The Research for Shale samples thermostatic Control System

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Abstract

Tthe analytic temperature is an important parameter in the process of shale gas content measurement, therefore, representing the reservoir temperature environment become one of the key links in shale gas content test. Based on comprehending existing thermostatic device used in the natural desorption process of the shale samples at home and abroad, for shale samples desorption field engineering needs. Determine the performance of shale samples thermostat Control System and its Design Program; it proposed to use the electrolyte heating to complete the design of hardware and software of system. After testing system, we achieved the intended functions and meet the design accuracy.

Keywords

Shale gas; shale gas desorption temperature; constant temperature measure and control system; electrolyte heating.

1. Introduction

Shale gas is an important parameter to calculate original shale gas, evaluate regional reserves and select favorable mining constituency. It is important for evaluation and development of shale gas resources. At present, domestic and foreign common shale gas testing methods, mainly are desorption, adsorption isotherm and log interpretation method [1][2]. Wherein method desorption is the most common method to measure the gas content of the shale. According to the site survey and geological engineering specifications, the desorption process refers to that under the conditions of the reproduction of reservoir temperature, shale samples was desorbed up to seven consecutive days and measured natural desorption process desorbed gas content, and ensure shale sample gas is desorbed enough [3]. Thermostatic device provides a constant temperature environment of a long period for natural shale sample desorption process, and ensure sufficiently natural desorption of the core at atmospheric pressure, and complete desorbing measurements.

Existing thermostatic device has several common problems, such as bulky, thermal hysteresis phenomenon is serious, low accuracy, low degree of automation, high labor intensity of the test personnel, time-consuming and labor-intensive and so on. To make up for lack of existing instruments, this article is designed a shale samples thermostat measure and control system based on heating of the electrolyte. The system thermostatically controls shale samples in the desorbing tank by thermal conduction, and it is used with gas content automatic measurement in the field, to complete the automatic measurement of shale samples of desorbing gas. The system has features of long holding time, high precision temperature control, easy operation, accurate measurement, good stability and reliability, low cost and easy to carry and so on.

2. Shale samples thermostat Control System Design Program

2.1 Shale samples thermostat Control System Design Program

Shale samples Thermostat Control System is used SCM as the main controller, in the shale samples natural desorption process, and the system can be a long, high-precision temperature controlled. Temperature sensors measure the temperature of incubators and desorption of the tank in real time, and display it on the LCD screen. By compared with the target temperature set a good value, determine the working status of the heater, so that the final desorption temperature of the tank reaches

the set value, and maintain a long, high-precision temperature. Additionally, you can set the temperature value by adjusting the button, make it easy for shale samples from different strata to perform its natural desorption. According to the performance requirements of the machine with shale samples thermostat control principle, presents an overall design of shale samples thermostat control system, as shown in Figure 1.
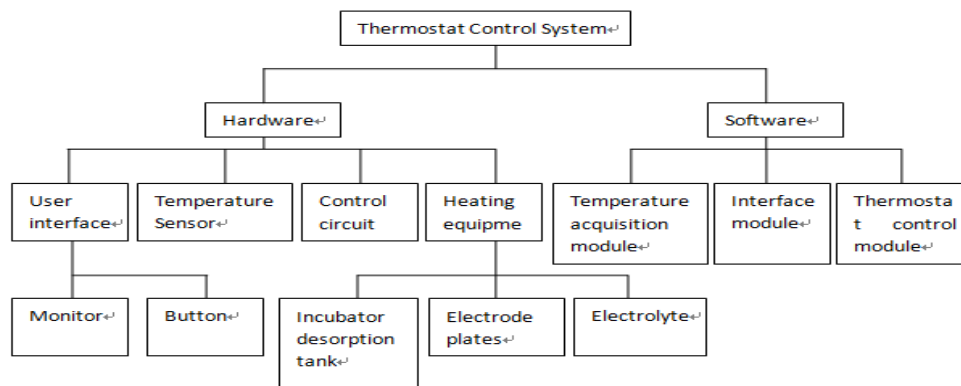

Fig.1 Overall design scheme of temperature measurement and control system of shale samples

In the design of the system, the main controller is implemented in microcontrollers. In the design of the peripheral circuit, consider the following major sections:

Control system module (SCM must peripheral circuits, such as clock, power supply, high-power MOS tube);

Temperature acquisition and control modules;

Operation key adjust and display module.

Thermostatic control system uses electrolyte heating to heat desorption tank, temperature sensor is a sensor networks of constant temperature control system. The control circuit module collects the data of various sensors to analyze the state of the heating system; the control module obtains the corresponding output data by processing the data obtained by the sensor with controller, and complete control functions by the appropriate enforcement agency.

2.2 Design performance indicators of shale samples Thermostat and Control System

In the natural desorption process of shale, after the core loaded into the desorption tank and sealed, and put the tank into the temperature equipment to be desorbed natural, cores from different stratum can be set the temperature for different values of the reservoir. In order to meet the engineering needs of natural desorption process of drilling site, improve natural desorption accuracy, shale samples Thermostat and Control System needs to achieve the following performance design specifications:

(1) constant temperature range: room temperature ~ 90.0 ℃ (can be set);

(2) Temperature control accuracy: ± 1 ℃;

(3) Temperature measuring accuracy: ± 0.5 ℃;

(4) Holding time is: continuous Thermostat for 7 days.

3. Design of system's hardware and software module

3.1 Design of system's hardware module

According to the general design of shale samples Thermostat and Control System, system's hardware is combined with heating means, temperature measuring device and user interface. Wherein the heating device consists of a graphite electrode plate and a certain concentration of electrolyte composition, temperature measurement device is completed by the temperature sensor, heating power of the system is through the microcontroller output PWM duty cycle to control solid state relays off state adjustment.

Thermostat Control system components and basic working principle

Thermostat and control system's temperature control target is a certain concentration of the electrolyte, under the influence of power, by controlling the microcontroller PWM duty to control the effective voltage across the electrode plates, thereby adjusting the electrolyte electrode plate heated power[4][5]; two temperature sensors monitor real time temperature of electrolyte and shale samples Desorbed temperature inside the tank, at the same time, display them on the LCD, and set and adjust the target temperature through the buttons. Shale samples Thermostat Control System's block diagram is shown in Figure 2.
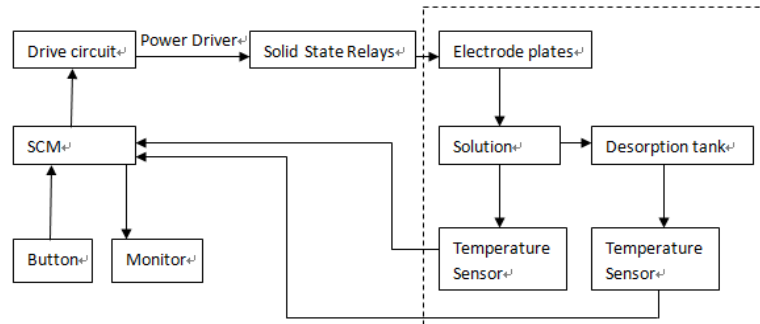

Fig.2 shale samples thermostat Control system block diagram

In the process of hardware module design of system, mainly complete thermostats shale sample measurement and control system hardware selection in terms of heating equipment, temperature sensors. Based on Thermostat Control System its own characteristics and principle experiment to determine the parameters of the electrolyte heating, and the working principle and circuit diagram of isolated drive, temperature measurements, display and power supply are designed and elaborated.

3.2 Design of System's Software Module

Tasks of shale samples Thermostat Measurement and Control System's software parts are: key scan, temperature display, temperature measurement, temperature control, in addition to the main function, PWM control subroutine, the portion corresponding to each software program designed part are: Button scanning procedures, LCD driver module, the temperature acquisition program, climate control procedures. Software main flow chart is shown in Figure 3.
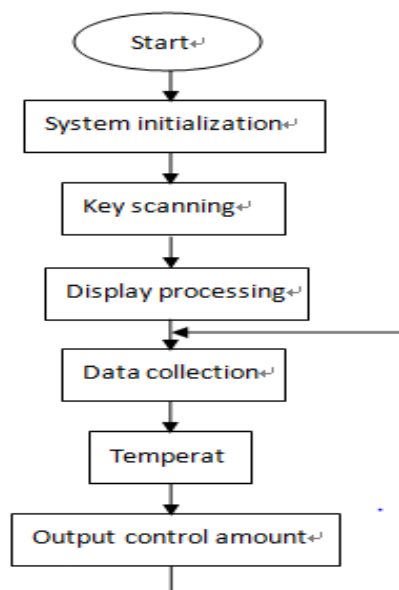

Fig. 3 the main program flow chart

According to software design requirements of shale samples thermostat measurement and control system, respectively, the software of key scan module, a liquid crystal display module, the temperature acquisition module and temperature control module are designed. Meanwhile, in order

to improve the accuracy of temperature control process control use fuzzy control[6]; eventually the system can achieve the following functions: key module can set thermostatic target temperature; Temperature acquisition module use digital temperature sensor DS18B20 for real-time detection to the temperature of incubators and desorption tank; The sensor module can display real-time status and temperature on the LCD screen; Temperature control use fuzzy controller module to set the desorbed tank temperature thermostat as the target temperature value.

4. Experiment and analysis of thermostat measurement and control system

In order to verify whether the system achieves the desired targets, were carried out to set the temperature of 70 ℃ and 60 ℃ reached thermostat control effect experiments. By observing the change in temperature thermostat tank and desorption tank, fluctuation in thermostat measurement and control system is ±0.3 ℃ ,and achieves the design of system performance indicators. By comparing 60 ℃ with 70 ℃ heating curve, it showed that the temperature reproducibility was better by electrolyte heating, it was shown in Figure 4.

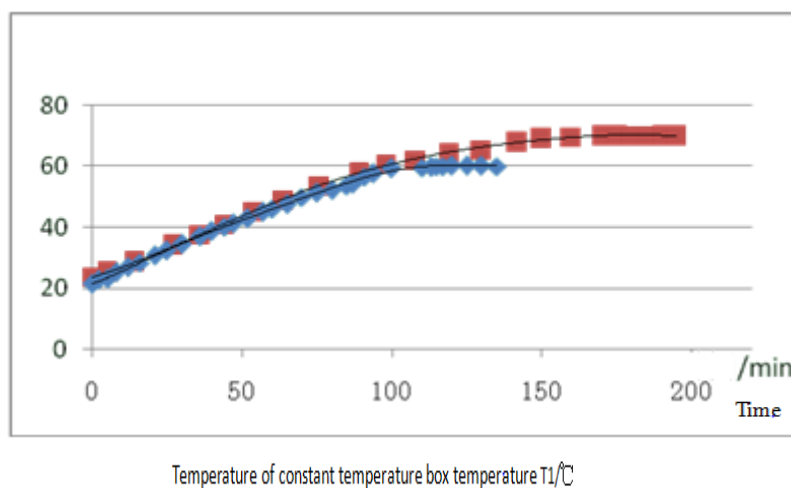Temperature of constant temperature box temperature T1/℃

Fig.4 Figure of the verification of the repeatability of electrolyte heating mode

Electrolyte heating mode repetitive verification of the repeatability

Through analysis, the possible sources of control error of thermostat Control System have the following main points:

(1) Temperature sensor DS18B20 has repetitive measurement error;

(2) Heating means heat dissipation, and other environmental factors, influence control error of the system.

5. Conclusions

In this paper, from the on-site engineering needs, use electrolyte heating and desorption of incubator to heat tank. Verify that the shale samples will be applied in the field of thermostat desorption feasibility electrolyte heating technology. By designing software and hardware, produce shale samples thermostat measurement and control system experimental principle machine. Make up for the deficiencies of the prior shale samples thermostat system, improve the automation of shale gas measurement.

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