

## Charge Method

### 1 General

Choose the appropriate charging method according to the application and conditions of CSB Battery to get full performance from the battery. Methods available are: semi-constant current charging method, constant current charging method, constant voltage charging method, and two-step constant voltage method. The semi-constant voltage method and constant voltage method are generally used for batteries with cycle servicing. The constant voltage charging method is generally used for standby servicing (trickle or float). Also, the semi-constant current charging method is used for supplementary charging of the battery with extended storage period. Recently the two-step voltage charging method is being used for rapid charging of the VRLA battery. Please refer to Table 1 for an explanation of the charging methods and their features.

Table 1: Sealed lead-acid battery charging methods and features

Charging method	Cycle service	Standby (trickle or float)	Supplementary charge	Characteristics diagram
Semi-constant current charging (simplified charging)	<ul style="list-style-type: none"> <li>✓ Charging is possible within a relatively short period</li> <li>✓ Overcharge is easy because it is difficult to control the charging current</li> <li>✓ Low cost</li> </ul>	Not applicable	<ul style="list-style-type: none"> <li>✓ Charging possible within a relatively short period</li> <li>✓ Suitable for charging batteries connected in a series. Control of the time is necessary to prevent overcharging</li> </ul>	Figure 1
Constant current charging	<ul style="list-style-type: none"> <li>✓ Charging is possible within a relatively short period</li> <li>✓ Protective circuit required to prevent overcharge</li> <li>✓ High cost</li> </ul>	Not practical	<ul style="list-style-type: none"> <li>✓ Charging to meet discharge quantity is possible by controlling the time</li> </ul>	Figure 2
Constant voltage charging (constant-current constant-voltage)	<ul style="list-style-type: none"> <li>✓ Proper charge method</li> <li>✓ In general, charging requires a lot of time</li> <li>✓ Rapid charging is possible by changing set voltage and current. Overcharge countermeasure necessary for the final stage of charge.</li> <li>✓ Normal cost</li> </ul>	<ul style="list-style-type: none"> <li>✓ Proper charge method</li> <li>✓ Inaccurate charge voltage may cause overcharge or undercharge</li> <li>✓ Relatively long time necessary for recovery after deep discharge</li> <li>✓ Normal cost</li> </ul>	<ul style="list-style-type: none"> <li>✓ Charging of batteries connected in a series is possible for batteries discharged under a given condition</li> <li>✓ Normal cost</li> </ul>	Figure 3
Two-step constant voltage charge	<ul style="list-style-type: none"> <li>✓ Reasonable rapid charging</li> <li>✓ High cost</li> </ul>	<ul style="list-style-type: none"> <li>✓ Charging for recovery is possible within a relatively short period even after deep discharge</li> <li>✓ High cost</li> </ul>		Figure 4

2 Charging methods

(1) Semi-constant current charging method (simplified method)

This method, referred to as a simplified method, is easy to perform and is widely used for cycle service batteries. The charger consists of a transformer, diode and resistor. Impedance from these elements ensures charging without excessive changes in the charging current. With this method, the battery voltage increases while the charging current decreases, as the charging proceeds. The problem with this method is that the charging current flows in a large quantity at the final stage and causes over charge. Care should be taken to avoid charging for more than the specified charge period.

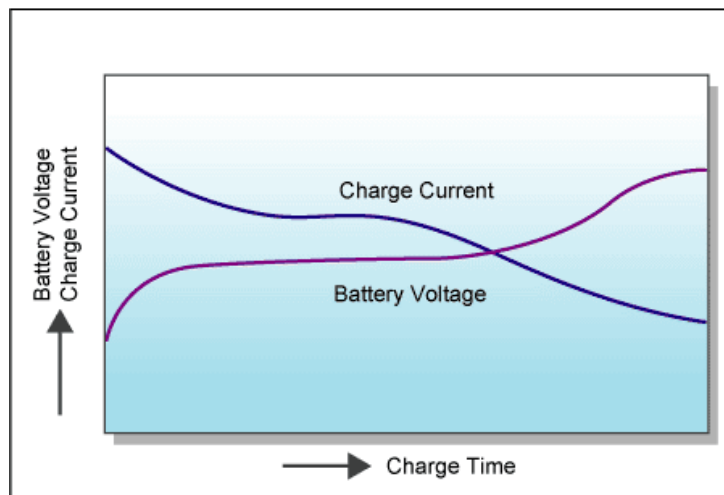


Figure 1: Semi-constant current charging characteristics

(2) Constant current charging method

This method consists of charging the battery with constant current. With this method the charging time and charging quantity can easily be calculated. To do so, an expensive circuit is necessary to obtain a highly accurate constant current. Consequently, this charging method is rarely used for general purposes.

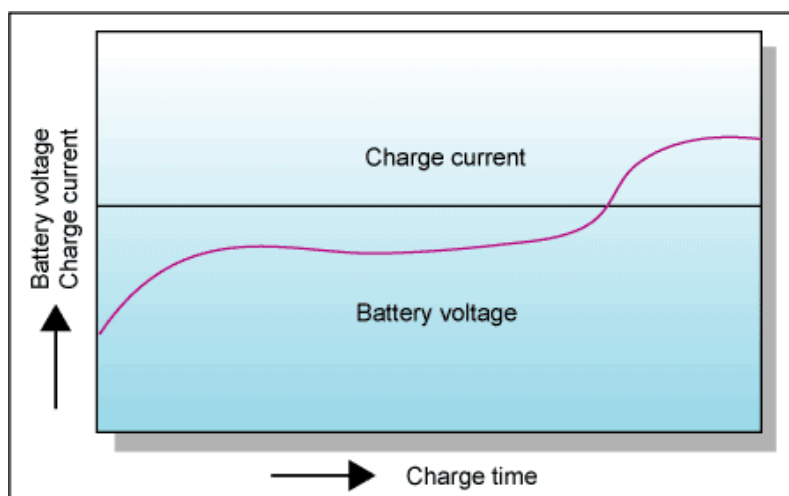


Figure 2: Constant current charging characteristics

(3) Constant voltage charging method (constant-current constant-voltage charging method)

This method consists of applying constant voltage to the battery with a constant voltage unit. This charging method utilizes a different voltage between its voltage and battery voltage. The charging current is initially large and decreases towards the end of charging. It is necessary to set the charging voltage according to battery charging and temperature characteristics. Inaccurate voltage causes an overcharge or an undercharge. Since there is a large current flow at the start, this method requires a large capacity charging unit which will be more expensive. Consequently the constant-current, constant-voltage charging method with limited initial current is widely used for cycle and standby use batteries.

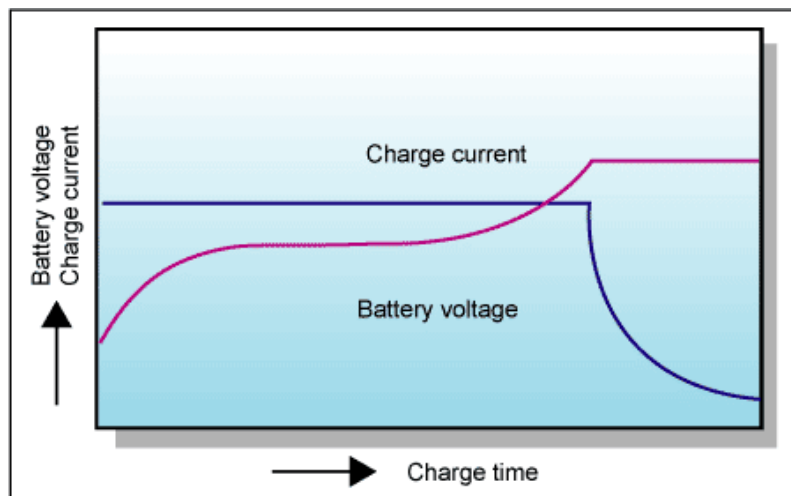


Figure 3: Constant-voltage constant-current charging characteristic

(4) Two-step constant voltage charging method

This method uses two constant-voltage phases. The phase with high charging voltage setting is used initially. When the charge is nearly complete, and the battery charging voltage has risen to a specified value (with the charging current decreased), the second phase is used with lower charging voltage and current setting. This method enables rapid charging during cycle service, without the possibility of overcharge even after a long extended charge. This method also allows rapid charge in stand-by use.

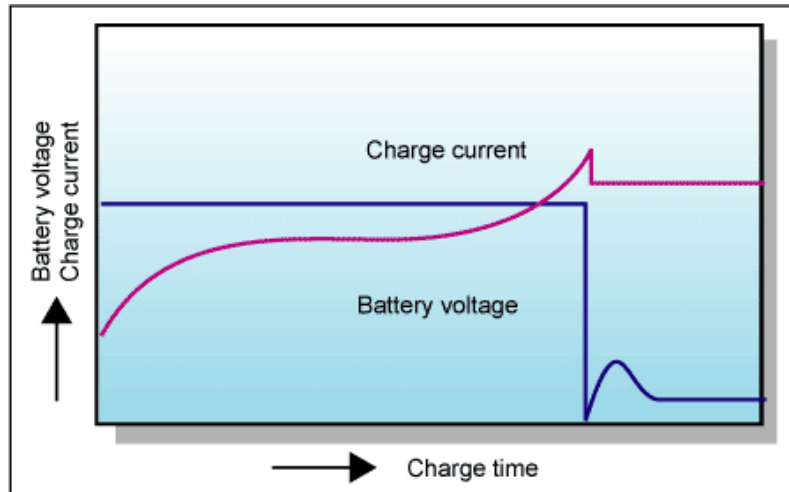


Figure 4: Two-step constant voltage charging characteristic

### 3 Charging Precautions

#### (1) For cycle use

Cycle use requires charging to be completed within a short period. However, care should be taken when an individual is not familiar with the battery or charger. Particularly when applying a rapid charge, protective measures (incorporation of a backup timer, etc.) should be taken to prevent overcharge.

- ✓ Take safety precautions, such as an automatic cut off of charging upon completion; or preventing overcharge even after a long extended charging by controlling the charge current.
- ✓ The charging characteristic is affected by temperature. Use a temperature compensation circuit when charging is to be made at an ambient temperature of less than 5°C (41°F) or more than 35°C (95°F), and average temperature is more than 25°C (77°F).
- ✓ Contact us if rapid charging needs to be made within two or less hours.

#### (2) For standby use

For standby use, please use a trickle or float charge. In either case, the battery is normally charged at a small current to compensate for the self-discharge of the battery. Supplying power from the battery is only used in emergencies such as a power failure, etc. This method requires a lot of time for charging, and the two-step constant-voltage charging method should be used when the battery's capacity is to be recovered within a short period after discharge. Please check the following points when configuring a charger for standby battery use.

- ✓ Because the battery is charging continuously for a long period of time, even a slight fluctuation in the charging voltage results in a big difference in the expected service life of the battery. It is essential to ensure accurate control to minimize charging voltage fluctuations.
- ✓ The charging characteristic is affected by temperature. Use a temperature compensation circuit when charging is to be made at an ambient temperature of less than 5°C (41°F) or more than 35°C (95°F), and an average temperature above 25°C (77°F).