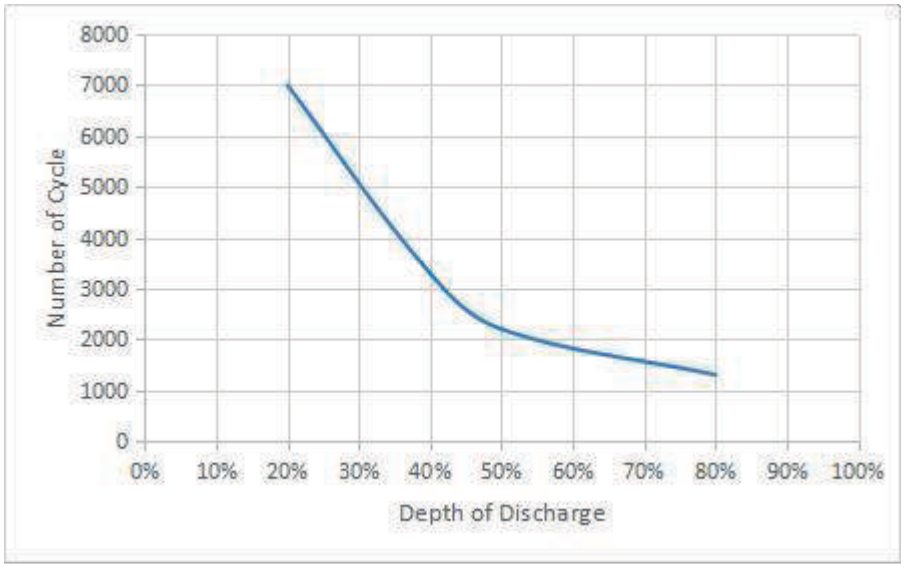
## OPzV 12V SERIES BATTERY CYCLIC PERFORMANCE CONDITION AND ESTIMATION

1. Ideal Cyclic Performance




Graph 1 Cycle life vs. DOD at Ideal Cycle Model

Table 1 Data of cycle number

| | Depth of Discharge/DOD | | | |
|---|---|---|---|---|
| | 80% | 50% | 40% | 20% |
| Cycle life | 1300 | 2200 | 3300 | 7000 |

**Discharge and Charge Conditions (80%DOD, 20 to 25℃)**

1) Cycle method: Discharge with 2I10 for 4 hours (80% DOD), charge with 2I10 for 3.5hour + I10 for 1hour + 0.25I10 for 3.5hour. This is one cycle.

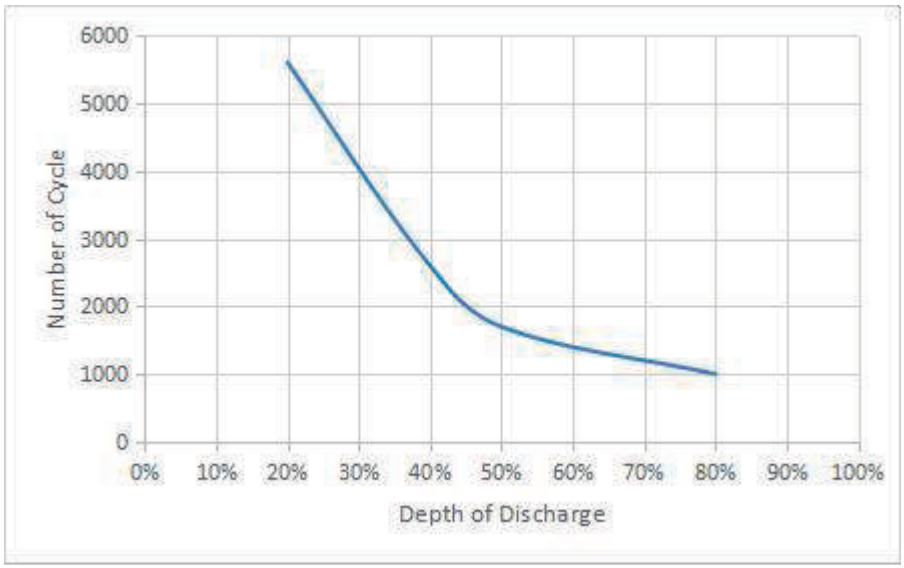
2) Residue Capacity determination: The batteries are discharged at 10 hour rate after every 50 cycles to test battery capacity. When residue capacity of 10 hour rate capacity is lower than 80%, test is ended. After discharge at 10 hour rate after every 50cycles, the charge method is: charge 80% of discharged capacity with current of 2I10 + charge 20% with current of I10 + charge 20% with current of 0.4I10 (i.e. charge 120% of discharged capacity)

Note:

- Above charge mode is Constant Current charge(CC), Battery can be charged fast and fully.
- The charge voltage is not limited at CC charge mode, battery has risk to malfunction or water loss in practice, It is not easy manage.

## 2. Practicable Cyclic Performance

**OPzV 12V Series Cyclic Performance**




Graph 2 Cycle life vs. DOD at practice Cyclic Scenario

Table 2 Data of cycle number

| | **Depth of Discharge/DOD** | | | |
|---|---|---|---|---|
| | 80% | 50% | 40% | 20% |
| Cycle life | 1000 | 1700 | 2600 | 5600 |

**Discharge & Charge Scenario (80%DOD, 20 - 25℃)**

1) Cycle method: Total discharge is 80% DOD at customer practice condition, charge with constant current and constant voltage (CC-CV) mode, charge time shall be 10 - 12 hours at least. This is one cycle.

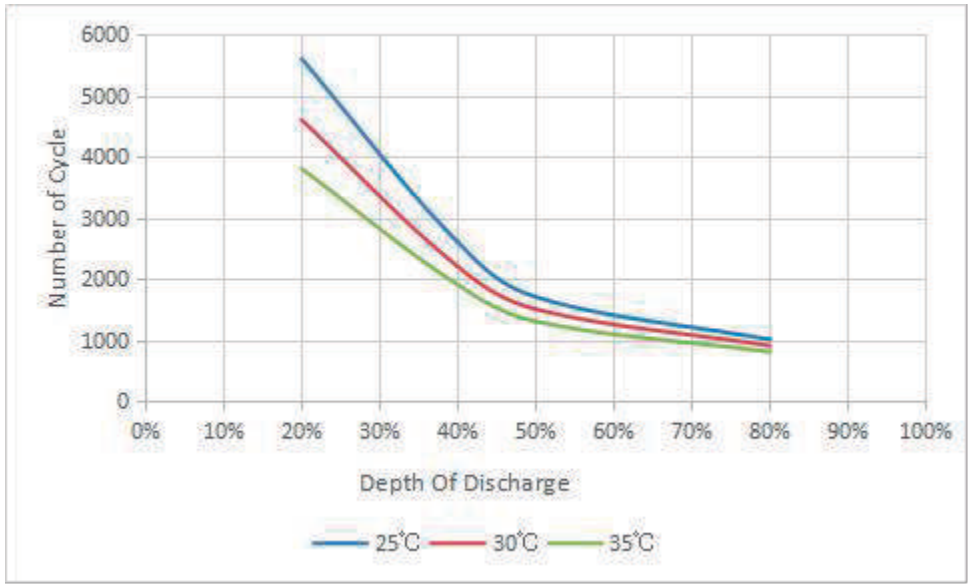
2) Battery failure determination: When the end voltage of discharge is lower than 1.80Vpc, battery is failed.

Note:

Above practical cycle life base on customer practice condition, charge and discharge can be 24 hours. Different charge & discharge scenario will affect battery cycle life.

## 3. Practicable Cyclic Performance vs. Ambient Temperature

**OPzV 12V Series Cyclic Performance**




Graph3, Cycle life vs. DOD Different Temperature

Table 3 Data of cycle number

| Cycle life | Depth of Discharge/DOD | | | |
|---|---|---|---|---|
| | 80% | 50% | 40% | 20% |
| 25℃ | 1000 | 1700 | 2600 | 5600 |
| 30℃ | 900 | 1500 | 2200 | 4600 |
| 35℃ | 800 | 1300 | 1900 | 3800 |

Note:

Temperature has a direct influence on the battery as VRLA is an electrochemical battery. At higher temperatures there is dramatically more chemical activity inside a battery than at lower temperatures, high temperature will decrease battery cycle life.