience a thermal runaway, which can trigger vehicle fires or explosions. There had been several instances where the Tesla Model S, which utilized Li-ion batteries, had infamously caught on fire due to issues with fluctuating charging or damage

to the battery. [3] A lithium anode has been the holy grail for a long time because it can store a lot of energy in a small space (i.e. it has a high energy density) and is very lightweight. Unfortunately, lithium heats up and expands during charging, causing leaked lithium ions to build up on a battery's surface. These growths short-circuit the battery and decrease its overall life. Researchers at Stanford recently made headway on these problems by forming a protective nanosphere layer on the lithium anode that moves with the lithium as it expands and contracts. [6]

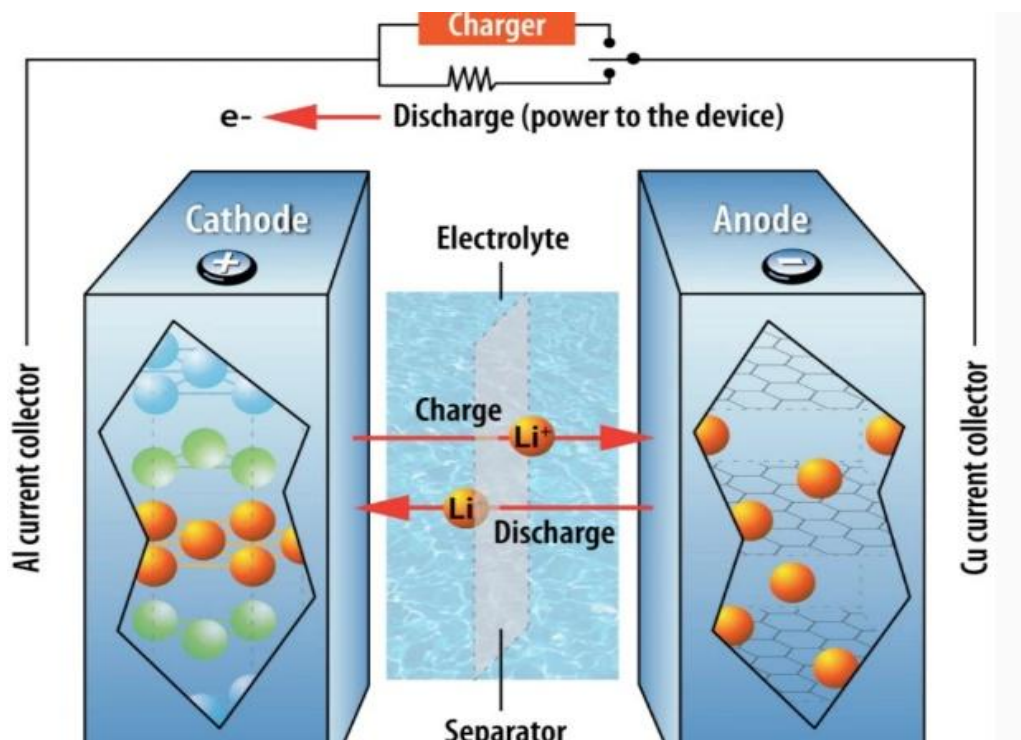


Fig 1: Movement of lithium ions and electrons in a lithium-ion battery during charging and use. [6]

A rechargeable battery is useless unless you have a place to recharge it. Unfortunately, recharging the large array of batteries in an electric car can take several hours, and most gas stations would prefer that you didn't block their lanes for that long. The best solution to the recharging problem is to take the car home in the evening and plug it in, similar to the way you might plug in a laptop, so that it can recharge overnight. Once an EV has been recharged, how far will it go before it needs to be recharged again? This depends on a number of factors, including the type of battery in the vehicle. EVs using lead-acid batteries have the shortest range around 80 miles (128.7 km) on a single charge. NiMH batteries turn in a better performance, with a range of about 120 miles (193.1 km) per charge. This is where lithium-ion batteries excel, with a range of more than 220 miles (354.1 km) per charge. The range of an EV can be extended even further with a technology known as regenerative braking, which uses the kinetic energy of the car's brakes to recharge the battery on the fly. Under optimum driving conditions, regenerative braking can extend the car's range up to 50 percent, though in most situations the gain in driving range will be smaller. [5]

CONCLUSION

Battery electric vehicles have become a significant segment of the automotive market. Electric vehicles will undoubtedly become more commonplace as batteries are improved. Advancements in batteries could not only transform the transportation industry, but they could also significantly affect global energy markets.

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