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Battery Capacity

"Battery capacity" is a measure (typically in Amp-hr) of the charge stored by the battery, and is determined by the mass of active material contained in the battery. The battery capacity represents the maximum amount of energy that can be extracted from the battery under certain specified conditions. However, the actual energy storage capabilities of the battery can vary significantly from the "nominal" rated capacity, as the battery capacity depends strongly on the age and past history of the battery, the charging or discharging regimes of the battery and the temperature.

Units of Battery Capacity: Ampere Hours

The energy stored in a battery, called the battery capacity, is measured in either watt-hours (Wh), kilowatt-hours (kWh), or ampere-hours (Ahr). The most common measure of battery capacity is Ah, defined as the number of hours for which a battery can provide a current equal to the discharge rate at the nominal voltage of the battery. The unit of Ah is commonly used when working with battery systems as the battery voltage will vary throughout the charging or discharging cycle. The Wh capacity can be approximated from the Ahr capacity by multiplying the AH capacity by the nominal (or, if known, time average) battery voltage. A more accurate approach takes into account the variation of voltage by integrating the AH capacity $\times V(t)$ over the time of the charging cycle. For example, a 12 volt battery with a capacity of 500 Ah battery allows energy storage of approximately $100 \text{ Ah} \times 12 \text{ V} = 1,200 \text{ Wh}$ or 1.2 KWh. However, because of the large impact from charging rates or temperatures, for practical or accurate analysis, additional information about the variation of battery capacity is provided by battery manufacturers.

Impact of Charging and Discharging Rate on Capacity

The charging/discharging rates affect the rated battery capacity. If the battery is being discharged very quickly (i.e., the discharge current is high), then the amount of energy that can be extracted from the battery is reduced and the battery capacity is lower. This is due to the fact the necessary components for the reaction to occur do not necessarily have enough time to either move to their necessary positions. The only a fraction of the total reactants are converted to other forms, and therefore the energy available is reduced. Alternately, if the battery is discharged at a very slow rate using a low current, more energy can be extracted from the battery and the battery capacity is higher. Therefore, the battery of capacity

should include the charging/discharging rate. A common way of specifying battery capacity is to provide the battery capacity as a function of the time in which it takes to fully discharge the battery (note that in practice the battery often cannot be fully discharged).

Temperature

The temperature of a battery will also affect the energy that can be extracted from it. At higher temperatures, the battery capacity is typically higher than at lower temperatures. However, intentionally elevating battery temperature is not an effective method to increase battery capacity as this also decreases battery lifetime.

Age and history of battery

The age and history of the battery have a major impact on the capacity of a battery. Even when following manufacturers specifications on DOD, the battery capacity will stay at or close to its rated capacity for a limited number of charge/discharge cycles. The history of the battery has an additional impact on capacity in that if the battery has been taken below its maximum DOD, then battery capacity may be prematurely reduced and the rated number of charge/discharge cycles may not be available.

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