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BATTERY CYCLIC PERFORMANCE CALCULATION AND ESTIMATION

V1.2, 21st Oct. 2015

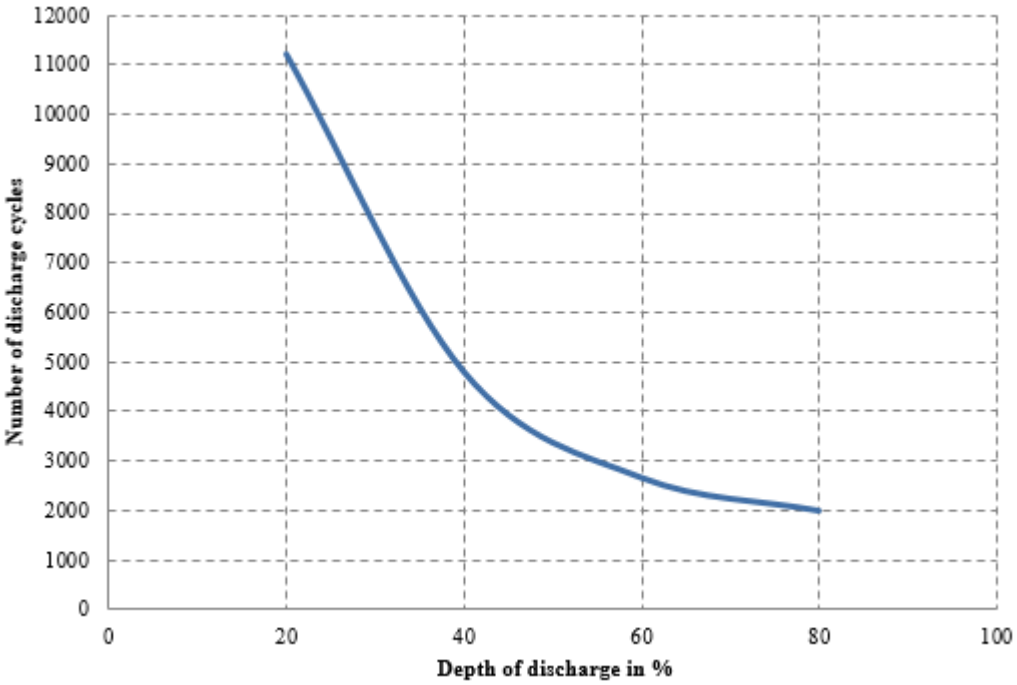
Note:

Lead carbon technology is a way to increase battery fast charge performance and PSOC performance. Nano carbon applied in negative can significantly increase reaction superficial area and conductance, nano carbon like fibers uniformly mixed into negative active material, which could be reaction points and better conductance, and this change makes battery be avoided negative lead sulphation issue to increase PSOC cyclic performance.

Lead carbon technology can be applied to existing deep cycle battery types.
But lead-carbon technology battery are not recommended for fully charged scenarios.

1. Ideal Cyclic Performance

1.1 REXC(2V&12V) Series Cyclic Test Result



Graph 1, Cycle life vs. DOD of REXC(2V&12V) Series with Ideal Charge Model

Table 1, data of cycle number

	Depth of Discharge/DOD			
	20%	40%	60%	80%
Cycle life	11200	4800	2700	2000

1.2 Discharge & Charge Scenario (80%DOD)

1) Cycle method: Discharge with $2I_{10}$ for 4 hours (80% DOD), charge with $2I_{10}$ for 3.5hour + I_{10} for 0.5hour + $0.25I_{10}$ 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 $2I_{10}$ + charge 20% with current of I_{10} + charge 20% with current of $0.4I_{10}$ (i.e. charge 120% of discharged capacity)

3) Temperature: 25℃

1.3 Advantage of Upper Constant Current Charge Model

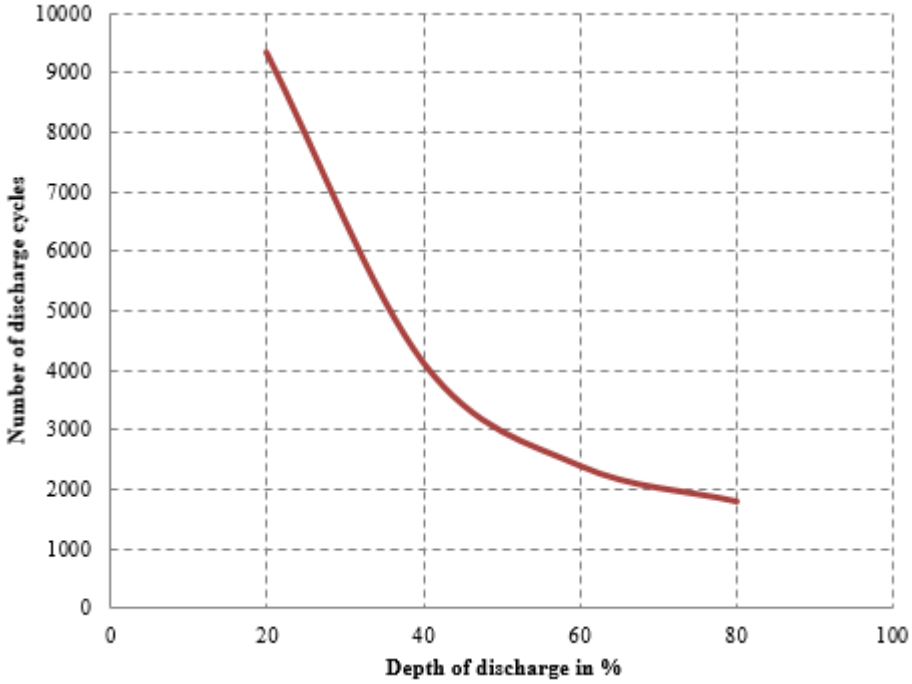
Battery can be completely recharged within 8 hours.
The end charge voltage will be higher than 2.6Vpc, which is good for active material exchange.

1.4 Disadvantage of Upper Constant Current Charge Model

It has risk of battery malfunction without voltage limited.
It isn't easy to manage charging in practice.

2. Practicable Daily Cyclic Performance

2.1 REXC(2V&12V) Series Cyclic Test Result



Graph 3, Cycle life vs. DOD of REXC(2V&12V) Series with Daily Cyclic Scenario

Table 3, data of cycle number

	Depth of Discharge/DOD			
	20%	40%	60%	80%
Cycle life	9400	4100	2400	1800

2.2 Discharge & Charge Scenario (80%DOD)

1) Cycle method: Discharge model is customizable, total discharge capacity is 80% DOD, charge with certain constant voltage and limited charge current which are recommended by manufacturer based on customer's discharge model, but charge time shall be 10 hours at least. This is one cycle.

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

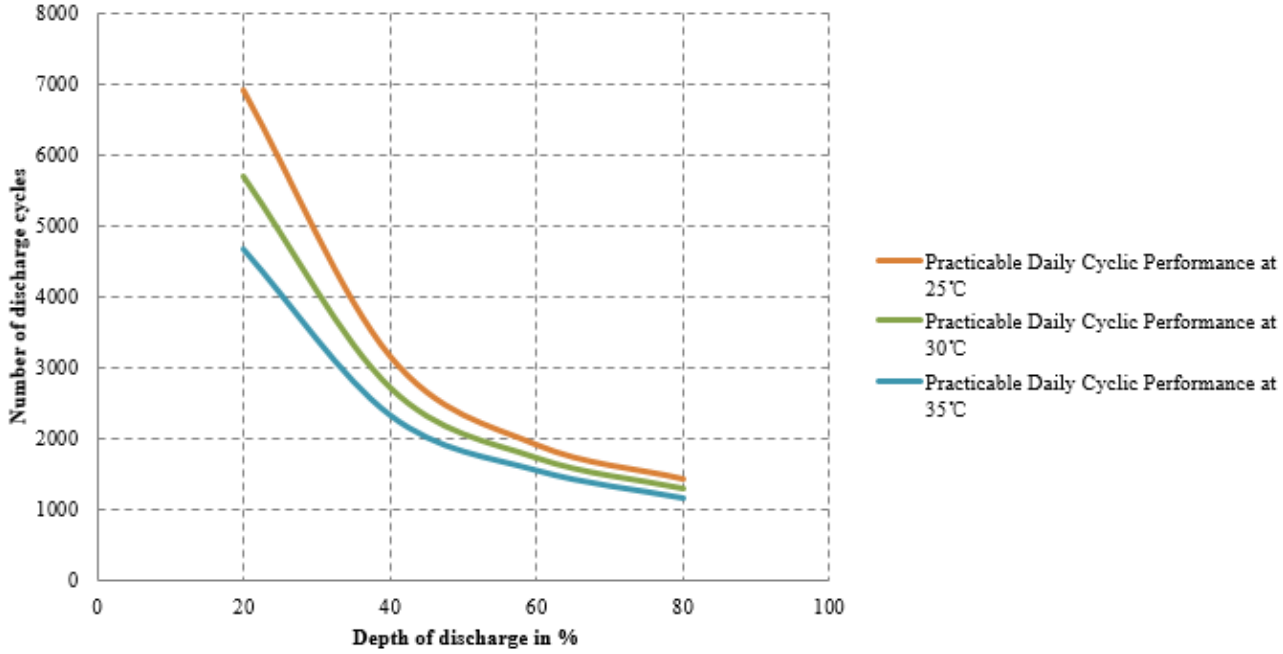
3) Temperature: 25℃

2.3 Upper Battery Cycle Life is Common Data

For practical daily cycle life, total charge & discharge time is constant of 24 hours. Different charge & discharge scenario will affect battery cycle life.

3. Practicable Daily Cyclic Performance vs. Ambient Temperature

3.1 REXC(2V&12V) Series Cyclic Test Result



Graph 4, Cycle life vs. DOD of REXC(2V&12V) Series with Daily Cyclic Scenario at Different Temperature

Table 4, data of cycle number

Cycle life	Depth of Discharge/DOD			
	20%	40%	60%	80%
25 ℃	6900	3200	1900	1400
30 ℃	5700	2700	1700	1300
35 ℃	4700	2300	1600	1200

3.2 Affect of Ambient Temperature

VRLA is an electrochemical battery, absolutely will be affected by ambient temperature. High temperature harm to cyclic application is not so terrible as to floating application. High temperature accelerates battery secondary reaction to shorten battery cycle life.

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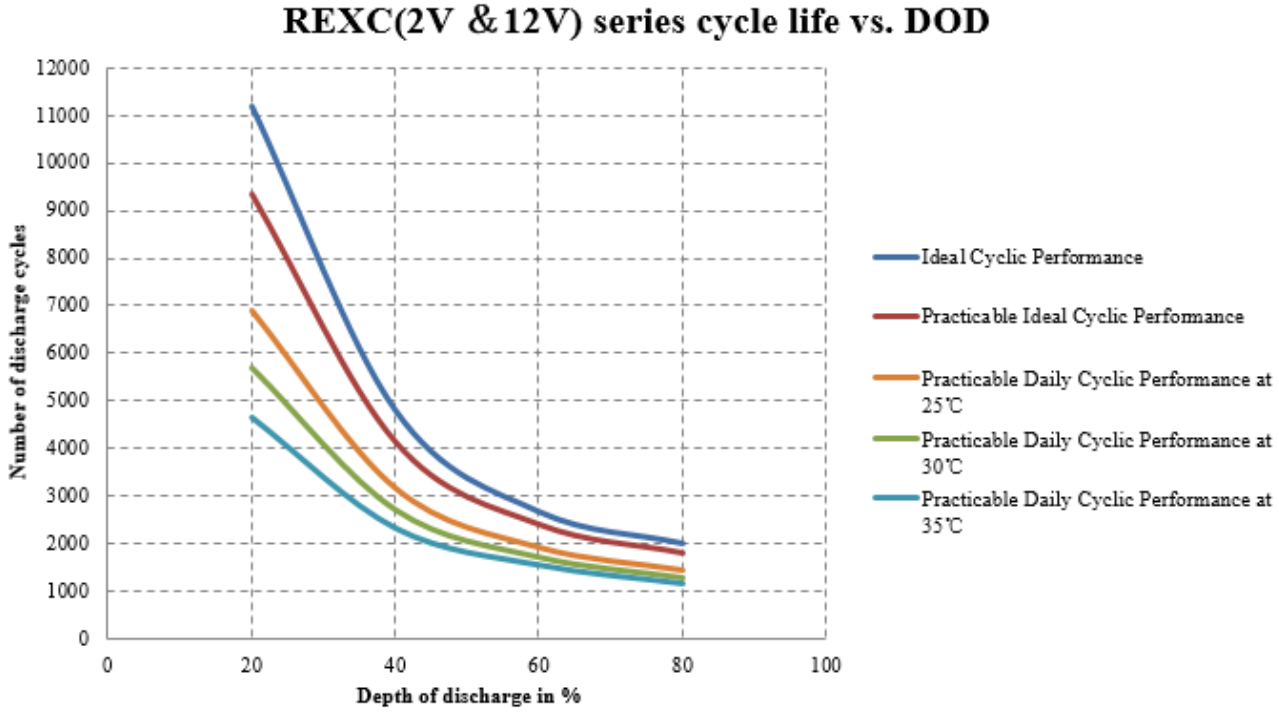
4. Comparison of Cyclic Performance at different conditions



Graph 5, Comparison of Cycle life vs. DOD of REXC(2V&12V) Series with Different Conditions