

The design of water supply automatic control system of ship based on PLC

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Abstract—the design of vessel centralized water supply system which can use diesel exhaust heat and solar energy hybrid, the system is better than the traditional water supply system and it can make full use of waste heat and solar energy, so the design will save the energy and protect environment. PLC centralized control system can realize the purpose of energy saving and intelligent control.

Keywords: vessel centralized water supply system; solar energy; the exhaust heat; environmental protection; PLC centralized control system

I. INTRODUCTION

According to statistics, the energy consumption of Shipping industry accounts for 1/10 of the total energy consumption. The operation cost of 40%~60% is fuel consumption. [1] the reduction of ship fuel consumption is the key to protect environment and improve ship earnings. Most ship's heat of water is provided by the auxiliary boiler. A large part of the ship energy consumption is in the auxiliary boiler. Reduction of the fuel consumption in auxiliary boiler and the recovery of the exhaust heat is an effective way to save energy. [2] To save energy, in addition to improve equipment utilization, reducing the energy loss in the process need to take appropriate technical measures to reduce energy consumption [3]

According to the need of energy saving and environmental protection in the world, the PLC intelligent control system use marine waste heat and solar energy to heat the centralized supply water. The system can supply all heat water of mechanical work and life. PLC has a variety of special machine languages. PLC control systems generally use simple ladder symbol language to be designed [4] The system can completely replace such as auxiliary boiler machinery to realize the purposes of reducing energy consumption and environmental protection.

II. THE DESIGN OF SCHEME

A. The Utilization of Exhaust Heat

The exhaust heat of the system of design is the main energy for heating water the temperature is high enough. So the heating water tank should be arranged around the exhaust pipe of the engine. The exhaust temperature of diesel is 400°C to 600 °C. the temperature of the heating

water will be suitable for the desired temperature.

B. The Selection of Solar Panels and Batteries matching

Solar panels can generate enough electricity to heat the mixed water, which requires the solar battery can store enough power. Many types of batteries can match a same solar panel. In our country, the main batteries are maintenance-free lead-acid batteries in ships. It is applicable for temperature and current range, storage properties. Chemical and electrical energy conversion efficiency is high, charge and discharge cycle times, high voltage, large capacity, and lead material is rich in resources, low cost of a series of advantages [6] Because of its inherent characteristics of maintenance-free and less environment pollution, the battery is very suitable for a large and unattended power supply system.

C. the Design of Structure

The system use Solar energy and exhaust heat comprehensively. The solar energy will be the auxiliary energy to heat water. The excess power in the Maintenance-free lead-acid batteries can be used for lighting and driving pump's electric motor. Only this case can achieve the purpose of reducing fuel consumption.

III. THE HEATING CIRCULATION SYSTEM

The heating cycle system is composed of a water tank around the exhaust pipe of diesel, circulating pump, buffer electric heating mixed tank, a heater, a bag of temperature sensor, battery and solar panels. The principle of heating circulating system is shown in Figure 1

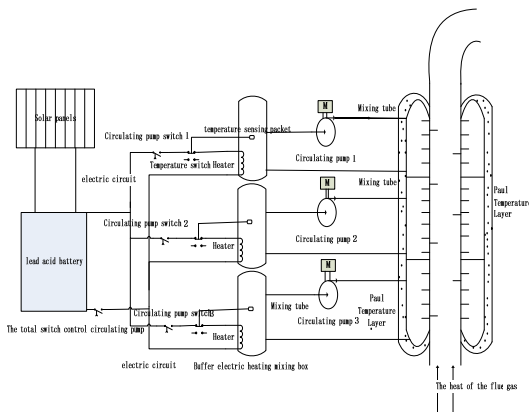


Fig. 1 heating circulating system

After this system starting up, circulating pump will be operated. The water in the packed by will be heated by the discharged energy of diesel engine. So the water in the mixing tank and the water jacket will be warm. The exhaust gas energy is the main source of the heat and the solar thermal plays the auxiliary heating and temperature preservation function by the temperature two-way switch opening and closing.

IV. MULTILEVEL UTILIZATION OF WATER SUPPLY SYSTEM OF VESSEL

Multilevel utilization system is composed of the heating system and other major components, which includes the main heating system, high position water tank, 3 new water entrance valves, supply water pump, three temperature probes. The principle of this system is shown in figure 2.

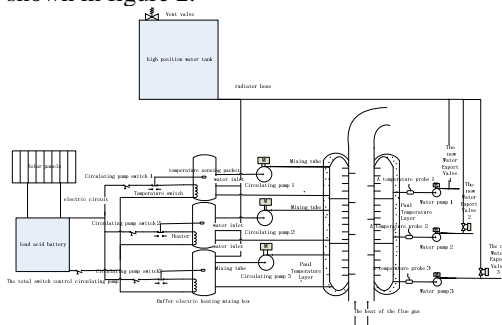


Fig. 2 Marine centralized principle of hierarchical water supply system diagram

The exhaust energy in the pipes heat the water in the water jacket which has heat losses. It often leads the water temperature in the water jacket is not up to the requirements. However, heating water with solar energy, the temperature of the water will raise. Only this can achieve the desired water temperature. When the water temperature is too low in the buffer electric heating mixed box. The temperature two-way switch will be closed. The heater will be switched on completely. When the water temperature in the mixed box meet the requirements of the temperature. The bidirectional switch will be switched off to be in the insulating state.

Because the exhaust heat temperature will be gradually reduced when it be transferred in the exhaust pipes. So the temperature of the first level water tank is 30 °C ~40 °C. The water in the water jacket is generally used as bathing water. The second tank water temperature is 70 °C ~80 °C, the water in the water jacket is mainly used for heating oil and cylinder liner cooling water. The water temperature of three stage water jacket is about 100 °C in general, the water in the tank will be the kitchen water, these three kinds of water temperature is adjusted by the temperature probe. The new gate valve and the heater.

At the same time, we need not to worry about the risk of water depletion in the water tank. High position water tank with gravity head to supply water to the system, air valve to avoid the harm of the vacuum.

A. Temperature Regulation in the Water Supply System

When the water temperature in the supply pipe is lower than the design value, the temperature probe will take temperature signal to the new gate valve. The gate valve will close slightly. At the same time, the temperature package in the buffer electric heating mixed will feel the water temperature reduced. The temperature switch will be closed. The heater heat water until the water temperature get the settings to keep the water temperature constant.

When the temperature of water supply in the pipeline higher than design value. The temperature probe will put the signal to the new gate valve. The gate valve will open slightly and add cold water. At the same time, The temperature sense bag in the mixing water package will send signals to the temperature switch. The temperature switch is disconnected. Then the heater stops working. The temperature will be decreased. Until the temperature reached the design value of temperature.

This system will keep the temperature of water in a certain temperature range. The buffer heating mixed tank has played the role of a buffer. This will avoid the temperature adjustment range is too large and too frequent.

When the supply of gas is stopped, the lead-acid battery can provide all the necessary energy to the water circulation system. This system includes heating electric pump motor and the heater in the water tank. The engineer's lives will not be affected.

V. PLC CENTRALIZED CONTROL SYSTEM

The system is controlled by the PLC. The system has 3 input signals and 3 output signals. Input signals include circulating pump control switch. A temperature probe and the flow switch. The output signal include circulating pump motor. The new inlet electromagnetic valve and the pump motor. The PLC control process is shown in figure 3.

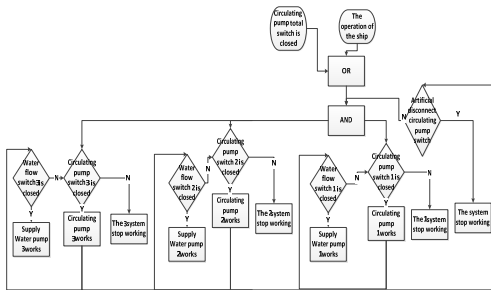


Fig. 3 the principle of PLC integrated control system diagram

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A. Start and Work

When the vessel operation or the occurrence of staff need the System will startup. When the circulating pump total switch and the individual systems be opened . Th system will be work in the condition of the normal operation . When the water flow switch is opened,The water pump will be started to work for water supply. A temperature probe is to sense the change of temperature、 to control the new water valve 、 to ensure the temperature 、 to meet the requirements .

B. System Stopping

The system can start to work according to the needs of disconnected or work. When the staff control switch of the circulating pump off. A single system will be corresponded to stop working.

In case of emergency, the staff will control the circulating pump control switch closing. The whole system will cease to work in order to avoid accident intensifies.

CONCLUSION

Multilevel utilization system of ship`s waste heat and solar energy reduced the ship `s fuel consumption during the operation .In accordance with the relevant requirements of " international ship pollution Convention " to protect the sea environment 、 low investment cost、 low operation cost and high income. The system can make a great contribution to the future of seafaring and the development of automation for international ships.

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