

Specification

A UPS system based on aqueous sodium ion batteries

technical field

The present invention relates to a UPS system, particularly a water based sodium ion battery as an energy storage module.

Background technology

UPS (Uninterruptible Power Supply) refers to an uninterruptible power supply. It is a constant voltage and frequency power supply device that contains an energy storage device and inverter. As the name suggests, it is a machine that can maintain power supply for a period of time when the power grid stops supplying. It is a specialized equipment that can provide continuous, stable, and uninterrupted power supply. Under normal circumstances, it inverts the AC power from the power grid and stores it in its own power source. When the power supply stops, the stored energy is released. Currently, lead-acid batteries are widely used in UPS systems as energy storage component, lead-acid batteries have issues such as temperature sensitivity and short lifespan. In addition, the lead-acid battery manufacturing industry chain (including primary lead smelting, battery manufacturing, battery recycling, and recycled lead smelting) has a high risk of lead pollution. Poor management can cause environmental pollution and harm human health problem.

The mainstream UPS in the current market mainly uses lead-acid batteries, the operating parameters of the UPS host are matched with lead-acid batteries, the matching degree with aqueous sodium ion batteries is relatively low. Mainly manifested in the operating voltage range.

The operating range of lead-acid batteries is generally between 13.5V-13.8V (for batteries with a rated voltage of 12V), with a median value of 13.65V. The specific parameters vary depending on the battery manufacturer. The termination voltage during

discharge is 10.5 (12V), which varies slightly depending on the discharge current from manufacturer to manufacturer.

The operating voltage range of aqueous sodium ion batteries with a rated voltage of 12V is 14.4V for charging and 8.8V for discharging. The operating range of aqueous sodium ion batteries is larger than that of lead-acid batteries (10.5-13.65V). If the existing UPS host equipment is used to replace the aqueous sodium ion battery, a aqueous sodium ion battery with the same capacity as the original lead-acid battery should be configured. Because the equipment does not support discharging to a lower voltage and cannot fully discharge, the capacity will decrease and cannot meet customer needs. In order to meet customer needs, it is necessary to increase the number of batteries, which increases the cost for users. Developing a new UPS host will result in significant waste of existing equipment.

summary of the invention

The purpose of the present invention is to overcome the shortcomings of existing technology and provide a UPS system based on aqueous sodium ion batteries. By utilizing the advantages of existing UPS hosts and the wide voltage range of choppers, the problem of mismatched operating parameters between aqueous sodium ion batteries and existing mainstream UPS hosts is solved, which can fully utilize the capabilities of aqueous sodium ion batteries and reduce user costs.

The technical solution to achieve the above objectives is: a UPS system based on aqueous sodium ion batteries, including energy storage modules, UPS host, and control devices, wherein:

The energy storage module comprises two battery packs, each of which uses a aqueous sodium ion battery energy storage module. The two battery packs are battery pack B1 and battery pack B2, respectively;

The control device comprises a microcontroller, two choppers, and four switches, wherein the two choppers and four switches communicate with the microcontroller respectively;

The UPS host comprises a rectifier and an inverter connected to it, the rectifier is connected to the power grid, and the inverter is connected to the load;

The battery pack B1 is respectively connected to the chopper D1 and switch K2, and the chopper D1 is connected to the switch K1;

The battery pack B2 is respectively connected to the chopper D3 and switch K4, and the chopper D2 is connected to the switch K3;

The connection ends of the rectifier and inverter are respectively connected to the switch K1, switch K2, switch K3, and switch K4;

The microcontroller monitors the voltage status of the power grid and controls the working status of the two choppers and four switches based on the voltage status of the power grid.

A UPS system based on aqueous sodium ion batteries mentioned above, wherein the aqueous sodium ion battery energy storage module comprises multiple aqueous sodium ion battery units connected in series or parallel. Each aqueous sodium ion battery unit has a rated capacity of 30-200Ah, a cycle life greater than 3500 times, a rated voltage of 1.5-2.0V, a charge discharge rate of 0.1-2C, and a suitable temperature range of -10-50 °C.

The above UPS system based on aqueous sodium ion batteries, wherein the minimum voltage of the chopper is less than the minimum discharge voltage of the aqueous sodium ion battery energy storage module, and the maximum voltage of the chopper is greater than the maximum charging voltage of the aqueous sodium ion battery energy storage module.

The above is a UPS system based on aqueous sodium ion batteries. When the power grid is normal, the microcontroller opens switch K1 and switch K3, closes switch K2 and switch K4, and the battery pack B1 and B2 are in a charging standby state. The entire UPS system is in normal power grid operation, and the load is powered by the power grid.

The above is a UPS system based on aqueous sodium ion batteries. When the power grid loses power, the microcontroller monitors that when the power grid voltage is 0V, battery pack B1 and battery pack B1 switch to a discharge state. The entire UPS system is in a state of power grid loss, and the load is supplied by the aqueous sodium ion battery

energy storage module. The voltage of the aqueous sodium ion battery energy storage module decreases due to discharge, The battery pack B1 and battery pack B2 are sequentially switched to power supply through a control device to ensure uninterrupted power supply and achieve disturbance free switching. Specifically:

Firstly, when the microcontroller disconnects switch K2, battery pack B1 exits the operating state, and battery pack B2 remains in the operating state, directly supplying power to the load through the inverter to maintain the continued operation of the UPS system; Then the microcontroller closes switch K1, chopper D1 enters the working state, battery pack B1 is put into operation, battery pack B1 supplies power to the load through chopper D1 and inverter, and the output voltage of battery pack B1 is set to the current bus voltage;

Then, the microcontroller disconnects switch K4, battery pack B2 exits the operating state, and battery pack B1 remains in the operating state, supplying power to the load through chopper D1 and inverter to maintain the continued operation of the UPS system;

At this point, switch K1 and switch K3 are in the closed state, switch K2 and switch K4 are in the open state, and battery pack B1 and battery pack B2 respectively supply power to the load through corresponding choppers and inverters.

The above UPS system based on aqueous sodium ion batteries, wherein, when the power grid is restored, the microcontroller monitors that the power grid voltage returns to normal, and the battery pack B1 and B2 switch to a charging standby state in sequence, specifically:

Firstly, the microcontroller sequentially stops the chopper D2, the disconnect switch K3, and the close switch K4, and the battery pack B2 switches to the charging standby state;

Then the microcontroller sequentially stops the chopper D1, disconnect switch K1, and close switch K2, and the battery pack B1 switches to the charging state, completing the switching of the two battery packs to the charging standby state, restoring normal grid operation, and the load is powered by the grid.

The UPS system based on aqueous sodium ion batteries of the present invention has the

following beneficial effects:

(1) Water based sodium ion batteries have advantages such as environmental friendliness (no pollution during production), long lifespan (3-4 times longer than lead-acid batteries), and low cost (using low-cost ceramic grade raw materials);

(2) Compared to lead-acid batteries, aqueous sodium ion batteries are easier to maintain and have a greatly expanded operating temperature range, reaching -10-50 °C. They are non corrosive liquids and will not explode, making them safer;

(3) The sources of cathode and anode active material are extensive, with low prices and no pollution to the environment, making aqueous sodium ion batteries green, low-cost, and commercially viable on a large scale;

(4) The present invention utilizes the existing UPS host and the advantage of the wide voltage range of the chopper (DCDC, DC transformer module), and adopts a chopper with an input voltage range that meets the voltage characteristics of aqueous sodium ion batteries (voltage range of 8.8V-13.8V), solving the problem of mismatched operating parameters between aqueous sodium ion batteries and mainstream UPS hosts. It can fully utilize the capabilities of aqueous sodium ion batteries and reduce user costs.

Illustration

Figure 1 shows the discharge curve of the aqueous sodium ion battery;

Figure 2 is a wiring diagram of the UPS system based on aqueous sodium ion batteries of the present invention;

Figure 3 shows the wiring diagram of a traditional UPS system in proportion.

Specific implementation methods

In order to enable technical personnel in this field to better understand the technical solution of the present invention, the following is a detailed explanation of its specific implementation method in conjunction with the accompanying drawings:

Implementation Example:

Please refer to Figures 1 and 2, the best embodiments of the present invention, a UPS

system based on aqueous sodium ion batteries, comprising an energy storage module, UPS host, and control device. The energy storage module consists of two battery packs, each using a aqueous sodium ion battery energy storage module. The aqueous sodium ion battery energy storage module includes multiple aqueous sodium ion battery units connected in series or parallel. Each aqueous sodium ion battery unit has a rated capacity of 30-200Ah, a cycle life greater than 3500 times, a rated voltage of 1.5-2.0V, a charge discharge rate of 0.1-2C, and a suitable temperature range of -10~50 °C.

Two battery packs are battery pack B1 and battery pack B2, respectively;

The control device includes a microcontroller 1, two choppers, and four switches. The two choppers and four switches communicate with microcontroller 1, respectively; The two choppers are chopper D1 and chopper D2, and the four switches are switch K1, switch K2, switch K3, and switch K4. The minimum voltage of the chopper is lower than the minimum discharge voltage of the aqueous sodium ion battery energy storage module, and the maximum voltage of the chopper is greater than the maximum charging voltage of the aqueous sodium ion battery energy storage module.

The UPS host includes rectifier 2 and inverter 3 connected to it. Rectifier 2 is connected to the power grid, and inverter 3 is connected to the load.

Battery pack B1 is connected to chopper D1 and switch K2 respectively, and chopper D1 is connected to switch K1; Battery pack B2 is connected to chopper D3 and switch K4 respectively, and chopper D2 is connected to switch K3; The connection terminals a of rectifier 2 and inverter 3 are respectively connected to switch K1, switch K2, switch K3, and switch K4.

Microcontroller 1 monitors the voltage status of the power grid and controls the working status of two choppers and four switches based on the voltage status of the power grid. The control logic of microcontroller 1 is:

(1) When the power grid is normal, microcontroller 1 opens switch K1 and switch K3, closes switch K2 and switch K4, and battery pack B1 and B2 are in charging standby state. The entire UPS system is in normal power grid operation state, and the load is powered by the power grid.

(2) When the power grid loses power, microcontroller 1 detects that when the voltage of the power grid is 0V, battery pack B1 and battery pack B1 switch to a discharge state, and the entire UPS system is in a power loss working state. The load is powered by the aqueous sodium ion battery energy storage module, and the voltage of the aqueous sodium ion battery energy storage module decreases due to discharge. Battery pack B1 and battery pack B2 switch to power supply sequentially through the control device to ensure that there is no interruption in power supply to achieve undisturbed switching, specifically:

Firstly, microcontroller 1 disconnects switch K2, and battery pack B1 exits the operating state. Battery pack B2 maintains the operating state and directly supplies power to the load through the inverter, maintaining the UPS system to continue operating; Then microcontroller 1 closes switch K1, chopper D1 enters the working state, battery pack B1 is put into operation, battery pack B1 supplies power to the load through chopper D1 and inverter, and the output voltage of battery pack B1 is set to the current bus voltage;

Then, microcontroller 1 disconnects switch K4, battery pack B2 exits the operating state, and battery pack B1 maintains the operating state by supplying power to the load through chopper D1 and inverter, maintaining the UPS system to continue operating; Then microcontroller 1 closes switch K3, chopper D2 enters the working state, battery pack B2 is put into operation, and battery pack B2 supplies power to the load through chopper D2 and inverter. The output voltage of battery pack B2 is set to the current bus voltage;

At this point, switch K1 and switch K3 are in the closed state, switch K2 and switch K4 are in the open state, and battery pack B1 and battery pack B2 respectively supply power to the load through corresponding choppers and inverters.

(3) After the power grid is restored, microcontroller 1 detects that the power grid voltage has returned to normal. Battery pack B1 and battery pack B2 switch to the charging standby state in sequence, specifically:

Firstly, microcontroller 1 sequentially stops chopper D2, disconnect switch K3, and close switch K4, and battery pack B2 switches to charging standby state;

Then microcontroller 1 sequentially stops chopper D1, disconnect switch K1, and close switch K2. Battery pack B1 switches to charging state, completing the switching of the two battery packs to charging standby state, restoring normal grid operation, and the load is powered by the grid.

Proportional:

Please refer to Figure 3. In a traditional UPS system, the energy storage module is directly connected to the grid, and the connection terminals a 'of rectifier 2' and inverter 3 'are respectively connected to battery pack B1' and battery pack B 2 '. In the event of a power outage in the grid, battery pack B1' and battery pack B 2 'directly supply power to the load through inverter 3'.

Table 1. Technical parameters of aqueous sodium ion battery units with a rated voltage of 12V:

Rated capacity	53 Ah @ 0.1C, 25 °C	cycle life	>3500 times
Rated energy	636 Wh	working temperature	-10-50 ° C
Rated voltage	DC 12V	Float charging voltage	13.8V
Cycle efficiency	>90%	Discharge termination voltage	8.8 V

Table 1 shows the technical parameters of aqueous sodium ion battery with a rated voltage of 12V. The float charging voltage is 13.8V and the discharge termination voltage is 8.8V. If directly connected to mainstream UPS hosts in the market, the charging termination voltage is 13.8V and the discharge termination voltage is 10.5V. At this time, the battery capacity is about 36Ah, which is 68% of the rated capacity (53Ah) (see Figure 1).

Using aqueous sodium ion battery unit with a rated voltage of 12V as the energy storage module, assuming building a 2-hour UPS system with a voltage of 48V and a power of 2KW, the required number of batteries is shown in Table 2 for the implementation example and different proportions of UPS system design. It can be seen that using the UPS system design in the implementation example, the chopper in the control device can expand the voltage range and maximize the battery capacity, Reduce battery usage by one-third.

Table 2 shows the required number of batteries for the proportion and implementation examples:

	Water based sodium ion battery unit capacity/Ah	Number of required aqueous sodium ion battery units	Series parallel mode
Implemen tation example	53	8	4S2P
Proportio nal	36	12	4S3P

The UPS system based on aqueous sodium ion batteries of the present invention utilizes existing UPS hosts and adds control devices to solve the problem of mismatched operating parameters between aqueous sodium ion batteries and existing mainstream UPS hosts. It can fully utilize the capabilities of aqueous sodium ion batteries, which are environmentally friendly (no pollution in production) and have a long lifespan (3-4 times that of lead-acid batteries) Advantages such as low cost (using low-cost ceramic grade raw materials); Compared to lead-acid batteries, aqueous sodium ion batteries are easier to maintain and have a greatly expanded operating temperature range, reaching 0-50 °C. They are non corrosive liquids and will not explode, making them safer; Positive and negative active substances come from a wide range of sources, are inexpensive, and have no pollution to the environment, making aqueous sodium ion batteries green, low-cost, and can be commercialized on a large scale, reducing user costs.

In summary, the UPS system based on aqueous sodium ion batteries of the present invention utilizes existing UPS hosts and the advantage of a wide voltage range of choppers to solve the problem of mismatched operating parameters between aqueous sodium ion batteries and existing mainstream UPS hosts. This can fully leverage the capabilities of aqueous sodium ion batteries and reduce user costs.

Ordinary technical personnel in this field should recognize that the above

embodiments are only used to illustrate the present invention and not as a limitation of the present invention. As long as they fall within the substantive scope of the present invention, any changes or variations to the above embodiments will fall within the scope of the claims of the present invention.

Claims

1. A UPS system based on aqueous sodium ion batteries, characterized in that it comprises an energy storage module, a UPS host, and a control device, wherein:

The energy storage module comprises two battery packs, each of which uses aqueous sodium ion battery as energy storage module. The two battery packs are battery pack B1 and battery pack B2, respectively;

The control device comprises a microcontroller, two choppers, and four switches, wherein the two choppers and four switches communicate with the microcontroller respectively; The two choppers are chopper D1 and chopper D2, and the four switches are switch K1, switch K2, switch K3, and switch K4, respectively;

The UPS host comprises a rectifier and an inverter connected to it, the rectifier is connected to the power grid, and the inverter is connected to the load;

The battery pack B1 is respectively connected to the chopper D1 and switch K2, and the chopper D1 is connected to the switch K1;

The battery pack B2 is respectively connected to the chopper D3 and switch K4, and the chopper D2 is connected to the switch K3;

The connection ends of the rectifier and inverter are respectively connected to the switch K1, switch K2, switch K3, and switch K4;

The microcontroller monitors the voltage status of the power grid and controls the working status of the two choppers and four switches based on the voltage status of the power grid.

2. A UPS system based on aqueous sodium ion batteries as claimed in claim 1, characterized in that the aqueous sodium ion battery energy storage module comprises multiple aqueous sodium ion battery units connected in series or parallel. Each aqueous sodium ion battery unit has a rated capacity of 30-200Ah, a cycle life greater than 3500 times, a rated voltage of 1.5-2.0V, a charge discharge rate of 0.1-2C, and an applicable temperature range of -10-50 °C.

3. A UPS system based on aqueous sodium ion battery as claimed in claim 2, characterized in that the minimum voltage of the chopper is less than the minimum discharge voltage of the aqueous sodium ion battery energy storage module, and the maximum voltage of the chopper is greater than the maximum charging voltage of the aqueous sodium ion battery energy storage module.

4. A UPS system based on aqueous sodium ion battery as claimed in claim 1, characterized in that, when the power grid is normal, the microcontroller opens switch K1 and switch K3, closes switch K2 and switch K4, and the battery pack B1 and B2 are in a charging standby state. The entire UPS system is in a normal power grid working state, and the load is powered by the power grid.

5. A UPS system based on aqueous sodium ion battery as claimed in claim 2, characterized in that when the power grid loses power, the microcontroller detects that when the power grid voltage is 0V, battery pack B1 and battery pack B1 switch to a discharge state, and the entire UPS system is in a power grid loss working state. The load is powered by aqueous sodium ion battery energy storage module, and the voltage of the aqueous sodium ion battery energy storage module decreases due to discharge, The battery pack B1 and battery pack B2 are sequentially switched to power supply through a control device to ensure uninterrupted power supply and achieve disturbance free switching. Specifically:

Firstly, when the microcontroller disconnects switch K2, battery pack B1 exits the operating state, and battery pack B2 remains in the operating state, directly supplying power to the load through the inverter to maintain the continued operation of the UPS system; Then the microcontroller closes switch K1, chopper D1 enters the working state, battery pack B1 is put into operation, battery pack B1 supplies power to the load through chopper D1 and inverter, and the output voltage of battery pack B1 is set to the current bus voltage;

Then, the microcontroller disconnects switch K4, battery pack B2 exits the operating state, and battery pack B1 remains in the operating state, supplying power to the load through chopper D1 and inverter to maintain the continued operation of the UPS system;

Then the microcontroller closes switch K3, chopper D2 enters the working state, and battery pack B2 is put into operation. Battery pack B2 supplies power to the load through chopper D2 and inverter, and the output voltage of battery pack B2 is set to the current bus voltage;

At this point, switch K1 and switch K3 are in the closed state, switch K2 and switch K4 are in the open state, and battery pack B1 and battery pack B2 respectively supply power to the load through corresponding choppers and inverters.

6. A UPS system based on aqueous sodium ion battery according to claim 5, characterized in that when the power grid is restored, the microcontroller monitors that the power grid voltage returns to normal, and the battery pack B1 and B2 sequentially switch to a charging standby state, specifically:

Firstly, the microcontroller sequentially stops the chopper D2, the disconnect switch K3, and the close switch K4, and the battery pack B2 switches to the charging standby state;

Then the microcontroller sequentially stops the chopper D1, disconnect switch K1, and close switch K2, and the battery pack B1 switches to the charging state, completing the switching of the two battery packs to the charging standby state, restoring normal grid operation, and the load is powered by the grid.