

# The Design of Cooling Water System for Ship Lead-Acid Battery

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**ABSTRACT:** In order to overcome the imbalance of temperature and the inability of detecting leakage, the cooling water system for ship lead-acid battery is designed. By using frequency converter, the temperature can be controlled accurately. The leakage of distilling water can be detected automatically through comparing the inlet flow and outlet flow. The new cooling water system is more useful and intelligent.

**KEYWORD:** Cooling water system; frequency converter; ship lead-acid battery; leakage of distilling water

## 1 INTRODUCTION

Most ship batteries are lead-acid battery, in the charging time of them, distilling water is needed to cool electrolyte in order to reduce the temperature of the electrolyte, it can speed up the charging rate, improve the availability factor of the battery, and prolong the service life. The lead-acid batteries are divided into two layers on some ship, the lower layer is under the waterline, the upper layer is above the waterline, and only one set of cooling water system is used for both of the two layers batteries. The ambient temperature of upper layer is always higher than the ambient temperature of lower layer, because only one set of cooling system is used for cooling both of the two layers batteries at the same time, so the electrolyte temperature of upper layer is always higher than the electrolyte temperature of lower layer. The upper batteries are in higher temperature environment for long-term, it cause that the active substrate of battery plate expand seriously, the corrosion of battery plate increased, so the reaction of active substrate and electrolyte intensified, self discharge intensified, the performance of upper level batteries declined obviously[1]. Otherwise, the cooling water pipeline which is made of metal is placed in the electrolyte, it maybe corroded by electrolyte and leaks, so the distilling water of cooling water pipeline can flow into the electrolyte, the electrolyte in the battery will overflow from the battery shell, the hull maybe corroded by the electrolyte.

In order to solve the above problems, the cooling water system with frequency converter and pipeline leakage protection is designed, it can control

temperature accurately and find pipeline leakage immediately.

## 2 THE SYSTEM DESIGN

The ambient temperature of upper layer and lower layer are different, the heats of lower layer send out upward to the upper layer, it can raise the temperature of upper layer, the simple and reliable way is to let the two layers batteries using two sets of cooling water system independently. The cooling water systems of upper layer and lower layer are the same, the purposes of them are both made the temperature not higher than the set value. The system has two operation modes of manual and automatic, the motor works in power frequency and controlled by the manual operation in manual mode, the system is controlled by the temperature sensor in automatic mode. the system is shown in Figure.1.

The system is consist of central control box, frequency converter, pump, inlet flowmeter, inlet solenoid valve, temperature sensor, outlet flowmeter, outlet solenoid valve and pipeline. The central control box is control center, it receives signals, and sends orders. The frequency converter is used to control the speed of pump, it can control temperature accurately. There are four temperature sensors in each group of batteries, they are used to measure the temperature of electrolyte. The inlet solenoid valve and outlet solenoid valve are used to turn on and turn off the pipeline. The purpose of the inlet flowmeter and outlet flowmeter is judging whether the pipeline leakage. The control relation is shown in Figure.2.

The data of inlet flowmeter、outlet flowmeter and four temperature sensors is send to the central

control box, the central control box outputs the data to display, and analyses the data to send orders. The data of temperature is used to judge whether to start the cooling water system, when the temperature becomes higher than the set value, the system opens inlet solenoid valve and outlet solenoid valve, starts the frequency converter, the pump turns round, the distilling water starts to cool the electrolyte. The frequency converter adjusts the pump speed according to the temperature of electrolyte

automatically, to make the temperature of electrolyte be in the range of set value. The data of inlet flowmeter and outlet flowmeter is used to judge whether the pipeline leak. their values should be the same, otherwise, the pipeline maybe leak, the system will stop pump、close inlet solenoid valve and outlet solenoid valve immediately, and alarm. When the temperature becomes lower than the set value for a certain period of time, the pump will be stop until the temperature meets the start-up condition again.

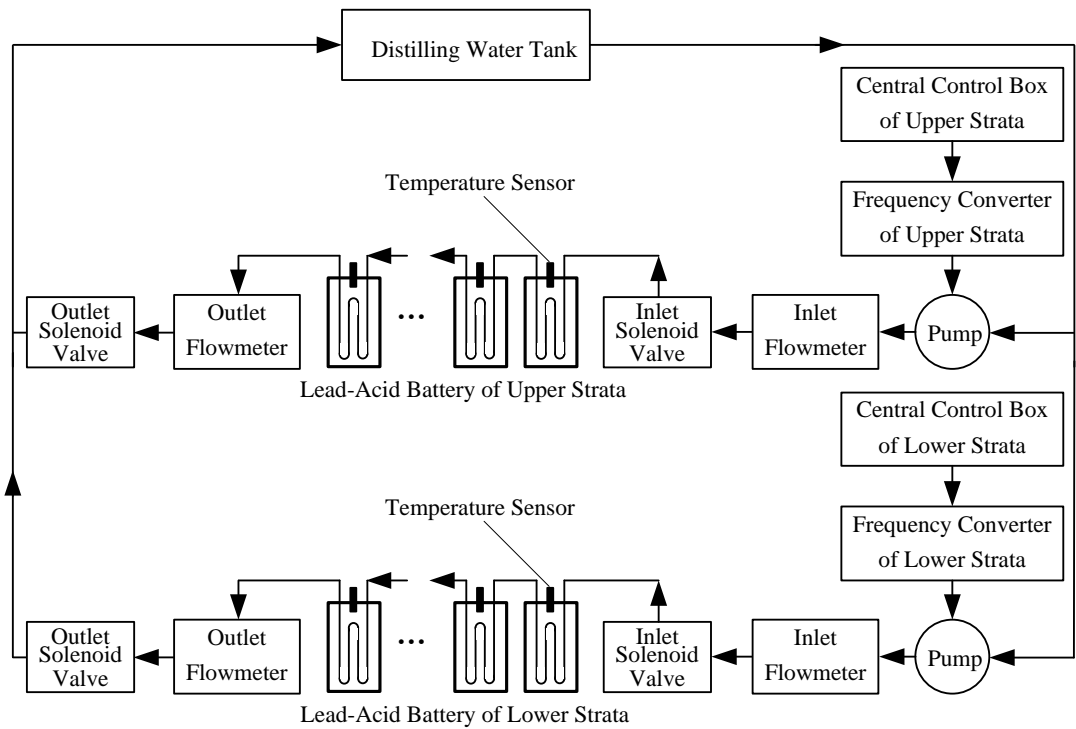


Figure.1 The cooling water system

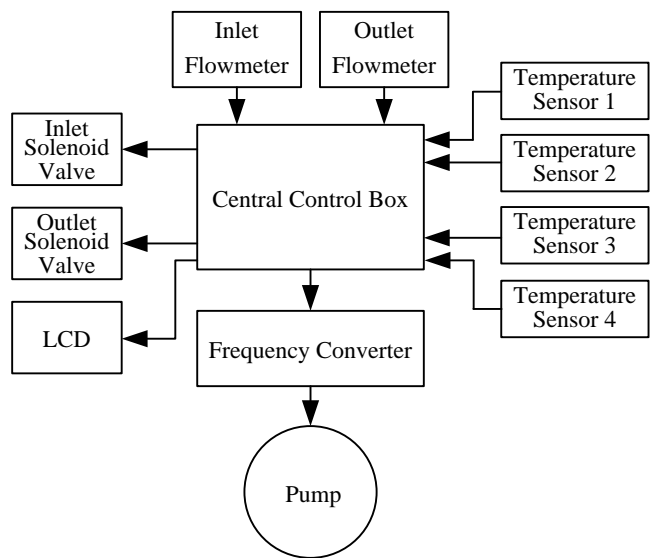


Figure.2 The control relation

### 3 THE HARDWARE DESIGN

#### 3.1 The central control box

The SST89E564RD [2] made by SST is selected as the single chip microcomputer, it has the

performance of large storage space and wide excellent working environment, can work in the bad environment of ship. The E2PROM CSI24WC256 is selected as the data storage module, it has enough storage space of 256Kb, its data will not lost when the power is off. The ICL7135 [3] made by Harris Company which has high accuracy is selected as A/D conversion chip. In order to meet the water requirements of ship, the body of controller box adopts a sealing structure.

#### 3.2 The frequency converter

MICROMASTER 430[4] made by SIMENS is selected as the frequency converter, it has very high reliability and versatility, and can make the motor work with low noise by using the special method of PWM. Full and perfect protection function provides good protection for the inverter and motor.

#### 3.3 The temperature sensor

The Pt100[5,6] thermistor sensor is selected as the temperature sensor, it has high accuracy and

excellent performance of thermal compensation, there are total 8 temperature sensors in the system.

#### 4 THE SOFTWARE DESIGN

There are manual and automatic operation modes of this system, the system is controlled by the manual operation in manual mode. The main mode is automatic operation mode, it need software to control this system, the software uses C51[7] programming language, the flow chart is shown in Figure.3.

After starting the system, it will initialize at first, then converts the analog data of temperature to

digital data, and outputs the data to display. If the analog data of temperature is larger than the set value, the system sends order to open the inlet solenoid valve and outlet solenoid valve, start frequency converter, the system start to cool the electrolyte. During the cooling, the system converts the analog data of temperature, inlet flowmeter and outlet flowmeter to digital data, all the data will be output to display. If the data of inlet flowmeter and outlet flowmeter is difference, the system will alarm, stop pump, close inlet solenoid valve and outlet solenoid valve. If the temperature becomes lower than the set value for a certain period of time, the pump will be stopped.

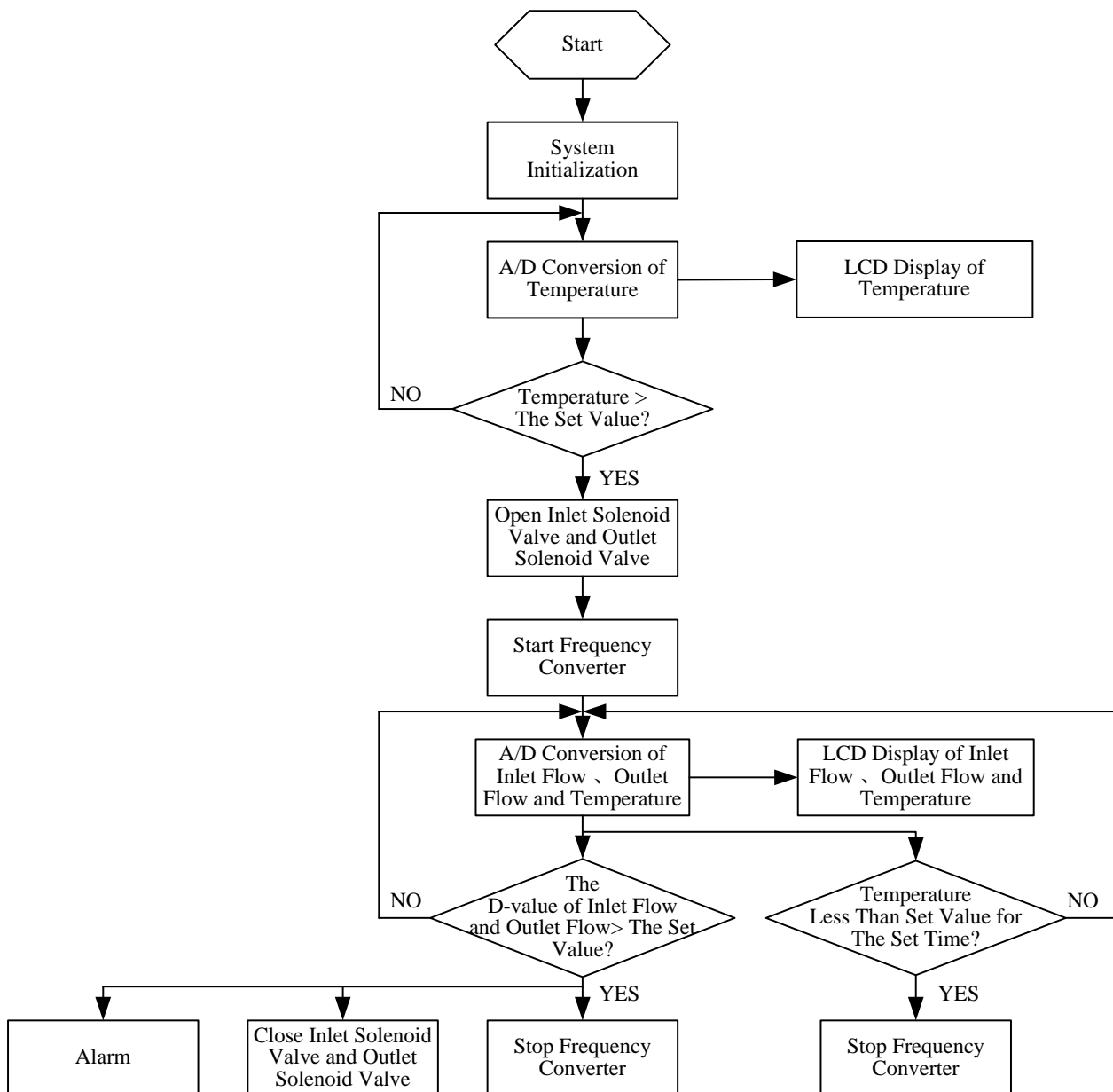


Figure.3 The software flow chart

#### 5 THE SUMMARY

The new cooling water system is designed in this paper, the imbalance of upper layer's and power layer's temperature is solved, by using the inlet

flowmeter and the outlet flowmeter, the leakage of distilling water can be detected and handled automatically. The system is more useful and intelligent.

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