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Research Article

Pest Control Lamp in Green Food Bases Based on Wind-solar Complementary Generation System

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Abstract: According to the energy complementary characteristics of wind energy and solar energy in time and space, in this study, the wind turbine and solar cells are used to design a pest control lamp in green food bases powered by a small power wind-solar complementary supply system and the intelligent controller is used to charge and discharge the batteries, realizing various protection functions. Application shows that the pest control lamp in green food bases system has the advantages of low manufacturing cost and high reliability, suitable for being used in farmland and woodland which are far from the grid.

Keywords: Battery, generation system, green food bases, pest control lamp, solar cell, wind turbine

INTRODUCTION

Pest control lamp in green food bases is an electronic device by using the pest phototaxis to attract and kill pests, is one of the main methods to protest and control the agricultural and forestry pests comprehensively. The use of pest control lamp in green food bases can effectively reduce the use the amount of pesticide, reducing the pollution on agricultural products, soil and water (Zhao, 2012a). But the work of the pest control lamp in green food bases needs to be powered by electricity; according to the energy complementary characteristics of wind energy and solar energy in time and space, in this study, the wind turbine and solar cells are used to design a pest control lamp in green food bases powered by a small power wind-solar complementary supply system, which has the advantages of low manufacturing cost and high reliability, suitable for being used in farmland and woodland which are far from the grid.

METHODOLOGY

Structure of wind-solar complementary pest control lamp in green food bases: The wind-solar complementary pest control lamp in green food bases is mainly composed of a wind turbine, solar cells, a controller, batteries, pest control lamp in green food bases and the bracket, etc., (Fig. 1). When the inflow velocity reaches the start-up wind speed of the turbine, the wind wheels begin to rotate; the wind energy is converted into mechanical energy and then converted into alternating current. Because the alternating voltage of the converted electrical energy is not very stable, it is needed to be rectified by the rectifier and then charge the batteries. Solar panels are composed of a number of solar cell panels connected and paralleled in series and its function is to directly convert the solar energy radiated on the photovoltaic array into DC power, then store the energy in the batteries (Zhao, 2012b). The batteries are mainly used for storing and adjusting the electrical power, in the conditions of strong wind or enough sunshine, the excess of electric energy will be generated, then the batteries will store the excess of energy; if the electric energy production of the whole system is not enough or the load power consumption increases, in order to maintain the stability of the system voltage, the batteries will recharge the energy so as to provide normal for the work load.

Wherein, the controller is the core of the system, its performance directly affects the efficiency of the system, the life span of the batteries and the maintenance cost of the whole system. Therefore, it is needed to design specially the controller, to ensure the continuity and stability of the wind power, solar power and complementary generation system. In this way, the controller designed must conduct continuous switch and adjustment for all kinds of working state of the battery based on the local instantaneous wind resources, the extent of sunshine intensity and the change of the load, so that it can alternately run in all sorts of conditions such as the recharge and discharge or float charging. The controller should also have the function of avoiding overcharge and over discharge. According to the specific requirements met by various systems, it is required that the controller should have the functions

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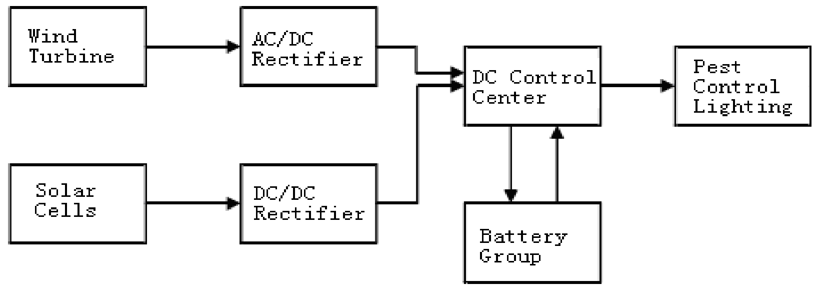

Fig. 1: Structure diagram of wind-solar complementary pest control lamp in green food bases

such as wind turbines and solar cell phalanx power distribution adjustment, high and low pressure alarm and disconnection, the automatic equalizing charge, Ah counting, current and voltage indication, etc.

The pest control lamp in green food bases is a DC load, but its working voltage and the voltage of the batteries is the same, the electricity only leads directly from the output end of the controller while using, so that the pest control lamp in green food bases works normally.

Energy configuration of pest control lighting: It is a primary link to calculate the total power of the pest control lamp in green food bases for the energy design of the wind-solar complementary pest control lamp in green food bases. If the energy design of the pest control lamp in green food bases is unreasonable and even wrong, which will lead to short lightening time, dim light in the cloudy days, early scrap for the batteries and too high cost; the key to judge the system technical level of the wind-solar complementary pest control lamp in green food bases is the power design and energy configuration design of the lamp in green food bases, which is the key technology to enhance the system efficiency and reduce the cost.

For the electric light trapping and the high-voltage power grid pest control lamp in green food basess, the total power is substantially equal to the sum of the light source power and high voltage network power; the other can be negligible; for the electric light trapping and water drowning, then it only needs to consider the light source power. At present, the main electric light source used for the pest control lamp in green food basess are black light, the lamp in green food bases of vibration frequency, double wave light and LED. The first 3 lights belong to the low-voltage fluorescent lamp in green food bases light source. When PL is used to represent the power of light source, then PL = lamp in green food bases power/converter efficiency; for the low-voltage fluorescent lamp in green food bases, the converter (ballast) efficiency is about 75%, for the LED light source, the converter efficiency is higher than 90%. When PN is used to represent the power grid, the high-voltage network power consists of 2 parts: one is a substantially constant standby power; the other is killing power, it is difficult to accurately measure the killing power due to the type and quantity of different pests, in the practical application, we calculate the average power of the high-voltage network power. For the high voltage power network of the vertical network structure, its average power is about 5 W and for the high-voltage network power of grid structure, its average power of about 6 W. Energy configuration design mainly takes four factors into consideration: the first one is the daily sunshine time; the second one is the wind speed and air density on the spot; the third one is to meet the total power requirements of trapping killing; the fourth one is the independent working time, namely in the conditions of solar cells and wind generators without power, the separately discharge hours of the batteries (Hao and Peng, 2012; Zhou and Ji, 2011; Gang *et al*., 2014). Only after these parameters are clearly calculated can the battery capacity and parameters of solar panels be calculated.

DESIGN OF WIND-SOLAR COMPLEMENTARY PEST CONTROL LAMP IN GREEN FOOD BASES

Design steps: First, list the basic data, such as power consumption, configuration, supply voltage, power time of the load (the pest control lamp in green food basess), any special requirements; the local location, including place names, longitude, latitude, altitude, etc.; Local wind resources and solar resources status, such as sunlight intensity, wind speed, temperature and other climatic conditions; power characteristics of wind turbines and solar modules.

Then determine the load size, calculate the product of all load current and average daily working hours. Choose the battery capacity, the load of electricity consumption determines the battery reserve capacity, it is also needed to consider comprehensively the environment temperature, weather conditions, rules of the system control and the consequences of system failure and other factors of the installation site. In the whole wind-solar complementary power generation system, the battery is in the floating charge state and its charging current is general much less than the normal charging current. If the battery is in the under-charge state in most cases, the battery in the deep discharge state for a long term, which will reduce the life span of the battery, thus, it is needed to have certain allowance in determining the capacity of the battery. Depth of discharge is too large will reduce the life of the battery; too small discharge will cause the scale of the wind-solar complementary power generation system becomes larger, increasing costs.

Matching design: Energy configuration design mainly takes site conditions, the total power requirements of trapping killing into consideration, the reasonable matching of the wind turbines and solar battery is the key for the system design. Because of the uncertainty of the weather, the instability of the wind and solar power, it is different for the wind speed, solar irradiation of each month. According to the changes of local climate, the operation mode of the wind-solar complementary power system is different, which is divided into wind turbines generation alone, photovoltaic power generation and the former two joint generations. In order to give full play to the superiority of the wind-solar complementary generation, reduce the cost, it is needed to optimize the configurations according to the installation site location, weather conditions and characteristics of components and load conditions.

Wind power generator mainly uses the rotation of the wind wheels to drive the generator and it is a mechanical device converting wind energy into electric energy. It is one of the most basic methods to convert the wind energy into the electric energy. And the generating principle is as follows: wind power has a certain kinetic energy; the rotation of the wind wheels will convert the wind energy into mechanical energy and then drives the generator to generate the power, to obtain steady electric current through non controllable three-phase rectifier and other equipment. The wind energy resources vary with location, even in 2 locations which are very close to each other, the characteristics of wind energy resources will not be the same. Therefore, for any wind-solar complementary power generation system, it is needed to conduct the short-term wind measurement on the spot, long-term wind capacity prediction, flow simulation calculation and power generation estimation. Only through the combination of the installation site of the actual environmental conditions to select the wind generator can we make full use of local wind power resources, maximize the efficiency of wind turbines.

Determine the dip angle of the solar battery group, in the south of China, the dip angle of the solar battery can be 10°~15° more than local latitude; in the north of China, the angle can be 5°~10° more than local latitude, when the latitude is larger, the increased angle is smaller. In order to be convenient for the design and installation of the solar battery bracket, the angle of the solar battery is generally to be an integer. When the amount of daily radiation is calculated, the meteorological data from the meteorological department are total solar radiation in the horizontal plane, the direct radiation and scattering radiation need to be converted into the amount of solar radiation on the slope. Through the amount of direct solar radiation and scattered radiation on the local average monthly surface, the radiation amount each month is calculated and then the annual average daily solar radiation and average sunshine hours are calculated and the minimum current and the maximum current that the solar cells should output are calculated. Then determine the optimal current and voltage of solar cells, the solar battery temperature directly affects the output power, the higher the temperature, the lower the output power, so we must ensure that the system can work normally at the highest temperature. Thus, it will be ok to select the appropriate mode by referring to the performance parameters of the battery and solar cell components provided by the manufacturer after calculating the battery capacity, voltage and power of the solar cell phalanx.

Control strategy of the controller: Twelve voltage lead-acid battery is used in the system, the charging method uses three stage charging method, namely, the charging current, constant voltage charge, float charge. Compared with solar energy, wind energy and solar energy is not stable enough and solar energy is only limited in the light conditions. Therefore, in the process of charging, it mainly uses solar energy in the daytime and wind energy is complementary; at night, only wind energy resources exist, it mainly uses wind energy; the maximum output current of wind energy end and solar energy end can be set by the reference voltage through the MCU output. MCU detected battery voltage in circulation, set charging voltage or current of the battery according to its state, disconnect the charging circuit when overcharge, disconnect the discharge circuit when over discharge. The detection of output voltage at solar energy end determines whether the discharge circuit is disconnected or not, the duty cycle rate of the output circuit in series controls the output current. When the discharge current is too large, the MCU comparator disconnects the output, after a certain period of time delay, it will be switched on again; turn off the discharge circuit when the battery terminal is over discharge (Gang *et al*., 2014).

CONCLUSION

In the remote areas of farmland, because of the influence of the geographical environment, it is very difficult for the electricity transmission; and it is also very difficult to realize power supply in the conventional method. It is needed to be in accordance with the time and the place, reasonably use the local natural resources. In these areas, solar and wind energy resources are very rich, but a single form of generation is very difficult to ensure the electricity for the users, the process of energy conversion is restricted by seasons and weather and climate factors. However, the complementarily in terms of time and space provides the possibility for the form of wind-solar complementary generation. Therefore, the pest control lamp in green food bases with the wind-solar complementary technology has the characteristics of reliable performance, no pollution to environment, which is especially suitable for using in remote tea plantations, orchards, vegetable fields, cotton fields, etc., where there is no electricity.

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