Smoke purification device of smoking room based on truncated continuous vortex ring air curtain

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ABSTRACT

In order to solve a series of problems existing in the existing smoking rooms in public places, such as "poor indoor environment of smoking, easy adhesion of second-hand smoke to walls, tables and chairs and other dead corners, low smoke collection and processing capacity, resulting in pollution of the smoking room and the surrounding environment", this device designs a smoke purification device in the smoking room based on cutting off the continuous vortex ring air curtain,The utility model can efficiently replace the indoor air by isolating the air curtain, so as to achieve the comprehensive purification of the air in the smoking room. MQ-2 smoke sensor is used, which is controlled by STM32 single chip microcomputer through AD conversion and serial port input, and ADC0832 is used to convert the collected data to obtain the actual smoke concentration,The smoke concentration is controlled by the P port of STM32, and the oledspi display module located inside the smoking room displays it in real time.The smoke concentration digital signal compares the parameters through the obtained smoke concentration and the set smoke concentration threshold. When the processing requirements are met, the circuit of the digital relay controls the motor drive of the forced draft fan, controls the isolated suction of the vortex ring air curtain, and pumps the indoor air into the subsequent pretreatment system efficiently and quickly,In the prediction system, nano mineral crystal flue gas toxic gas adsorption and activated carbon filter plate are used to filter the flue gas generated by smoking, and then discharged outdoors after passing the detection of tail gas detection sensor.

Keywords:Smoke alarm; MQ-2 smoke sensing; digital output control relay; wind curtain vortex ring; AD conversion; communication control system; oledspi serial port display.

1. INTRODUCTION

Smoke refers to the smoke formed from the smoking end of the cigarette in the closed system. When the cigarette is pumped, the smoke at the smoking end contains a large number of toxic gases in the state of spontaneous combustion, including nicotine and other toxic gases, which are easy to diffuse in the air and pollute the surrounding environment[1]. Many public places have smoking rooms, which can keep a controllable distance between smokers and non-smokers and ensure the health of non-smokers. Banning smoking in public places has become a common code of conduct, but there are still many people smoking in public places. At present, the smoking rooms in public places are very simple, There was no treatment of cigarette smoke. Usually, it is directly discharged outdoors through the exhaust fan, and the smoking room also loses its meaning. The details are shown in Figure 1 below.

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Figure 1. Environment of smoking room

Referring to the study on the tobacco pollution level of smoking rooms in some typical public places in Shanghai, Typical public smoking room can not isolate tobacco smoke[2-3]. The indoor air quality is poor. Not only some smokers are unwilling to smoke in the smoking room, but also the smoking room has caused obvious smoke pollution to the surrounding non-smoking area. Some office buildings even use the staircase as a smoking room. There are problems in these places, such as lack of smoke and dust treatment system and poor air circulation, and are easy to cause potential safety hazards. They are also the places with the most serious smoking pollution. Therefore, it is imperative to develop a smoking room with purification treatment at the same time. Smoking control can only be carried out step by step[4]. The huge base of smokers needs environmentally friendly and clean smoking rooms as the transition of smoking prohibition. At present, there are still great problems in smoking rooms and there is a lot of room for improvement.

With the development of society, the application of smoking room is more and more extensive. Therefore, the demand for a smoke purification device for smoking room is increasing day by day[5]. Based on the above background, this project designs a device that can isolate the smoke in the smoking room from the non-smoking area and purify the smoke in the smoking room, so as to ensure the air quality in the smoking room and detect and purify the discharged air at the same time.

2. REFERENCE FOR SELECTION OF ELECTRONIC DEVICES

2.1 Smoke sensor selection

Gas sensor is a kind of sensor used to detect a specific gas. It mainly includes semiconductor gas sensor, contact combustion gas sensor and electrochemical gas sensor, among which semiconductor gas sensor is widely used because of its superior performance. It has a wide range of applications, such as the detection of carbon monoxide gas, gas detection, gas detection, freon (R11, R12) detection, detection of ethanol in breath, etc. In practical projects, MQ-2 and MP-2 are two commonly used sensors, which may have different analog output voltage values under the same environment.

MQ-2 sensors are commonly used in household and factory gas leak monitoring devices, suitable for the detection of liquefied gas, benzene, alkane, alcohol, hydrogen, smoke, etc. MQ-2 Smoke sensor belongs to tin dioxide semiconductor gas sensitive material, is a surface ion type N type semiconductor. When it is at 200~300 degrees Celsius, tin dioxide absorbs oxygen in the air, forming the negative ion adsorption of oxygen, so that the electron density in the semiconductor is reduced, so that its resistance value is increased[6]. When in contact with smoke, if the barrier at the grain boundary is changed under the influence of smoke, it will cause a change in the surface conductivity. Using this, information about the presence of smoke can be obtained. The higher the concentration of smoke, the higher the conductivity and the lower the output resistance, the greater the analog signal output. MQ-2 sensor has good repeatability and long-term stability, initial stability, short response time, long time performance. Circuit design voltage range is wide, 24V below can be heating voltage of 5±0.2V.

According to the data, the formula for calculating the smoke concentration of MQ-2 is as follows:

$$\log R = m \log C + n$$

$$Rs = (\frac{Vc}{V_{RL}} - 1) \times R_L$$

Of which:

Constant n: it is related to gas detection sensitivity and can be set according to different sensitivity.

Constant M: refers to the sensitivity of the sensor that varies with the gas concentration. Generally speaking, the value of M is mostly between 1 / 2 and 1 / 3.

Vc: power supply voltage;

V_{RL}: output voltage of pins 4 and 6 of mq-2.

According to the calculation, the detection range of mq-2 sensor for smoke is 5000 ~ 20000 ppm, i.e. 0.5% - 2%.The smoke detection concentration of MP-2 is much higher than that required by the smoking room[7-8]

Moreover, the two types of smoke sensors also fluctuate with respect to the change of temperature and humidity. In the range of 50 ℃, the fluctuation range of MP-2 voltage output value is 1.2-1.6v and mq-2 is within 0.7V. The fluctuation range of MP-2 is larger, which may affect the experimental effect of the project.

In view of the above measurement range and the comparison of anti-interference intensity, mq-2 is used as the main smoke sensor in the smoking room and the smoke sensor for exhaust gas detection.

2.2 AD conversion module selection

ADC module: analog-to-digital conversion module / AD conversion module, whose function is to convert voltage signal into corresponding digital signal[9]. practical application, this voltage signal is the physical quantity of smoke concentration, which is transformed by the sensor and the corresponding conversion circuit.After AD conversion, MCU can process the smoke concentration.

The specific processing flow is shown in Figure 2 below

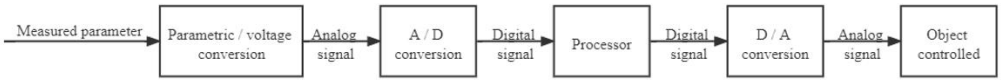

Figure 2. Flow chart of digital to analog conversion

For the smoke sensor, the voltage fluctuation range is 0-5V. The output data accuracy of the smoke sensor designed in this project is 0.05v. Through calculation, an AD conversion chip with 8-bit resolution can be selected. In this project, ADC0832 is used as the digital to analog conversion of the smoke alarm, which can support two single ended input channels and one differential input channel.

3. RESEARCH CONTENTS:

3.1 Overall design of the device

Therefore, the device designs a smoke purification device for the smoking room with a truncated vortex ring air curtain to solve these problems existing in the current smoking room. The details are shown in Figure 3 below.

Figure 3. Dverall model of the device

The device is composed of four modules: vortex ring air curtain device, smoke detection and alarm system in smoking room, smoke treatment device and tail gas detection device.The air inside the smoking room is detected by the mq-2 smoke sensor in the second part, and then the analog signal is processed to obtain the real-time smoke concentration. Through the set threshold, the relay is controlled by the digital output of the sensor (0 is qualified, 1 is too high concentration).The sensor analog output is collected and converted by ADC0832, and the GSM module is used for internal communication to realize information synchronization. The GSM module can control it by using AT command. The module can be connected with the computer RS232 serial port or controlled by single chip microcomputer.

Figure 4. STM32 board serial port wiring diagram

In this project, the digital signal processing part is connected with STM32 by connecting RXD and TXD serial ports. When the smoke concentration output by the smoke alarm reaches a certain degree, the message will be sent automatically, the digital signal will be sent to the control relay to control the air supply device, and the front-end air curtain will start to isolate the indoor gas circulation, The rear end exhaust smoke sensor also gives real-time feedback on its exhaust gas to ensure that the exhaust gas meets the standard. The pin diagram is shown in Figure 4 above.

3.2 Vortex ring wind curtain module

According to the types of smoking rooms on the market at present, the investigation found that due to the defects of the smoking room itself, the door has been often opened and closed, and the cigarette smoke cannot be captured and adsorbed in time, resulting in a large amount of smoke leakage. Therefore, the vortex ring air curtain is set at the door plate to isolate the external air and accelerate the replacement of indoor air in the Figure 5.

Figure 5. Overall drawing of air curtain device

This module utilizes the unique characteristics of vortex rings, which allows for a concentrated energy wind curtain with less energy loss, making it energy-efficient and environmentally friendly. Additionally, it binds the surrounding air and fluid, improving the blocking effect of the wind curtain and overall quality. The low wind speed of the vortex ring also reduces the wind feeling, providing a more comfortable experience while ensuring that indoor smoke does not spread and facilitating smoke absorption.

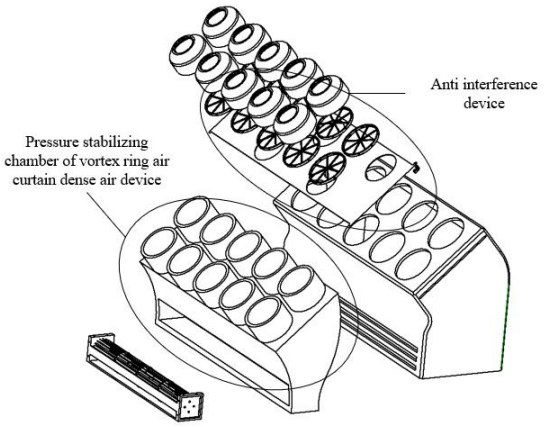

Figure 6. Structure diagram of module core design

Its core part includes the design of pressure stabilizing chamber and anti-interference structure of vortex ring air curtain sealing device. This paper expounds some of the structural design. Its structure diagram is shown in Figure 6 above

1) Design of voltage stabilizing cavity

The main focus of this part of the design is to design the specific size of the pressure stabilizing chamber. In view of the complex air conditions of the smoking room, it is necessary to achieve the effect of efficient ventilation under the condition of non-proliferation of indoor smoke, which requires that the absorption rate and air flow intensity of the air curtain reach an appropriate level on the premise of stability of the air curtain in the Figure 7.

Figure 7. Model diagram of pressure stabilizing chamber and air supply device

In order to ensure the quality of each vortex ring.The project plans to develop a pressure stabilizing chamber matched with the vortex ring wind curtain generation device.The function of the pressure stabilizing chamber is to evenly distribute the gas and fluid to each vortex ring nozzle, so as to ensure that the gas volume, flow rate and other state parameters of each vortex ring are kept within a certain range.

In addition, the project proposes the overall optimization scheme of the voltage stabilizing cavity shown in Table 1:

Table 1. Definition dimension table

Model definition dimensions		
Variablesize1	20°	Fix other values, say a variable is reduced to 90% or increased to 110%, and analyze the influence rate of the cavity on the performance of the cavity
Variablesize2	140mm	
Variablesize3	50mm	
Variablesize4	20°	

This project mainly changes one variable size by setting four variable sizes and one fixed size, and then fixing three variable sizes. A set of experimental data is obtained by changing this variable size for many times.Then repeat the above operation to obtain four groups of experimental data.By comparing the experimental data and sensitivity analysis, the variable size ranking of the influence on the performance of the voltage stabilizing cavity from high to low is obtained.The optimal solution is obtained from the variable size with high sensitivity to low sensitivity, and finally the optimal solution of the voltage stabilizing cavity is obtained.The vortex diagram of pressure stabilizing chamber is shown in Figure 8 below.

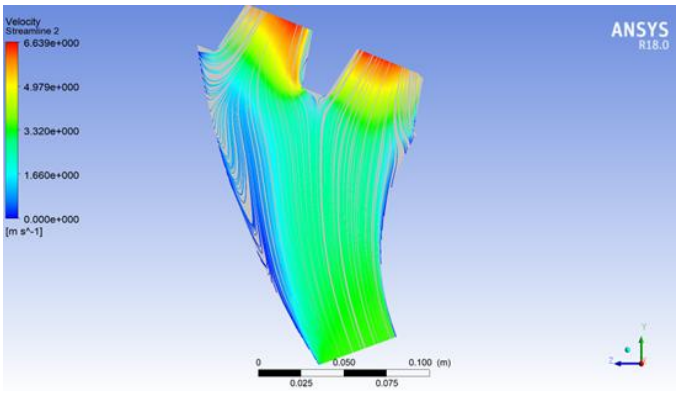

Figure 8. Vortex diagram of pressure stabilizing chamber

2) Anti interference structure design

For the vortex ring generated in the designed pressure stabilizing cavity, during the process of passing through the cavity, due to the multi ring structure of the device, interference may occur between the vortex rings, and due to the narrow section and short path of the pressure stabilizing cavity, other exchange rates of the vortex ring are relatively low. If all vortex ring nozzles are carried out at the same time, other exchange rates of the vortex ring cannot meet the requirements,It will reduce the actual efficiency of the device, and it is necessary to set a reasonable structure, which can not only ensure the gas exchange efficiency, but also prevent the interference between vortex rings, so as to destroy the stable air flow, which may lead to gas disorder and greatly reduce its transportation efficiency.

In view of the above situation, the device is designed with a flexible cut-off plate, which is driven by a stepping motor to switch two groups of different vortex ring nozzles, so as to ensure its gas exchange efficiency and prevent the adjacent vortex ring nozzles from passing at the same time, resulting in interference, disordered air flow and interference with gas flow.

Figure 9. Schematic diagram of vortex ring mode generated by single and double truncation

Figure 9 shows that the vortex ring wind curtain generation device has two operational modes. The vortex ring nozzles that correspond to each mode can be in either an open or closed state. A flexible plate is located beneath the device's shell, and circular holes with the same diameter as the shell are cut into the flexible plate. One side of the cut-off plate is connected to a motor, and the other side is connected to a coil spring. The motor operates in a periodic manner, causing the cut-off plate to move to the right. When the motor stops working, the coil spring pulls the cut-off plate back to the left. This mechanism enables the nozzles to alternate between open and closed states, allowing the device to generate the vortex ring wind curtain in a controlled manner.

3.3 Smoke monitoring and alarm processing system and tail gas detection module in smoking room

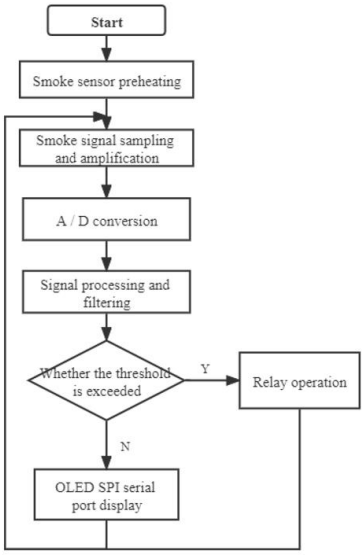

Figure 10. System flow chart

Figure 10 above is the flow chart of the smoke alarm system. The device outputs the concentration analog signal through the mq-2 sensor, then obtains the stable filtered signal with the maximum value through the signal processing circuit, and then obtains the concentration digital signal through the signal processing of ADC0832. The digital signal is compared with the set threshold. If the concentration is high, the relay will be cleaned by the relay opening device to ensure that the smoke concentration in the smoking room is at normal value. This part takes STC32 as the control core and cooperates with the necessary peripheral circuits to complete the functions of signal acquisition, status display, concentration display and communication with the serial port of the upper computer. The smoke concentration alarm adopts the working mode of real-time sampling.

Figure 11. Smoke sensing design drawing of tail gas

Figure 11 above shows the structure of tail gas smoke alarm. Its program setting includes interruption part, which can directly cut off the device and transmit it through mq-2 smoke sensor. The signal output does not need maximum

filtering, because considering that the flue gas concentration of tail gas is uniform and one-way traffic, the stability of flue gas concentration is high, Higher accuracy measurements can be obtained.

1) MQ-2 smoke concentration signal processing

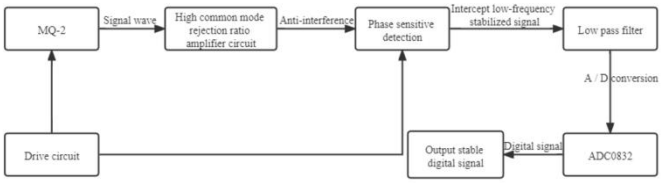

Figure 12. Overall signal processing flow diagram

The output of smoke concentration sensor is 0-5V sinusoidal signal. Firstly, the signal fluctuation is relatively weak. Secondly, it can not be measured with AC meter, because it can not reflect the positive and negative displacement.Therefore, these signals must be amplified before they can be sent to the subsequent circuit.Because the smoke sensor is in the smoking room, it needs a long line to lead the signal to the signal processing unit. Therefore, the suppression of common mode signal should be considered. Therefore, the amplification circuit with high common mode suppression ratio should be used in the design of amplification circuit.

Because MQ-2 smoke sensor has strong anti-phase-shift interference ability, the probability of large random fluctuation caused by different external conditions is low. In view of this, low-pass filtering and DC amplification must be carried out on the signal. Only in this way can the real change of modulated concentration signal be obtained, and the interference of various other external signals can be greatly reduced.

a) Sinusoidal drive circuit

The structure of RC bridge sine wave oscillation circuit is shown in Figure 13. The working principle of RC bridge sine wave amplification circuit is to generate sine wave output voltage by relying on the self-excited oscillation of the circuit without external input signal. The so-called self-excited oscillation refers to that there is no external input signal at the input end, and there is still a signal output of a certain frequency and amplitude at the output end.

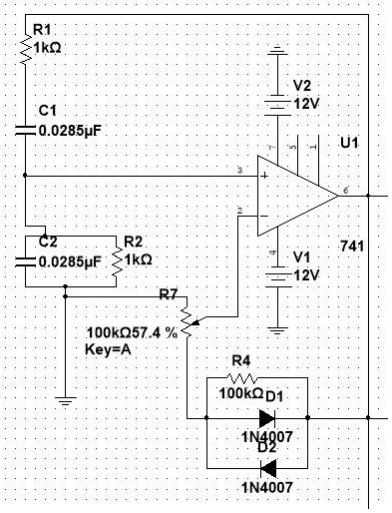

Figure 13. RC bridge sine wave oscillation circuit

The resonant frequency of the sine wave generated by the sine wave oscillation circuit is:

$$f = \frac{1}{2\pi\sqrt{C_1 C_2 R_4 R_5}}$$

The frequency to be generated is 5KHz, and then it is adjusted according to the actual simulation situation. Finally, the selected value is:

$$C_1 = C_2 = 0.0285\mu F, R_1 = R_2 = 1k\Omega$$

In sine wave generation, the performance requirements of operational amplifier do not need to be very high, so the operational amplifier selected here is the commonly used lm358 operational amplifier, which is a single operational amplifier.It is characterized by wide input voltage, high performance, internal compensation operational amplifier, low power consumption, no external frequency compensation, short-circuit protection and offset voltage zeroing ability, no latch effect in use, to prevent slow feedback of devices with high smoke concentration. The final circuit diagram is shown in Figure 14 below.

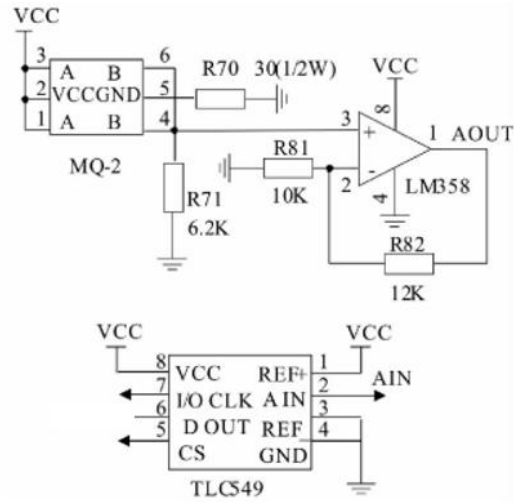

Figure 14. LM358 wiring diagram

b) Filter circuit

Considering that the smoke concentration in different areas is different, and the smoke concentration in different positions of the same smoking room is also changing in real time, considering the large fluctuation of the detection of the smoke sensor, it may be impossible to control the opening when the concentration in the smoking room is high or start working when the concentration is low,The Butterworth filter can be used to filter the maximum value, and the real smoke concentration can be obtained by sampling according to the complex smoke concentration in the smoking room.

In order to achieve better filtering effect of concentration signal, this structural design selects infinite gain multi-channel feedback circuit to form Butterworth filter. Because there is no positive feedback in this circuit, this circuit always exists stably, although it has high requirements for the performance of operational amplifier.And because it contains active components, it can reduce the loss of the signal, while the ordinary RC passive filter will consume the power of the signal.The circuit is shown in Figure 15.

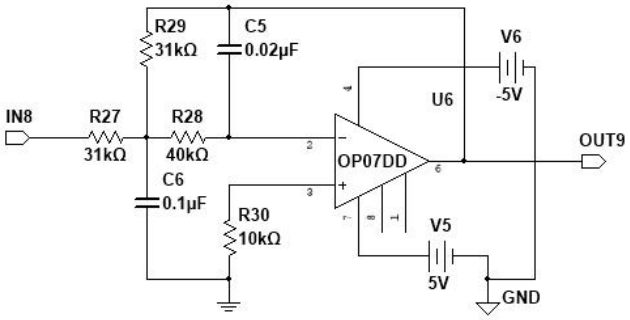

Figure 15. Second order infinite gain low-pass filter circuit

The selected operational amplifier is op07d, which has very small offset voltage and offset current, high common mode rejection ratio and low noise. It is a common operational amplifier for low-pass filter with good economy. Its parameters are shown in Figure 16 below

Part Number	Number of channels (#)	Total Supply Voltage (Max) (+5V=5, +/- 5V=10)	Total Supply Voltage (Min) (+5V=5, +/- 5V=10)	Vos (offset voltage @ 25 C) (Max) (mV)	GBW (Typ) (MHz)	Slew Rate (Typ) (V/us)	Rail-to-rail	Offset drift (Typ) (uV/C)	Iq per channel (Typ) (mA)	Vn at 1 kHz (Typ) (nV/rtHz)	CMRR (Typ) (dB)	Rating
OP07D	1	36	6	0.15	0.6	0.3	No	0.7	2.4	9.8	110	Catalog

Figure 16. Basic parameters of op07d

Since the frequency of the residual carrier signal is 5KHz, in order to select the useful signal from the mixed signal, the cut-off frequency of the filter is required to be at least 1 / 10. Here, a low-pass filter with a cut-off frequency of 100Hz is selected. It can be seen from table 4.5 and table 4.6 $C_6 = 0.1\mu F$.

According to the resistance conversion coefficient:

$$K = \frac{100}{f_c C_1}$$

The values of other resistance and capacitance can be obtained, and the common nominal resistance value is selected, which is taken as:

$$R_{27} = R_{29} = 31k\Omega, R_{28} = 40k\Omega, C_5 = 0.02\mu F$$

Table 2. Design parameters of second-order infinite gain multi-channel feedback Butterworth low-pass filter

K_P	**1**	**2**	**6**	**10**
$R_1(K\Omega)$	3.111	2.565	1.697	1.625
$R_2(K\Omega)$	4.072	3.292	4.977	4.723
$R_3(K\Omega)$	3.111	5.13	10.18	16.252
C_1 / C_2	0.2	0.15	0.05	0.033

The selection of various parameters is shown in Table 2 above.

2) Circuit design

In the following Figure 18, the three and a half digit digital display meter replaces the oledspi serial port display part, and replaces the original smoke sensor by adjusting the resistance value of the potentiometer to prevent the change of smoke concentration. Its external circuit is shown in the following Figure 17.

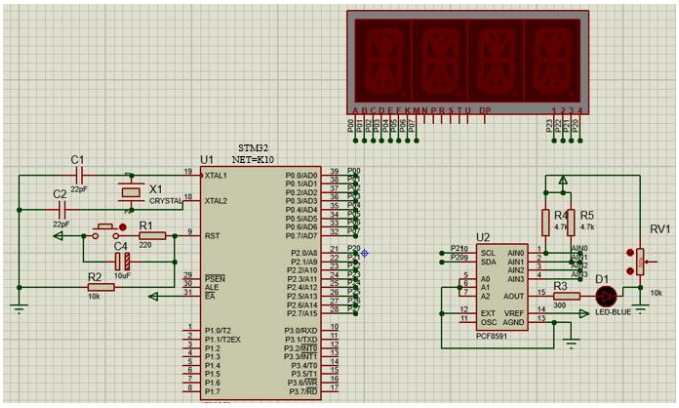

Figure 17. Simulation diagram of external circuit

The signal processing flow in this system is as follows: the signal first goes through a filter, then address gating, and is input into the ADC0832 chip from the IN0 port. The chip is initialized, and a positive pulse of no less than 100 nanoseconds is given to the start end to start analog-to-digital conversion. After the conversion is completed, the EOC

(End of Conversion) terminal sends a high level, and the data is sent to the P0 port of the single-chip microcomputer through the latch. The interface circuit between the ADC0809 and MCU is shown in Figure 12.

The clock frequency of the ADC0832 is generally 500 kHz. The clock frequency of the MCU is 11.0592 MHz, so the clock frequency of the ALE (Address Latch Enable) pin is about 1.84 MHz. The frequency obtained by twice frequency division of the D trigger is almost 450 kHz, which meets the frequency requirements of the A/D converter.

3) Quantization error of 3A / D conversion

The ADC0832 used for ad quantization error is 8 bits, and the corresponding force measuring range is 5V, so its resolution is:

$$R = \frac{V}{2^8 - 1} = 0.00392V$$

The designed sensor accuracy is:

$$a = V_s \times 0.5\% = 0.0019N$$

The quantization error of the sensor is

$$e_q = \frac{1}{2}LSB = 0.005N$$

The calculation shows that the quantization error of the sensor meets the accuracy requirements of the sensor.

4. FLUE GAS TREATMENT MODULE

This part of the device plays an important role in filtering and purifying the smoke generated from smoking. The nano mineral crystal adsorption area in the front is designed to effectively capture suspended particles, tar, nicotine and other substances with strong adsorption capacity due to its hexagonal pore structure. On the other hand, the activated carbon adsorption area in the rear is mainly responsible for removing unpleasant odors, ensuring that the smoke is purified before being released into the surrounding environment.

The combination of the two adsorption areas not only improves the overall efficiency of the device, but also prolongs the service life of the adsorption module. With an activated carbon adsorption efficiency of up to 97%, the module is able to effectively capture and collect the smoke, ensuring that it is fully purified before proceeding to the next stage of operation shown in Figure 18.

Figure 18. Structure diagram of flue gas treatment part

Nano mineral crystal also has high thermal stability, making it more suitable for use in smoking rooms where cigarette smoke can generate high temperatures. In contrast, activated carbon can lose its adsorption capacity under high temperature conditions. Additionally, nano mineral crystal has a longer service life compared to activated carbon, which needs to be replaced frequently to maintain its adsorption efficiency. These advantages make the use of nano mineral crystal as an adsorption material in the device a more efficient and cost-effective solution.

Additionally, nano mineral crystal has high thermal stability, which means it can withstand high temperatures without losing its adsorption capacity. This is an important feature for use in smoking rooms, as cigarette smoke can generate high temperatures. On the other hand, activated carbon can easily lose its adsorption capacity under high temperature conditions. Moreover, nano mineral crystal has a longer service life compared to activated carbon, which needs to be replaced frequently to maintain its adsorption efficiency.

At the same time, the nano mineral crystals can desorb in the environment above 45 ℃, discharge the adsorbed substances and reuse the nano mineral crystals. Compared with the property that the activated carbon is difficult to desorb, it is more suitable for the device. The nano mineral crystal can be used repeatedly by replacing the nano mineral crystal, so as to reduce the cost of the device.

The adsorption efficiency of nano mineral crystals to impurities decreases with the increase of service time. Therefore, the device combines it with tail gas smoke sensing to detect the smoke concentration of purified air. When the smoke concentration does not exceed 10mg / m^3When, it can meet the national emission standard. If the purification efficiency decreases due to the purification of more nano minerals, the detected smoke concentration is greater than 10mg / m^3, By using the interrupted program setting, the device can temporarily stop the purification of indoor flue gas, and alarm the management personnel through serial port communication for replacement. The high-efficiency nano crystal plate, combined with the rear activated carbon treatment device, can adsorb about 97% of impurities.

The analysis of its economic benefits can be obtained: the carbon monoxide of mainstream smoke with one cigarette is M_1. The mass of carbon monoxide in the tributary smoke of a cigarette is M_2. The mass of carbon monoxide produced by smoking in the total passenger flow m. This device can reduce the air volume V under a standard atmospheric pressure with the maximum pollution of carbon monoxide in the nearby non-smoking area by the traditional smoking room.

$$M_1 = 900 \times \frac{1}{6} \times 10^{-6} \times 12000 \times \frac{29}{55} = 5.17(\text{mg})$$

$$M_2 = 900 \times \frac{1}{6} \times 10^{-6} \times 12000 \times 15 = 28.89(\text{mg})$$

$$\text{M} = (M_1 + M_2) \times 1.2 \times 10^4 = 408720(\text{mg})$$

$$\text{V} = \text{M} \div 10 \times 59\% = 24114.48\ (\text{m}^3)$$

After calculation, compared with the traditional smoking room, this device can reduce the volume of nearby non-smoking area by 24114.48m^3 air pollution.

5. CONCLUSIONS

Aiming at the problems of smoke leakage polluting the surrounding environment, poor air quality in the smoking room and air pollution caused by direct exhaust in the public smoking room, this project designs a smoke purification device in the smoking room based on the cut-off continuous vortex ring air curtain. It creatively adopts the cut-off vortex ring air curtain to replace the sealing structure, and designs an embedded circuit to control the switch of the device,Mq-2 with high sensitivity for low concentration monitoring is used as the data acquisition part of the project, and a signal processing circuit suitable for the range is designed for the collected signal.This project creatively sets up smoke sensors for air intake and exhaust, which can not only ensure the efficient treatment of the device, but also prevent the problem of unqualified exhaust caused by the long operation time of the device.Compared with the traditional smoking room, the purification device designed in this project has better air purification and protection effect of the surrounding air, and has a good application prospect.

REFERENCES

[1] Huang, B., Design and Simulation of Butterworth digital filter [J] Henan science and technology, 40 (36): 10-12 (2021).

[2] Xie, Y. C., Yang, L., Yan, J., Design of smoke detection alarm based on mq-2 sensor [J] Computer measurement and control, 29 (08): 255-259 (2021). DOI:10.16526/j.cnki. 11-4762/tp. 2021.08.049.

[3] He, W. B., AD conversion module design and signal integrity analysis applied to wireless acquisition node of seismic exploration [J] Shandong University (2021).

[4] Long, S. Y., He, C., Yang, W., Wu, J. Q., A PWM to DAC design composed of Butterworth low-pass filter [J] Application of single chip microcomputer and embedded system, 21 (04): 64-67 (2021).

[5] Wang, B. P., Test of AD conversion bits of CC2530 single chip microcomputer [J] Office automation, 25 (23): 27-29 (2020).
[6] Li, J. K., Zhang, J. Q., Design of AD conversion expansion circuit based on AVR MCU [J] Wireless Internet technology, 15 (23): 48-49 (2018).
[7] Su, Y. K., Qiu, C. Y., Zhang, Y., Liu, R. L., Silicon based waveguide devices for signal modulation, filtering and analog processing [C] / / the 17th National optical fiber communication and 18th Academic Conference on integrated optics - album of optical fiber, waveguide devices and sensors, 93-95 (2015).
[8] Zhang, Q. Q., Zhao, Q. N., Design of fire alarm system based on mq-2 sensor [J] Value engineering, 34 (13): 96-98 (2015).
[9] Zheng, D. L., Sun, Y. J., Zuo, Z. H., Design of CO monitoring and alarm system based on mq-2 and GSM [J] Electronic design engineering, 2014,22 (04): 162-165 (2014).