Battery Performance Characteristics

Objective

The basic battery design, performance depends on how the batteries are used and on the environmental conditions under which they are used, but these conditions are rarely if ever, specified in mass-market advertising. For the consumer this can be very confusing or misleading. The battery industry itself however does not use such vague terms to specify battery performance and specifications normally include a statement defining or limiting the operating or environmental conditions within which the claimed performance can be delivered.

Batteries may be advertised as Long Life, High Capacity, High Energy, Deep Cycle, Heavy Duty, Fast Charge, Quick Charge, Ultra, and other, well defined, parameters and few industries or legal standards are defining exactly what each of these terms means. Advertising words can mean whatever the seller wants them to mean.

The following section outlines key parameters used to characterize the cells or batteries and shows how these parameters may vary with the operating conditions.

Key Characteristics

- Temperature Characteristics
- Self-Discharge Characteristics
- Charging Characteristics

Temperature Characteristics

All batteries depend for their action on an electrochemical process whether charging or discharging and we know that these chemical reactions are in some way dependent on temperature. Nominal battery performance is usually specified for working temperatures somewhere in the 27 (±3) °C range however the actual performance can deviate.

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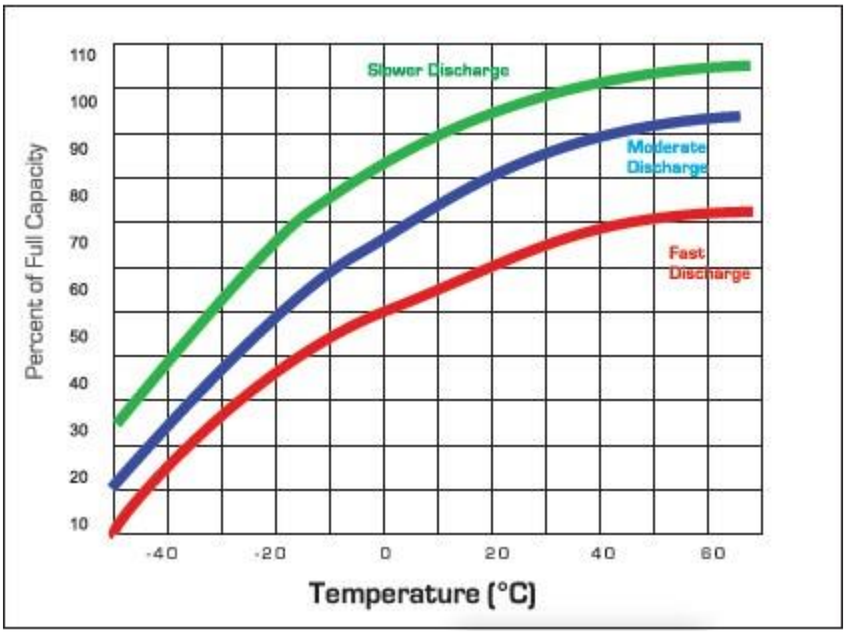
substantially from this if the battery is operated at higher or lower temperatures. See Temperature Characteristics for typical performance graphs.

Arrhenius Law tells us that the rate at which a chemical reaction proceeds, increases exponentially as temperature rises. This allows more instantaneous power to be extracted from the battery at higher temperatures. At the same time higher temperatures improve electron or ion mobility reducing the cell's internal impedance and increasing its capacity.



The above graph shows how the performance of Lead Acid batteries varies at different temperatures. If the temperature in the battery is very low (Red curve). Then battery discharge at a faster rate. And if the temperature of the battery is in between the ambient temperature then the battery discharge at moderate rate and if the temperature is above 30 Degree that mean battery performs well.

Self-Discharge Characteristics

The self-discharge rate is a measure of how quickly a cell will lose its energy while sitting on the shelf due to unwanted chemical actions within the cell. The rate depends on cell chemistry and the temperature.

The following shows the typical shelf life for some primary cells:

- Zinc Carbon (LaChance) 2 to 3 years
- Alkaline 5 years
- Lithium 10 years or more

Typical self-discharge rates for common rechargeable cells are as follows:

- Lead Acid 3 to 4%per month

- Nickel Cadmium 15% to 20% per month
- Nickel Metal Hydride 30% per month
- Lithium 2% to 3% per month

The rate of secondary reactions that cause internal current leakage between the positive and negative electrodes of the cell, like all chemical reactions, increases with temperature thus increasing the battery self-discharge rate.

Charging Characteristics

More batteries are damaged by bad charging techniques than all other causes combined.
The battery charging process thus has at least three characteristic time constants associated with achieving the complete conversion of the active chemicals which depend on both the chemicals employed and on the cell construction. The time constant associated with the charge transfer could be one minute or less, whereas the mass transport time constant can be as high as several hours or more in a large high-capacity cell. This is one of the reasons why cells can deliver or accept very high pulse currents, but much lower continuous currents. (Another major factor is the heat dissipation involved). These phenomena are nonlinear and apply to the discharging process as well as to charging. There is thus a limit to the charge acceptance rate of the cell. Continuing to pump energy into the cell faster than the chemicals can react to the charge can cause local overcharge conditions including polarization, overheating as well as unwanted chemical reactions, near to the electrodes thus damaging the cell. Fast charging forces up the rate of chemical reaction in the cell (as does fast discharging) and it may be necessary to allow "rest periods" during the charging process for the chemical actions to propagate throughout the bulk of the chemical mass in the cell and to stabilize at progressive levels of charge.

Basic Charging Methods

- **Constant Voltage** In this mode of charging the voltage is kept at certain volts and the current will be down to float current. A constant voltage charger is a DC power supply which in its simplest form may consist of a step-down transformer from the mains with a rectifier to provide the DC voltage to charge the battery. Such simple designs are often found in cheap car battery chargers. The lead-acid cells used for cars and backup power systems typically use constant voltage chargers. Besides, lithium-ion cells often use constant voltage systems, although these usually are more complex with added circuitry to protect both the batteries and user safety.

- **Constant Current** Constant current chargers vary the voltage they apply to the battery to maintain a constant current flow, switching off when the voltage reaches the level of a full charge. This design is usually used for nickel-cadmium and nickel-metal hydride cells or batteries.

- **Taper Current** This is charging from a crude unregulated constant voltage source. It is not a controlled charge as in V Taper above. The current diminishes as the cell voltage (back emf) builds up. There is a danger of damaging the cells through overcharging. To avoid this the charging rate and duration should be limited. Suitable for SLA batteries only.

- **Pulsed charge** Pulsed chargers feed the charge current to the battery in pulses. The charging rate (based on the average current) can be precisely controlled by varying the width of the pulses, typically about one second.

During the charging process, short rest periods of 20 to 30 milliseconds, between pulses allow the chemical actions in the battery to stabilize by equalizing the reaction throughout the bulk of the electrode before recommencing the charge. This enables the chemical reaction to keep pace with the rate of inputting electrical energy. It is also claimed that this method can reduce unwanted chemical reactions at the electrode surface such as gas formation, crystal growth, and passivation. It is also possible to sample the open-circuit voltage of the battery during the rest period.

Conclusion

Temperature, self-discharge & charging are the main key points that decide the battery life.
If we focus on these points. it helps to perform battery in a better way. Monitoring of temperature & Charging at regular interval of time gives an advantage to battery life.

Eastman Batteries are known for their proven performance. Our batteries are known to withstand temperatures of wide operating ranges. We have been successful in installing our battery achieving performance characteristics.