

THE IMPACTS OF OVERCHARGING ON BATTERY LIFE AND PERFORMANCE: WHAT YOU NEED TO KNOW

Batteries have become integral to our daily lives, powering everything from our smartphones to electric vehicles and renewable energy storage systems. However, while batteries have evolved in terms of efficiency and capacity, improper charging practices can have profound effects on their overall lifespan and performance characteristics. Among the various charging-related concerns, overcharging stands out as a significant factor that can detrimentally affect battery health.

Before discussing the consequences of overcharging, let us understand the fundamentals of battery charging. Consider batteries as miniature energy-storing chemical factories. Reversing these chemical processes through charging converts electricity back into energy storage. The following key stages make up the charging process:

1) Bulk Charge Stage - Initially, when you connect a discharged battery to a charger, the charger usually applies a constant current to the battery. This means that the charger supplies a fixed amount of current, usually at a higher level, to push electrons back into the battery at a relatively fast rate. During this phase, the voltage across the battery gradually increases as it starts absorbing more energy.

2) Absorption Stage - As the battery charges and its voltage increases, it approaches its full capacity. At a certain voltage, the charger switches from providing a constant current to supplying a constant voltage. This voltage is often referred to as the absorption voltage. During this phase, the charging current gradually decreases as the battery becomes closer to being fully charged. This current safely brings up the charge without overheating it.

3) Float Charge Stage - The float charge stage is a phase in the battery charging process that occurs after the battery has been fully charged. It's a maintenance phase designed to keep the battery at a fully charged state without subjecting it to the continuous stress of being overcharged.

The transition from the bulk charging phase to the float charging phase is important for preventing overcharging. Overcharging occurs when you continue to apply voltage and current to a fully charged battery. This can lead to various issues, including excessive heat generation, electrolyte decomposition, and even physical damage to the battery. Modern battery charging systems, especially for lithium-ion batteries, incorporate circuitry to monitor voltage and current and to automatically switch to a lower charging rate or stop charging when the battery is fully charged.



Now, let's delve into the consequences of upsetting the charging equilibrium. Picture overcharging as pouring water into the glass until it spills over – except, with batteries, the consequences are far more severe and here are some of the following:

1) Reduced Lifespan: Overcharging heats up the battery and speeds up the deterioration of internal parts. If a battery is consistently overcharged for extended periods, this can further shorten its lifespan.

Overcharging subjects the battery to stress, which can lead to the formation of tiny needle-like structures known as lithium dendrites. These dendrites are made up of metallic lithium and tend to grow on the battery's anode (the negative electrode). The formation of dendrites is a gradual process that occurs over multiple charge and discharge cycles. When these dendrites pierce through the separator (barrier between the anode and cathode), it may lead to internal short circuit.

Overcharging may make your battery dangerous. It might burst, leak, or even catch fire. These major safety risks must be avoided at all costs.

2) Performance Degradation: Batteries, like athletes, lose their edge with time. This aging process is accelerated by overcharging. When a battery is overcharged, it continues to receive an excessive amount of electrical energy, resulting in increased heat generation that can lead to decomposition of the cell materials.

Overcharging can cause the electrolyte (the liquid or gel substance inside the battery) to breakdown more quickly that can result in the formation of gas (oxygen and hydrogen), increased internal resistance, and potential leakage, all of which can damage the battery. This can also lead to the plating of metallic lithium on battery's anode that can create unwanted deposits that reduce the battery's capacity and overall performance.

3) Thermal Runaway: The process of thermal runaway starts with an increase in temperature due to factors like overcharging, physical damage, or exposure to high temperatures.

Thermal runaway is a critical safety concern in the context of battery operation and can occur due to an internal short circuit that may be caused by physical damage to the battery or poor battery maintenance practices.

Overcharging also increases the risk of thermal runaway. Thermal runaway is a dangerous cycle where rising temperatures within the battery lead to more chemical reactions, which generate even more heat. This self-sustaining process can escalate rapidly and is a significant safety concern. When thermal runaway occurs, it can result in the release of gases, increased pressure, and ultimately, the potential for a battery to rupture or explode.



A Battery Management System (BMS) plays a pivotal role in preventing overcharging of batteries, offering several important benefits in terms of safety, performance, and overall battery health. They are circuits that monitor and manage all of the battery's performance. It keeps a tight eye on the charging procedure and intervenes to stop any energy overflow. It achieves this by regulating the charging voltage and current to ensure that the battery does not receive excessive energy that could lead to damage or thermal runaway.

To put it simply, overcharging batteries is like subjecting them to an arbitrary endurance test. They become less effective, less strong, and in certain situations, it might be dangerous. Therefore, remember to regularly charge and gently top off your gadget the next time you put it in. If your device has a BMS, be aware of how important it is to the health and performance of your battery. It's crucial to understand and follow proper charging procedures to maximize battery lifespan, ensure safe operation, and avoid overcharging-related consequences.

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