

DUAL-POWER ENERGY-SAVING SYSTEM FOR RUBBER TYRED GANTRY CRANE

Technical Field

The present invention relates to a wharf equipment power system which belongs to the field of a new energy application, and more particularly to a dual-power energy-saving system for a rubber tyred gantry crane (RTG).

Background Art

With the developments of the world economy, industrial production, transportation, and the like, dependence on oil is getting higher and higher. The environmental problems, such as the greenhouse effect, ecological deterioration and so on have become more and more severe. How to maintain the harmonious development of the economy and the environment becomes a global concern. A conventional rubber tyred gantry crane (RTG) of wharf equipment adopts a single generator unit as its power. The fuel efficiency is less than 30%. The main reasons are as follows:

a) Large installed capacity: RTG must meet the short-time maximum load demand. The power of the generator must be designed according to the highest requirements of the RTG, which is about 8 times greater than the average power of the actual operation of the RTG.

b) Low fuel efficiency: When the generator unit is running in the best economical fuel consumption zone, the energy efficiency is optimal. When the rubber tyred gantry crane (RTG) is operated, in order to ensure the normal power supply of the control system and the working mechanism, the output power of the generator unit must be greater than the required power of the RTG. The generator unit needs to run at a rated speed without interruption. Because the required power of the RTG depends on different conditions, the generator has to adjust the output power in real time to match the required power of the RTG. Most of the time, the generator unit is running not in the best economical fuel consumption zone, so the energy efficiency is low. FIG. 2 illustrates the fuel consumption contour map of the diesel engine. The generator unit has a minimum fuel consumption rate of about 186 g/kWh at 1200-1300 rpm, which is called "the best economical fuel consumption zone". When the required power of the system is lowered below 40kW, the fuel consumption rate is up to 426g/kWh (B zone, FIG. 2), which is about 2.3 times greater than the best economic fuel consumption. When the RTG is overloaded and the lifting mechanism accelerates, the fuel combustion of the generator is bad, resulting in black smoke and serious pollution.

c) No braking energy recovery function: When the lifting mechanism of the RTG is lowered and the small trolley travelling mechanism and the crane travelling mechanism slow down, the feedback energy cannot be stored due to no energy storage device, and it must be consumed by energy consumption resistance.

Accordingly, the inventor of the present invention has devoted himself based on his many years of practical experiences to solve these problems.

Disclosure of the Invention

In view of the shortcomings of the aforesaid RTG, the primary object of the present invention is to provide a dual-power energy-saving system for a rubber tyred gantry crane (RTG),

aiming at realizing the power output power to match the required power, thereby improving the energy efficiency of the RTG, reducing the overall energy consumption of the RTG, saving energy and reducing emission.

The present invention changes the power generation mode of the traditional RTG with a single generator unit or a generator unit with a battery pack. As to the two power sources of the generator unit and the battery pack, the two power sources can independently satisfy the required power for the normal operation of the RTG.

When the power of the battery pack is in the setting range, the operation of the RTG uses the battery pack as the power source so that the output power of the power source highly matches the required power of the RTG. When the power of the battery pack is low, the generator unit will be started to supply power. Once the generator unit is actuated to run, it is controlled to run in the best economical fuel consumption zone, so that the generator unit runs with the highest efficiency. When the generator unit directly supplies power to the RTG, the surplus energy is to charge the battery pack. When the power of the battery pack reaches the set high value, the generator unit shuts down.

The charging power of the battery pack is greater than the maximum feedback energy of the RTG to achieve the recycling of the feedback energy of the RTG.

The system is described in detail as follows:

- a) The generator unit and the battery pack can independently support the operation of the RTG to form the "dual power" source of the RTG. When the battery pack malfunctions, it can be switched to the operating mode of the generator unit, improving the reliability of the RTG.
- b) The generator unit runs intermittently. When the power of the battery pack reaches the set high value of the system, the generator unit is turned off, and the required power of the RTG is completely provided by the battery pack. When the power of the battery power drops to the set low value, the generator unit is started to supply power to the RTG and the surplus energy is used for charging the battery pack. When the generator unit is actuated to run, it will always run in the best economical fuel consumption zone to ensure the most efficient operation;
- c) When the lifting mechanism of the RTG is lowered and the small trolley travelling mechanism and the crane travelling mechanism slow down, the feedback energy is recycled to the battery pack to achieve recycling.

The object of the present invention can be implemented by the following technical scheme.

On the premise of not changing the performance parameters and structure of the original RTG equipment, a battery power source system is provided. The system mainly comprises a battery pack, an inverter power source, a 24V DC power source, a system controller, and other components.

An input end of the inverter power source is connected in parallel with the DC bus. An output end of the inverter power source is connected with the auxiliary transformer for supplying power to auxiliary electrical equipment of the RTG, such as a lighting device, an air conditioner and

the like. An input end of the 24V DC power source is connected in parallel with the DC bus. An output end of the 24V DC power source is to supply DC power to the control system of the RTG.

When the system is applied to modify the conventional RTG for energy-saving, there is no need to replace the original power system of the RTG and there is no need to change the parameters and structure of the original equipment. Only a set of a power battery supply and a control system is added to complete the energy saving modification. For a new RTG, the energy-saving effect is better by accurately calculating the parameters of the configuration of the generator unit and the battery pack.

Brief Description of Drawings

FIG. 1 is a block diagram of the dual-power system of the present invention; and
FIG. 2 illustrates the fuel consumption contour map of the diesel engine.

Best Mode for Carrying out the Invention

Advantages and features of the inventive concept and methods of accomplishing the same may be understood more readily by reference to the following detailed description of embodiments and the accompanying drawings.

As shown in FIG. 1, the present invention discloses a dual-power energy-saving system for a rubber tyred gantry crane (RTG). The RTG uses the battery pack as a primary power source. The system comprises a system controller 1, a battery pack and management system 2, a generator unit 3, a unidirectional DC/AC inverter power supply 4, a unidirectional DC/DC direct current power supply 5, and an auxiliary transformer 6. The RTG comprises electrical equipment associated with the system, including a lifting mechanism converter 7, a small trolley travelling mechanism converter 8, a crane travelling mechanism converter 9, auxiliary electrical equipment, and a control power source.

The connecting ways and the main functions of the parts are as follows:

The battery pack 2 is connected with a DC bus of the RTG to supply power, auxiliary power source and DC power source to a working mechanism and to recycle energy. An input end of the inverter power supply 4 is connected in parallel with the DC bus. An output end of the inverter power supply 4 is connected with the auxiliary transformer 6. The auxiliary transformer 6 outputs AC380V / 220V50Hz three-phase four-wire power to the auxiliary electrical equipment of the RTG, such as a lighting device, an air conditioner, and the like. An input end of a 24V DC power supply is connected in parallel with the DC bus. An output end of the 24V DC power supply is to provide the control power supply of the RTG. The generator unit 3 has two output ways. One output way is connected to an AC input end of the lifting mechanism converter 7 and then connected to the DC bus after rectification to supply power to the working mechanism of the RTG or to charge the battery pack. The other output way is connected to an input end of the auxiliary transformer 6. When the generator unit 3 is actuated to work normally, it will directly supply power to an auxiliary electrical mechanism.

The energy management control and working principle of this system are as follows:

The voltage working range of the battery pack 2 (or through DC/DC) is set to match the voltage working range of the converter according to the power-voltage characteristics of the battery to ensure the stability of the control system of the RTG.

The system controller 1 monitors the state of the voltage and the electricity of the battery pack 2, and controls the generator unit 3 to start, idle, full speed or shut down.

When the electricity of the battery pack 2 is within the set working range, the whole power demand is provided by the battery pack 2 through the DC bus. When the power of the battery pack 2 is lowered to the set low value, the generator unit 3 is started. After the generator unit 3 is actuated to work normally, the generator unit 3 supplies power to all the electrical equipment of the RTG and the surplus energy charges the battery pack 2. With an increase of the electricity of the battery pack 2, the voltage is gradually increased. When the voltage of the battery pack 2 reaches to the set high value, the system controller 1 controls the generator unit 3 to idle for a period of time, and then the generator unit 3 shuts down.

The output power control of the generator unit 3: FIG. 2 illustrates the fuel consumption contour map of a diesel engine. When the rotational speed of the diesel engine is at 1500 r/min and the output is 200-300kW, the fuel efficiency is the best. The system controller 1 controls the output power of the generator unit 3 in the range of 200kW-300kW. When the battery pack 2 is started at a low battery level, since the voltage of the battery pack 2 is low and the charging current is large, the charging power is greater than the rated output power of the generator unit 3. At this time, the system controller 1 controls the maximum charging current of the battery pack 2 to ensure that the sum of the charging power and the required power for the normal operation of the RTG is not greater than the rated power of the generator unit 3, that is, the output power of the generator unit 3 is controlled to less than 300 kW. As the voltage of the battery pack 2 continues to rise, the charging current is gradually reduced. The generator unit 3 is turned off when the sum of the charging power and the required power for the RTG system deviates from the economic fuel consumption of the generator unit 3, namely, less than 200 kW. When the generator unit 3 is actuated to work, it will work in the economical fuel consumption zone. The fuel efficiency is the highest.

Energy recovery and control: Each working cycle of the RTG has a certain proportion of the feedback energy. When the feedback energy is generated, the bus voltage increases. The feedback energy gives a priority to the inverter power supply 4 and the 24V DC power supply 5, and the surplus energy is recycled to the battery pack 2. The recycled energy is used in the next working cycle of the RTG. Since there is a certain loss in each charge and discharge, the recycling energy can be recycled endlessly theoretically until it is close to "0" but never returns to "0" to achieve energy recycling.

In view of the above, according to the working characteristic of the rubber tyred gantry crane, the present invention is to provide a dual-power energy-saving system for the RTG, which uses the battery pack as the main power source. The battery pack can meet the full power operation the RTG for a period of time. The output power of the power source exactly matches the required power of the equipment to improve energy efficiency, achieving RTG braking energy recovery and

recycling. When the generator unit is running, it is controlled to output power with the optimum energy efficiency, namely, the highest energy efficiency. The generator unit won't be overloaded, without black smoke. The running time of the generator unit can be shortened, and the maintenance cycle can be prolonged.

The dual-power energy-saving system for a rubber tyred gantry crane (RTG) of the present invention has the following features:

1. The power of the generator unit 3 and the battery pack 2 can meet the maximum required power of the RTG, and can independently support the normal operation of the RTG to improve the reliability of the equipment. The RTG uses the battery pack 2 as the primary power source. The output power of the battery pack 2 exactly matches the required power of the RTG to improve energy efficiency.
2. The generator unit 3 works intermittently. When the generator unit is actuated to work, its running is controlled in the economical fuel consumption zone, with high fuel efficiency. The generator unit won't be overloaded, without black smoke. The running time of the generator unit can be shortened, and the maintenance cycle can be prolonged.
3. The feedback energy of the RTG can be fully recycled.
4. When the system is applied to modify the conventional RTG, there is no need to replace the power system of the original generator and there is no need to change the performance parameters and structure of the original equipment, thereby reducing the cost of modification. When the system is applied to a new RTG, the efficiency of energy-saving is high by accurately calculating the parameters of the configuration of the generator unit and the battery pack.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

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CLAIMS

1. A dual-power energy-saving system for a rubber tyred gantry crane (RTG), comprising a system controller, a battery pack and management system, a generator unit, a unidirectional DC/AC inverter power supply, a unidirectional DC/DC direct current power supply, and an auxiliary transformer, the RTG comprising electrical equipment associated with the system, including a lifting mechanism converter, a small trolley travelling mechanism converter, a crane travelling mechanism converter, auxiliary electrical equipment, and a control power source;

connecting ways and main functions of each power module being as follows:

the battery pack: the battery pack being connected in parallel with a DC bus of a variable frequency driver of a working mechanism of the RTG for supplying power and auxiliary power supply to the working mechanism and for supplying power to a 24V DC power source; wherein when the working mechanism has inverter feedback energy, the inverter feedback energy is supplied to the inverter power source through the DC bus or recycled to the battery pack;

the inverter power source: an input end of the inverter power source being connected in parallel with the DC bus to convert the DC into AC, an output end of the inverter power source being connected with the auxiliary transformer, the auxiliary transformer outputting AC380V / 220V50Hz three-phase four-wire power to the auxiliary electrical equipment including a lighting device and an air conditioner;

the 24V DC power source: an input end of the 24V DC power source being connected with the DC bus, an output end of the 24V DC power source supplying power to the control power source;

the generator unit: the generator unit having two output ways, one output way being connected to an AC input end of the lifting mechanism converter of the RTG and then connected in parallel to the DC bus after rectification for supplying power to the working mechanism of the RTG, the inverter power source and the 24 DC power source or for charging the battery pack; the other output way being connected to an input end of the auxiliary transformer, wherein when the generator unit is actuated to run, the generator unit directly supplies power to an auxiliary electrical equipment;

wherein the generator unit and the battery pack can independently support the RTG to operate normally, the RTG uses the battery pack as a primary power source, output power is highly matched with required power; the generator unit works intermittently, when the generator unit is actuated to run, it is controlled to work in an economic fuel consumption zone, the generator unit can be controlled to work in the economic fuel consumption zone, idle or shut down so as to save energy and reduce emission and to improve power reliability of the RTG.

2. The dual-power energy-saving system as claimed in claim 1, wherein a voltage working range of the battery pack of the system is exactly matched with a voltage working range of the variable frequency driver of the RTG, the battery pack can be directly connected in parallel with the DC bus of the variable frequency driver of the working mechanism of the RTG without the DC/DC direct current power source,.

3. The dual-power energy-saving system as claimed in claim 1, wherein when the system is applied to modify the RTG, there is no need to replace an original generator unit.

4. The dual-power energy-saving system as claimed in claim 1, wherein charging power of the battery pack is greater than maximum feedback energy of the RTG to recycle the feedback energy of the RTG.