REKOSER BATTERY

USE AND MAINTENANCE GUIDE

RKE, RKC, RKG SERIES

Important Safety Instructions

Please read this operation manual carefully. It offers very important safety instructions, installation and operation guide, and ensure your equipment with best performance and prolong the service life of your equipment.

For the sake of your safety, please do not attempt to remove the components of the battery. The maintenance of the battery can only be carried out by service engineers specially trained by the principal.

Considering the potential harm of the lead component to the health and environment, the battery can be replaced only by the service center authorized by the manufacturer. To replace the battery or maintenance equipment, please call the after-sales service hot-line for information of the nearest service center.

Please check the local regulations on the correct way of dealing with battery disposal or send the battery to the authorized service center for replacement.

Battery replacement should be operated or supervised by engineers who are experienced and aware of the preventive measures on the potential harm of the battery.

Warnings:

- **Do not smoke and refrain having fire near the battery.**
- **Do not use any organic solvent to clean the battery.**
- **Do not have fire near the battery or it may explode.**
- **Do not remove the components of the battery as it contains electrolyte that may cause injury to the human body.**
- **Battery may cause short circuit. Please remove any watches and jewelry during replacement of the battery, and operate with tools with insulated materials.**

Index

1. Conditions

Ambient Temperature: -15ºC～＋60 ºC (Best operation temperature 20 ºC～25 ºC)

Ambient Humidity: ≤95％

2. Capacity and Influencing Factors

2.1 Capacity

The capacity of the battery is the capacity that battery can be discharged under certain conditions, represented by the symbol 'C'. The standard unit of measurement for capacity is ampere-hour (Ah).

The capacity can be expressed in Rated Capacity or Actual Capacity. Please refer to the Series Guide or the Specific Datasheet for the Rated Capacity of any Rekoser battery. The Actual Capacity is the product of the discharge current and the discharge time i.e. Ah.

2.2 Factors that influence the Actual Capacity

The actual capacity is mainly related to the battery's construction, manufacturing process and operational environment. During operation, the factors that influence the actual capacity are the discharge rate, end voltage, ambient temperature and discharge time.

2.3 Discharge Rate

If the discharge rate (hour rate) is lower, the discharge current is larger, and the discharge time is shorter, then the capacity that can be discharged will be lesser. For example, the discharge current of 3 hours rate is larger than that of 10 hours rate; and the capacity of 3 hours rate is smaller than that of 10 hours rate.

2.4 End Voltage

The end voltage is the lowest working voltage below which the battery will not be able to discharge further. The end voltage of SOLAR series battery is typically 10.8V per block. Due to the characteristics of lead acid battery, the battery will not be able to discharge even if the end voltage drops. The lower end voltage will harm the battery, especially when the voltage drops to 0V and the battery cannot be recharged in time. This will shorten the life of the battery.

Table 3-1 Discharge End Voltage at Different Current

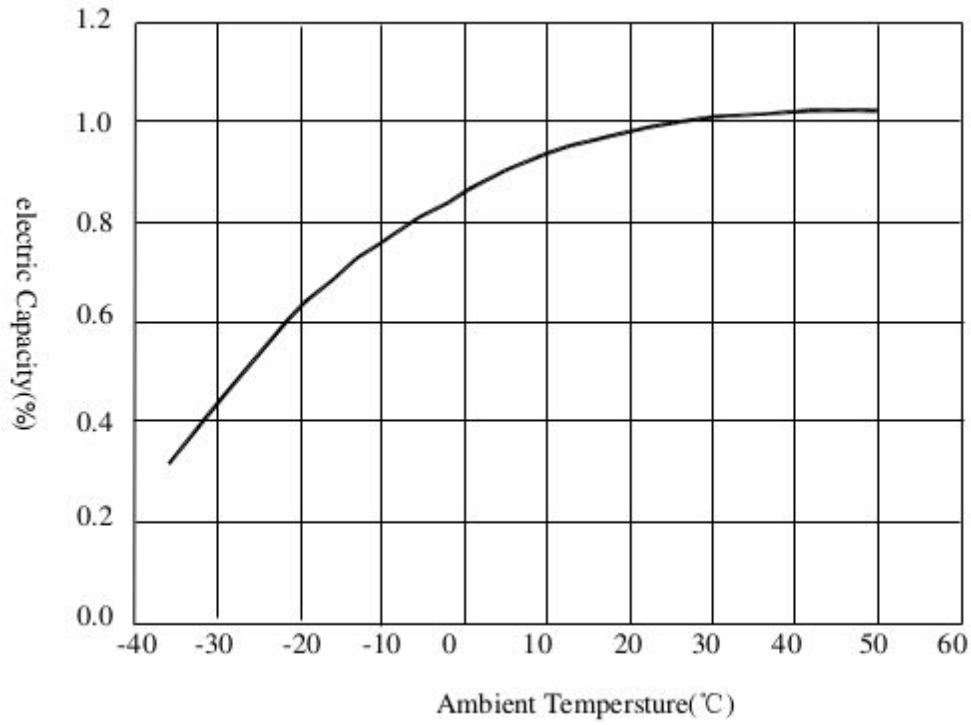
Discharge current (A)	Discharge end voltage (V/block)
I＜0.2C	10.8
0.2C≤I＜0.5C	10.2
0.5C≤I＜1.0C	9.30
I≥1.0C	7.80

3. Ambient Temperature, Capacity and Life

3.1 Relationship between Ambient Temperature and Capacity

RKG batteries can be used in very low or high temperature (below -15°C or above 60°C). However the battery data such as capacity life and floating voltage are measured with temperature between 20°C-25°C as a standard. The capacity of the battery will decrease with lower temperature as shown in Fig. 3-1 below.

Fig.3-1: Ambient Temperature VS Available Capacity



As represented by the graph above, the capacity of the battery will decrease when the temperature is too low. For example, if the temperature decreases by 20°C, the

capacity will drop by 16%. The battery will be in a less-charged state with lower temperature and this will lead to battery failure in discharging and the active material in the negative plate to saltilize.

The capacity of the battery will increase when the temperature rises. For example, the capacity will increase by 6% when the temperature increases by 10°C. However the high temperature will accelerate the corrosion of the grid and cause water loss in the battery, thus shortening the battery life.

As such it is always important to control the ambient temperature at the customer premises. Please ensure room ventilation and usage of air-condition is recommended in high temperature working environment.

3.2 Floating Operation

Floating voltage is chosen with the assumption of battery operating under the optimal working condition. If the floating voltage is too high, the battery floating current will get larger and increase the grid eroding speed, thus reducing the service life of the battery. When the floating voltage is too low, the battery will not be able to maintain its fully-charged condition. This will create sulphate and reduces the battery capacity, hence affecting the service life of the battery.

The floating voltage of Rekoser RKG series battery is 13.5V/block under 25°C. The temperature compensation is at -18mV/°C/block.

Floating voltage under different temperature is calculated by the following formula:

V_T=13.5-(T-25)×0.003×6 where VT is the Floating voltage under T temperature

Table 3-2 Floating Voltage under Different Temperature

Ambient temperature(°C)	Floating voltage (V/block)
0	13.95
5	13.86
10	13.77
15	13.68
20	13.59
25	13.50
30	13.41
35	13.32
40	13.23

3.3 Equalization Charge

RKG batteries needs Equalization Charge regularly to ensure the battery operating under 25°C working condition. The equalization voltage of Rekoser RKG series battery is 14.4V/block. The temperature compensation is at -30mV/°C/block.

Equalization voltage under different temperature is calculated by the following formula:

V_T=14.4-(T-25)×0.005×6 where VT is the equalization voltage under T temperature

Table 3-3 Equalization Voltage under Different Temperature

Ambient temperature(℃)	Equalization voltage (V/block)
0	15.15
5	15.00
10	14.85
15	14.70
20	14.55
25	14.40
30	14.25
35	14.10
40	13.95

3.4 Ambient Temperature and Life

High temperature is harmful to the battery and affects its service life. When the ambient temperature exceeds 25°C, the service life reduces by half for every 10°C increment in temperature. For example, the battery service life is 10 years under 25°C but if the operating temperature is 35°C, the service life will become 5 years.

The formula to calculate the service life is as follows:

$t_{25}=tT\times2^{(T-25)/10}$ where T is the actual ambient temperature and tT is the design life under T.

t25: design life under 25°C.

As such the ambient temperature should always be controlled.

4. Charging Request

4.1 Equalization Charging

Equalization charging should be carried out in the following situations:

- There are more than two batteries which voltage is under 13.0V in one group.
- More than three months after floating operation.

Equalization charging is recommended as follows:

1. Charge the battery group with constant current not exceeding 0.1C10A till the average voltage increases to 14.4V/block(25°C)
2. Change into constant voltage of 14.4V/block charging.
3. The equalization charging time should be 24 hours.

4.2 Battery Charging

Battery Charging should be carried out in the following situations:

- The batteries should be recharged in time after discharge.
- After battery system is installed.
- Battery storage period exceeding three months or open circuit voltage lower than 12.6V/block.

Battery charging is recommended as follows:

1. The batteries should first be charged on the constant current of 0.15C10A till the average voltage of the batteries increases to 14.1V
2. Batteries should be charged with constant voltage of 14.1V till the charging has completed.

On some occasions, the batteries have to be fully charged immediately, then fast charging could be adopted. The value of limit current should not be larger than 0.2C10A, and the charge voltage should be 14.4V/block(25°C).

We can determine if the batteries are fully charged by one of following two conditions:

- After charging 18～24hours. The charging time will be lesser if it is not deep discharged. For example at 20% DOD (refer to Table 2-1 for the Depth of Discharge vs Charging Time), the charging time can be shorten to 10 hours.
- Under the condition of constant voltage, the value of charge current has no variation for continuously three hours.

When to charge using an off-board charger

• Once the machine has been operated for an entire shift, connect the battery pack to the specified charger and unplug once the charging cycle is completed.

When to charge using an on-board charger

• Once the machine has been operated for a full or partial shift, with the battery pack unplugged from the machine, couple the connector from the charger and the batteries together. The automatic charger will activate indicating that the charging process has started.

Opportunity Charging is only recommended

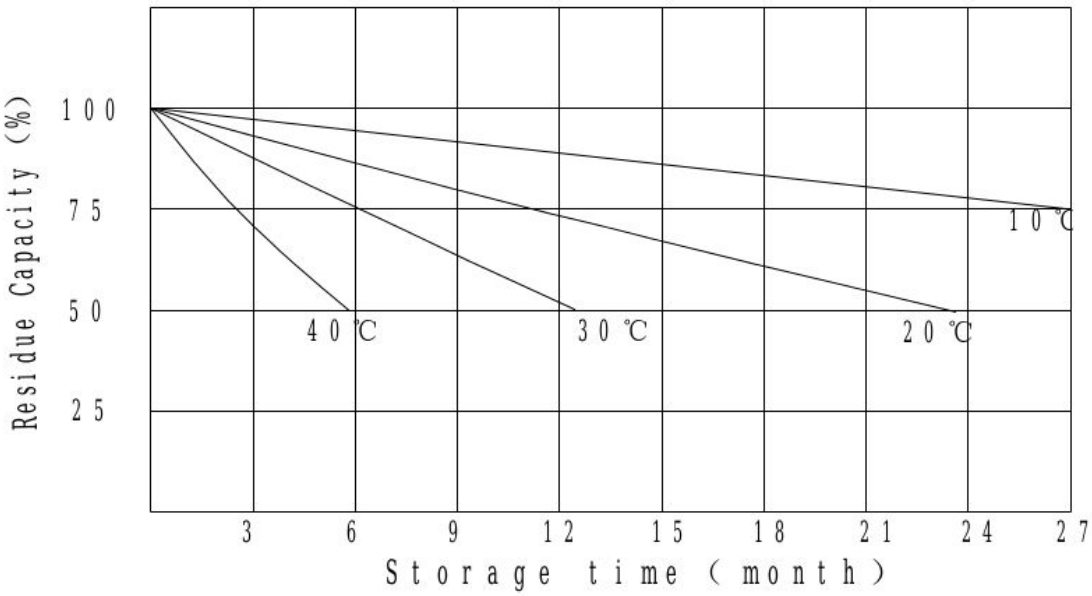
- No more than 50% discharged. “Short Charging” (charging that occurs when the battery is more than 50% discharged) is NOT recommended.

5. Storage

All lead acid batteries experience self-discharge in open circuit. The result is that the voltage of open circuit is decreased, and the capacity also decreases. Please note the following during storage period:

a. The self-discharge rate is related to the ambient temperature. The degree of self-discharge is smaller when the ambient temperature is lower, otherwise it will be larger. The required temperature for Rekoser batteries’ storage is 5ºC to 30ºC. The storage place must be clean, ventilated and dry.
b. An important parameter in storage is open circuit voltage, which is related to the density of the electrolyte. In order to avoid permanent damage to the plate caused by self-discharge, the batteries should be recharged if they have been stored for more than three months. The equalization charge method should be adopted.
c. During storage, if the open circuit voltage is lower than 12.6V/block, the batteries should be recharged before usage. The equalization charge method should be adopted.
d. All batteries should be fully charged before storage. It is recommended to record the storage time in the periodic maintenance record and to note down the time when the next necessary recharge should be carried out.

Fig. 3-2 Self-discharge Curve



6. Maintenance

6.1 Regulated maintenance

6.1.1 Instruments and tools

- Instruments and tools
- Digital Voltage Meter.
- Insulated wrench.
- Internal resistance, conductive and instant loading experiment instruments.

6.1.2 Monthly Maintenance

- Keep the battery-room clean.
- Measure and record the ambient temperature of the battery-room.
- Check each battery's cleanliness, check damage and trace of overheating on the terminal, container and lid.
- Measure and record the total voltage and floating current of the battery system.

6.1.3 Quarterly Maintenance

- Repeat monthly inspection.
- Measure and record floating voltage of every on-line battery. If there is more than one battery with voltage of less than 13.1V after temperature adjustment, the batteries have to go through equalization charged. If the problem persists after adopting the above-mentioned measure, the batteries will require yearly maintenance or even three years' maintenance. If all methods are ineffective,

please contact the manufacturer.

6.1.4 Yearly Maintenance

- Repeat quarterly maintenance and inspection.
- Check whether the connectors are loose or not annually.
- Perform a discharge test to check the exact load every year and discharge 30-40% of the rated capacity.

6.1.5 Three-year Maintenance

- Perform a capacity test every three years and every year after six years' of operation. If the capacity of the battery decreases to lower than 80% of the rated capacity, the battery should be replaced.

6.2 Precautions

6.2.1 Insufficient Charge

If the floating voltage is not set correctly i.e. too low or not amend according to the temperature, the battery system will have an insufficient charge state for a long period of time. When the electricity is cut, the battery may not be able to work because the active material is saltilized and the capacity is decreased.

6.2.2 Over Charge

Please ensure the rectifier transfers floating charge to equalization charge. If the rectifier is not able to transfer charge modes, the battery system will always be in an

equalization charge state which may cause battery water loss, decrease in service life, overheating and deformation.

6.2.3 Extreme Temperature

Maintain the correct temperature to ensure the performance of the battery. Extremities in temperature will be detrimental to the battery life and performance.

6.2.4 Low End Voltage

The end voltage is an important parameter for battery. The normal end voltage is 10.5V and in some cases 9.6V. The battery will stop discharging when it reaches a certain voltage. If the end voltage is too low, it will be difficult to recharge the battery and decrease the charging efficiency, thus affecting the battery life.

6.2.5 Charging Battery Immediately after Discharge

If the battery is left uncharged for a long period of time i.e. > 2 hours after discharging, it will affect the capacity and battery life. This is due to large size $PbSO_4$ being created in the negative and will be difficult to transfer to active Pb.

Contacts

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Annex 1.

Battery Regular Maintenance Record

Battery Regular Maintenance Record

Type			Place		
Status			Number of battery		
Total Voltage (V)		Current (A)		Temperature	
No.	Voltage (V)		No.	Voltage (V)	
1			13		
2			14		
3			15		
4			16		
5			17		
6			18		
7			19		
8			20		
9			21		
10			22		
11			23		
12			24		
Check by sight					
Result					
Tester:			Date:		

Annex 2.

Warranty Claim Form

Warranty Claim Form

Please complete the following form and send it with the Battery Regular Maintenance

Record to support@rekoser.com with the subject: [Warranty Claim Form] [Customer]

Customer information

Company		**Date of Claim**	
Customer name		**Telephone number**	
Customer country		**Email address**	

Battery information

Battery series		**Battery model**	
Battery code		**Date of installation**	
Quantity		**Remark**	
Cause of failure	**A: Short back up time**	**B: Electrolyte leakage**	**C: Others(specify below)**
Other			
Notes			

Use information

Application		**Charging source**	
Voltage		**Watts**	