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White Paper: Omnicharge Battery Cycle & Performance Whitepaper

Understanding Lithium-Ion Battery Behavior in Portable Chargers

Portable power has become an essential part of modern mobile computing. From laptops and tablets to cameras and professional electronics, reliable portable energy allows users to work and create without being constrained by wall outlets.

Omnicharge portable chargers are designed to deliver high-performance mobile power through advanced lithium-ion battery technology and intelligent power management systems. These portable chargers are engineered to provide stable output, efficient energy delivery, and long operational lifespan.

Like all rechargeable battery systems used in modern electronics, lithium-ion batteries are **consumable components that gradually age over time**. This aging process affects battery capacity, power delivery capability, and overall battery health.

This whitepaper explains how lithium-ion batteries function inside portable chargers, how battery aging occurs, and the factors that influence long-term battery performance.

1. Lithium-Ion Batteries in Portable Chargers

Lithium-ion batteries are widely used in modern portable electronics because they offer an optimal balance of **energy density, efficiency, and power capability.**

For portable chargers, these characteristics are essential.

High Energy Density

Portable chargers must store significant energy within a compact and lightweight form factor. Lithium-ion batteries provide substantially higher energy density than traditional rechargeable battery chemistries, enabling Omnicharge power banks to deliver laptop-class energy storage in a portable design.

High Power Capability

Omnicharge portable chargers are designed not only for smartphones but also for high-power devices such as laptops and professional electronics. Lithium-ion cells are capable of delivering high discharge currents when paired with advanced power regulation systems.

Efficient Energy Conversion

Lithium-ion batteries typically achieve high charge and discharge efficiency. Combined with Omnicharge's optimized power conversion architecture, this allows stored energy to be delivered efficiently to connected devices.

Low Self-Discharge

Compared with older battery technologies, lithium-ion batteries have relatively low self-discharge rates. This means a portable charger can retain stored energy for extended periods when not in use.

Despite these advantages, lithium-ion batteries experience gradual chemical aging, which is a natural characteristic of the technology.

2. Chemical Aging of Lithium-Ion Batteries

All rechargeable batteries used in portable electronics - including those inside Omnicharge portable chargers - gradually become less effective as they **chemically age**. This aging occurs as a result of both time and repeated charging and discharging.

As lithium-ion batteries age, gradual changes occur in the internal materials of the battery cells. These changes affect the battery's ability to store energy and deliver power. Chemical aging is a natural characteristic of lithium-ion battery technology and occurs in all rechargeable battery systems used across the electronics industry.

Battery Capacity and Runtime

One of the most visible effects of battery aging is a reduction in maximum battery capacity.

Battery capacity represents the total amount of energy that can be stored in the battery relative to when it was new.

For example:

- A new portable charger begins at **100% design capacity**
- Over time, the battery may retain **90% or 80%** of its original capacity

As capacity declines, the portable charger will still operate normally, but the **total energy available for charging external devices decreases**. This may result in fewer charging sessions before the portable charger itself needs to be recharged.

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Capacity reduction occurs gradually and is a normal characteristic of rechargeable lithium-ion batteries.

Battery Impedance and Peak Power Delivery

In addition to total capacity, batteries also have a characteristic known as **peak power capability** - the ability to deliver energy quickly when high power demand occurs.

A key factor influencing peak power capability is **battery impedance**.

Battery impedance represents the internal resistance within the battery that affects how easily electrical current can flow. As lithium-ion batteries chemically age, their internal impedance gradually increases.These behaviors are normal characteristics of lithium-ion battery chemistry.

When a device draws power from a battery with relatively high internal resistance, the battery voltage will drop more significantly. Electronic components require a minimum operating voltage in order to function properly.

The device's **BMS (Battery Management System)** evaluates the battery's current ability to deliver power and manages the system load accordingly to maintain normal operation. When the BMS determines that the battery can no longer support the system's operation, the system may initiate a shutdown. Although this shutdown is a proactive measure taken by the device to protect the system, from the user's perspective it may appear to occur quite suddenly.

3. Understanding Battery Charge Cycles

Battery lifespan is often described using **charge cycles**.

A charge cycle represents the cumulative use of **100% of the battery's capacity**, but this does not need to occur in a single discharge.

For example:

- Using 50% of the battery today
- Recharging the portable charger
- Using another 50% later

Together equals **one full charge cycle**.

For portable chargers, cycles accumulate based on the total energy delivered to connected devices.

High-quality lithium-ion batteries used in professional portable chargers are typically designed to maintain strong performance across **hundreds of charge cycles**, though actual lifespan depends on operating conditions.

4. Battery Capacity Retention

Battery max capacity describes the current condition of a battery relative to its original performance.

A new battery begins with 100% max capacity, representing its original design capacity.

Over time, battery max capacity gradually declines as the battery ages.

For example:

- 100% max capacity → original capacity
- 90% max capacity → battery retains 90% of original energy storage
- 80% max capacity → battery retains 80% of original capacity

Battery health decreases progressively due to both **usage cycles and calendar aging**.

This gradual change is expected for all rechargeable lithium-ion batteries and does not indicate a product defect.

5. Factors That Influence Battery Health

Lithium-ion batteries achieve optimal performance and longevity at an operating temperature of approximately 25 °C. Exposure to temperatures outside the recommended range can accelerate the chemical aging processes within the battery. Over time, this accelerated aging may lead to faster capacity loss and reduced overall battery lifespan.

Several environmental and operational conditions can influence how quickly battery aging occurs.

Temperature

High temperatures accelerate chemical reactions inside lithium-ion batteries and can significantly increase long-term aging.

Portable chargers should ideally be operated and stored within moderate temperature ranges.

Depth of Discharge

Frequent deep discharges - fully draining the battery before recharging - can increase stress on battery cells.

Partial discharge cycles typically result in lower long-term battery wear.

Charging Conditions

Charging a portable charger in high ambient temperatures can contribute to accelerated battery aging.

Long-Term Storage

If a portable charger is stored for extended periods:

- very high temperatures
- extremely low battery levels
- Fully charged states for long durations

can accelerate capacity loss.

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