# The Design of the Electronic Control System of Self-cleaning Pulsed Electrooxidation Sewage Treatment Based on Photovoltaic System

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Abstract: In order to improve the efficiency of chemical wastewater treatment as well as the security and reliability of systems operation, PLC light tracking technology is applied to the photovoltaic device in the system. According to the requirements of electro-catalytic oxidation process, design the energy storage and impulse voltage generating control system using SCM technology，to realize the sewage treatment by catalytic oxidation of pulsed power.

## 1 INTRODUCTION

Solar energy is an efficient, clean and never-fail renewable energy source. In recent years, solar power has been widely used in various industries. Combined with the catalytic oxidation of sewage treatment process, solar energy can provide the power source for electrolyzing wastewater, which can transform and upgrade the traditional process.

In order to remove the refractory substances in the wastewater, it is necessary to electrolyze the wastewater with impulse voltage in the water treatment industry. In fact, this is applying periodic voltage to the wastewater intermittently according to the law of time. The width and frequency of the periodic voltage can be adjusted according to the pollution condition of treating water and the corrosion resistance of the electrode. The structure of the sewage treatment control system based on PV electrochemical catalytic oxidation is shown in Figure 1.

## 2. SYSTEM DESIGN

This design uses PLC technology to realize the fully automatic three dimensional rotation of photovoltaic panels tracking the sun and it also uses SCM technology to control the energy storage of photovoltaic panels and the automatic adjustment of high voltage pulse, which breaks through the technology bottleneck that the electrode is easily vulcanized and the service life is shortened during the use of the electric storage appliance.

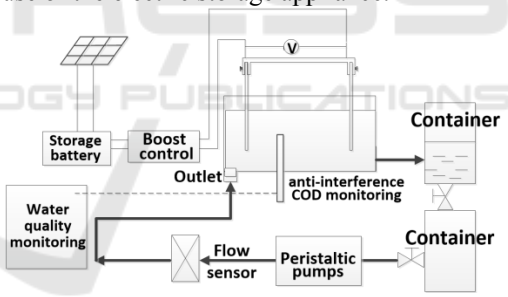


Figure 1: The structure of the sewage treatment control system based on PV electrochemical catalytic oxidation.

### 2.1 Light Tracking System

Using IC200UDR040-CC as a system controller, this system can process the incident angle of the solar light collected by the light tracking device to control the DC motor and adjust the angle of solar energy plate. Realizing the function of solar energy plate tracking solar light automatically can make the solar energy plate face to the sun automatically, which can improve the efficiency of photovoltaic conversion in photovoltaic system.

There are two modes in this control system: testing and running. In the running mode, the light signal is converted to the electrical signal through

the photosensitive sensor, and PLC control system receives the electrical signal and then it controls the motor rotation. The photosensitive resistance is used as the photoelectric sensor and the circuit is controlled by the characteristic of the photosensitive resistance when it meets light that makes the resistance smaller and current conduct. Four groups of photodiodes detect four directions respectively through special devices, so that the system can determine the direction of the sun by judging whether any of the four groups of photodiodes is illuminated. Combined with a mechanical device, it can track sunlight. PLC determines the current state by the instruction of the test / run button. In the testing mode, we can control the lighting of the three analog light sources by manual buttons to determine whether the operation of the program and the hardware device is normal and to test the stability of light tracking. The PLC wiring diagram of the solar light tracking system is shown in Figure 2.

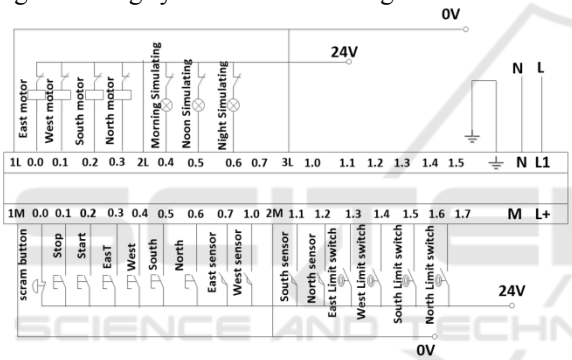


Figure 2:The PLC wiring diagram of the solar light tracking system.

The control system determines the stopping position automatically according to the wind speed. When there is no wind, it does real-time tracking in the daytime and stays at 15 degrees in the elevation at night to ensure that the condensate can flow down. When there is a wind, it returns to the initial horizontal position to reduce wind resistance. The control system switches between the day and night modes automatically according to the time. When the system time is in the night time, the solar light tracking motor is in a stop working state. When the system time is in the daytime, the motor is in a working state.

## 2.2 Energy Storage Control System

This system is mainly used to detect the output voltage and current parameters of photovoltaic cells and control over charging, balanced charging and float charging to the battery through the DSP. Meanwhile, it supplies power to the DC load by judging the over discharging protection, over current protection, under voltage protection and other situations in the discharging technology of storage battery.

The system analyses and processes the collected data of the system clock, the working state of the electric storage appliance and so on. When there is continuous rainy weather and the electric storage appliance lacks power and it is unable to obtain solar energy, the controller quickly cuts off the discharging circuit of the electric storage appliance and switches on the high voltage input side of the stand-by power to provide energy for the electrolysis system. The input side and the high voltage power of the standby power are always in a state of circuit breakage, so that there is no energy consumption of the standby power. The system is consist of solar cell component unit, DC voltage acquisition module, temperature acquisition module, IGBT-driving module, DC current acquisition module, relay control module, battery pack, DC load, communication module and so on. Figure 3 is the schematic diagram of the electric energy conversion system.

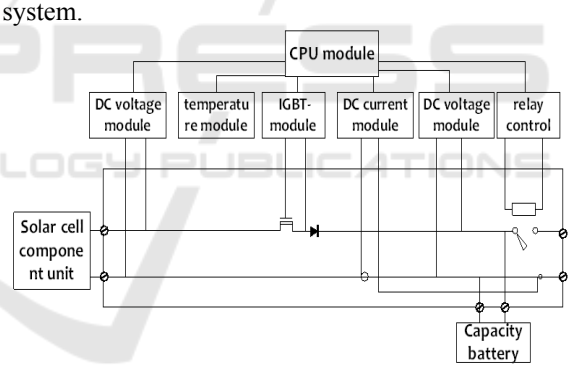


Figure 3:The schematic diagram of the electric energy conversion system.

## 2.3 Pulse Control System

The main power supply methods of electro-catalytic oxidation wastewater include DC power supply and pulse power supply. The effect of sewage treatment by pulse electrolysis can be maintained, whose energy consumption is lower than DC electrolysis. In addition, impulse action can reduce sediment on the surface of the plate and maintain high current efficiency. According to the technical requirements of the catalytic oxidation of sewage treatment process and the design index of the impulse power supply, a pulse bias power supply with a frequency range of 10-40 kHz and a rated power of 1kW is

developed. The duty ratio is continuously adjustable in the range of 10%-60%. The schematic diagram of the control unit is shown in Figure 4.

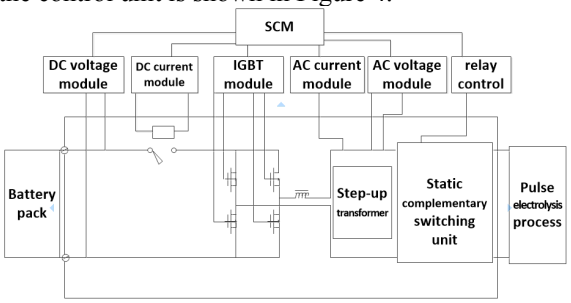


Figure 4: The schematic diagram of the control unit.

Based on the control technology of SCM, IGBT with high frequency high pressure resistance and PWM, using high frequency transformer, this system proposes a new system structure suitable for high power pulse power supply. This design is made up of voltage regulation circuit, full bridge inverter circuit, high voltage rectifier and filter circuit, pulse voltage output circuit and protection and control circuit. Full bridge inverter circuit is the core part. The single-phase full bridge inverter circuit of Figure 5 is the inverter circuit. The V1 - V4 in the diagram are the main inverter switch tubes. This circuit uses voltage source type inverter—VSTI. The DC side is the voltage source. There is a smooth capacitor with a rectifier and filter circuit in front of the reverse bridge, which can make the DC circuit appear low resistance and make the DC side voltage stable and smooth without voltage fluctuation basically. This can provide a smooth DC current for the full bridge inverter circuit. The DC conversion circuit also determines and switches inverter input current through the controller, according to the state of the battery. And meanwhile, it can test whether the input current meets the conversion condition through a Hall current sensor to ensure the stability of the output pulse signal. In this design, there is a resistance between the grid and the emitter of the IGBT, which is made close to the emitter, restraining the overvoltage between the collector and emitter. In the end, the high frequency transformer is used to make the output voltage variable in a certain range. And the frequency can be adjusted by the SCM in order to meet the requirements of different wastewater treatment.

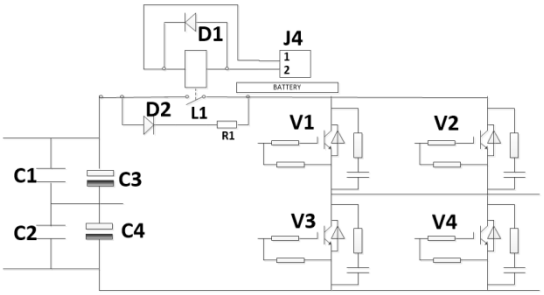


Figure 5: Single-phase full bridge inverter circuit.

## 3. CLOSING REMARKS

A control system for sewage treatment based on solar electro catalytic oxidation method is talked in this paper, which can track the sun by the fully automatic three dimensional rotation of solar panels and increase the utilization of solar energy. The design of battery charging control mode and the automatic adjustment and control of electrolysis pulse voltage of wastewater can reduce energy consumption and prevent electrode corrosion effectively.

New energy photovoltaic technology is in the early stage and electrolysis wastewater with pulse method is an important tendency in waste water treatment. With the continuous development of the use of equipment and the improvement of the stability and reliability of pulse power supply, this system will play a positive role in water treatment.

## ACKNOWLEDGEMENTS

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## APPENDIX

A brief introduction to the author: Shen Jie(1981-), female, was born in Hefei, Anhui. She is an associate professor with a master's degree in control engineering. She is the director of the new energy development center and is engaged in research on photovoltaic system control and energy saving engineering.

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