International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST229246

Electric Bus Diesel Heating Boiler System

Xinyue Li[1], Tianhao Sun[2], Shuai Wang[3], Shuwen Yang[4], Gaoying Sun[4], Mengnan Hu[5], Shaogang Ma[4], Wei Cong[4], Pengyuan Yang[4], Xuzhao Li[4], Song Wang[4], Xuzhao Li[4], Xuemeng Bai[4], Yixuan Wang[4], Shirui Liu[4]

[1]Liaoning Equipment Manufacturing Vocational and Technical College,Shenyang Liaoning，110165，China
[2]School of Physical and Mathematical Sciences,Nanjing Tech University,Nanjing,Jiangsu.211816,China
[3]School of Forestry, Northeast Forestry University, Harbin, Heilongjiang, 150040, China
[4]School of Traffic and Transportation, Northeast Forestry University, Harbin, Heilongjiang, 150040, China
[5] School of Foreign Languages, Northeast Forestry University, Harbin, Heilongjiang, 150040, China

Article Info
Volume 9, Issue 2
Page Number : 230-236

Publication Issue
March-April-2022

Article History
Accepted : 01 April 2022
Published : 09 April 2022

ABSTRACT

This paper provides an electric bus diesel heating boiler system suitable for cold areas, through design the combustion chamber structure and control system construction, improve the safety and heat efficiency of the existing diesel heating system, and increase the touch screen display and temperature regulation function, improve the use experience. On the basis of fully understanding the present situation of domestic electric bus diesel heating boiler system, the technical parameters of diesel heating boiler system are determined, and the structural design and circuit design are carried out. The test proves that the device meets the safety and efficiency requirements of diesel heating boiler system of electric buses.

Keywords : Diesel Heating, The Combustion Chamber

I. INTRODUCTION

This paper provides an electric bus diesel heating boiler system suitable for cold areas which can improve the safety of electric bus diesel heating boiler system, reduce the accident rate; improve the utilization efficiency of heat energy, more energy saving and environmental protection; use touch screen display and the temperature adjustment to enhance the user experience. The diesel heating boiler system has characteristics of low fuel consumption, low cost and high combustion effect. Therefore, it has great value in terms of application. The internal structure of the system consists of a combustion chamber and a heat exchanger to form an area where have combustible mixture flow around, and air is supplied to the combustion chamber by an intake fan. While supporting combustion air, a specific field that is full of mixture formed in the combustion chamber. The hot mixture in the chamber turbulent diffusion combustion releases a large amount of heat. Therefore, the combustion chamber structure should be designed reasonably from two aspects of heat exchange and combustion to improve the performance of diesel heating boiler system. At the same time, the SCM is used as the central processing module, and various sensors are set in the key parts of the combustion chamber to achieve all-round control. The whole structure of the device is composed of a vortex combustion chamber

and control system, the control system includes the alarm system, touch screen temperature control system and intelligent control system.

II. Structural Design of Vortex Combustor

The internal structure of vortex combustor is shown in Figure 1.

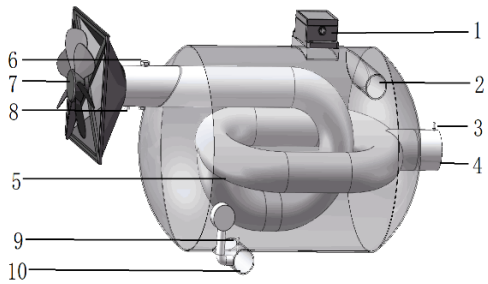

FIG. 1 Internal structure diagram

1, collision sensor, 2, water inlet, 3, temperature sensor, 4, exhaust manifold, 5, combustion chamber, 6, nozzle, 7, intake fan, 8, ignition plug, 9, pressure sensor, 10, water outlet

The internal structure of the system consists of a combustion chamber and a heat exchanger to form an area where have combustible mixture flows around. Air enters the combustion chamber by the intake fan, which provides combustion air and forms a specific field that is full of mixture formed in the combustion chamber. After the fuel mixture is formed, the mixture of burning gas with high temperature carries on turbulent diffusion in the combustion chamber, and releases a lot of heat. After heat exchange with the wall, the tail gas is discharged through the exhaust port.

Different from the traditional combustor, the vortex structure effectively increases the retention time of fuel in the combustor and makes the energy utilization more full. The space Cartesian coordinate system is established inside the combustion chamber and the function is constructed and the bounded closed region D is set. The surface area and volume can be calculated by geometric calculation and multiple integral formula, and then the improvement of utilization rate can be compared.

$S=\int_b^a f(x)dx$(1)

Where, f(x) is a function; [a,b] is a bounded interval.

$V=\iint_D f(x,y)dxdy$ (2)

Where, f(x,y) is a function; D is a bounded closed region.

The boiler is made of 304 stainless steel, straight pipe, u-pipe, outer diameter of 68cm, inner diameter of 64cm, wall thickness of 2cm.

Volume of designed diesel heating boiler system :

$V=V_{\text{straight pipe 60mm}}+V_{\text{straight pipe 110mm}}+V_{\text{straight pipe 180mm}}+V_{\text{u-pipe}}* 3 = 4761430.85\ mm^3$

Surface area of designed diesel heating boiler system:

$S=S_{\text{straight pipe 60mm}}+S_{\text{straight pipe 110mm}}+S_{\text{straight pipe 180mm}}+S_{\text{u-pipe}}* 3 = 311663.8\ mm^2$

At the same size, traditional diesel heating boiler system surface area:

$S=S_{\text{cylinder}}= \pi dh = 239703.5\ mm^2$

Its surface area is increased by 30.02%, thus greatly improving the heat efficiency.

Parameters of scroll combustor are shown in Table 1:

Table 1

project	parameter
inlet water temperature /°C	30
drainage temperature /°C	95
exhaust manifold temperature /°C	154
CO value/PPM	60
inlet and outlet pressure /Kg	19
inlet fan speed /r/min	4500

The improved combustor structure plays an obvious role, on account of the fuel evaporates and vaporizes in the combustor and mixes with oxygen in the air more fully, and making the combustion more sufficient. The flow dead zone is reduced, the residence time of the mixture in the combustion

chamber is prolonged, and the combustion efficiency is improved. It can fully improve thermal efficiency in the combustion process, reduce emission of pollutants, optimize economy and applicability of the diesel heating boiler system, and achieve the goal of high efficiency and low consumption.

II. Control System

The control system includes the alarm system, touch screen temperature control system and intelligent control system, with single chip microcomputer as the central processing module. MEGA2560PRO microcontroller is adopted in this device, which is compatible with official compilers and other third-party graphic compilers. The data line interface used is microUSB and the interface type is IPS. MEGA2560PRO uses the same ATmega2560 (16M crystal oscillator) chip as the standard version MEGA2560. The driver chip is CH340 (12M crystal oscillator) chip. The size of the main control board is very small, 38*55mm.

The main parameters are shown in Table 2.
Table 2.

project	parameter
power input /V	5
operating voltage /V	5
operating temperature /℃	- 40 ~ 85
digital interface/PCS	54
analog interface/unit	16

3.1 The the alarm system

The the alarm system is composed of RH80408 temperature sensor, the collision sensor, single chip microcomputer, buzzer and ignition plug. If the vehicle hits, rollover and the combustion chamber temperature exceeds the predetermined threshold, the alarm circuit module will automatically alarm and cut off the fire source.

3.1.1 Temperature sensor

The system adopts RH80408 temperature sensor which resistant to 1000 degrees Celsius high temperature, suitable for boiler system internal temperature measurement. In the process of signal transmission, RH80408 temperature sensor will convert the temperature into the corresponding range of voltage, and then through the AD converter into a signal that can be recognized by the MCU, in order to issue a command under the control of the program.

3.1.2 Collision sensor

Collision sensor is a device controlling the input of signals in the alarm system. The collision sensor adopts inertial mechanical switch structure, and its working state depends on the acceleration of the vehicle during collision. Generally, the collision sensor can be used as a collision signal sensor or a cthresholdollision protection sensor, but its deceleration must be set.

The collision sensor is used to detect and judge the collision signal of the car, so as to timely alarm the system. When cars collide, the collision sensor will detect the intensity signal of the car collision and input signal into single chip microcomputer, which will determine whether to close the fuel injection nozzle and open the alarm according to the signal of the collision sensor.

3.1.3 Buzzer

In the buzzer circuit module, the positive end of the buzzer is connected with 5V power supply, the negative end of the buzzer is connected with the triode collector, and the triode base level is controlled by the pin of the MCU through a "Nand gate". Specifically, when the pin of MEGA2560PRO MICROcontroller P1.5 is low, the "Nand gate" outputs a high level, at this time the audion turns on, and the current in the buzzer forms a loop to emit sound; when the pin of MEGA2560PRO MICRO controller P1.5 is high, the "Nand gate" outputs low level, at this time the audion cuts off, no current forms the loop, so that the buzzer can not make the sound. Here, "Nand gate" is actually used as "no gate". The function of

using one "no gate" is to prevent the buzzer from making sound when the system is reset, because the I / O port outputs a high level after the system is reset. The user can write a program to switch on the "low" and "high" of the buzzer pin to make the buzzer sound or turn off the sound.

3.1.4 System design

MEGA2560PRO microcontroller is used as the center processing module. Meanwhile, the temperature and pressure information collected by RH80408 and collision sensor is sent to the microcontroller through the bus. When the temperature or pressure exceeds a certain limit, the microcontroller generates a pulse of a certain frequency to make the buzzer alarm. The system design block diagram is shown in Figure 3.

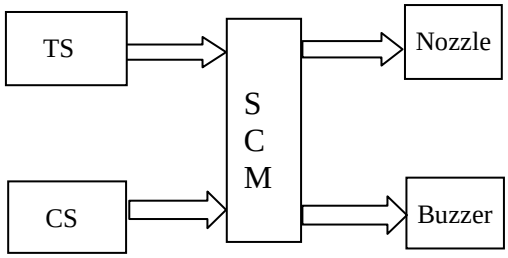

FIG. 3 Block diagram of the alarm system design

3.2 Touch screen temperature control system

3.2.1 Touch screen control temperature system design

MCU receives the temperature sensor information and displays it on the screen. The amount of fuel injection can be controlled through the SCM through the user window to achieve the purpose of heating up or cooling down. Touch screen control temperature system design block diagram is shown in Figure 4.

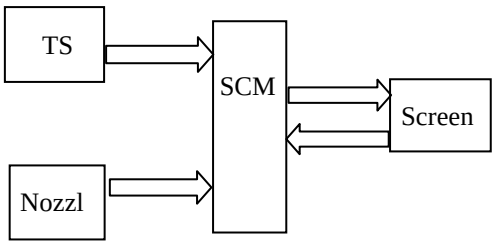

FIG. 4 Design block diagram of touch screen temperature control system

3.2.2 User Window design

The touch screen adopts SKTOOL7.0 configuration design. In the user window, you can design a rich graphical interface with various graphics objects provided by the configuration software, and realize the monitoring and control of the single chip microcomputer by connecting various objects in the interface with the parameters of the single chip microcomputer. In the main interface can feedback the temperature, the user can raise or lower the temperature according to different situations.

Its interface is shown in Figure 5.

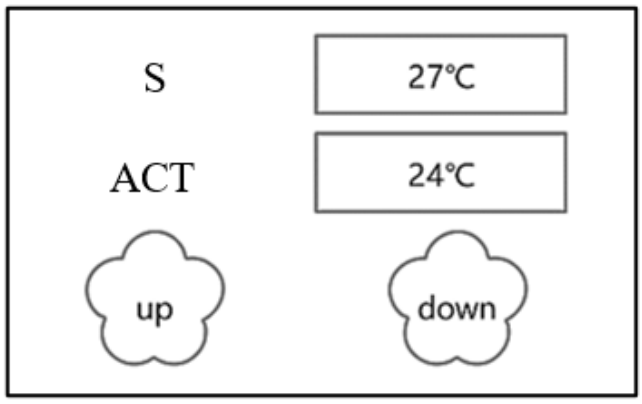

Figure 5. User interface

The rich information of the user interface can provide a reference for users. During operation, you can run commands by setting the temperature. The actual temperature reflects the real-time temperature. After setting, the actual temperature gradually approaches the set temperature and finally reaches the same value.

3.3 intelligent control system

The circuit of intelligent control system is composed of MQ-7 carbon monoxide sensor, the temperature sensor, the pressure sensor and single chip microcomputer to control the temperature, fuel injection and the air intake. The signal collected by each sensor is transmitted to the microcontroller, which compares the basic data set in advance. If it does not match, adjust it through the nozzle, the ignition plug and the intake fan until the specified data range is restored.

3.3.1 CO Sensor

CO sensor which adopts MQ-7 model has good sensitivity to carbon monoxide detection and has fast response and recovery characteristics. The MQ-7 sensor has a power indicator and TTL signal output indicator, DO switch signal (TTL) output and AO analog signal output. TTL output effective signal is the low level. The signal will light when low level output, and it can be directly connected to the MCU. When the air is received by an internal system for sampling, it generates a voltage signal proportional to the concentration of carbon monoxide. The MQ-7 sensor outputs the voltage at an analog level, with the higher the concentration, the higher the voltage.

If the carbon monoxide concentration is too high and the combustion is not sufficient, the power of the fan is increased through the single chip microcomputer to increase the air intake.

3.3.2 Pressure sensor

The principle of pressure sensor is piezoelectric effect. When some dielectric is deformed by an external force in a certain direction, the polarization phenomenon will occur inside the dielectric, and positive and negative charges will appear on its surfaces. When the external force is removed, it returns to an uncharged state, a phenomenon known as the positive piezoelectric effect. As the direction of the force changes, so does the polarity of the charge. On the contrary, when an electric field is applied in the direction of polarization of the dielectric, the dielectric will also deform. When the electric field is removed, the deformation of the dielectric will disappear. This phenomenon is called inverse piezoelectric effect. The piezoelectric element is supported on the body, and the diaphragm transmits the measured pressure to the piezoelectric element, and then the piezoelectric element outputs an electrical signal which is related to the measured pressure. The sensor has small volume, good dynamic characteristics and high temperature resistance, which meets the working conditions of diesel heating system.

The circuit board consists of three units :(1) Temperature AD conversion unit, which is used to convert the analog value of the sensor into digital value;(2) The control unit is used to input the digital quantity by the AD conversion unit into the control unit;(3) The communication unit sends the converted digital quantity to PC. Through these three parts, to achieve the measurement of pressure.

Pressure sensors always monitor and signal the water pressure in the vortex combustion chamber. Water pressure is too low or too high, is not conducive to the system work. When abnormal data is detected, water intake is controlled to restore normal water pressure.

3.3.3 Principle of PID control temperature

The PID working principle is: due to the continuous generation of various disturbances from the outside, in order to achieve the purpose of keeping the value of the control object constant, the control action must be continuously carried out. If disturbance makes the values of object change, the detection element will collect this change to the input end of the PID controller through the transmitter, and compare it with the given value to obtain the deviation value. The controller follows this deviation and sends out the control signal to change the opening of the controller and make the opening of the controller increase or decrease, then the value of the object changes and tends to be a given value to achieve the control purpose. In fact, the essence of PID is to carry out proportional, integral and differential operations

on the deviation, and control the process of the executive parts according to the operation results.

Through PID operation of temperature, the result fOut is produced. This parameter determines whether to heat and how long the heating time is. Set the program for controlling temperature, the program is as follows:

Proportion=2: // Sets the PID ratio

StPID. Integral = 0;// Set PID integral value

StPID. Derivative = 5;// Set PID differential

FOut = PIDCalc (& stPID, (int) (fT * 10));/ / PID calculation

if(fOut<=0)

* P_IOA_Buffer & = Oxff7f;// When the temperature is higher than the set value, close the ignition plug

else

* P_IOA_Buffer | = 0 x0080;// When the temperature is below the set value, open the ignition plug

...

Intelligent temperature control is achieved by controlling the nozzle, the ignition plug and the intake fan.

2.3.4 System design block diagram is shown in Figure 6.

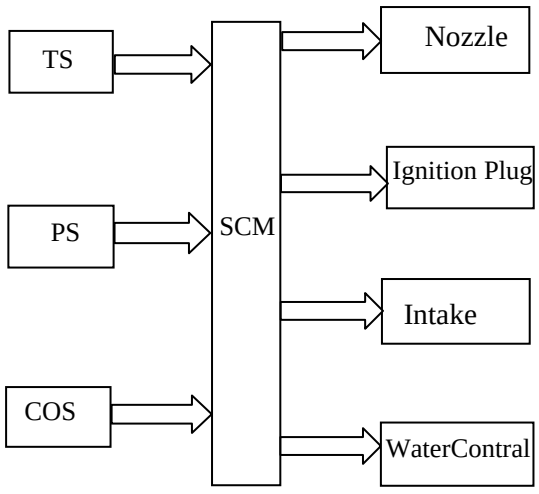

FIG. 6 Block diagram of intelligent control system design

III. Summary and Prospect

The research of electric bus diesel heating boiler system can improve the research system of diesel heating boiler system, improve the safety and heat efficiency of the existing diesel heating system, and increase the function of touch screen display and the temperature regulation, meet the demand of the application market, and lay a foundation for the subsequent research.

At the same time, the research results of electric bus diesel heating boiler system structure and system promote future research on the safety and efficiency of the vehicle, help to raise awareness of this aspect for further develop the research.

The highlights of this study are the following innovations:

(1) The vortex combustion chamber system is used to increase the retention time of fuel in the combustion chamber. At the same time, the amount of fuel injection and the amount of air intake are controlled by MCU intelligently, so that the combustion is more sufficient and the thermal efficiency is higher. After testing, the conversion efficiency of heat energy of the common combustion chamber is 32%, and the efficiency of heat energy conversion of the vortex combustion chamber is 62% , increasing by 30%.

(2) The working chamber temperature sensor and collision sensor and other real-time detection of the vehicle state, when the firewood heating device fire or violent collision and rollover automatically cut off the fuel supply, at the same time the use of warning lights and the buzzer alarm. Improved security.

(3) Through the boiler outlet and return water temperature sensor, detect and reflect the working state of firewood heating, can use the touch screen to adjust the temperature.

(4) The temperature sensor collects the temperature information of each part, and then the single chip microcomputer intelligently controls the ignition plug, fuel injection and air intake through the program, so as to achieve the most reasonable

working state. The combustion gas exhaust outlet is equipped with a temperature sensor, which can correct the amount of fuel injection according to the exhaust temperature and save fuel.

Electric bus diesel heating boiler system for the subsequent related research, provides research road and research theory. But at the same time, there are some limitations. It is believed that with the deepening of research, building a more efficient, green, energy saving system will become the trend of the future.

IV. REFERENCES

[1]. Li Zhizhen, Zou Luhua, Deng Qiwei, Jiang Youhua. Design of temperature controller based on PID control [J]. Ship electric technology,2020,40(10):62-64.

[2]. MA Chao. Design of intelligent digital Temperature measurement and control System [J]. Knowledge Economy,2011(10):104.

[3]. JIANG Kun. Design of Temperature Control System based on SCM [J]. Electronic Testing,2021(06):13-14.

[4]. Zou Zhexiang, WANG Sizhuo, Li Mingyang. Optimization design and simulation of combustion chamber structure of parking heater [J]. Development and innovation of mechanical & electrical products,2012,25(03):82-84.

[5]. BI Tao. Design of temperature the alarm system based on AT89C52 MCU and DS18B20 sensor [J]. Fujian computer,2018,34(08):130-131.

Cite this article as :

Xinyue Li, Tianhao Sun, Shuai Wang, Shuwen Yang, Gaoying Sun, Mengnan Hu, Shaogang Ma, Wei Cong, Pengyuan Yang, Xuzhao Li, Song Wang, Xuzhao Li, Xuemeng Bai, Yixuan Wang, Shirui Liu, "Electric Bus Diesel Heating Boiler System", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 2, pp. 230-236, March-April 2022. Available at

doi : https://doi.org/10.32628/IJSRST229246

Journal URL : https://ijsrst.com/IJSRST229246