Application of the green port technology

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Abstract. Green development is the future development direction of the port, and the foundation of green port construction is the application of new technology. This paper introduces the key technology (Application of high voltage shore power, Large scale application of RTG oil to electricity, Application of intelligent and precise dust suppression technology in coal terminal) applications of several types of green port development, and provides suggestions for the future development of the port.

1. Introduction
With the continuous upgrading of global environmental problems, countries' requirements for environmental protection are also constantly improving. In recent years, the port industry has developed rapidly, and many port groups have entered the ranks of the top ten ports in the world. However, the development of ports has also brought serious environmental problems. Therefore, green development is bound to become the future development direction of ports.

At present, many scholars at home and abroad have studied this problem [1-17]. Starting from the reality, this paper introduces several kinds of technologies applied in the port, and provides suggestions for the green development of the port.

2. Application of high voltage shore power
This part mainly introduces the application of high voltage shore power in port

2.1. Primary objective
The construction of full coverage of high voltage shore power of container terminal ships is realized. It mainly includes: Bridge transformation at the front of the wharf, installation of shore power box transformer, laying of high-voltage cable and reasonable distribution of shore power junction box to meet the power supply demand of the ship receiving high-voltage shore power when berthing at any berth in the port area, and ensuring stable power supply. The main objectives include:
• Improve the air environment around the port and reduce the surrounding water pollution, establish the environment-friendly corporate image of enterprise
• It can reduce the cost of power consumption and the maintenance cost of the ship's own power generation facilities during the berthing period.
• Optimize the energy structure and reduce the environmental pollution caused by the auxiliary power generation of berthing ships.
• To ensure the high utilization rate of high voltage ship shore power system.
• To explore a set of mature port ship shore power project business cooperation mode.

![Shore power system diagram](image)

**Figure 1** Shore power system diagram

### 2.2. Introduction of key technologies

The high-voltage shore power system of wharf adopts high-high mode. The specific scheme of high voltage ship shore power system is as follows: The high-voltage switch cabinet in the shore power box substation of the port area is output to the high-voltage frequency converter by 6kV cable, and the high-voltage frequency converter will be 6kV / 50Hz 6 kV / 60Hz power supply is transformed into 6.6kv/60hz power supply through phase-shifting transformer, AC-DC-AC rectifier and inverter. Finally, it is sent to shore power junction box on both sides of berth through isolation transformer output in two ways. Finally, shore power is sent to shipboard step-down transformer for ship power supply through ship cable. Shore power system diagram see the Figure 1.

#### 2.2.1. Layout of shore power junction box

Because the enterprise is an old container terminal in operation, the transformation of the wharf front should not only take into account the waterproof under the wharf surface, but also the scientific point on the wharf surface, that is, the convenience and operability of connecting the ship on the shore electrical equipment when the ship berths. At the same time, it is necessary to consider the influence on the existing facilities under the wharf (bridge crane high voltage cable, etc.) and the feasibility of the reconstruction project. There are many factors affecting the project, which are difficult to construct and difficult to reconstruct.

Therefore, each berth of the project will be equipped with a shore power junction box, which adopts the sinking shore power foundation pit, and the box adopts the vertical Kaifu shore power socket box.

#### 2.2.2. Frequency conversion power supply for high voltage ship shore power

In order to meet the shore power supply requirements of ships in different countries, it is necessary to convert the 50 Hz AC power supply system of China's port power supply system into 60 Hz AC power supply suitable for foreign ships. The frequency conversion power supply used is AC-DC-AC direct high voltage (high high) high voltage frequency conversion power supply.
The frequency conversion power supply consists of phase shifting transformer, power unit and filter device. The power unit is a three-phase input and single-phase output AC-DC-AC PWM inverter structure. The output end of adjacent power units is connected in series to form a Y-type structure, and the rated voltage of each power unit is 690V.

2.2.3. Switching connection of ship power and shore power
The shore power system has the technology of fast switching and connecting ship power and shore power. Through the same equipment on board, the thermal grid connection with shore power supply is realized, so as to ensure the safety and reliability of power supply.

In view of the short time to shore of large ships arriving at port and the need for cable safety and quick connection, high voltage cable is adopted to get on board, so as to realize rapid connection, improve the efficiency of shore power on board and connect with the grid.

3. Large scale application of RTG "oil to electricity"

3.1. Project overview
In this project, the oil electric hybrid power supply mode of "small engine group + lithium battery" is adopted to supply power to RTG, Under the all-weather operation capacity, the hybrid tyre crane has achieved the effect of "three low and four high" (low fuel consumption, low emission, low noise, high economy, high environmental protection, high flexibility and high safety), which not only promotes the energy saving and consumption reduction in the port area, but also improves the production efficiency of the company, and provides an effective template for the green port construction through technical innovation. See the table 2

3.2. Hardware structure of the system

3.2.1. diesel generator set
The high-power diesel generator set is changed into the low-power one to charge the lithium battery energy storage unit. When the battery pack fails, it can be switched to the direct power supply of the diesel unit. The direct power supply of the diesel unit can meet the normal requirements of the slow operation of the crane mechanism, trolley mechanism and lifting mechanism, and the power supply of air conditioning, lighting and communication.

3.2.2. Controlled rectifier unit module
In this project, the diode rectifier unit of the equipment is changed into a controllable rectifier unit module. It has the functions of rectifying, limiting current, boosting and stabilizing voltage, rectifying 400V AC output from diesel engine set into required DC, boosting and stabilizing to the required voltage, and at the same time, it can prevent overload and flameout of generator set when lifting heavy load. Limiting the current can make the generator always work at the best efficiency point and improve the power generation efficiency of diesel generator.

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3.2.4. Battery intelligent management system
The system has the functions of monitoring, alarm protection, communication, self diagnosis, SOC calibration, equalization and heat management.

Framework of hybrid system see the Figure 2.

3.3. Software structure of the system

3.3.1. Power supply system
The hybrid power system is managed and powered by UPS, which mainly includes PLC power supply, BMS power supply, AC/DC rectifier control power supply, DC/DC converter control power supply and auxiliary power inverter control power supply.

3.3.2. BMS communication
The PLC of hybrid power system communicates with intelligent battery management system (BMS) through CAN bus and reads data. Meanwhile, it controls the operation and stop of diesel generator set by detecting the contact output signal (fault, low battery power and high battery power) of BMS.

3.3.3. Operation status monitoring
The PLC of hybrid power system can detect the status of diesel generator set (fault, oil level, oil temperature and operation), ac/dc rectifier status (fault, operation), dc/dc inverter and auxiliary power inverter. Meanwhile, the operation of diesel generator set, ac/dc rectifier, dc/dc inverter and auxiliary power inverter are controlled.

![Figure 2 Framework of hybrid system](image)

4. Application of intelligent and precise dust suppression technology in coal terminal

4.1. Project overview
In this project, the conventional manual sprinkling mode is upgraded to intelligent computer control system, and the bus control box arranged near the equipment is connected by optical cable for efficient data transmission, so as to realize intelligent sprinkling monitoring and management.

The upper computer of the system can realize the real-time monitoring and automatic fault alarm of the spray equipment, and control the spray equipment manually or automatically according to the actual needs. In addition, it can realize automatic control according to the change of wind speed, time and other factors, and automatically adjust the spraying equipment according to different seasons and scenes. Operators can carry out remote real-time monitoring, greatly reducing the labor intensity and production costs.
4.2. System function introduction

4.2.1. Local manual mode
Local mode has the highest priority. When the local / remote transfer switch is turned to the "local manual" position, it will enter the local manual mode. Depending on the start / stop button on the local box, the solenoid valve will be directly controlled through the hardware logic control circuit to spray water or stop operation. The local manual mode is not controlled by PLC.

4.2.2. Upper computer manual mode
The manual mode of the upper computer is controlled by PLC. When the local / remote transfer switch is turned to the "remote control" position and the upper computer selects manual mode, it will enter the manual mode of the upper computer, which can monitor the screen button through the upper computer. The upper computer directly controls the solenoid valve in manual mode to spray water or stop operation.

4.2.3. Automatic mode of upper computer
The automatic mode of the upper computer is controlled by PLC. When the local / remote transfer switch is turned to the "remote control" position and the upper computer selects automatic mode, it will enter the automatic mode of the upper computer. According to the program set by the upper computer and the feedback wind speed of the on-site anemometer, it can spray water or stop the operation of the water gun in the designated area. Structure of PLC control system see the Table 1.

| Control and display | application layer |
|---------------------|-------------------|
| touch panel         | Transfer stations |
| Central Control Room| New pump house     |
| CPU                 | Old pump house     |

5. Conclusion
All of the above three technologies (Application of high voltage shore power, Large scale application of RTG oil to electricity, Application of intelligent and precise dust suppression technology in coal terminal) have been successfully applied in ports. Through experience summary, they will be applied in more ports in the future. Overall situation of the project see the Table 2.

| Entry name                                      | Difficulty of technology implementation and promotion |
|------------------------------------------------|------------------------------------------------------|
| Application of high voltage shore power        | very difficult                                       |
| Large scale application of RTG oil to electricity | relatively easy                                   |
| Application of intelligent and precise dust suppression technology in coal terminal | difficulty                        |

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