Kaise®

OPZV SERIES TUBULAR GEL BATTERY

OPERATION MANUAL

Version 1.1

Contents

Security Instructions

Please read this manual! It provides very important information for security, installation, operation, which can make best capability for the equipment, and elongate the using life.

- Do not try to take apart batteries. The spare parts are not inside the battery. Maintenance works should be done by professionals.
- As a result of the battery's latent danger to health and environment, they should be only changed in authorized service center. If you need to change the battery or maintain the equipment, please call the nearest service center.
- Batteries can be reclaimed, if it could not be carefully handled, it would bring a lot of dangers to environment and health. Please check laws to get the valid ways or send the equipment to service center.
- The replacement should be made or supervised by professionals with suitable protection. The batteries for replacement should be used as the same as the old ones in model and type.
- Warning——Do not smoke or use fire near batteries.
- Warning——Do not use any organic cleanser to clean batteries.
- Warning——Do not put the batteries on fire, or they will explode.
- Warning——Do not cut open the batteries. They contain electrolyte which is toxic to skin and eyes.
- Warning——Batteries may cause shock and short. Please remove the watch and jewelry such as rings when replacing the batteries. Also please operate with insulating tools.
- Warning——Tightening the screws, otherwise there will be spark and heat while closing the circuit, this may cause battery burnt. The F-M6 terminal torque is 6～8N.m, The F-M8 terminal torque is 10～12N.m.

Please take care of the following marks during operation

Symbol	Explain	Symbol	Explain	Symbol	Explain
	Warning		Electricity danger		Protecting your eyes
	Watch Short-circuits		With adults custody		Read the manual
	Fire forbidden		Recycle use		Do not put batteries into dustbin
	Pass CE Safety authentication		Handle with care		

Part one Product Introduction

1. Construction

- **Battery lid, container**

Made of reinforce ABS plastic with sufficient strength and acid-resistance ability, to prevent leakage of electrolyte and gas

- **Terminal**

With tin-coated red copper insert to reduce internal resistance, and with good conductivity

- **PVC-SiO_2 separator**

With high oxygenation-resistance and heat-proof ability, and electrolyte can be well absorbed and retained in the separator

- **Positive and negative plate**

Made of Pb-Ca-Sn alloy tubular positive grid and flat negative grid and special formula active material

- **Valve**

Made of acid-proof, aging-proof synthetic rubber

- **Flame arrestor**

With acid-proof, explosive-proof functions

2. Product Specifications

Model	Nominal Voltage (V)	Capacity (Ah)@10hr	Dimension (mm)				Weight (kg)
			Length	Width	Height	Total Height	
4OPzV200	2	200	103	206	354	390	17.3
5OPzV250	2	250	124	206	354	390	20.7
6OPzV300	2	300	145	206	354	390	24.4
5OPzV350	2	350	124	206	471	506	27.5
6OPzV420	2	420	145	206	471	506	32.5
7OPzV500	2	500	166	206	471	506	37.3
6OPzV600	2	600	145	206	646	681	44.2
8OPzV800	2	800	191	210	646	681	60
10OPzV1000	2	1000	233	210	646	681	71.5
12OPzV1200	2	1200	275	210	646	681	87
12OPzV1500	2	1500	275	210	796	831	107
16OPzV2000	2	2000	399	212	772	807	147
20OPzV2500	2	2500	487	212	772	807	185
24OPzV3000	2	3000	576	212	772	807	216

3. Working Principle

The chemical reactions take place in lead acid battery is as follows:

$$Pb+PbO_2+2H_2SO_4 \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} 2PbSO_4+2H_2O$$

Following by-reaction ① takes place in ordinary lead acid battery:

$2H_2O \longrightarrow 2H_2\uparrow+O_2\uparrow$ ①

$2Pb+O_2 \longrightarrow 2PbO$ ②

$PbO + H_2SO_4 \longrightarrow PbSO_4 + H_2O$ ③

OPzV Battery adopt gel electrolyte and PVC-SiO_2 Separator to set up oxygen cycle principle: Battery is full of gel electrolyte inside, and A 3-D porous network is formed with framework of SiO_2. The net contains electrolyte necessary for battery. At initial stage, the construction is not steady. As time goes on, the framework is shrink and some cracks appeared in the gel. The cracks exist between pos.& neg. plates and separator and become a path between the positive and the negative. Thus it is possible to build GEL battery in sealed structure.

Part two Operation and Maintenance

1. Operation Condition

1.1 The recommended operating temperature range for optimum life and performance is from 15 ℃ to 25 ℃.

If the battery is used at high or low temperature, it will affect battery performance.

1.2 Max Operating Temperature Range:

GEL batteries：

Charge -20～+55℃;

Discharge -40～+60℃;

Storage -20～+45℃;

1.3 Humidity: ≤ 95%

1.4 Ventilation requirements:

During normal charging conditions the volume of hydrogen emitted from a Kaise VRLA / Gel battery is virtually negligible, and will normally dissipate rapidly into the atmosphere. The room or cabinet ventilation should comply with standard EN 50272-2: 2001.

2. Capacity

2.1 Concept of capacity of battery

The capacity of battery is the capacity that battery can be discharged on the established conditions, expressed as signal C. The usual unit of capacity is ampere hour, shortened as AH. Normally we indicate discharge hours rate in lower corner of C. e.g. C_{10} is 10 hours rated capacity, and C_3 is 3 hours rated capacity.

The capacity can be expressed in Rated Capacity or Actual Capacity. The Rated Capacity please sees Table 1-1. The Actual Capacity is the product of the discharge current and the discharge time, the unit is AH.

The way to determine capacity: e.g. when we try to determine 10 hours rated capacity, please discharge with current of I_{10} for 10 hours, if the voltage of battery is larger than 1.80Vpc, it means 10 hours rated capacity is qualified.

2.2 The Influence Factor of the Actual Capacity

The actual capacity is mainly related with the positive and negative active materials and their utilization ratio. The utilization ratio of the materials is mainly influenced by the discharge system, the structure of the battery and manufacture technology. In operation process, the factors that influence the actual capacity are discharge rate, discharge system, end voltage and temperature.

2.3 Discharge Rate

The discharge rate is often described as hour-rate and multiple rates.

If the discharge rate is higher and the discharge current is larger, then the discharge time is shorter, and the capacity which can be discharged is less.

2.4 End voltage

The end voltage is the lowest working voltage below which the battery can’t be discharged

any more or it will harm the battery. Usually the 10hr rate end voltage of battery is 1.80V/cell, and the 20hr rate end voltage of battery is 1.80V/cell.The batteries are not able to discharge more capacity even if the end voltage is lower because of characteristics of lead acid battery, yet the low end voltage makes great harm to the battery. It will greatly shorten batteries' life especially to discharge the battery to 0V while not to recharge in time. Thus the end voltage should not be lower than what is described in table 3-2, or it will cause over-discharge and make battery failure after several times of over-discharge.

Table 3-2 Discharge End-voltage

Discharge Current（A）	Discharge End Voltage (V/cell)
I <0.08C	≥1.85
0.08C≤ I <0.2C	≥1.80
0.2C≤ I <0.6C	≥1.75
0.6C≤ I <1.0C	≥1.70
1C≤ I <2C	≥1.60

3 Temperature

3.1 Available Capacity vs. Ambient Temperature

Temperature affects capacity of the battery. Fig. 3-1 is the available capacity curve vs. ambient temperature. If the temperature drops, the capacity will decrease, for example, the capacity will decrease to 80% of rated capacity if temperature decreases from 25℃ to 10℃; and too low temperature will cause battery long term insufficient charged, also will cause no discharge and negative plates sulfate.

Though VRLA battery can be operated at -20℃, the standard data is the test result at 25℃.

The capacity will increase when temperature rises. For example the capacity will increase to 102% of rated capacity if temperature increases from 25℃ to 50℃. But the capacity increase very little when temperature goes on increasing, and it will stop increase at last. However, it will quicken plates' corrosion and water loss if temperature rises, and shorten battery's life.

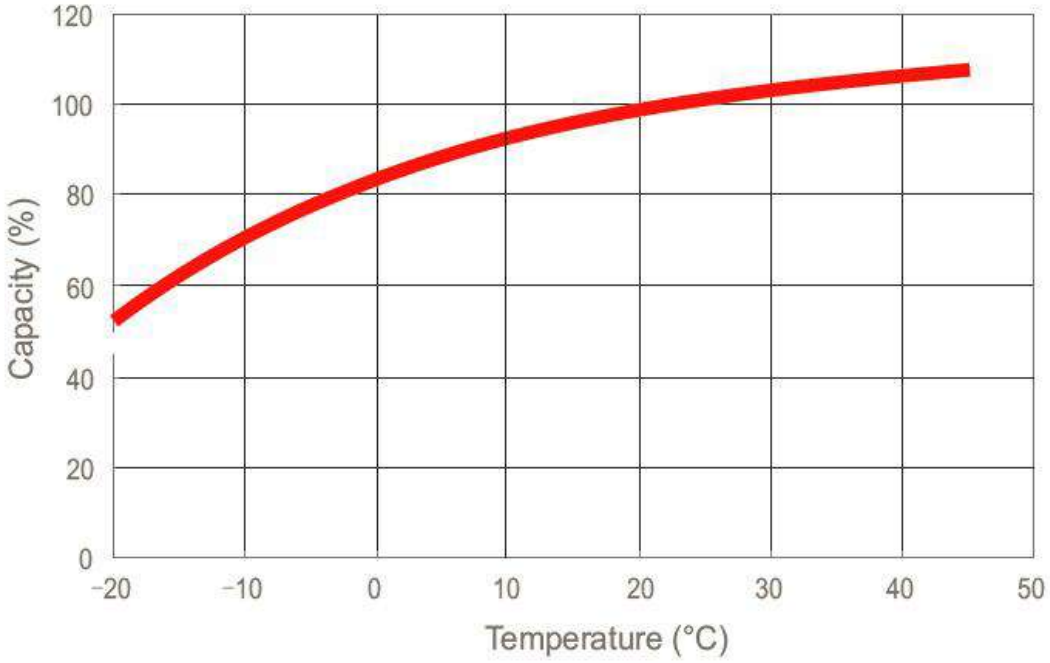

Fig.3-1 Available Capacity vs. Ambient Temperature

3.2 Temperature and Floating Voltage

The purpose of choosing proper floating voltage is to make the battery operate in a best condition. If the floating voltage is higher, and then the floating current is also higher, it will accelerate corrosion of the grid and shorten life of the battery. If the floating voltage is lower, the battery can't be kept in fully charged state; this will cause sulfate, decrease the capacity, and also shorten the life of the battery.

Table 3-3 is floating voltage of VRLA battery at 25℃. And temperature compensation coefficient is -3Mv/℃/cell

Table 3-3 Floating Voltage of VRLA Battery（25℃）

Series	Floating voltage （V/cell）
OPzV	2.23±0.02

The formula to calculate float voltage at different temperatures:

$V_T = V_{25} - (T-25)\times 0.003$

V_T—Floating charge voltage at T temperature

V_{25}—Floating charge voltage at 25℃,

When the float voltage is lower than 2.20V/cell or higher than 2.30V/cell after being adjusted by temperature compensation coefficient, we suggest stopping making temperature compensate and charge the battery with 2.20V/cell or 2.30V/cell.

3.3 Temperature and equalization charge

VRLA battery needs equalization charge periodically to guarantee normal operation. Table 3-4 is equalization voltage of VRLA battery at 25℃. And temperature compensation coefficient is -5mV/℃/cell.

Table 3-4 equalization charge of VRLA battery(25℃)

Series	Equalization charge（V/cell）
OPzV	2.35

The formula to calculate equalization voltage at different temperature:

$V_T = V_{25}-(T-25)\times 0.005$

V_T—Equalization charge voltage at T temperature

V_{25}—equalization charge voltage at 25℃,

When the boost voltage is lower than 2.30V/cell or higher than 2.45V/cell after being adjusted by temperature compensation coefficient, we suggest to stop making temperature compensate and charge the battery with 2.30V/cell or 2.45V/cell.

3.4 Ambient Temperature vs. Battery Life

Higher temperature will harm the battery and reduce battery life. When temperature exceeds 25℃, the battery life will decrease half per 10℃ temperature rises. For example, the designed life of battery at 25℃ is 10 years, when battery operates at 35℃, for a long period of time the actual life is only 5 years.

$t_{25}=t_T\times 2^{(T-25)/10}$

Notes：T is the actual ambient temperature;

t_T is designed life at T ambient temperature

t_{25} is designed life at 25℃ ambient temperature

The heat disseminates performance of VRLA battery is bad, it's liable to cause thermal run away when heat accumulates. Please improve ventilation and temperature condition when room temperature is high. The distances between batteries should not be smaller than 10mm. Please also adjust the float voltage and equalization voltage according to the manual.

4 Charge and discharge requirements

4.1 Equalization charge

Equalization charge is needed in following conditions:

a The floating voltage of at least two batteries are lower than 2.16V/cell;

b Floating operation is more than three months.

The method of equalization charge is: First charge the batteries with the constant current of $0.1C_{10}A$ ～$0.15C_{10}A$ till the average voltage of the batteries increases to 2.35V/cell(25℃)， then charge the batteries with constant voltage of 2.35V/cell, the time of equalization charge is 24 hours.

4.2 Charge after discharge

The batteries need to be charged in time after discharge. The charge method is constant current and limited voltage charge: Charge the batteries with constant current of $0.1C_{10}A$～$0.2C_{10}A$ till the average voltage of the batteries increases to a certain voltage, then charge the batteries with this constant voltage till finishing charge, meanwhile the current will reduce.

The certain voltage can be equalizing voltage or floating voltage. When the discharge depth is large (such as larger than 10% C_{10}), equalizing voltage is recommended, which will make charging more sufficient. We can also determine the voltage according to initial current. When current is large than $0.05C_{10}A$ (the reference current when transfer to equalizing charge), we recommend equalizing charge. the time of charge is 24 hours. Or the value of charge current is not varied for continuous three hours under the condition of constant voltage, we can determine the charge is finished.

We can raise charge current if batteries need to be fully charged in a short time, but the current cannot be higher than $0.25C_{10}A$.

4.3 Battery Recharging Method

This method is used for battery charging for the first time after installing or battery recharging after long time storage.

- **Recharging Parameter**

We use equalizing charge to recharge the batteries, the parameter is as below:

① Charging mode: equalizing charge;

Charging voltage: 2.35V/cell, for -48V system, charging voltage is 56.4V;

Charging voltage (made up with 2V cell) = 2.35 × 1× battery quantity

② Current limited: $0.10C_{10}$ (A);

③ Cut-off condition: the charging current is less than 0.005C10 with another extended 3 hours or charging time reached 16 hours;

- **Recharging Procedure**

① Connect the batteries in series with cables or copper bars, and make sure that all the screws tightened with each joint, then connect the positive of battery group to the positive of charging equipment (charger), and the negative of battery group to the negative of charger. Pay attention, a breaker or fuse should be connected in the circuit in order to protect the batteries and charger, the capacity of breaker or fuse should be 1.5 times of circuit maximum current.

② Turn on the charger, set the charging voltage and current according to 3.1 Recharging Parameter.

③ Turn on the breaker or fuse, and then turn on the charger to recharging batteries.

④ Stop charging when reaching the cut-off condition. At the last one hour before finishing, test the battery voltage one by one, the battery which voltage is below 2.16V/cell should be dealt with the method in chapter 3.3, if that battery still can not accord with the requirement, it should be rejected.

- **Cycle Procedure**

We can use the method as below to recharge the batteries after long time storage (for example: more than 1 year):

First connect the batteries in series to the charger, discharge batteries with constant current $0.25C_{10}$ (A) for about 3 hours. Then use the method in chapter 3.2 to charge the batteries. Stop charging when reach the cut-off condition

If the capacity still can not be renewed by this method, this means the batteries fail because of long time storage or other reasons.

- **Battery Capacity Test Method**

If we can not confirm whether the long time storage batteries can be used again after the cycle in chapter 3.3, capacity should be checked as follow:

① Discharge batteries with constant current of $0.1C_{10}$ (A);

② During discharge, test battery voltage one by one once an hour. When the voltage reaches 1.9V/cell, test the voltage once ten minutes in order to check and record discharge time of each battery exactly, till the voltage reaches 1.80V/cell. Record time and calculate the capacity.

③ Stop discharging when all the battery voltages are below 1.80V/cell. Immediately recharge the batteries for 16 hours with constant voltage of (2.35±0.02)V/cell and current limited of $0.15C_{10}$ (A);

How to judge capacity: Compare actual capacity (actual capacity = discharge current in A × discharge time in hour) with rated capacity. If actual capacity is more than 80% of rated capacity, the battery can be used after recharging; If it is less than 80% of rated capacity, the battery should be charged for 24 hours and be discharged for another time to test capacity, if it is still less than 80% of rated capacity, then the battery already fails.

- **Charging Equipment and Tools**

No	Tool	Explanation	Purpose
1	Battery Test Equipment or Power System	If there is no Battery Test Equipment, we can use Power System instead of it.	Used to recharge and test batteries
2	Multimeter	Precision: 5mV	Test battery voltage
3	Amperemeter	Precision: less than 3%	Test charge and discharge current
4	Monkey spanner		Tightening the screws
5	Screwdriver		Prize up battery top cover

- **Attention Proceedings**

- Use battery testing equipment to recharge batteries, if there is no equipment, the power system can be used. Pay attention to the parameter of charge and discharge.
- In order to prevent accident occurs, a person should be on spot during recharging.
- Battery terminals should be bright and clean. Check and clean terminals before connecting in order to decrease contact resistance.
- A circuit breaker must be stringed in the circuit to prevent battery from damaged because of wrong connection.
- Make sure all the screws tightened reliably, otherwise there will be spark and heat while closing the circuit, this may cause battery burnt.
- Pay attention to prevent short-circuit while connecting, all the tools should be insulating.
- Strictly prohibit connect anode and cathode in reverse.

- Avoid over-charge; otherwise, battery life will shorten. The maximum charging time by constant voltage of 2.35V/cell and current limited of $0.15C_{10}$ (A) should be not more than 24 hours.

5 Storage

All lead acid batteries experience self-discharge in open circuit. The result is that open circuit voltage decreases, and the capacity also decreases. During storage please note:

A) The self-discharge rate is related with ambient temperature. The self-discharge rate is smaller when the ambient temperature is lower, otherwise is larger. The required temperature of battery's storage environment is from 5℃ to 30℃. The storage place must be clean, ventilated and dry;

B) An important parameter in storage is open circuit voltage, which is related with density of the electrolyte. If the open circuit voltage is lower than 2.08V/cell, or have been stored for long time, the batteries should be charged to avoid damage caused by self discharge;

Storage temperature	Longest interval
over 30℃	once 6 months
under 30℃	once 9 months

C) All batteries, which are ready to store, should be fully charged before storage. It's suggested to record the storage time in the periodic maintenance record and record the time when another necessary supplemental charge should be made;

D) The quality certificates and packages of VRLA/gel batteries record the latest charge time of the batteries, next charge time can be calculated according to this charge time.

6 Maintenance

In order to assure service life, the batteries should be correctly inspected and maintained.

6.1 Cleaning

- Keep batteries and battery room clean and dry.
- Avoiding induce of static electricity during clean of batteries.
- Use damp cloth for cleaning, don't use gasoline, alcohol and other organic solvents.

6.2 Check and maintenance

Perform following routine checks and keep records.

Monthly Maintenance

Items	Details	Benchmarks	Maintenance
① Total battery group voltage	Use multi-meter check total voltage across positive and negative terminal	1.The value of measured and displayed on equipment should be close. 2. Voltage error after compensation should be less than ±50mV	Adjust the charging voltage to recommended range if there is a deviation; Repair the equipment if voltage can't be adjusted.
② Battery appearance	Bulge, leakage or damage	Appearance should be OK	Replace the battery if bulge, leakage or damage
	Dust, dirty	Clean	Cleaning
	Connectors, terminals	No rust	Clean and anti rust dealing
③ Battery surface temperature	Use infrared thermometer measure surface temperature	Less than	Further check and analysis if high temperature found

Quarterly Maintenance

Items	Details	Benchmarks	Maintenance
①Float voltage for each battery	Measure the voltage of each battery under floating, using a meter with four and half digits.	Voltage difference less than 2V: 90mV 6V: 240mV 12V:480mV	If there is a deviation, discharge the batteries and perform a equalizing charging, observe for one through two months under floating. Contact us if no improvement.
② Correct the low voltage batteries	If more than two cells' voltages are less than 2.16V/cell after temperature adjustment, the batteries need equalization charging.	Float voltage ≥2.16V/cell	If battery float voltage less than 2.16V/cell after equalization charge, the battery need do a 80% capacity test.
③ Activated discharge	Perform a discharge-charge cycle, using lower level of equalizing charge voltage for the charge.	Discharge around 30% of the nominal capacity.	Perform the discharge-charge cycle if no power-off for six months.

Yearly Maintenance

Items	Details	Benchmarks	Maintenance

① Check-up discharge	Disconnect the AC power and discharge the battery to a DOD of 30%～40%	The final voltage be greater 1.90V/cell.	Perform a equalizing charge if voltage less than 1.90V/cell. Observe for one through two months. Contact us if no improvement.
④ Connections	Use torque wrench to check connection hardware	Refer to torque values	Re-tight if there is a loose connection
	Connector appearance	No rust	Clean or replace if rusted connectors found

Three-year Maintenance

Items	Details	Benchmarks	Maintenance
② Capacity test	Discharge battery at I10 current to 1.80V/cell	Remained capacity higher than 80%	Replace battery with low capacity

7 Disposal

VRLA batteries are recyclable. Scrap batteries must be sent to a licensed recycling facility for disposal. Scrap batteries must be packaged, transported and recycled in accordance with local and national regulations

8 Operation and Maintenance Precautions

- **Insufficient Charge**

If the floating voltage is not set correctly (too low or not compensate according to temperature), the battery system will in an insufficient charge state for a long period of time. When the electricity is out, the battery may not be able to work because negative plate sulfation and the capacity is decreased.

- **Over Charge**

Please do not neglect the performance of rectifier to transfer floating charge to equalization charge. If the rectifier cannot transfer charge modes because of its wrong performance or none adjustment, the battery system is always in an equalization charge state. Thus may cause serious problems for battery, such as water loss, life decrease, thermal run away deformation, etc.

- **Too low or too high temperature**

We have mentioned that too low temperature will affect the capacity of battery. While too high temperature will also cause problems, such as water loss, life decrease, thermal run away, deformation, etc.

- **Too low end voltage**

The end voltage is also an important protection method for battery. The battery shall stop discharge when reaching a certain voltage (The normal end voltage is 1.80V/cell at 10h rate). If the end voltage is too low, it will be difficult to recharge the battery and decrease the charge efficiency, thus reduce the life of battery.

- **Not recharge in time after discharge**

If the battery is put aside without charge for a long time after discharge, it will affect the capacity and life of the battery. Because in the negative, some large size $PbSO_4$ will be formed which is difficult to transfer to active Pb.

Part Three Battery Installation

1 Unpacking and Inspection

1.1 Inspection: Open the shipping containers and check the contents for damage and against the packing list. Immediately inform the sales department of any damaged or missing item

1.2 Reference-installation drawing and operation manual;

1.3 Measure: measure the open circuit voltage of battery, and the battery can't be installed if open circuit voltage is lower than 2.0V/cell.

2 Installation Precautions

2.1 Fix the battery to avoid vibration and shock;

2.2 Combustible gas(hydrogen) will be generated during charge and storage, so keep the battery away from spark source (like switch and fuse);

2.3 Do not use sealed container or container within which combustible gases easily accumulate;

2.4 When internal installation is required, place battery at the bottom of the equipment to avoid overheating. Beside, contact with the inner wall of the equipment and other batteries should be avoided;

2.5 Keep the battery away from heating things (such as a transformer).

3 Installation and Wiring

3.1 Wrap the metal mounting tool(such as spanner) with insulating tape;

3.2 If batteries are mounted in KAISE' rack, Install rack according to KAISE' rack installation guide.

3.3 Connect battery connector between the batteries, then connect the battery string to charger or load;

Be sure to tighten the screws to avoid fire incidents, and the allowable set value of M6 terminal torque is 6～8 N•m, M8 terminal torque is 10～12N•m.

If the terminal has L-copper, check the crew between the L-copper and terminal is screwed up before connecting batteries; if not, be sure to Tighten the screws.

3.5 A quantity of anti-rust is spread on the terminal surface of the battery before or after the installation;

3.6 After battery installation, check total voltage of battery string before power on;

3.7 After finishing installing the batteries, If the site is not open temporarily, be sure to cut off the connection between the batteries and the system to avoid overdischarge.

OPzV Battery Operation Manual

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