



SDS820/720 Automatic Sulfur Analyzer

Operating Instructions

Hunan Science and Technology Co., Ltd

Attention

- **Read the instruction book carefully before operating the instrument.**

- **How to prevent fire**
 - **Only high-temperature power cable shipped together with the instrument can be used.**
 - **Electrical parameters of the outlet and knife switch should in accordance with the requirement of the instrument.**
 - **Cut off electricity supply if the instrument will not be used for a long time.**
 - **Take out foam and other material filled in the instrument, and take off the dust cover. No inflammable or explosive substance is supposed to be placed around the instrument.**
 - **Do not cover the dust cover until the instrument reaches room temperature.**

- **How to avoid electric shot**
 - **The instrument shall be connected to earth reliably.**
 - **Do not repair or disassemble the instrument while it is powered on.**
 - **Container loaded with liquid is forbidden to be placed above the instrument.**

- **To ensure stable and reliable performance, it is advised to use spare parts provided by Sundy. Sundy does not provide warranty service against problems of under-performance, unstable test results, or increased failure rate etc., which are caused by using spare parts not provided by Sundy.**

Content

Chapter 1 Instrument Description and Features	1
1.1 Application	1
1.2 Description	1
1.3 Features	2
Chapter II Instrument Composition and Working Principle	4
2.1 Instrument Composition	4
2.2 Working Principle	8
Chapter III Instrument Installation and Debugging	12
3.1 Environmental Requirements	12
3.1.1 Working Environment	12
3.1.2 Software Environment	12
3.2 Installation Procedures	12
3.2.1 Preparation	12
3.2.2 Installation of the Instrument	13
3.3 Installation, and Un-installation of Software	15
3.3.1 Software installation	17
3.3.2 Software un-installation	17
3.3.3 Instrument online	17
3.3.4 Instrument Debugging	17
Chapter IV Functions of Operating System	20
4.1 Start and Exit the Test and Control Software	20
4.1.1 Start the Test and Control Software	20
4.1.2 Exit the Test and Control Software	20
4.2 Functions of Main Windows	21
4.2.1 System Menu (Fig. 4-3)	23
4.2.2 Temperature Menu	23
4.2.3 Detection Menu	34
4.2.4 Main menu for test	37
4.2.5 Data management	40
4.2.6 Help menu	40
4.2.7 Exit the main menu	40
Chapter V Data Management	41
5.1 Database Management Window	41
5.2 Functions of the menu bar	42
5.2. System Menu	42
5.2.2 Edit Menu	42
5.2. Find Menu	42
5.2.4 View Menu	51
5.2.5 Database Menu	51
5.2.6 Help Menu	52
Chapter VI Instrument Operation	53
6.1 Operation Procedure	53

6.2 Precautions	57
Chapter VII Instrument Maintenance.....	59
Chapter VIII Common Troubles and Solutions.....	61

Chapter 1 Instrument Description and Features

1.1 Application

This instrument offers a simple technique that measures total sulfur content in coal, coal cinder, coke, catalyst, mineral substance, rocks, petrochemicals, and etc.. It can be applied in coal industry, electrical power, metallurgical industry, petrochemical industry, geological exploration, environment protection, scientific research, educational institutions and so forth.

1.2 Description

1. Sulfur determination range: 0.01%~40 %;
2. Single sample test time: 3~4.5 min per sample;
3. Number of samples: 21 samples;
4. Heating time: 15~35min;
5. Furnace temperature: for coal and coke, $1150\pm 5^{\circ}\text{C}$; and oil and pyrite, $900\pm 5^{\circ}\text{C}$; cement (1190 ± 5) $^{\circ}\text{C}$
6. Temperature control range: 500~1200 $^{\circ}\text{C}$
7. Temperature control precision: $<5^{\circ}\text{C}$;
8. Electrolytic cell capacity: 400ml, electrolytic electrode area: $(1\times 1.5)\text{ cm}^2$, indicating electrode area: $(1\times 0.5)\text{ cm}^2$;
9. Power Supply: $(220\pm 22\text{V}, (50\pm 1)\text{ Hz})$;
10. High temperature furnace instantaneous maximum power: $\leq 3.5\text{Kw}$;
11. Sample particle size: $<0.2\text{mm}$; sample size: 10~110mg;
12. Precision

St,%	Repeatability		Reproducibility	
	GB requirement	SDS820/720	GB requirement	SDS820/720
≤ 1.5	0.05	<0.05	0.10	<0.10

1.5(not included)-4	0.10	<0.10	0.20	<0.20
>4	0.20	<0.20	0.30	<0.30

Table 1-1

1.3 Features

1.3.1 High automation and high efficiency

- a. SDS820/720 is equipped with a chain-like sample delivering device. The operator only needs to put the prepared samples on the device, and can place 21 samples at the same time, then the system will automatically test the samples one by one without attention and intervention by the operator during the test. The equipment has reasonable design, high reliability.
- b. High-quality air pump with stable performance;
- c. Desiccant with long working period;
- d. USB-CAN interface card with strong reliability;
- e. With balance interface and online weighing software, samples can be weighed at any time, and the weights can be entered into system automatically.

1.3.2 High accuracy & high reliability of the experimental results

The instrument adopts hardware integration working method, which can avoid software integration errors. The results are accurate, stable and reliable.

1.3.3 Easy to operate, safe and reliable

After starting the test all the process is controlled by computer, without artificial participation, and the high temperature furnace is enclosed completely in the shell. It is safer and more convenient for the operator to operate. With SDS820/720, the operator does not need to take away the high-temperature crucible manually. Therefore, the eyes are free from infrared radiation.

1.3.4 User-friendly interface and powerful function

User-friendly windows-based operating software provides full automatic operation and flexible data storage. Heating up, constant temperature, and cooling are all

controlled by computer system. Linearity deviation, system deviation, and sample weight can be automatically calibrated. Besides, the instrument has automatic alarm and protective function against over temperature, thermocouple disconnection and thermocouple counter-connection.

Chapter II Instrument Composition and Working Principle

2.1 Instrument Composition

SDS820/720 Automatic Sulfur Analyzer mainly consists of high temperature furnace, sample delivering mechanism, sample introducing mechanism, electrolytic cell, magnetic stirrer, air pump, purification system, dust filter, air tightness detection device, control system, and etc..

Composition of SDS820/720 is shown as Fig. 2-1-1:



Fig.2-1-1

Key:

- | | |
|-----------------------------------|---|
| 1. Dust filter | 2. Gas tightness detection device |
| 3. Agitation speed adjusting knob | 4. Mains switch |
| 5. Electrolyte cell | 6. Flow meter |
| 7. Purification tubes | 8. Chain-like sample delivering and introducing mechanism |

1. High temperature furnace

The high temperature furnace applies dual-spiral silicon carbide tube as heating element, and platinum and rhodium platinum thermocouple as temperature detector.

The temperature is controlled by computer system. The uniform temperature zone is over 70mm in length. The silicon carbide tube is covered by a corundum tube to avoid breaking. Aluminum silicate wool is stuffed between the corundum tube and furnace shell to achieve good insulation. The combustion tube is a quartz tube, which is installed into the silicon carbide tube.

2. Sample delivering and introducing mechanism

The sample delivery mechanism of SDS820/720 mainly consists of sample delivery motor, chain, and gear. It is used to deliver the sample.

The sample introducing mechanism mainly consists of sample introducing motor, sample introducing rod and position limitation device. It is used to introduce samples into the furnace (or withdraw samples from the furnace).

When the computer indicates the controller to deliver the sample, the chain will move one step forward to align the crucible with the furnace mouth.

When the computer indicates the controller to introduce (or withdraw) the sample, the sample introducing motor will drive the gear and chain →drive the sample introducing rod → introduce the samples into the furnace (or withdraw samples from it).

The structure of sample introducing mechanism is shown as Fig. 2-2:

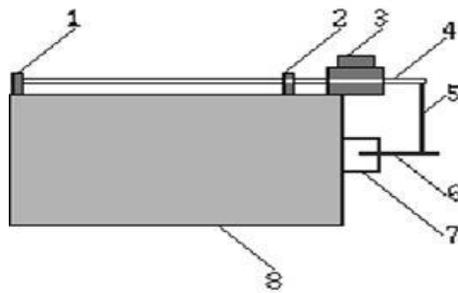


Fig. 2-2

Key:

- | | |
|--------------------------------|---------------------------------|
| 1. Left position switch/sensor | 2. Right position switch/sensor |
| 3. Motor | 4. Driving rod |
| 5. Interlocking rod | 6. Sample delivering rod |

3. Electrolytic cell and agitator

The electrolytic cell is made of organic glass, and the volume is 400mL. There are an air inlet hole and gas outlet hole at the plastic top cap and o-ring is used to seal the top cap and shell. A pair of electrolysis electrodes ($1 \times 1.5 \text{ cm}^2$) and a pair of indicating electrodes ($1 \times 0.5 \text{ cm}^2$) are installed at the cap. The four electrodes are parallel, and align with each other.

At the bottom of the electrolytic cell, there is a magnetic stirrer, which will agitate the electrolyte driven by the agitator. The stirring speed can be controlled by adjusting the speed knob at the panel.

NOTE: When adjusting the agitation speed, do not make the stirrer jump up. Try to make the stirrer at the critical condition of jumping up.

Q: Why should high agitation speed be kept?

A: If the agitation speed is too slow, the resultant iodine cannot be rapidly diffused, and the control of reaction endpoint will fail. As a result, results are not accurate. When at the appropriate speed, lots of bubbles are formed in the cell, but the stirrer does not jump up and touch the electrodes.

The electrolytic cell is used to measure total sulfur content with coulomb method. Please refer to section 2.2 for detailed information of working principle. (Structure of electrolytic cell and magnetic stirrer is shown in Fig.2-3)

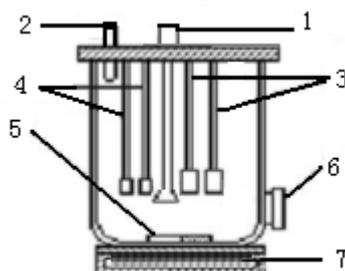


Fig 2-3

Key

- | | |
|---------------------------|-------------------------|
| 1. Inlet end | 2. Outlet end |
| 3. Electrolytic electrode | 4. Indicating electrode |
| 5. Magnetic stirrer | 6. Electrolyte outlet |
| 7. Agitator | |

Note: If the electrolyte PH value is less than 1 or the color turns red or software prompts the operator to replace the electrolyte, please timely replace the electrolyte in order to ensure stable and accurate test results.

4. Purification system

The system consists of air pump, flow meter, purification device, and dust filter. The purification system can purify and dry the air entering into the furnace, and gases released from it.

- a. Air pump:** One air pump is used to supply clean and dry air for combustion, and the other is to pump gases generated from combustion and electrolysis.
- b. Flow meter:** SDS820 has two flow meters internally, one is digital meter with range of (0 ~ 1500 mL/min), and the software will automatically adjust to 1000 mL/min during test. The other one is a float flow meter used for direct observation with range of (0 ~ 1500 mL/min), and the software will automatically adjust to 1000 mL/min during the test. SDS720 has two float flow meters with the range of (0 ~ 1500 mL/min). They need to be manually adjusted to 1000 mL/min during test. Generally, a value between 900~1000mL/min is considered to be normal.
- c. SDS820/720 gas tightness detection device:** It is close to the dust filter. To check if the gas tightness is well during test, the operator only needs to start the gas tightness detection or urn on the main pump and open the gas tightness detection cover, then push forward the detection knob.
- d. Purification device:** The purification device is used to remove acid gases and moisture in the air. The air inlet and gas outlet parts of the SDS820/720 purification device are consists of purification tubes filled with allochroic silicagel.

NOTE: When 70% of allochroic silicagel has discolored, please replace it. The replaced allochroic silicagel should be dried for backup use. To ensure accurate test results, please timely replace the much discolored silicagel.

e. Dust filter: The filter is made of heat-resisting material. It can effectively prevent dust generated from the furnace to enter into the electrolytic cell. The absorbent cotton in the filter should be flattened and fully stuffed. But do not block the gas inlet end. Once it gets wet, dark, or filled with lots of dust, replace it.

NOTE: The dust filter and gas tightness detection device are hidden on the left of the upper cover plate, and when using please open the cover door. Please regularly check absorbent cotton to ensure test accuracy.

The gas diagram is shown as Fig. 2-4:

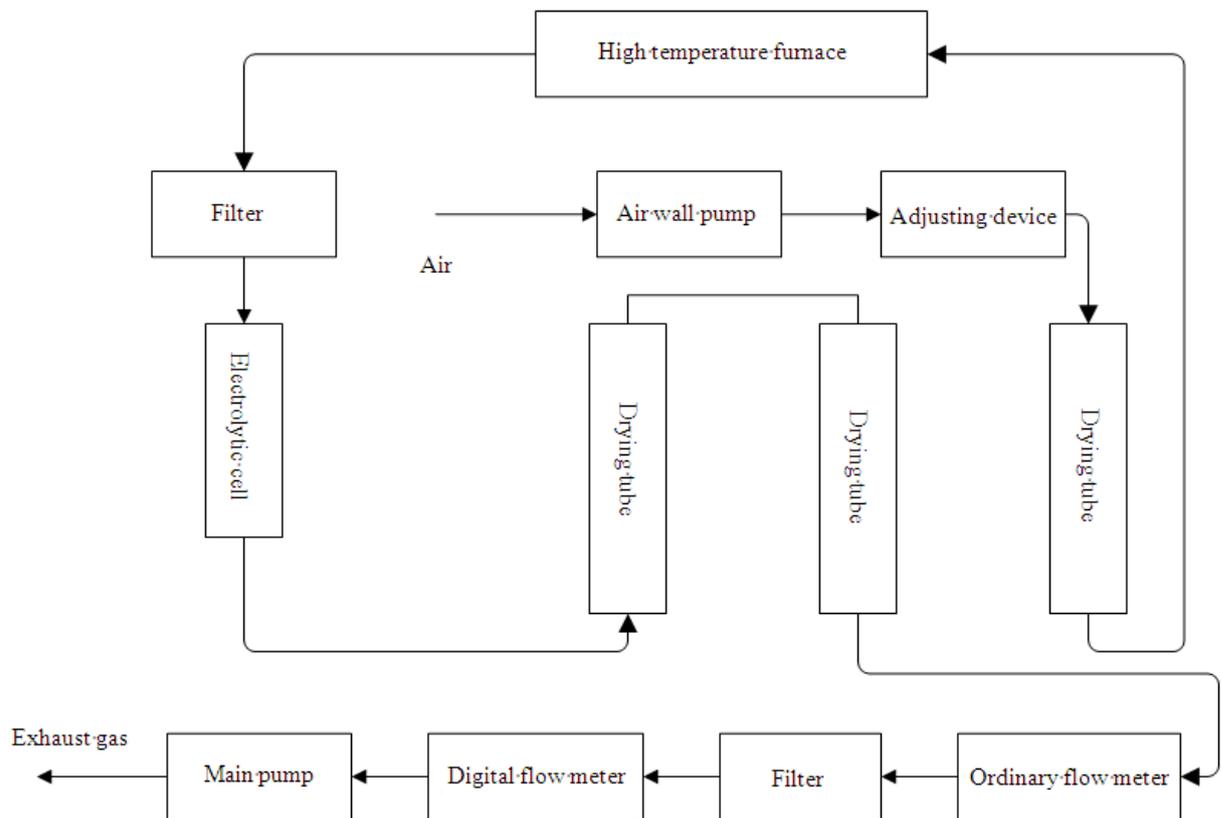
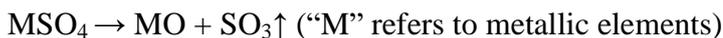
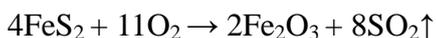


Fig. 2-4

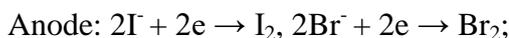
2.2 Working Principle

The instrument is designed based on the principle of coulometric titration. A

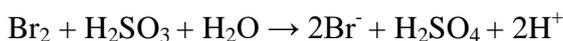
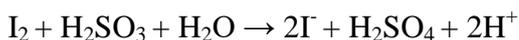
known mass of coal or oil is burnt in a stream of purified air at a respective temperature of 1150°C and 900°C. During combustion, all sulfur contained in the sample is oxidized to gaseous oxides of sulfur (sulfur dioxide, SO₂, and sulfur trioxide, SO₃). The reactions are as follows:



The generated SO₂ and SO₃ are then carried by the air flow to the electrolytic cell where they dissolve forming sulfurous acid H₂SO₃. The H₂SO₃ is then oxidized to sulfuric acid H₂SO₄ by the iodine in the solution. As a result, the iodine (bromine) decreases and iodide ion (bromide ion) increases, and the balance between iodine and iodide ion is destroyed. The quantity of H₂SO₃ is dependent upon the amount of iodine generated. Once the amount of the iodine has been determined, the percentage of sulfur contained in the coal may be calculated. The reactions are as follows:



The redox reaction of SO₂ with I₂ and Br₂ are as follows:



When testing oil, under the control of the software, the sample will first be sent to 300°C temperature zone for preheating, then to 600°C temperature zone for further preheating. After the two steps, a majority of sulfur has been dissolved. Then the oil is sent to 900°C temperature zone for complete decomposition, during which balance sulfur is dissolved. When the test has finished, the sample delivery vehicle will retreat to the initial position.

The quantity of electricity used to generate iodine can be calculated through integral based on circuit sampling, transferring and computer. Then under the Law of Faraday, the percentage of sulfur contained in the sample may be determined.

$$S(\%) = (Q \times 16 \times 1000) / (96500 \times mL)$$

S — total sulfur content(%):

Q — electrical quantity, Coulomb(C):

M — sample mass, g.

Q: What is the principle of coulometric titration?

A: Coulometric titration is based on Coulomb Law (or Law of Electrolysis). The mass of a substance altered at an electrode during electrolysis is directly proportional to the quantity of electricity transferred at that electrode. For example, during electrolysis, when 96500C (1 Faraday) electricity is transferred, one mol of substance is altered.

$$M = [(I \times t) / F] \times Mm$$

$$\text{Coulomb(C)} = I \times t$$

M — electrode deposited mass, g;

Mm — material mole mass, g/mol;

F — Faraday constant, 96500 C, 96500 C;

I — current let in the electrolyte, ampere (A);

t — current let in time, second (S);

Q: What kind of catalyst is used? Why is it?

A: To increase the production rate of SO₂, and to achieve the reversible balance of SO₂ and SO₃, high combustion temperature must be kept. However, if the temperature is too high, the combustion tube can not work long. After repeated experiments and comparison, it has been found that tungsten trioxide is a catalyst that can help to decompose the sulfur in sulfate. Therefore, to make the sample combusted completely at 1150~1200°C, the coal sample is covered by a layer of tungsten trioxide.

Q: Why the carrier gas is air? Why the air should be purified?

A: To increase the production rate of SO₂, and to achieve the reversible balance of SO₂ and SO₃, relative low oxygen pressure must be kept. So, in coulometric

titration, Sundry chooses air instead of oxygen. Meanwhile, if with un-dried air, before it enters the electrolytic cell SO_2 (or SO_2) will generate H_2SO_3 (or H_2SO_4), which will be absorbed on the tube. As a result, test values will be lower than actual values. Therefore, the carrier gas should be dry and purified air.

Chapter III Instrument Installation and Debugging

3.1 Environmental Requirements

3.1.1 Working Environment

1. Temperature: (5~35)°C, and relative humidity≤85%;
2. Two-phase power supply: voltage (220±22) V, power frequency (50±1) Hz;
3. No corrosive gases around the lab;
4. No strong current, strong magnetic field, infrared emission source or vibration source around the lab;
5. No smoke or dust in the lab (especially coal smoke);
6. The lab should be clean, dry and ventilated.

3.1.2 Software Environment

1. Operating systems: Windows7
2. Basic configuration
 - CPU: 1GHZ or above;
 - Memory: 1GB or above
 - Display card: standard VGA 800 x 600 display mode;
 - Hard disk: 20G or above;
 - Driver: speed CD-ROM;
 - Others: USB interface, mouse, keyboard, and so on.

3.2 Installation Procedures

3.2.1 Preparation

1. Appropriate lab;
 - Smooth and stable experiment table (cement table is recommended);

2. Analytical balance, measuring cylinder, chemical products, sample coal etc.

Analytical balance: range (0~100) g, capable of weighing to the nearest 0.1mg;

One beaker or measuring cylinder of 500mL, one measuring cylinder of 10mL for preparing electrolyte;

3. Reagents:

KI (Potassium Iodide): analytical pure;

KBr (Potassium Bromide): analytical pure;

Glacial acetic acid: analytical pure;

Sodium hydroxide: chemical pure;

Tungsten trioxide: chemical pure (or tungsten dioxide);

Allochroic silicagel: industrial product.

4. Standard coal sample: coal of first class, or coal and coke of second class but meeting the requirements.

3.2.2 Installation of the Instrument

1. Carefully unpack the instrument in the cases and lay them on a solid and tough operating platform. Generally, the computer (the host, display and keyboard) is placed in the middle, the printer at the left, and sulfur analyzer at the right.

2. Check carefully if the vulnerable are in good condition.

3. Open the left cover of the sulfur analyzer, and install the silicon carbide tube, and quartz tube, and exhaust pump.

● Install the silicon carbide tube:

a. Fix the tube, and keep the front end of it 1mm from the furnace wall to reduce damage caused by thermal expansion and contraction.

b. Fix the silicon carbide tube connections respectively to the two terminals of the furnace. And tighten the screws with spanner.

c. Check if the silicon carbide tube circuit is correct.

d. Fix the cover and protective hood

● Install the quartz tube:

a. Place the quartz tube into the silicon carbide tube. Install the metal ring to the

-
- tube end.
- b. Properly fix quartz tube through adjusting the distance between the fixing screws and metal ring (direct contact is forbidden).
 - c. Connect the air tube between the quartz tube and dust filter.
 - Install the main gas pump:
 - a. Install the main gas pump at the reserved position. Do not make it contact any metal surface.
 - b. Connect the pump connections.
 4. Open the back cover of the sulfur analyzer, and take out the hold-down bar in the thermocouple. Then fix the back cover, and install the thermocouple and the thermocouple protection cover.
 5. Open the right cover, and check if the chain of the sample delivering vehicle runs smoothly. When installing the sample introducing rod, place the front end of the sampling rod at its sampling position, and the quartz boat at the sampling position. Then check if the sampling rod works well with the quartz boat. (In order not to damage the quartz boat, it is put only when the sample delivering vehicle and the rotation position have been debugged.)
 6. Fix the cover, and connect the exhaust pipe of the main gas pump. It is advised to extend the pipe out of the window or door.
 7. Install the purification tube, electrolytic cell and dust filter:
 - Install the exhaust pump:
 - a. Place the filter seal at the filter cover;
 - b. Put absorbent cotton into the dust filter. Take care not to cover the inlet hole (the longer one);
 - c. Tighten the filter cap to avoid air leakage.
 - Install the purification tube:
 - a. Put allochroic silica gel and analytical pure NaOH into the purification tube (one) at the air feed circuit (first NaOH, then a plate, and at last the allochroic silicagel). Normally only allochroic silicagel is needed. And then put allochroic silicagel into purification tubes (two) at the exhaust gas circuit.

-
- b. Put the seal into the tube lid, and tighten the purification tube with rubber plug to avoid gas leakage.
 - c. Lubricate the seals with vaseline for good lubricity and tightness.
 - d. Install the purification tubes from the top downward. Then slightly adjust to ensure good tightness and convenient un-installation.
- Install the electrolytic cell:
 - a. Check if there is any bending, damage, or dirt to the electrodes. Change or clean the electrodes if necessary.
 - b. Daub vaseline to the seal if dry.
 - c. Load the electrolyte and tighten the cell.
 - d. Connect the air inlet tube (the bigger one), the outlet tube, and indicating signal wire;
 - e. Place the electrolytic cell stably onto pedestal. The location hole under the cell should be perfectly inserted to the dowel pin of the stirring platform
8. Place the heat resisting ceramic plate at the sample discarding door, which is at the right side of the instrument. And push it to the sample discarding slide way.
 9. Recheck if all components are correctly installed, and the tubes are properly connected.
 10. Connect the instrument control power line, heating power line, and USB-CAN communication line. Check if the instrument is reliably earthed. If every thing is well, turn on the computer and the instrument, install the test and control software and then get the instrument authorized.

3.3 Installation, and Un-installation of Software

3.3.1 Software installation

Insert SDS Sulfur Analyzer CD into the CD-ROM. Click to open “SDS820 Automatic Sulfur Analyzer Installation” folder at the “Resource Manager”, and then double click on “Sundy. exe” to open the installation program. Follow prompt message to press “Next” or “Yes” until SDS820 Automatic Sulfur Analyzer short icon appears on the computer desktop.

3.3.2 Software un-installation

Click on “Control Panel” → double click on “Add/Remove Programs” → Select “Change or Remove Programs”, click on “SDS820 Automatic Sulfur Analyzer” → Click on “Delete” button, to perform un-installation. Then follow prompt message to remove the software and shortcut icon safely and efficiently.

3.3.3 Instrument online

After installation of the software, use the communication settings to set IP before the instrument can be online.

1. Firstly install the multi network card and the computer will automatically install the driver for it.

2. Set the IP address as following steps:

Turned on the computer network and sharing center, click on "local connection 2", open the property, set the computer IP as "77" segment, such as "192.168.77.113", then save and exit.

3. Open the communication management system

Communications Settings tab: Mainly used for online communication between software and instrument system by debugging personnel.

- Click “Start” in the taskbar, find "Sundy" folder in all the procedures, open "SDS automatic sulfur analyzer" folder, and click on "IP Settings tool". Set the communication parameter, and input the equipment communication IP.
- Computer IP address: Before setting, change the computer Ip address to 77 segments, such as "192.168.77.10". After software online, open communication Settings, the system will automatically read the computer IP address
- Device IP address: After open communication settings, the lower software will send the IP address to communication settings window, and show online, as shown in Fig. 3-1.
- Input parameters: Enter the device IP address into the parameters parameters setting box, click on "Write", the IP address can be written in the system. Then click on "Close" to restart the software then it will get online.

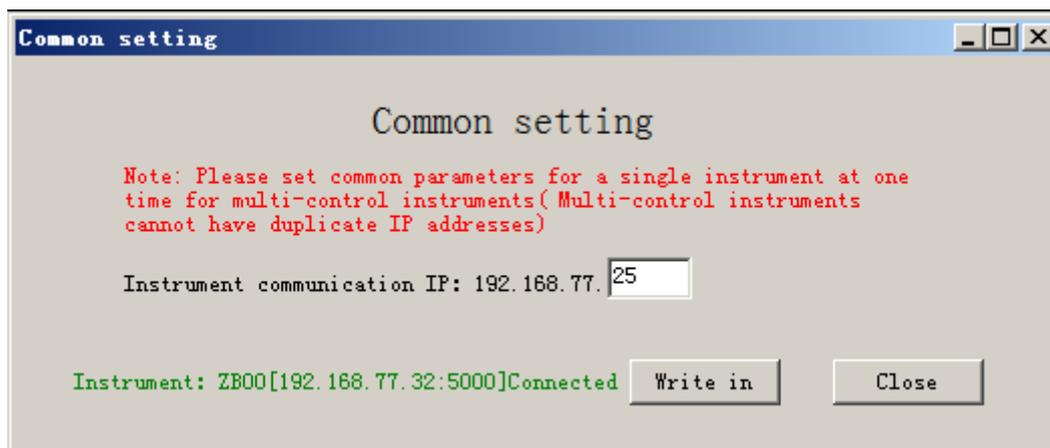


Fig 3-1

3. Instrument Debugging

The status bar will indicate “Ready” once the instrument is authorized. Then click on “Manual Detection” to start on-line debugging. The contents and precautions are as follows:

1. Start the test and control software, and click on “Manual test”, to check if all positioning signals are correct.
2. Turn on the exhaust pump, to check if the flow rate of the system is stable within (1.0 ± 0.05) L/min.
3. Gas tightness detection: Turn on the exhaust pump, push forward the gas tightness detection knob. If the flow rate decreases to 250mL/min below, the instrument is with good air tightness. Otherwise, check the following and solve the problems accordingly:
 - a. Tubes are not well connected;
 - b. Seals at the upper and lower connections of the purification tube are not lubricated with vaseline or the seal is broken;
 - c. The purification tube is with no seal ring, or the tube is not tightened, or the purification tube is broken;
 - d. Seal of the electrolytic cell is broken, or the cell has air leakage;
 - e. No seal is placed in the dust filter cap or the cap is not tightened.

To check if there is leakage in the gas system, generally turn on the main gas

pump and check the circuit from back to the front. The sequence is: air tube connecting the flow meter — air tube connecting the second purification tube of the exhaust circuit — air tube connecting the first purification tube of the exhaust circuit — outlet tube connecting the electrolytic cell — inlet tube connecting the electrolytic cell — air tube connecting the dust filter (push forward the gas tightness detection knob).

4. Adjust agitator speed

Turn on the main gas pump and start agitating. Adjust the stirrer to the critical status of jumping-up status. Then repeatedly turn on the main gas pump and start agitating, to check if the stirrer will jump up. Reduce the agitation speed if the stirrer jumps up.

5. Slightly adjust the rotation positioning card of the chain

Click on “Rotation” at the “Manual Detection” window. Modify the timing of reverse rotation (Please modify as necessary), to make the gap between the two chain plates align with the furnace mouth. This is single Hall detection.

NOTE: The chain will rotate reversely once when having rotated one section forward. If it rotated several sections forward, the chain only rotates reversely at the last section rotation.

6. Adjust sample sending mechanism position

Firstly, open the “Manual Detection” window and click on “Sample sending mechanism forward” or “Sample sending mechanism backward”, to preliminarily check the running condition of it. Then slightly adjust the towing plate position according to the running stability of the sample sending mechanism, and make the sample sending mechanism point to the central position of the furnace mouth during moving. Normally, after the sample sending mechanism move to the end point, the sample introducing rod is 3-5mm from the furnace mouth in height.

Secondly, check if the furnace door Hall is positioned when the sample sending mechanism moves forward the end. If it is positioned, adjust the left Hall setting plate to make it un-positioned.

Thirdly, open the “System Setting” window, to input and adjust if necessary

the factory adjusting parameters. Make sure that in the first stage the sample is sent to the 500°C temperature zone for preheating, and in the third stage to the 1150°C zone for dissolving (Refer to parameters of coal sample to set up sample introducing parameters for other types of the samples).

Finally, install the quartz boat, and ensure the right Hall is “positioned” when the sample sending mechanism moves backward to the end. Meanwhile, the upper inner end of the quartz boat should lie between the upper and lower line of the small hole near the upper end of the left chain plate.

7. Height adjust for platforms

The sample delivering platform is slightly higher than the quartz boat surface, and the quartz boat surface is slightly higher than the cooling platform. The relative height deviation is 0.5~1mm.

NOTE: If the combustion boat is squeezed during the debugging, please adjust the sample sending or introducing device until the problem is solved.

8. System self detection

Click on “System self-detection” at the “System” menu, and the system will automatically detect the forward and backward moving of sample sending mechanism, and the rotation positioning of the chain as well. A window for detection results will pop up when the detection has finished. Only when all function is normal, can the test be started.

NOTE: The rotation positioning of the chain are conducted by double-Hall.

9. Click on “Heating up” to heat the furnace to 1150°C. No incidents are supposed to happen during the whole heating process.

10. Only when all above debugging is finished, can the test be started. Otherwise, find out the problems and solve them.

Chapter IV Functions of Operating System

The illustration is based on SDS820 Automatic Sulfur Analyzer. Operating system of SDS720 is similar.

4.1 Start and Exit the Test and Control Software

4.1.1 Start the Test and Control Software

There are two methods to start the test and control software for SDS820 Automatic Sulfur Analyzer:

Method 1: Click on “Start” button → select “Program” → select “SDS820 Automatic Sulfur Analyzer Test and Control Software”, to enter into the main interface shown as Fig. 4-1.

Method 2: Directly double click on “SDS820 Automatic Sulfur Analyzer” desktop shortcut icon, to enter into the main interface shown as Fig. 4-1.

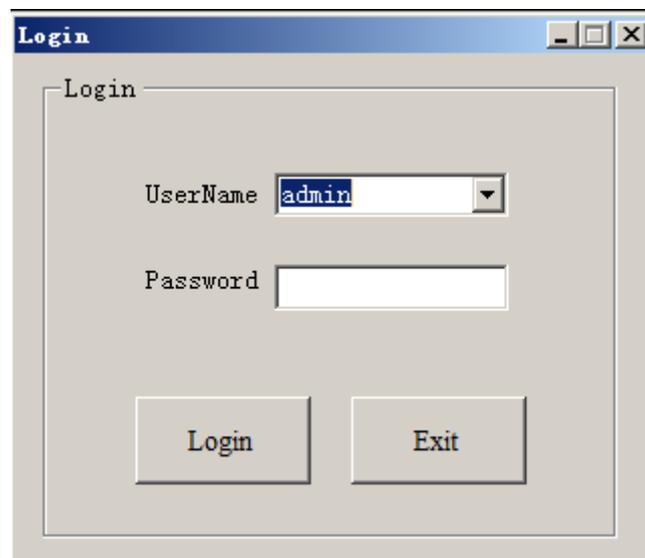


Fig.4-1

4.1.2 Exit the Test and Control Software

Before exiting Windows or power off the computer, the test and control software must be stopped first. So the test data and parameter files will not corrupt.

When the exit the software, if the option “Shut down the computer” is checked, the software will be stopped and the computer will power off automatically.

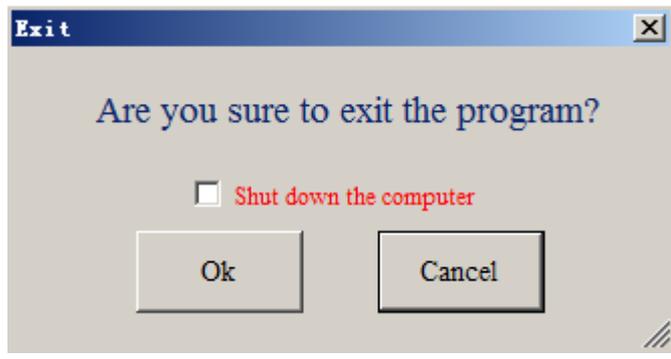


Fig.4-1-1

4.2 Functions of Main Windows

Main windows of the test and control software includes the title bar, menu bar, shortcut bar, data sheet, information bar, status bar, etc. (Fig. 4-2).

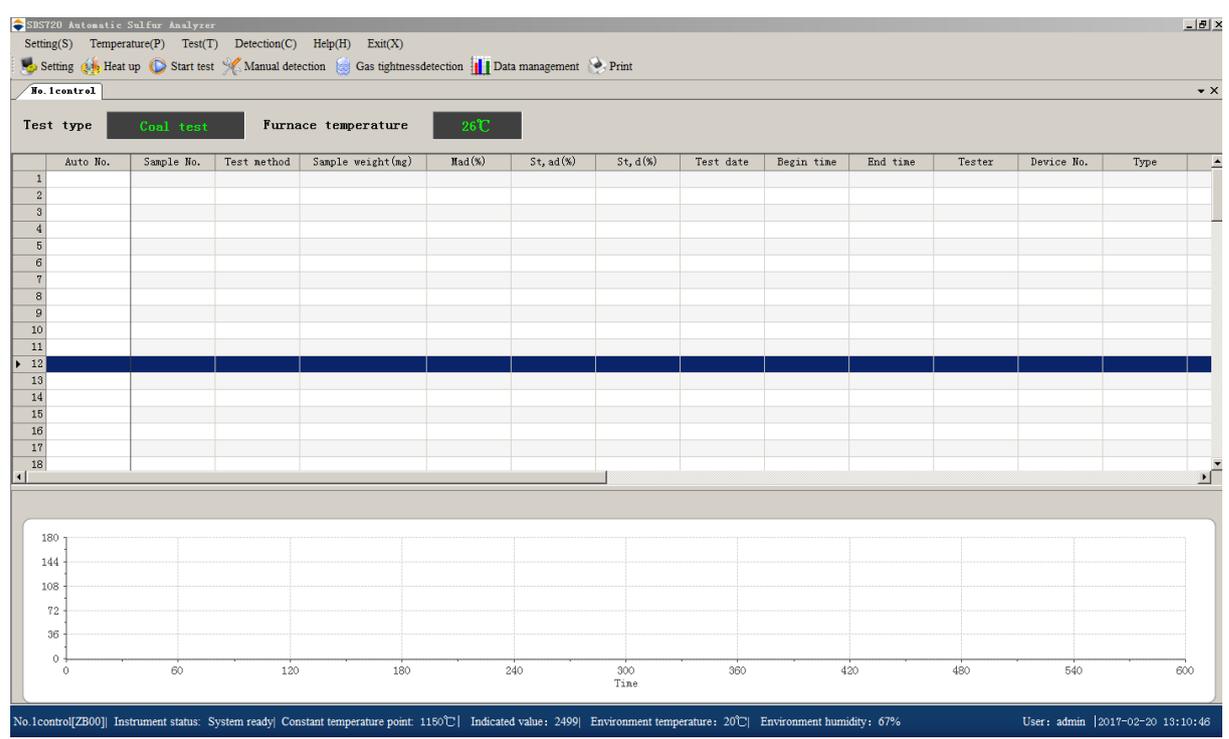


Fig.4-2

Data sheet has ‘Insert/Delete the sample to be tested’, ‘Automatically adjust column width’, ‘Hide/Display all columns’ and other functions. When the cursor is moved to the data column, right click the mouse, then menu as shown in figure 4-2-1

will pop up. Each function is described in detail below

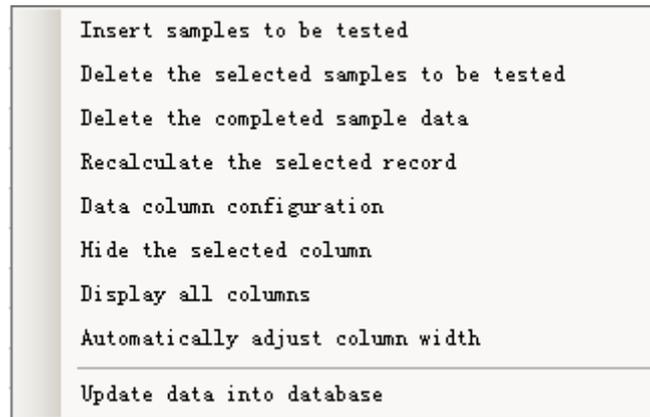


Fig.4-2-1

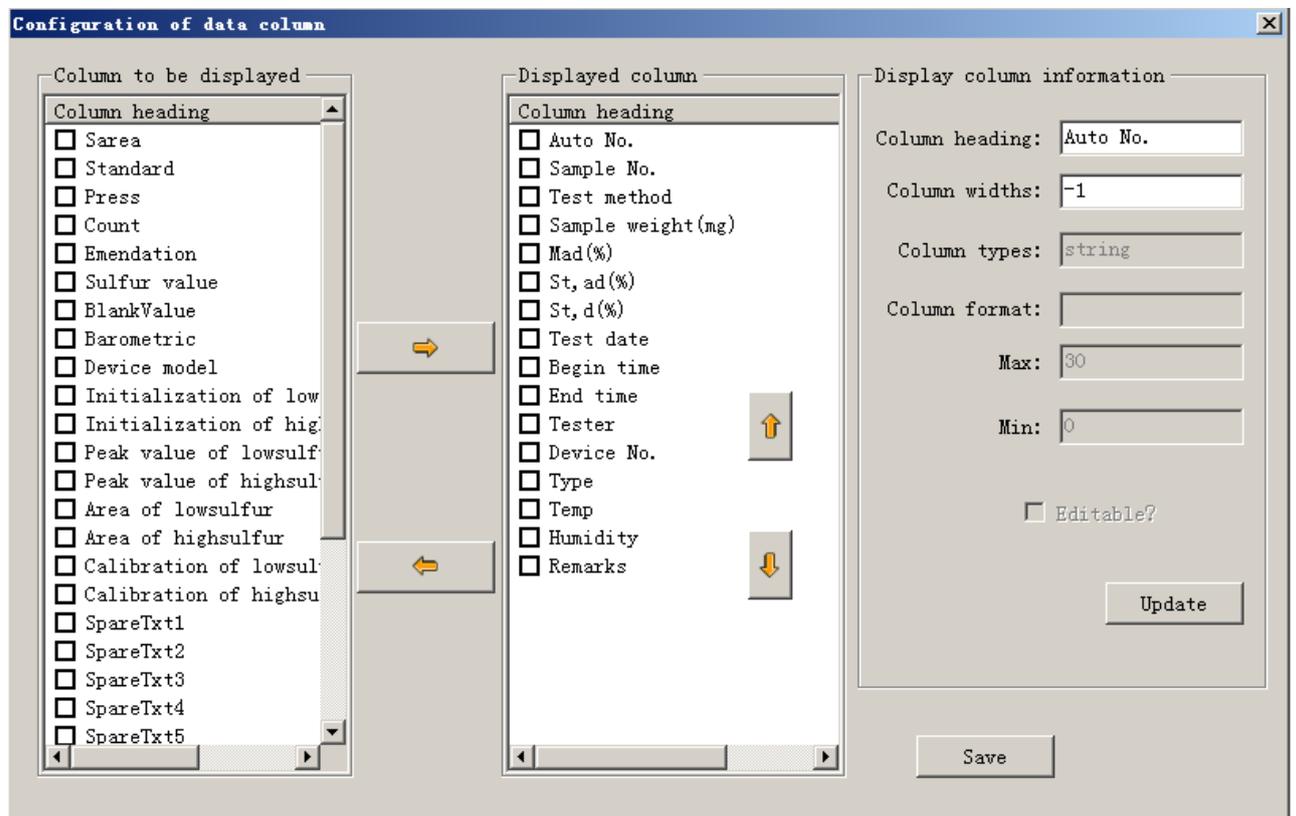


Fig.4-2-2

- Insert the sample to be tested: In the position to insert the sample, click this button, you can generate a blank line, and then enter the corresponding sample weight, number etc., and then put the inserted sample to the location on the sample plate with number accordingly.
- Delete the selected sample to be tested: Select the sample record need to be deleted, click the menu to delete records in the main interface, and then

remove the crucible on the sample plate with number accordingly.

- Data column configuration: Click on the menu, the window as shown in fig 4-2-2 will pop up, then can process data column configuration in the window.
- Hide the selected column: Hide the displayed columns: Select the column need to be hidden, click on “Hide the displayed column” to hide it.
- Display all columns: Click on this button, all the displayed columns in the “Data column configuration” window will display.
- Automatically adjust column width: All of the data column will automatically adjust to the appropriate width.
- Recalculate: Recalculate the selected record: Modify the correction formula, Mad %, parameters such as sample weight, sample number. It required checking "Recalculate the selected record" to recalculate the results and save it into the database, otherwise the record will not automatically update.
- Updates data into database: click on this option, the system will automatically update the completed or modified data to the database.

4.2.1 System Menu (Fig. 4-3)

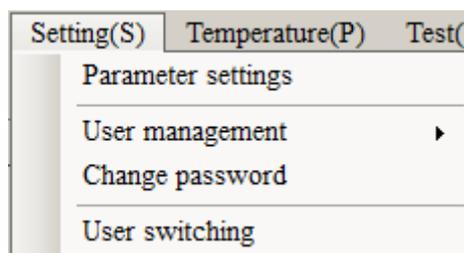


Fig. 4-3

1. Parameter Settings: Click on this menu option or the setting icon in the shortcut menu bar to get into the parameter settings window (Fig 4-4-1) and set the related parameters.

Parameter settings include Test parameters setting, Temperature parameters setting, Standard CRM, Advanced parameters setting, Balance parameter setting, Remote Interface Settings, etc.

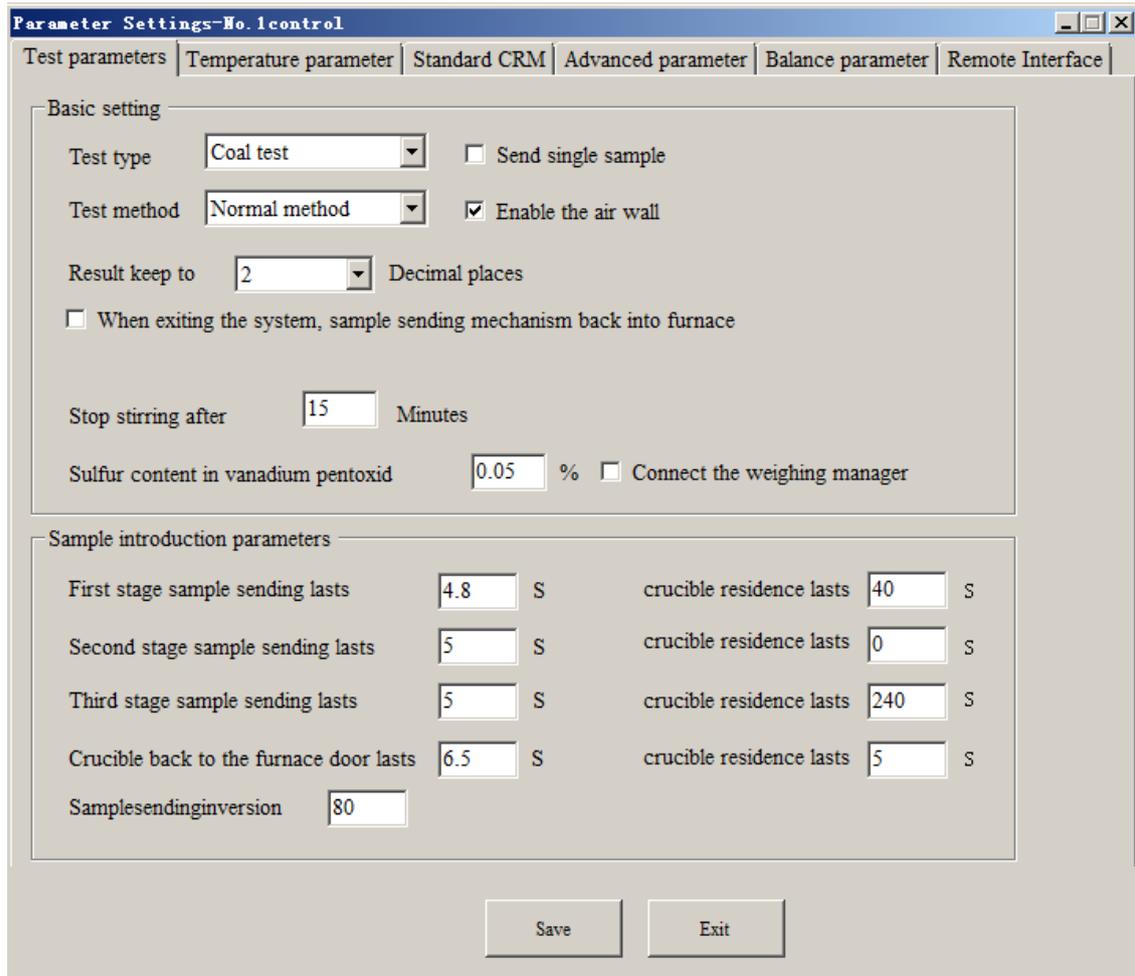


Fig 4-4-1

1-1 Test parameters setting: Click "Setting" tab, as shown in Fig 4-4-1.

The test parameters setting window is mainly used for basic parameters and basic functions parameters setting for instrument test.

The setting menu includes Test type, Test method, Stop stirring time, Decimal places setting, Enable the air wall and sample sending rod or not, When exiting the system, sample sending mechanism back into furnace, Sulfur content in vanadium pentoxid, Sample introduction parameters setting and etc.

- Test type: Including Coal test, Coke test, Heavy oil test, pyrite test, cement test. Choose coal or coke test, the system constant temperature point is 1150 °C; Choose heavy oil or pyrite test, system temperature point is 900°C; Choose cement test, the system constant temperature point is 1190 °C. Drop down to select test type and switch. The default test type is coal test.
- Test method: Including fast method, normal method and fixed time method,

it is suggested to choose fixed time method for heavy oil or pyrite test.

- Stop stirring time: Input number like 30 for example, it can stop stirring 30 minutes later after the test stop .The default time is 30 min.
- Results keep to ** Decimal places: Set decimal places for the test results after test completed in the control software interface, It can be set as 0,1,2,3,4. It is default to keep two decimal places.
- Enable the air wall: After checked this option, system will automatically turn on the air wall pump when the test starts. If not checked, the pump will not turn on. It is default to not turn on.
- Send single sample: After checked this option, the instrument will change sending sample continuously to sending single sample. During test, the sample sending chain will not rotate.
- When exiting the system, sample sending mechanism back into furnace: When the system is exited, the sample sending mechanism will get back to the furnace automatically. Check “save” and it will take effect.
- Sulfur content in vanadium pentoxid: For element test, it needs to input sulfur content in vanadium pentoxide for calculation.
- Sample introduction parameters: Parameters for sample sending time and crucible residence time vary according to different test methods. Sample sending time is the time taken to send the crucible to a certain temperature zone of the furnace (Through the time setting, the temperature zone which the crucible will stay is determined). Crucible residence time is the time the crucible stays at certain temperature zone.
- Crucible back to the furnace door: The setting is conducted by the debugging worker. Through the time setting, the distance the crucible moves from the furnace can be adjusted. As a result, the crucible can be cooled in advance, and the crucible introducing can continue smoothly.)
- Inversion of timing: The setting is conducted by the debugging worker. The chain will rotate reversely once based on the time setting when it has rotated one section forward. If the china rotates several sections forward, it

only rotates reversely at the last section rotation.

- Save: Save the changes of parameters.
- Return: Exit from the current window and return to main interface window.

NOTE: Back to furnace door time, crucible residence time, and inversion of timing are common setting parameters for three test methods (Fast method, normal method and fixed time method).

1-2 Temperature setting:

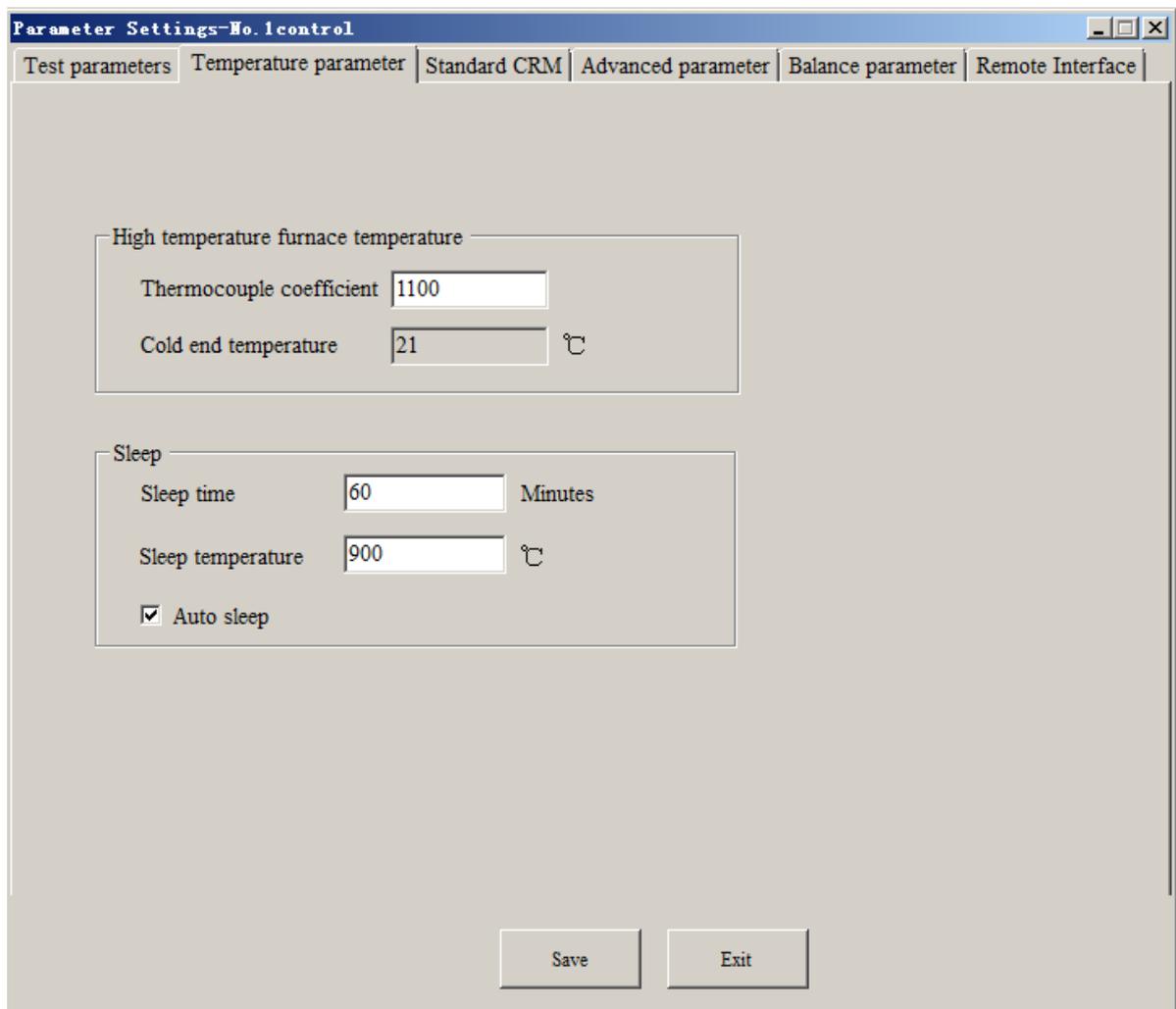


Fig. 4-4-2

The “Temperature Settings” tab is mainly used for parameters settings such as system temperature calibration, instrument dormancy, flow meter parameter and etc.

- High temperature furnace temperature

a) Thermocouple coefficient: Under the same condition, to adjust the deviation between the system temperature and standard temperature.

b) Cold-end adjustment: to set the cold junction compensation slightly and read by system automatically.

➤ Sleep: If the system under constant temperature of 1150 °C does not start test after the set time, the system will automatically cool the instrument to set temperature to protect the high temperature furnace and prolong the service life of the high temperature furnace.

a) Sleep time: To set the sleep time;

b) Sleep temperature: To set the sleep temperature and the default value is 900°C;

c) Auto. sleep: If this option is checked and saved, the instrument will automatically enter sleep status. If not checked, it will not.

1-3 Standard CRM: Click on the “Standard CRM” tab in “Setting” , the window as shown in Fig 4-4-3 will pop up.

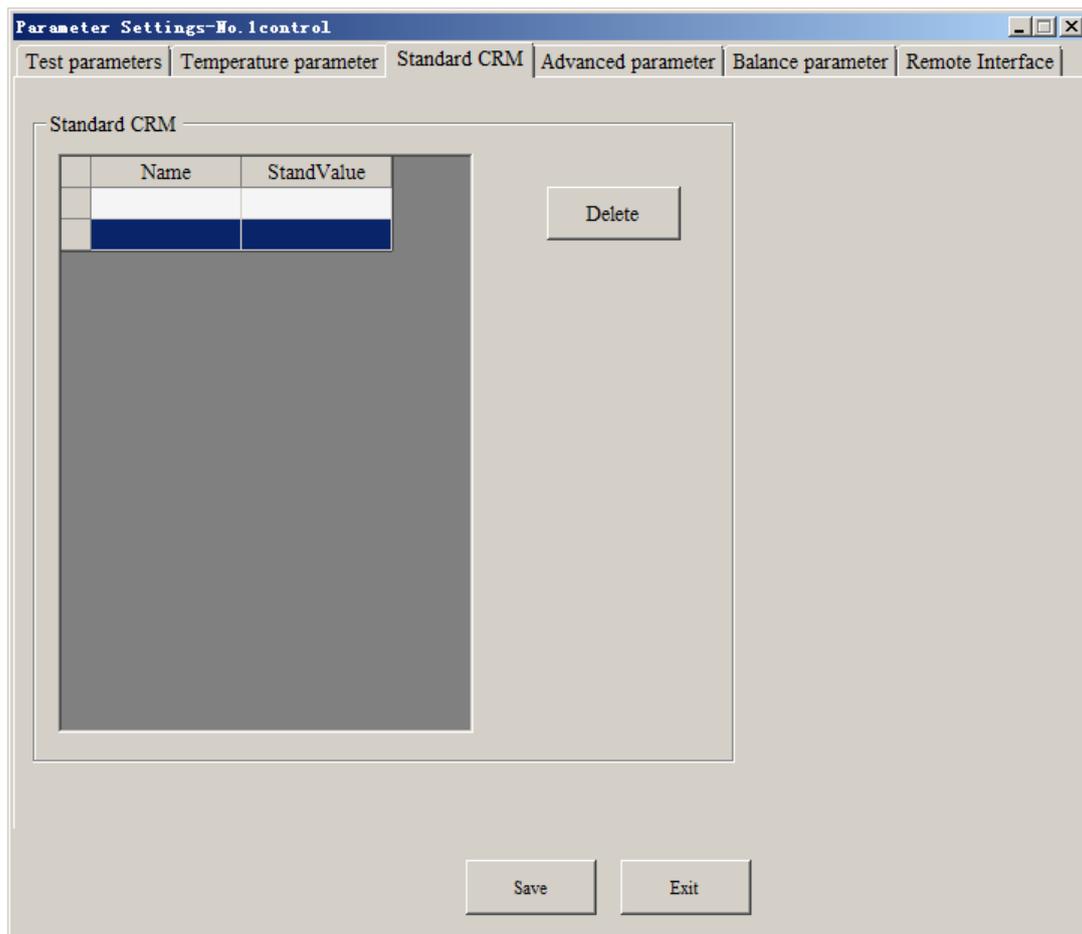


Fig 4-4-3

“Standard CRM” tab is mainly used to enter the standard material data and as judgment standard when Calibrating.

- a) Delete: Click the button, the selected records rows on the left will be deleted automatically.
- b) Add standard sample: Directly input the related parameters in the tab, the program will add blank record rows automatically.
 - Name: Input the name of the standard sample in the left textbox.
 - Dry basis sulfur value (%): Input the standard sulfur value of the standard sample in the right textbox.
 - If the name field of a record has number, but dry sulfur column value is null, or the name field is empty, but dry base sulfur value column has a value, then click "save", this record will be deleted automatically, which belongs to invalid records.

- It will not be allowed to input two records with the same name, which the system will delete automatically.

1-4 Advanced parameter: Click on the “Advance parameters” tab in “Settings” window, the figure as shown in Fig4-4-4 will pop up.

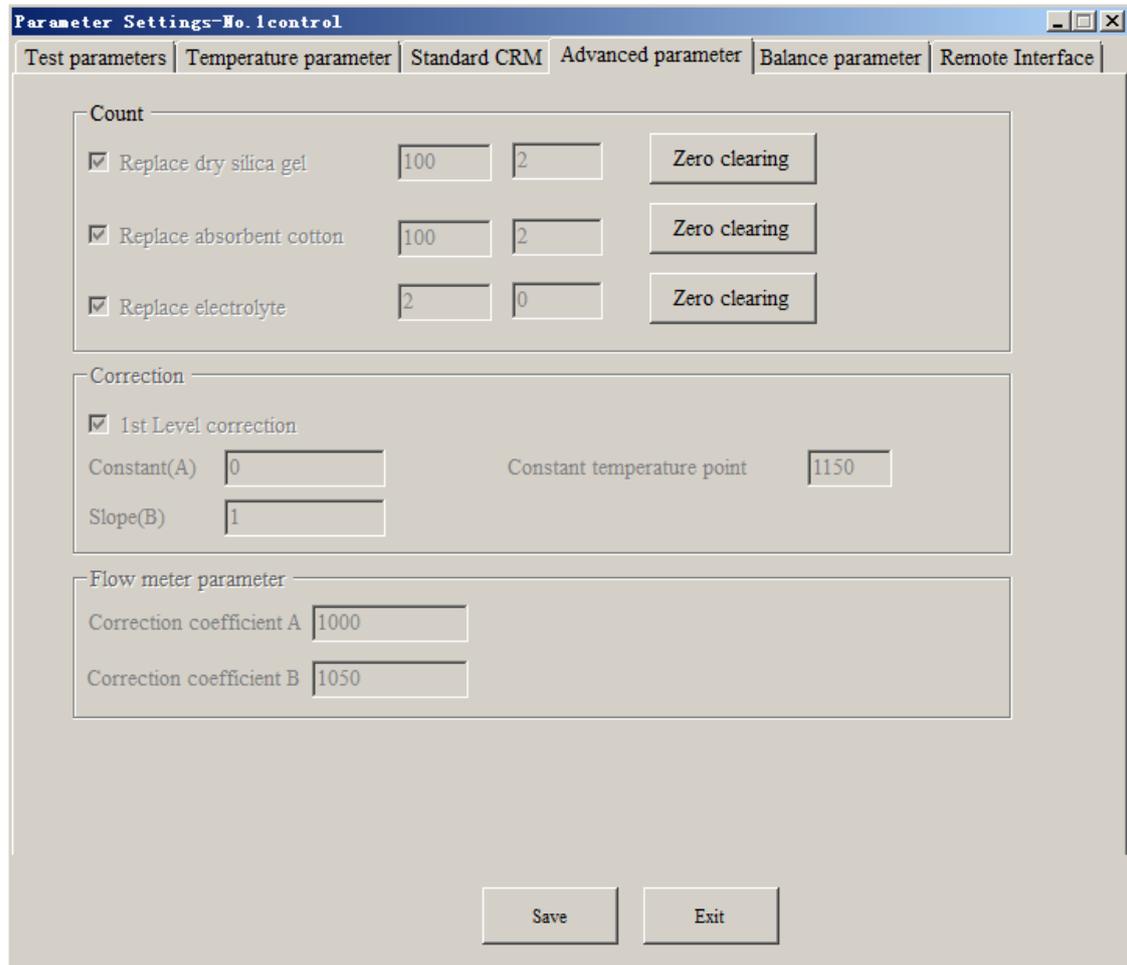


Fig 4-4-4

The advanced parameter setting tab consists of count, 1st level correction and flow meter parameter. This page is used for debugging personnel.

- Count: This function includes three settings: Replace dry silica gel, Replace absorbent cotton, Replace electrolyte.
 - Replace dry silica gel: To keep record of the maximum sample numbers the dry silica gel can test. Click "Zero clearing" button on the right, the maximum counting number will show.
 - Replace absorbent cotton: To keep record of the maximum sample numbers the absorbent cotton can test. Click "Zero clearing" button on

the right, the maximum counting number will show.

- Replace electrolyte: To keep record of the maximum sample cumulative integral value the electrolyte can test. Click "Zero clearing" button on the right, the maximum cumulative integral value will show.

Note: After replacing the dry silica gel, absorbent cotton and electrolyte, it all needs to click the "Zero clearing" button to manually refresh the count.

b) 1st level correction:

- Constant A and slope B: 1st level correction parameters are mainly shown as constant A and slope B in the correction formula. After generating the corresponding i correction formula for the control device in the database, constant A and slope B in the correction formula will be shown in this interface. When calculating the test result, the formula will be referred.
- Constant temperature: It is mainly used to display the constant temperature for the current type of test. For coal, coke testing, the constant temperature point is 1150 °C, for cement test the point is 1190 °C, and for pyrite, heavy oil testing, it is 900 °C.

c) Flow meter parameter (For debugging personnel use)

- Set the flow rate (mL/min) : The default experimental flow is set as 1000.
- Correction coefficient: To correct the readings of automatic meter and flow meter. Default value is 1000.

1-5 Balance setting: Click on “Balance parameter” tab in “Setting”, the window as shown in Fig4-4-5 will pop up.

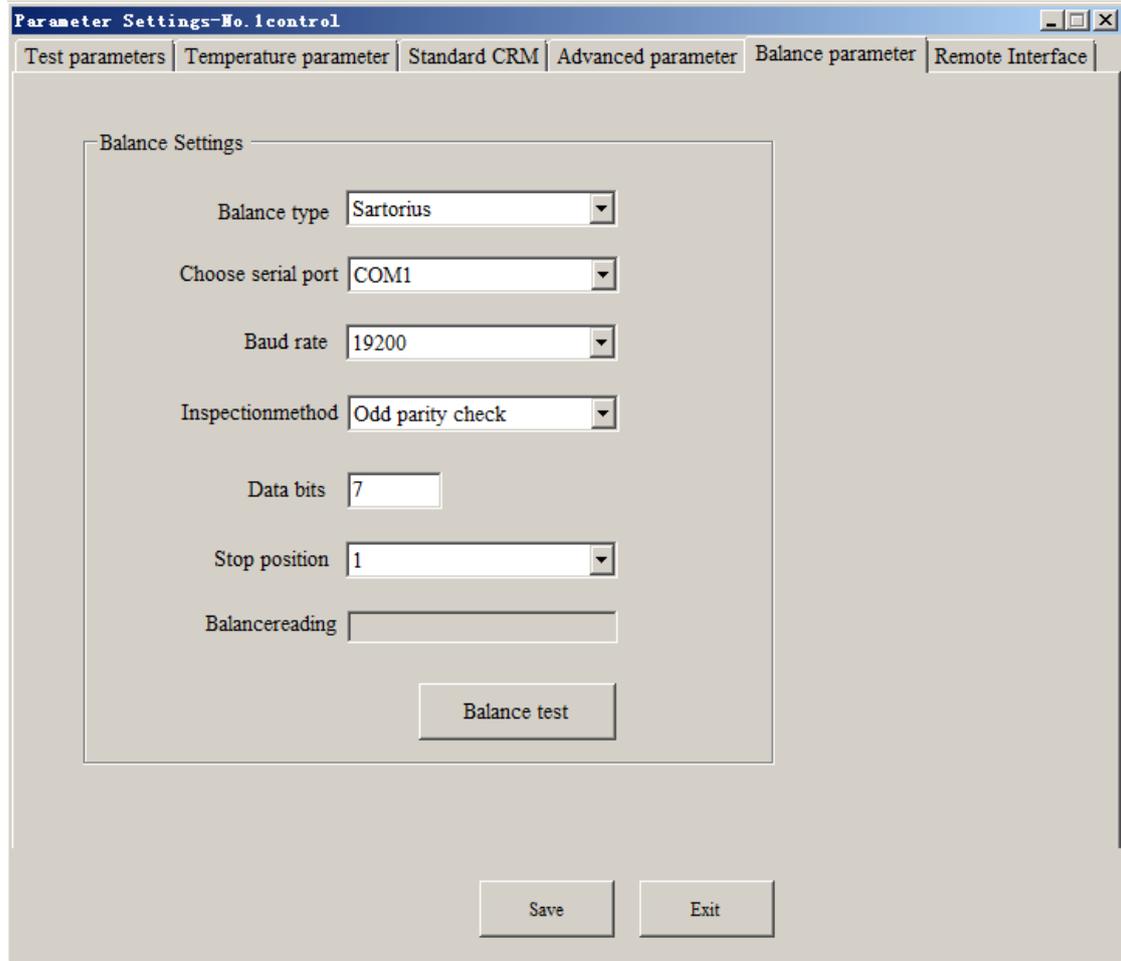


Fig 4-4-5

“Balance parameter” tab: Used to set the communication parameters for the balance.

1-6 Remote interface: Click on the “Single point correction” tab in the “Parameter settings”, a window shown as Fig4-4-7 will pop up.

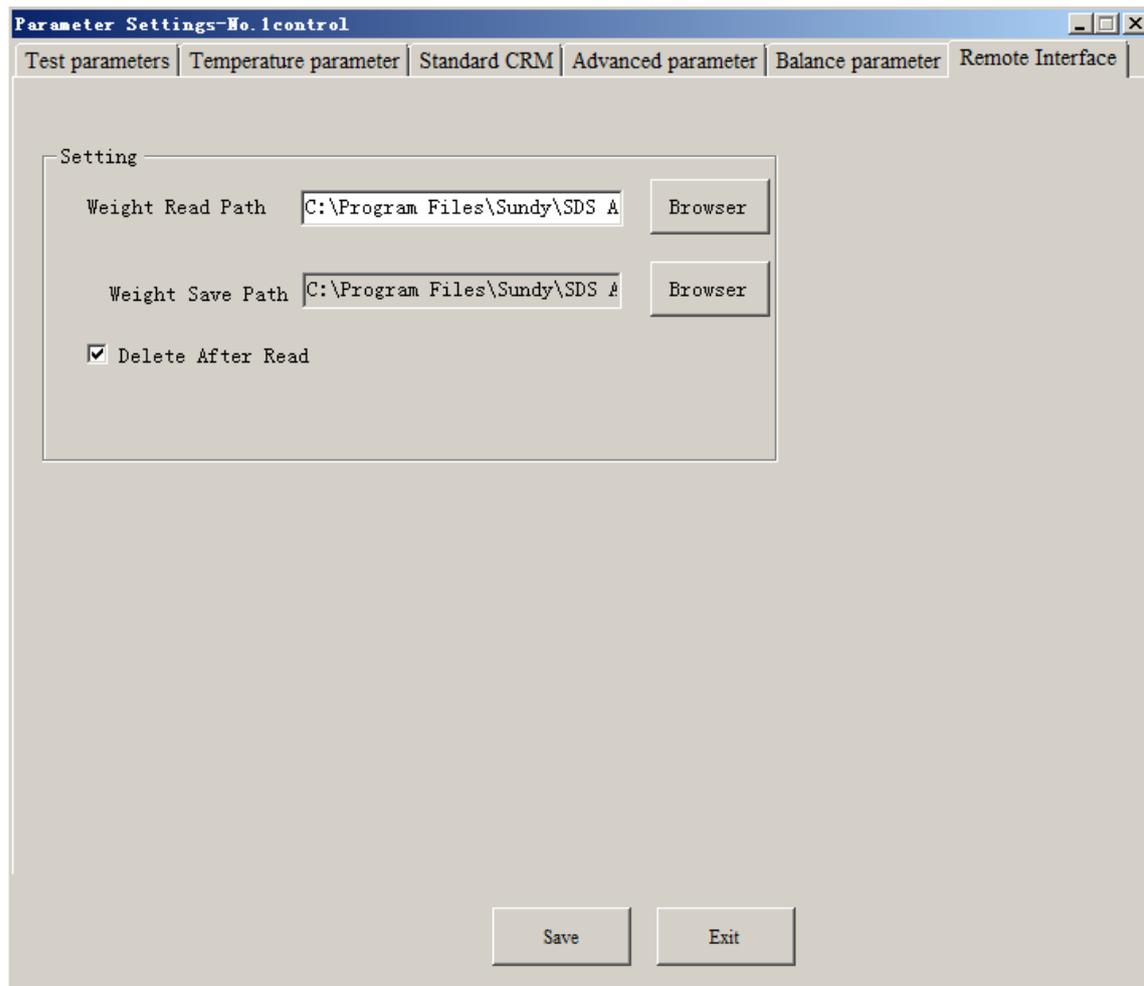


Fig4-4-7

Remote interface: To set link address and memory address for the weighing manager.

- Weight read path: It is set as read path for the file in remote management server. After settings being saved, weighing management interface will refresh the data from this path.
- Weight save path: After the set the save path, the data will be saved to the set address.
- Delete after read: If checked, the sample weight data after reading in this machine will be automatically deleted

2. User management: To add user roles and permissions settings

3. Change password: Click the option, user can login and change password.

Shown as Fig 4-5-4

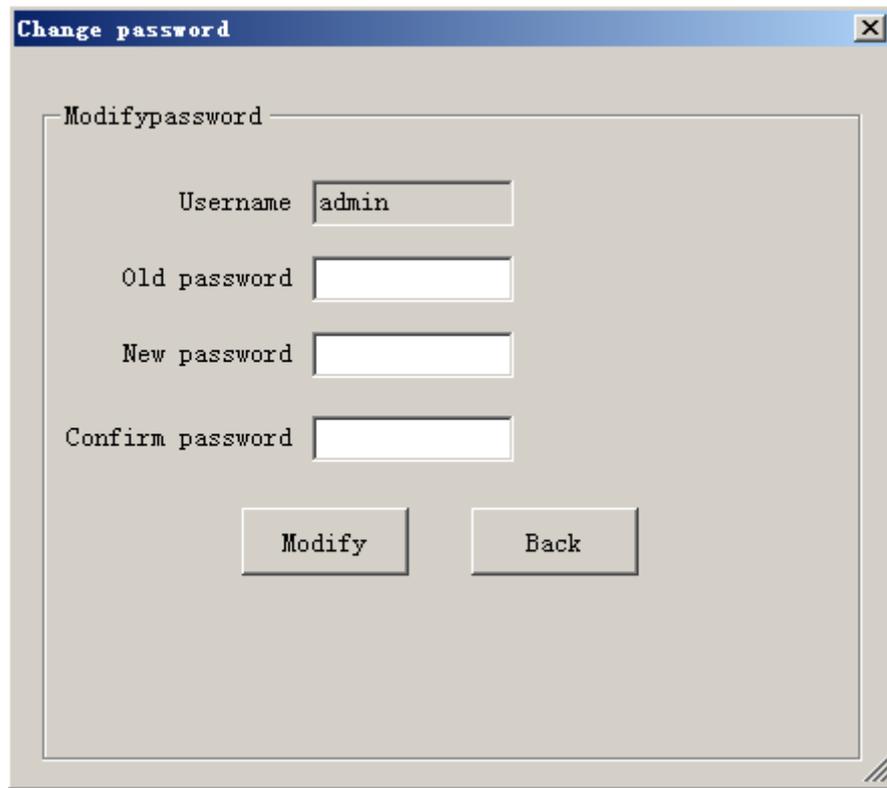


Fig 4-5-4

4. User switching: Click on this option, to re-login or switch between different users.

4.2.2 Temperature Menu: (Shown as Fig. 4-6)

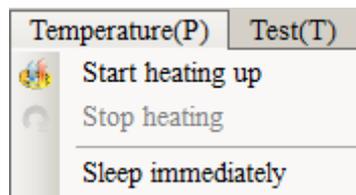


Fig 4-6

- Start heating up: Select this option in the menu or click on the "Heating" button in the shortcut button bar, the high temperature furnace will begin to heat up until the system automatically entered into constant temperature status.
- Stop heating: Select this option in the menu or click on the "Cooling" button in the shortcut button bar, the high temperature furnace will stop heating and enter the ready status.
- Sleep immediately: Select this option in the menu, the system will cool down to 900 °C, and keep constant temperature at this temperature.

4.2.3 Detection Menu:

Select this option in the menu or click on the “Detection” on the shortcut button bar, it will enter the window as shown in Fig 4-7, where you can test each functional unit of the system is normal.

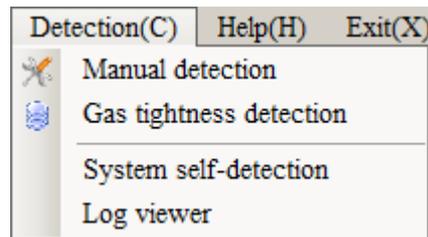


Fig 4-7

2-1 Manual detection

Click on “Manual detection” menu or the shortcut icon to open the window as shown in Fig. 4-7-1:

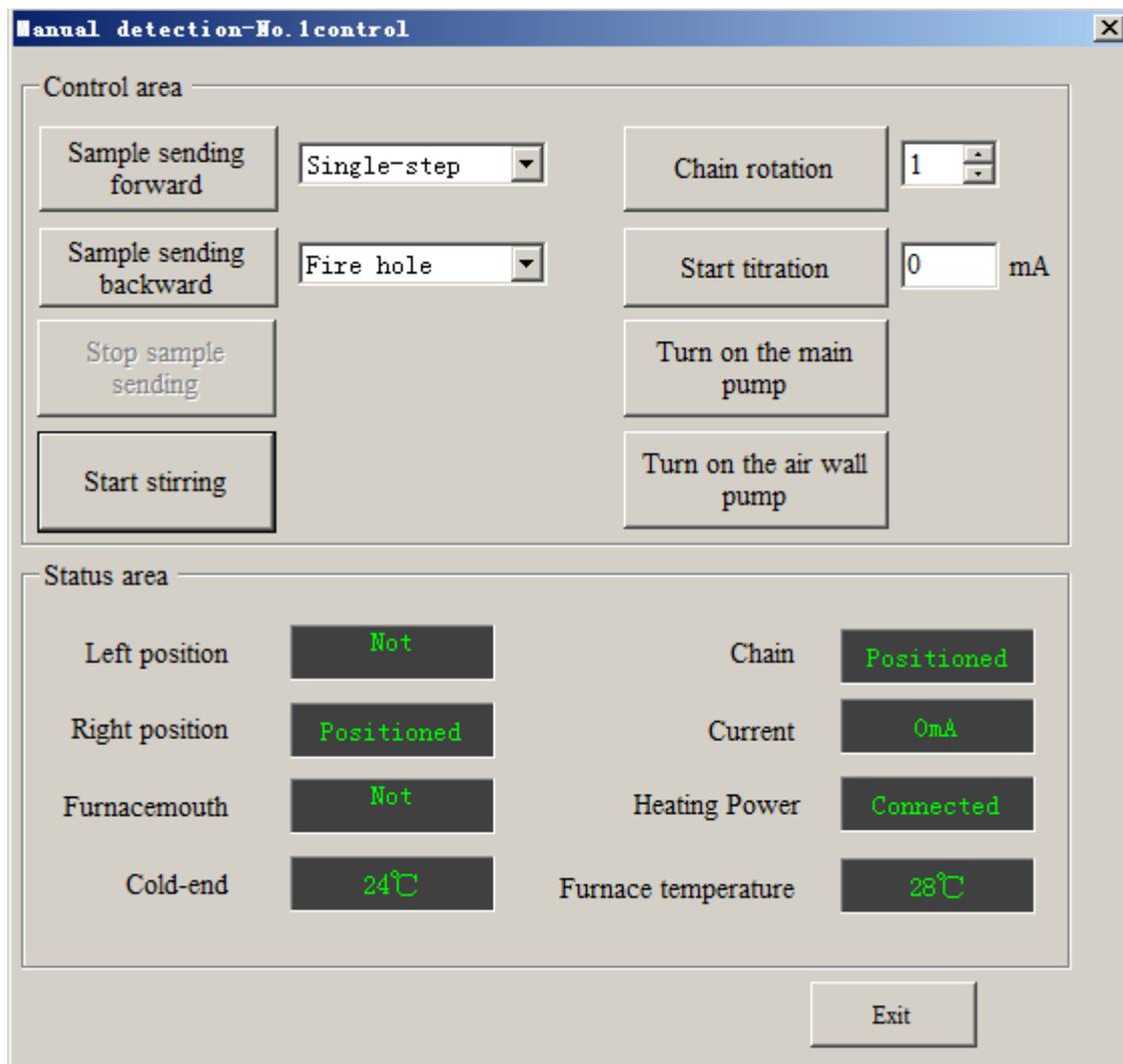


Fig. 4-7-1

Manual detection: This option is used for debugging instrument system to check if each component is normal, observing the display of system status is correct.

- Start stirring/Stop stirring: Click on “Start stirring” button to check the stirring. And adjust the stirring speed to the test status. The stirring will stop if click on “Stop stirring”.
- Turn on fan/ Turn off fan: Click on “Turn on fan”, the fan at the back cover of the instrument will be started. The fan will be turned off if click on “Turn off fan”.
- Turn on/ off the main pump: The main pump is used to bleed the gases after the combustion and electrolysis. Click on select to turn on the “Turn on the main pump”, the operator can check the working status of the main pump.

-
- Click “Turn off the main pump”, the main pump will stop working. .
- Turn on/off the air wall pump: Air wall pump is used to supply clear and dry air for combustion. If select to turn on the “Turn on the air wall pump”, the operator can check the working status of the air wall pump. The pump will be turned off if select to “Turn off the air wall pump”.
 - Sample sending forward: To check if the crucible is in the right position when it at the Step 1 position and Step 3 position, and if the distance between the crucible and the furnace door is appropriate when the furnace door Hall is in “Positioned” status.
 - Sample sending backward: Mainly to check if the furnace door right Hall is in “Positioned” status when the crucible moves back to the end.
 - Stop sending sample: The crucible will be stopped if click on the button during crucible forward or crucible backward.
 - Start titration/ Stop titration: to check if the electric circuit for titration works properly. Input the titration value (normally 10-40) into the textbox at the right of the button, and then click on “Manual titration” button. If the indicating signal weakens, it indicates that the circuit is in good condition. Otherwise, find out and solve the problems.
 - Chain rotation: Enter the chain rotation number in the text input box on the right or click on the up and down arrow to set the rotation number. Click the button, the chain will stop rotating after it rotate for set number.
 - System status: To display the status of each instrument part which is operating

2-2 Gas tightness detection: Click "Manual detection" option in "Detection", a window as shown in Fig 4-7-2 will pop up.

Gas tightness detection: After opening the window, the main pump will open automatically. Follow the prompt to press down the air tightness test rod, if the flow rate comes down to 0.1 L/min, the gas tightness is good. Click "Exit", the detection window will disappear and main pump will close.

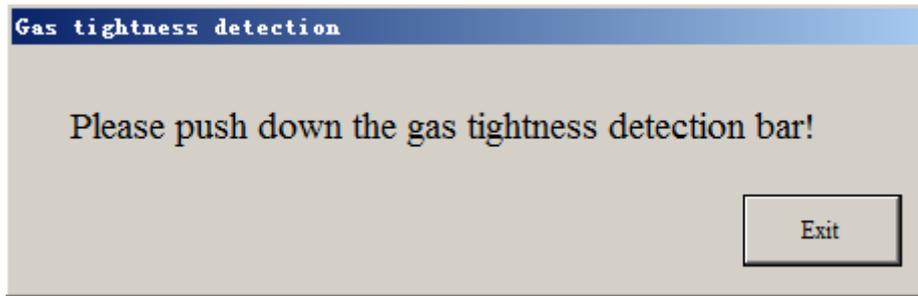


Fig. 4-7-2

2-3 System self-detection: Click “System self- detection” option in "Test " window, the system will automatically start testing. This function is used to check if each component of the sulfur analyzer works properly. Select this option in the main menu, self-detection will be started. The detection content will display at the prompt window of the main interface. After the detection is finished, a dialog box for detection information will pop up.

2-4. Log viewer: Click this option, the log window will pop up and log query is available.

4.2.4 Main menu for test (Shown as Fig4-8)

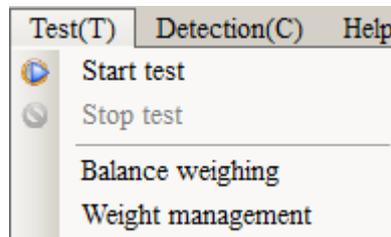
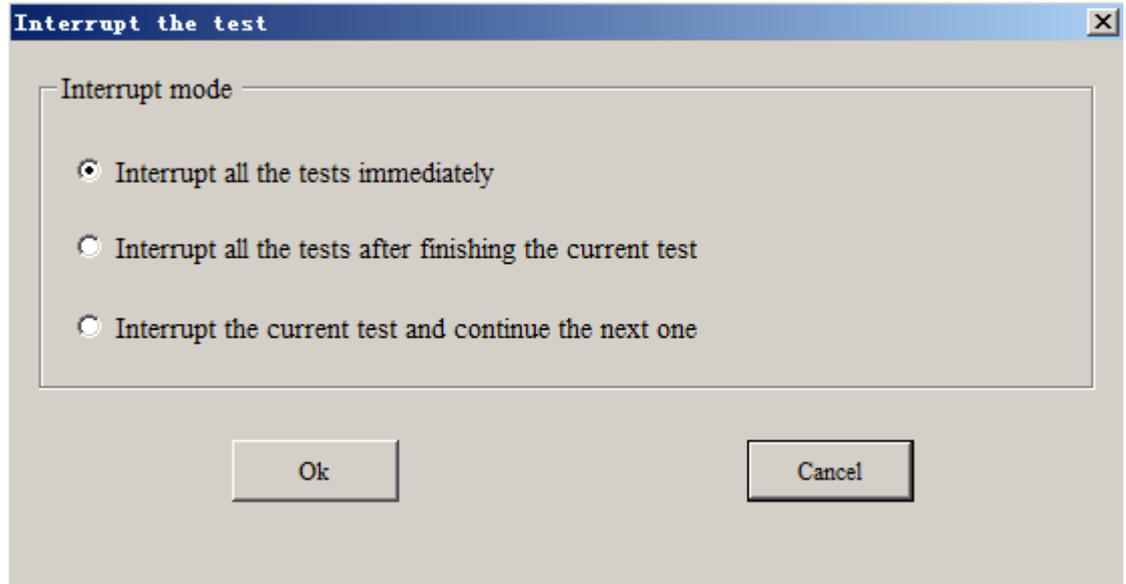


Fig.4-8

1. Start the test: When system temperature is constant, click on “Test” button at the shortcut icon at the shortcut icon bar, the system will automatically enter test state. Otherwise, wait until the system temperature is constant.
2. Stop the test: During the test, to interrupt please click "stop" button on the shortcut button bar, and Fig 4-8-4 will pop up. Select one of the check box according to test requirement and click on “Ok” confirm, or click “Cancel” to continue testing.



3. Balance weighing: After set the balance properly in Settings window, click the menu and it will be checked as shown in Fig 4-8-2 and start balance weighing. Press "Print" button it will upload data automatically. For data without the sample weight range, there will be a prompt and will not upload automatically. Click on the option again it will cancel checking.

Note:

- ✧ The output requirement for balance data is set as: No functional store, single print after stabilization (613).
 - ✧ After the weighing sample quality is stable, manually press the "print" button on the balance to transfer weight data.
4. Weight management: Click "Weight management," tab in " Test " or click on "weight management" in the shortcut bar, the window as shown in figure 4-8-3.will pop up

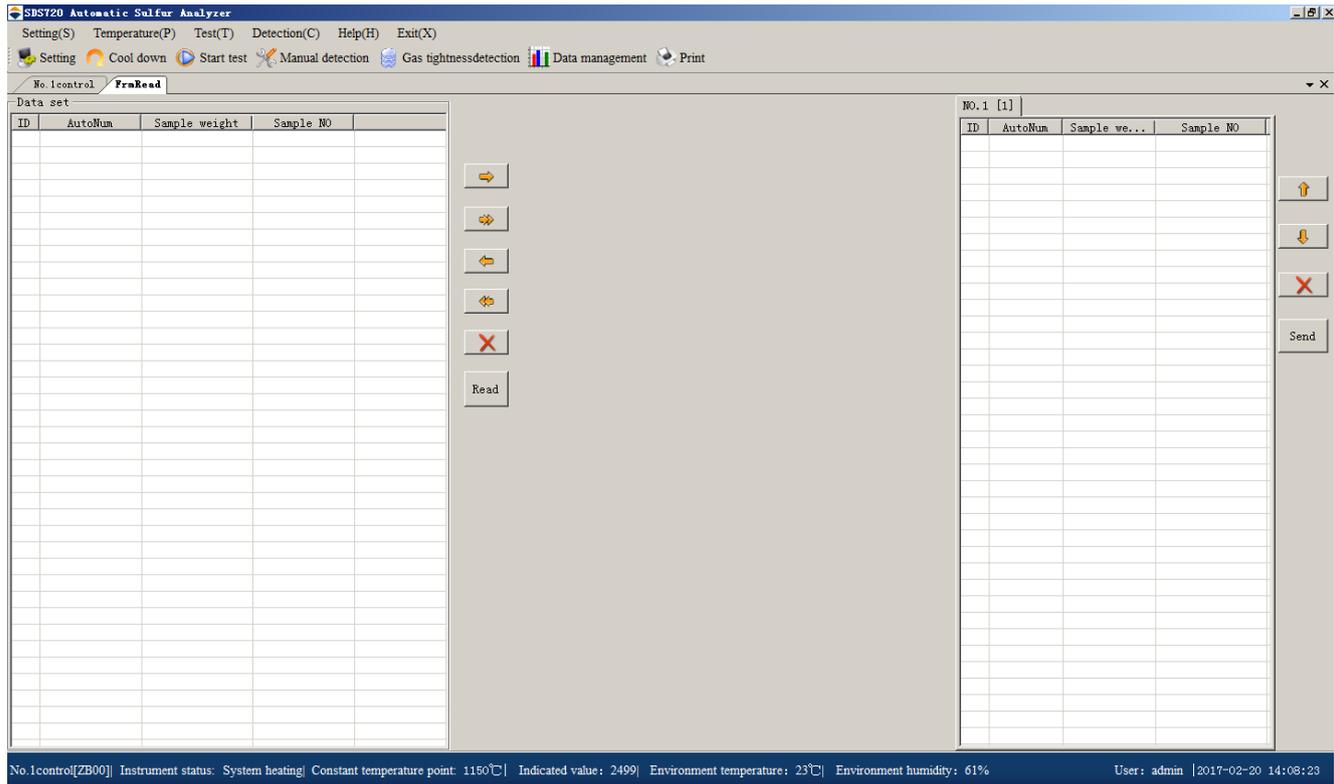


Fig.4-8-3

Weight management: It is used to get the data from the remote server and transferred to the corresponding control device, then sent the data to the main interface for testing.

- Refresh: Click “Refresh”, the data will be read from the remote server to this window.
- Move left and right: Through the icon in the middle of the interface can transfer the data left or right. It can transfer a single data to the corresponding control device, or move all data in one time.
- Move up and down: When data is transferred to the control device, it can move up and down through the icon to sort the data.
- Delete: Click "Delete", the data will be removed manually.
- Send: Click “send”, the software will automatically transfer the data in order to the test interface. The data without the sample weight range will not be sent to the test interface. The unit of the data sent to test interface is already transferred from "g" to "mg".

4.2.5 Data management

Please refer to Chapter V for details.

4.2.6 Help menu (Shown as Fig4-9)

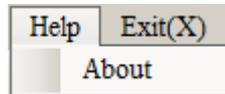


Fig. 4-9

1. About: Click on this option to get the version information about the control and test software. Click on "ok" in the window, you can return to the main window.

4.2.7 Exit the main menu

Click this menu or the icon 'X' on the top right of the program, Fig. 4-11 will pop up.

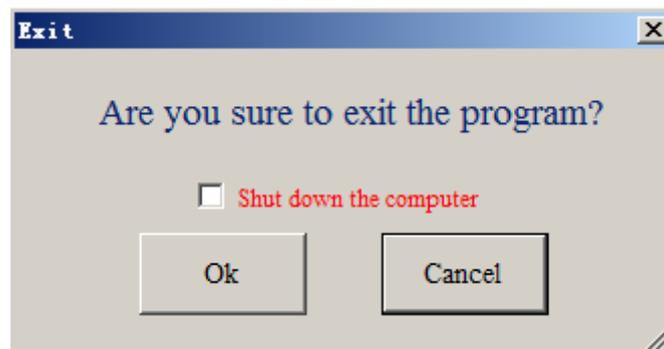


Fig. 4-11

- Shut down the computer: When selected, the program will exit the test and control software and close the computer.
- Ok: Click on this option to exit the software and back to the desktop.
- Cancel: Click on this option to close the prompt message and back to the software main interface.

Note: When the computer is on, do not insert or remove the card, so as not to damage the computer and the corresponding circuit board

Chapter V Data Management

(Take SDS820 for example, SDS720 is similar)

5.1 Database Management Window

The database main window of SDS820 sulfur analyzer consists of the title bar, menu bar, shortcut bar and data sheet etc. The columns of data sheet can be dragged or placed at will for easy viewing. Detailed introduction for each menu is as follows:

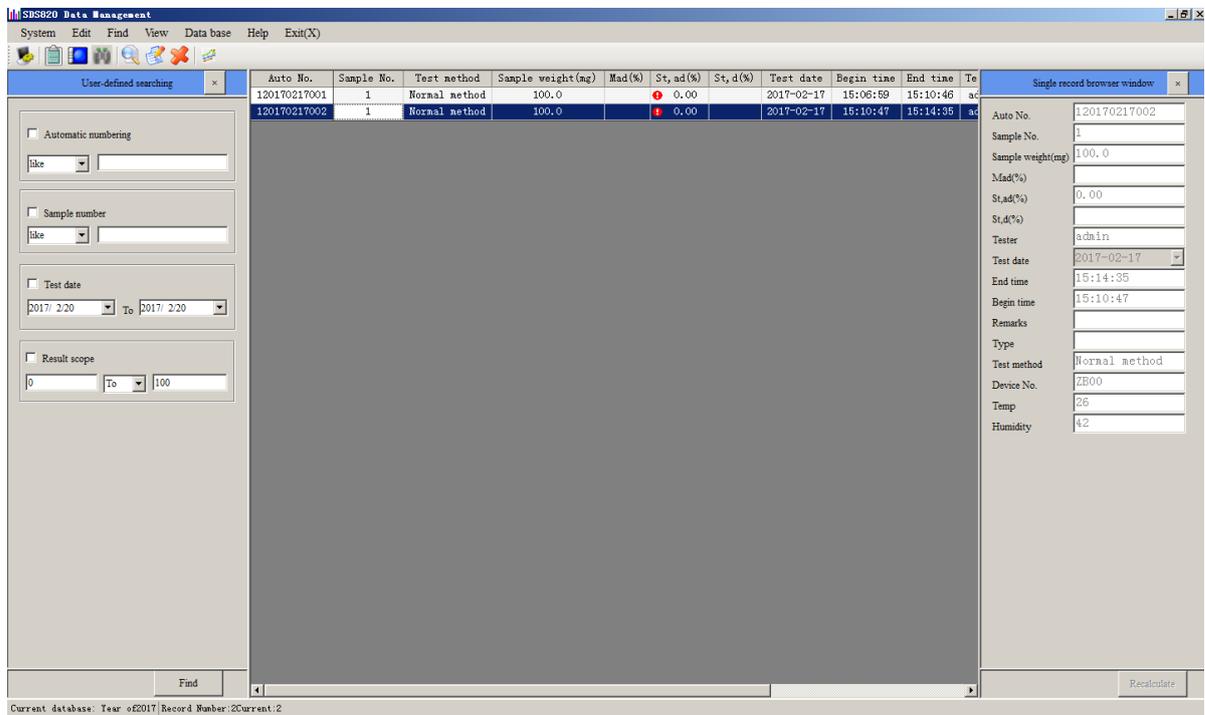


Fig. 5-1

Right click the mouse, window as Fig 5-1-1 will pop up.

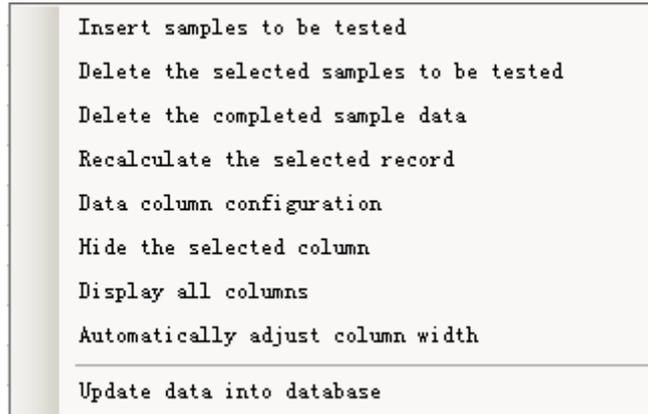


Fig 5-1-1

- Export the selected record: After the record being selected, choose the file format to export data.
- Data column configuration: The function and operation is the same as the main program.
- Other functions are the same as menu functions in the database which has the same menu.

5.2 Functions of the menu bar

5.2. System Menu (Shown as Fig. 5-1-2)

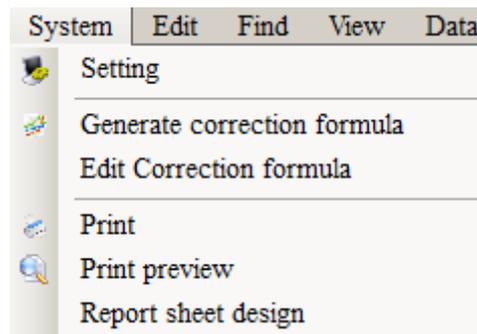


Fig. 5-1-2

1. Settings

Click on this option, window as Fig.5-1-3 will pop up.

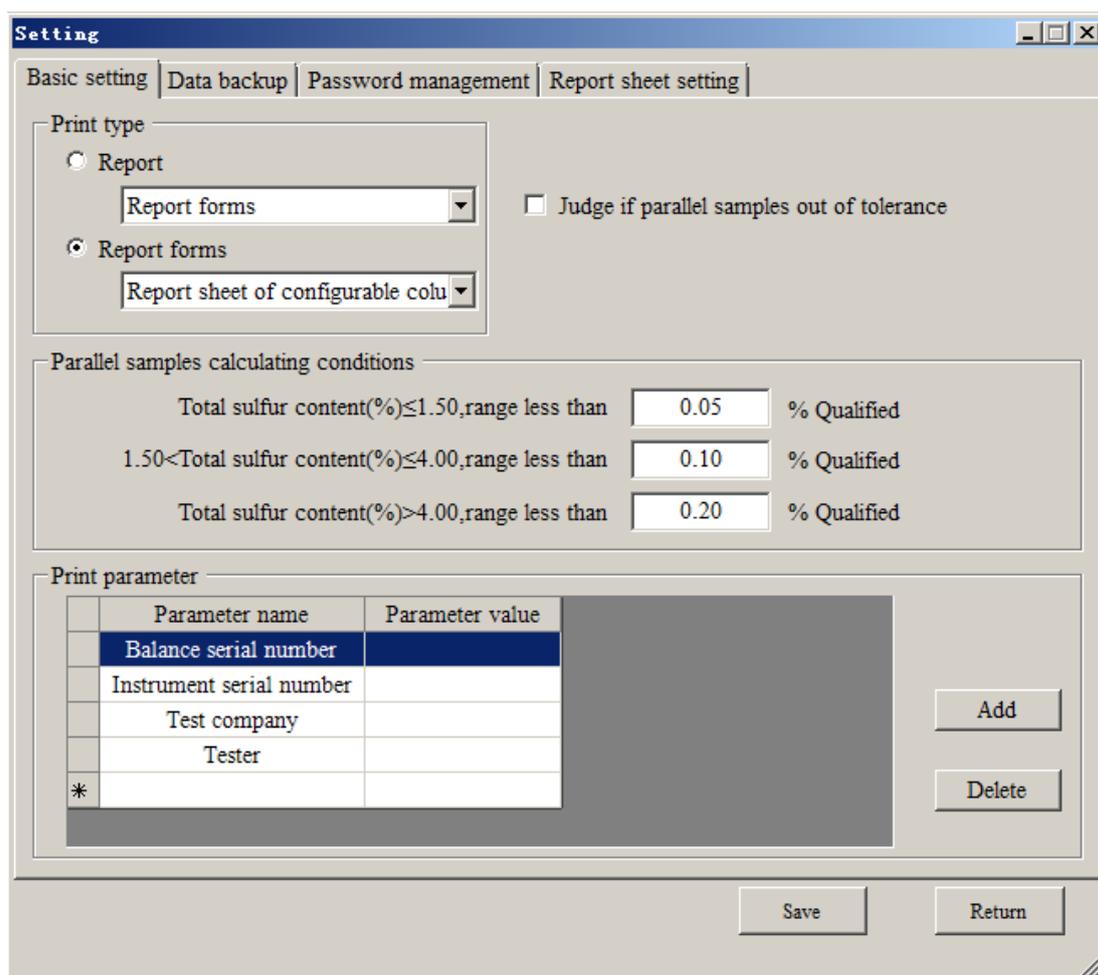


Fig. 5-1-3

1-1. Basic setting: Click "basic Settings" option in "Settings", window as shown in Fig. 5-1-3 will pop up.

- Print type:
 - ◆ Report: Select this option, all the record will be printed in the form of report.
 - ◆ Report sheet: Select this option, all the record will be printed in the form of report sheet.
- Judge if parallel samples out of tolerance: Select this option, in the report and report sheet it can judge if parallel samples out of tolerance according to the sample "parallel samples calculating conditions ". Otherwise, the report or the report sheet will only show average value and not judge if the parallel sample is out of tolerance.
- Parallel samples calculating conditions: Set different range period of total

sulfur content whether parallel sample out-of-tolerance judgment criteria

- Printing parameters : Set the statements report need to print a special name and parameter values, can add and remove
- Save: After modify the relevant parameters, click the button, parameters can be saved, otherwise the parameter will not be saved
- Return: Click the button, out of the window, return to the database main interface

1-2. Data backup: Click "Settings" window "data backup" TAB, as shown in figure 5-1-4 popup Windows

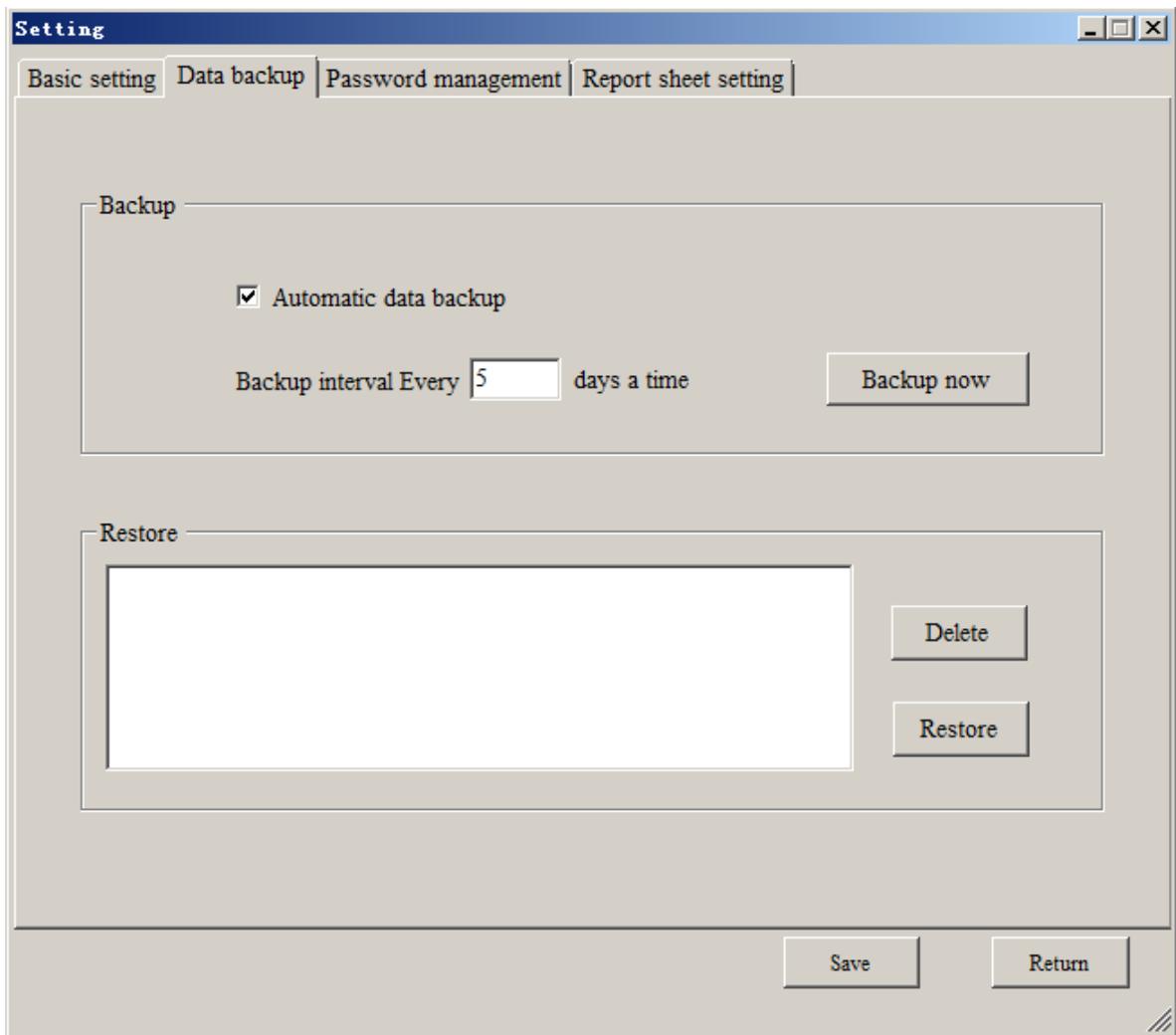


Fig 5-1-4

- Backup
 - ◆ Database backup automatically: If select this option, the data management program will automatically back up in the set time.

- ◆ Backup now: Click the button, it will back up the data on the day in the year.
 - Restore
 - ◆ Delete: After the selected records in the text box on the left, click the button, then delete the backup database
 - ◆ Restore: After the selected records in the text box on the left, click the button, then restore the backup database
- Note:
- ✧ Please use this function carefully

1-3. Password management: Click "Settings" window "password management" TAB, as shown in figure 5-1-5 popup Windows

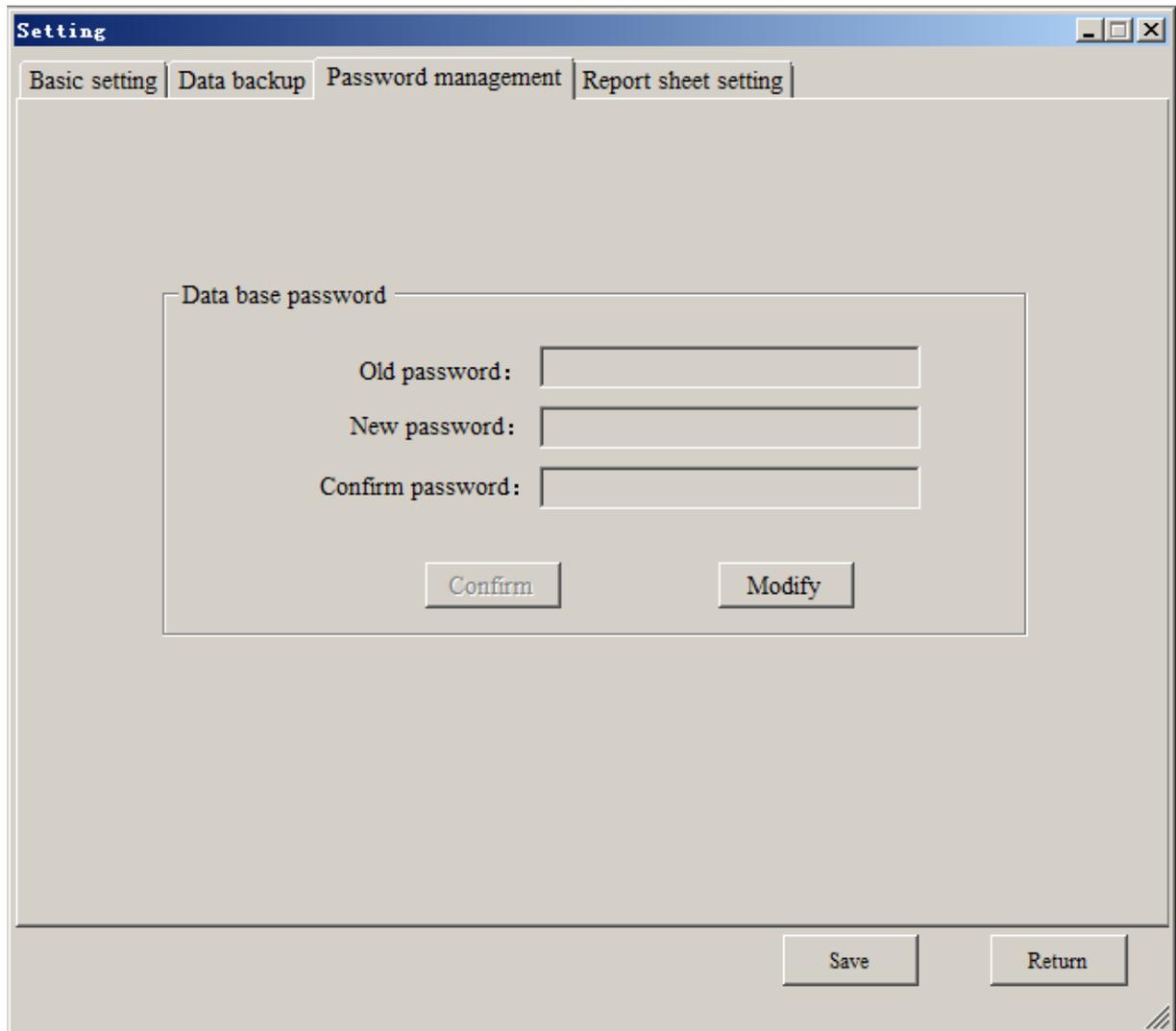


Fig. 5-1-5

- Data base password:
 - ◆ Old password: Enter the old password
 - ◆ New password: Enter the new password
 - ◆ Confirm password: Confirm the new password
 - ◆ Modify: After clicking this button, enter the password to edit state
 - ◆ Confirm: Click the button, save the new password

1-4 Report sheet setting: Click "Settings" window configuration "statements" TAB, as shown in figure 5-1-6 popup Windows

- Column name: And the main form the name of the corresponding column
- Print or not: The column is printed in the statement
- Print Name: The report shows the column name
- Print order: Report printing sequence of each column in ascending order to print
- Print width: The width of the columns in the report to take up, the unit is mm

Note: Squared of the selected rows cannot too much, just in case is beyond the scope of the A4 paper to print.

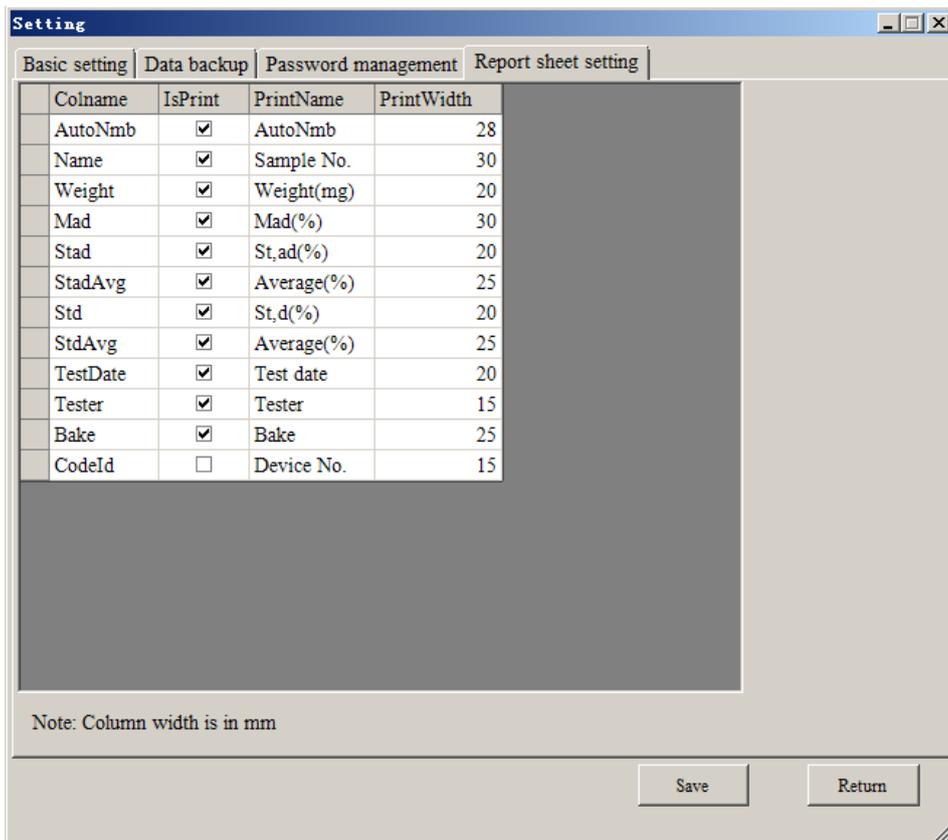


Fig 5-1-6

2. Generate correction formula: Select the record to participate in generating correction formula in the data display column, then click on this option, the window as shown in Fig 5-1-8 will pop up.

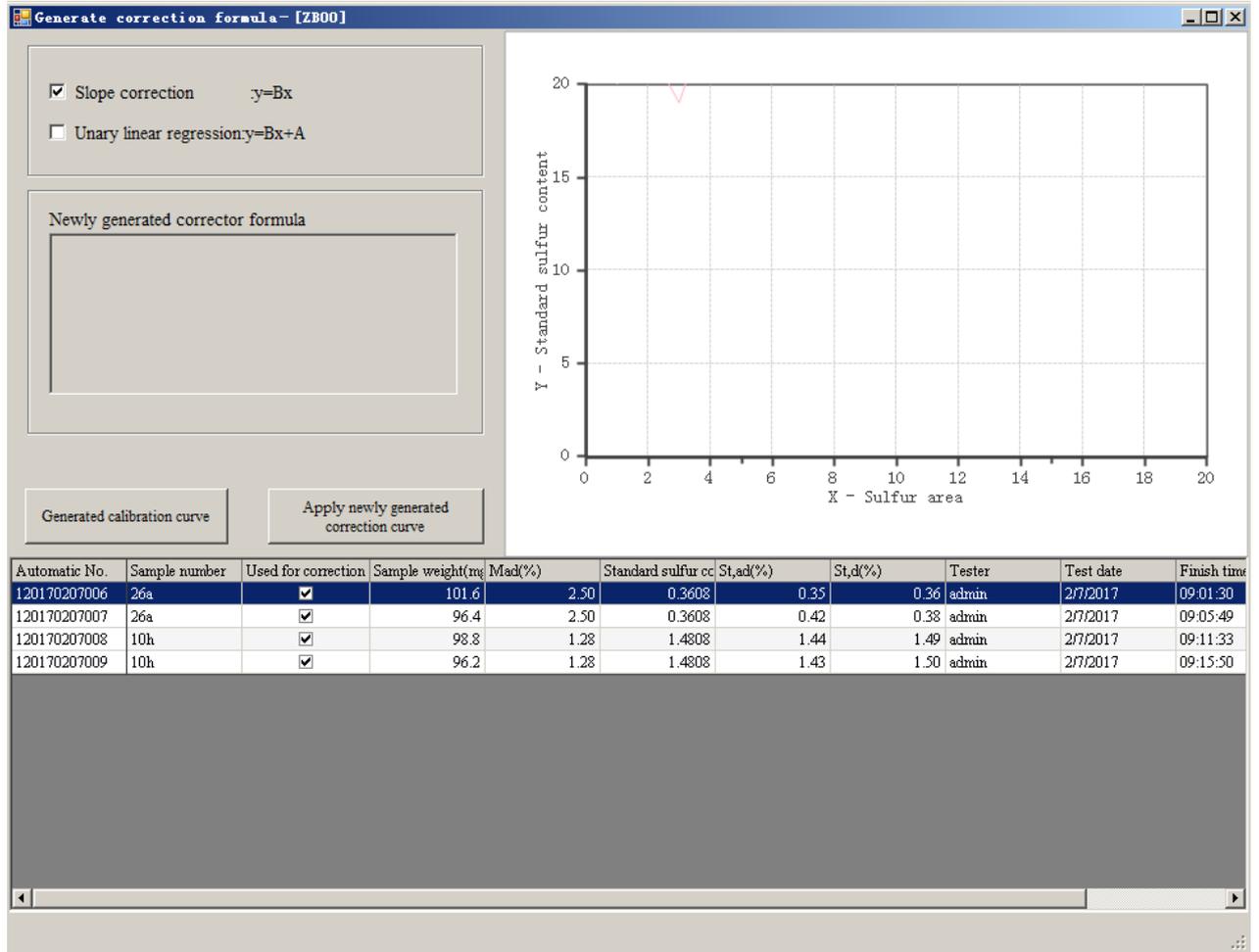


Fig 5-1-6

In the data column of the database management window, select the effective record that need to participate in correction, click on "generate correction formula" in the shortcut button bar or click the "system"-“ generate correction formula”, the window as shown above will pop up.

- Test method: Choose the correction method, generally should be consistent with the methods for the selected record.
- Calibration curve: Choose the type of calibration curve, generally choose the slope correction, correlation coefficient (R) > 0.9990.
- Current calibration curve used: The current using calibration curve.

- Generate calibration curve: Click the button, the program will automatically generate a calibration curve.
- Apply the new calibration curve: Click the button, the program will automatically apply the new calibration curve.
- “Used for correction” column in the data column: The selected record in the column will participate in correction, otherwise will not.

Note:

- ✧ The number of selected record for calibration should can be find in the Standard CRM database, or else when opening the interface for generating calibration curve, the system will automatically discharge the records which do not meet the requirement.

3. Edit calibration curve: Click the option the window as shown in figure 5-1-8 will pop up, which is used to view and modify a certain correction formula or linear.

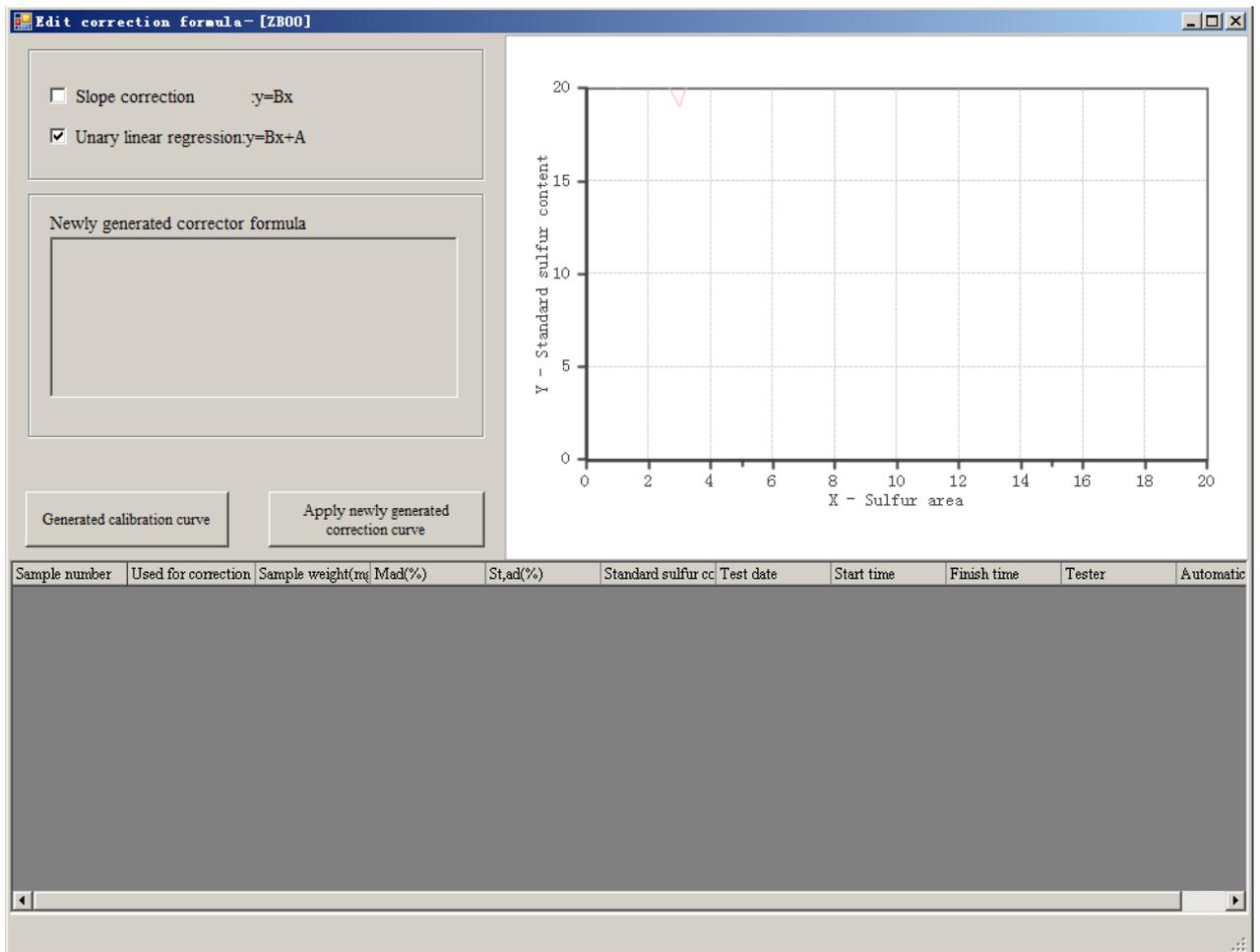


Fig.5-1-8

4. Print: Print the selected records in the data column.

5. Print preview: Preview the selected records in the data column.

5.2.2 Edit menu

Shown as Fig 5-2

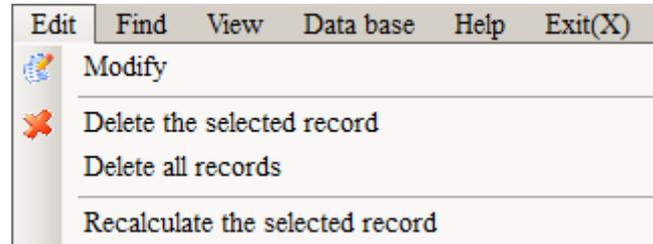


Fig 5-2

1. **Modify:** Click on this option, a single-record browsing and editing window will be opened.
2. **Delete the selected record:** Delete the selected record in the data display column.
3. **Delete all records:** Delete all the records displayed in the data column.
4. **Recalculate the selected record:** System will recalculate the selected record in the data display column

5.2.3 Find menu

As shown in Fig 5-3-1

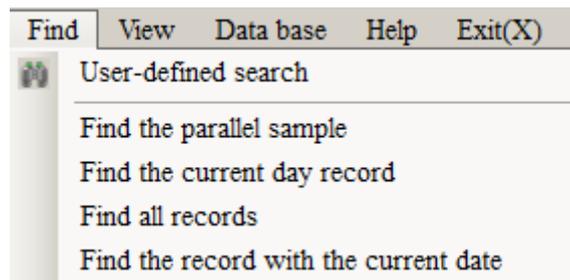


Fig 5-3-1

- **Find the parallel sample:** Click on this option, the records with same sample number and testing date will be displayed in the data display column.
- **Find the current day record:** Click on this option, the records whose testing date is the same with computer system date will be displayed in the data display column

- Find all records: Click on this option, all the records will be displayed in the data display column.
- Find the record with the current date: Click on this option, the record having the same testing date with the selected record will be displayed in the data display column.
- User-defined search: Click on this option, the window as shown in figure 5-3-2 will pop up.

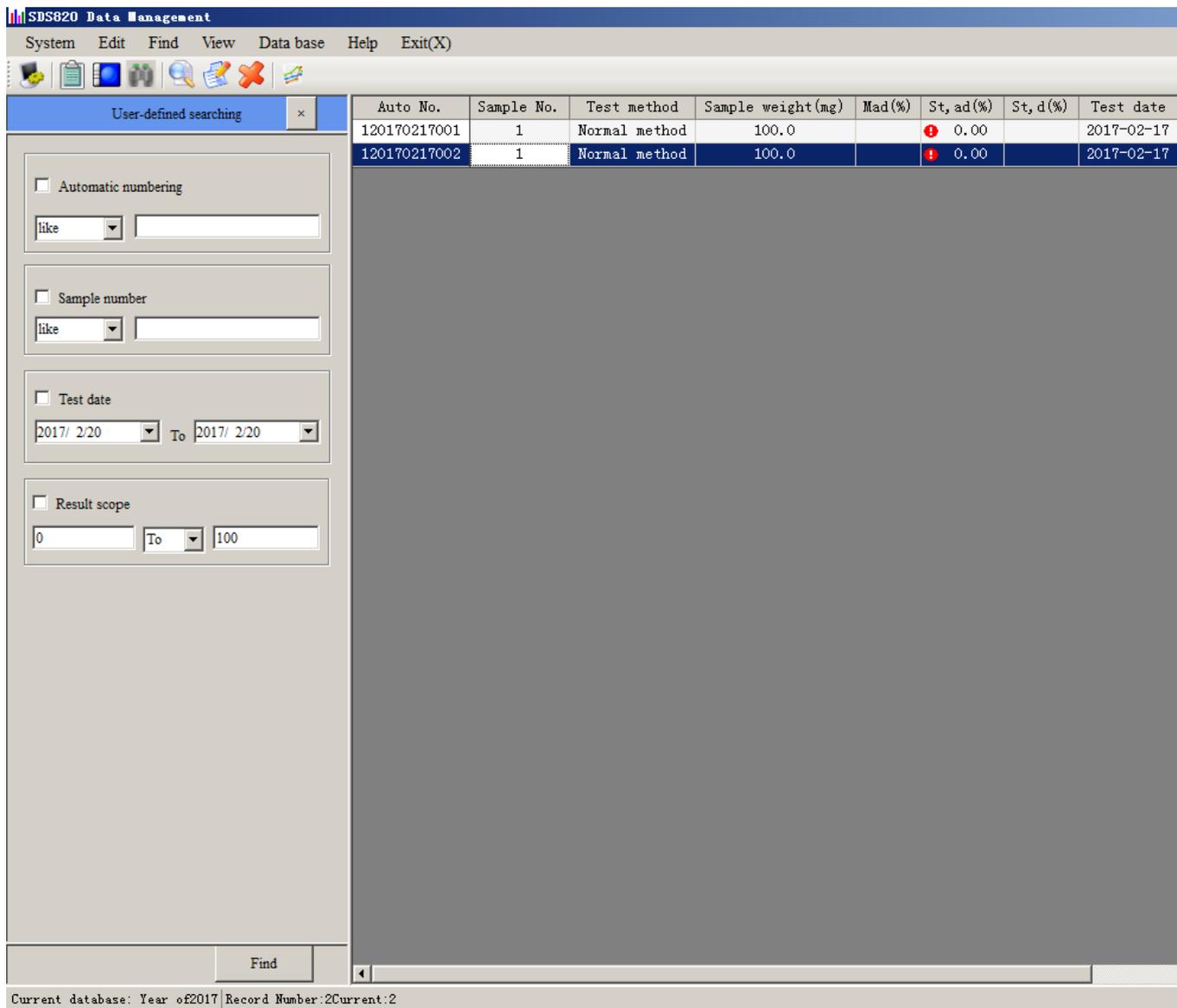


Fig 5-3-2

There are 4 kinds of data query methods: Automatic numbering, Sample number, Test date, Result scope.

Query based on one or more condition(s): Select query method, and then

searching condition. Input searching condition content into the textbox, and then click on “Find” button. All records satisfying the searching condition will display in the data column. For example, search according to the automatic numbering, steps as follows:

- Set the searching method: Click the "Automatic numbering" checking box, to make it for the selected state.
- Set search condition: Click on the "v" button and choose one item (e.g. "Like") according to need. Then on the right side of the box to input date (e.g. 201505)
- Find: Click this button, the system will display all the records having the automatic number of 201505 in the data display column. .

5.2.4 View Menu

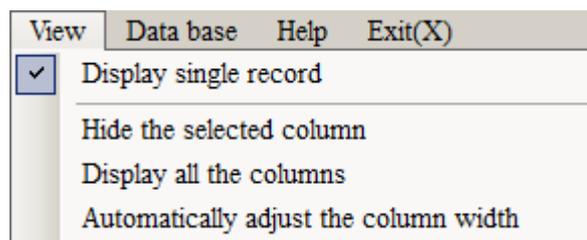


Fig 5-4-1

1. Display single record: Click on this option, on the right side the data display column will show the single record browser window.
2. Hide the selected column: Click on this option, hide the selected columns in the data display column.
3. Display all the columns: Click on this option, the data display column shows all the columns.
4. Automatically adjust the column width: Click on this option, each column will automatically adjust the display width according to the contents in the data display column.

5.2.5 Database Menu

After selecting the year, it will display all records of the selected year in the data

display column.

5.2.6 Help Menu (Fig. 5-6-1)

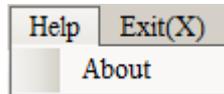


Fig. 5-6-1

- Click on this option, to get the software version information of data management program in SDS820 sulfur analyzer.

5.2.7 Exit data management

Shown as Fig 5-7-1, Click the "x" on the top right corner of the window of data management, the window below will pop up. Click "yes", to exit from data management and return to the main interface of SDS820 sulfur analyzer program; Click "no", to give up exiting data management window.

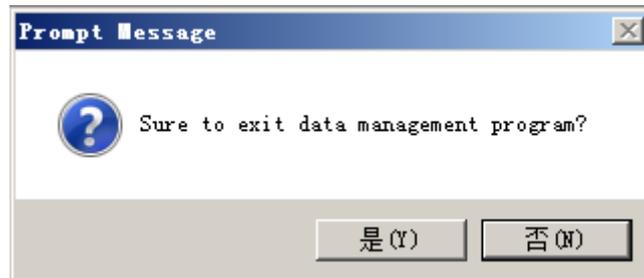


Fig 5-7-1

Chapter VI Instrument Operation

6.1 Operation Procedure

This chapter introduces the usage of instrument and procedures. Please make sure to read carefully.

1. Preparation

The following are to be properly prepared: electrolyte reagent, test sample, tungsten trioxide, dry and cooling silica gel, clean ceramic boat, spoon, tweezers, brush, and heat-resisting ceramic plate.

2. Start the System

- 1) Switch on power supply of computer and sulfur analyzer, and switch on heating power knife switch;
- 2) Start the computer, and wait for the system to automatically enter into the Windows operating system;
- 3) Double click on the “SDS820 Sulfur Analyzer” icon at Windows desktop to run the test and control software. Or click on “Start”, select “Program” item, and click on “SDS820 Sulfur Analyzer test and control software”.

2. Parameters Setting

Enter into “System setting” to set up parameters for test type, test method, etc.

3. System Heating Up

- 1) Click on “Heating” shortcut button or “Heating up” option at the “Temperature” menu to start heating.

NOTE:

- a) If the system self-detection for SDS820/720 has been started, wait until the self-detection finishes.
- b) If click on “Heating up” option when the furnace temperature is between 300°C and 1000°C, the system will stop heating when the temperature increases to 1000°C. Five minutes later, heating will be started again until

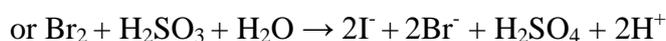
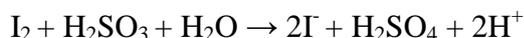
the temperature reaches 1150°C.

2. In the course of heating, the operator can prepare the following:

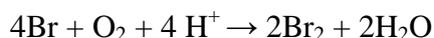
- Prepare the electrolyte:
 - a) Prepare the solution: Prepare 5g of potassium iodide and 5g of potassium bromine, 10mL of glacial acetic acid, 250~300mL of distilled water. Then mix them and stir evenly.
 - b) Load the electrolyte: Insert the water discharge tube into the electrolyte container, and turn on the exhaust pump, and then the electrolyte will be pumped to the electrolytic cell automatically. Clamp the water discharge tube with tongs. Or, you can uncover the cap and load the electrolyte in.
 - c) Electrolyte discharge: Loosen the tongs to discharge the electrolyte. After having discharge the electrolyte, remember to clamp the tongs.

Q: Why does the electrolyte need to be replaced when the PH is less than 1?

A: With the increased and repeated use of the electrolyte, the acidity will increase due to following reactions:



When the electrolyte becomes acid, more I_2 and Br_2 will be generated because of more active photosensitized reaction of I and Br:



These I_2 and Br_2 are not generated from electrolysis. As a result, the test values will be lower than the standard value. So the electrolyte should be replaced when the PH is less than 1.

- Replace silica gel and sodium hydroxide
 - a. Replace silica gel: If color of 70% of silica gel has changed, please replace it. Steps: Remove the purification tube. Put the silica gel in a vessel and get it in the drying oven for drying. Load the dried and cooling silica gel into the purification tube, and install the purification tube.

-
- b. Replace absorbent cotton: When the absorbent cotton becoming black or partially into powder, please replace it. Steps: Open the air tightness test plate at the top of the instrument, unscrew the plastic cover with filter, remove the cotton wool inside, and put new clean cotton wool in. .

- Gas tightness detection

Open the “Manual Detection” window, click on “Turn on exhaust pump”, and push forward the gas detection knob (SDS516), or pinch tightly the inlet tube of the filter (SDS-IVa). If the flow meter drops below 250mL/min, gas tightness is good. Otherwise, check if there is any leakage at the filter circuit, electrolyte cell circuit, or purification tube circuit

NOTE:

a. Do not turn on the agitator when checking gas tightness, in case the stirrer will jump up and attack the electrodes.

b. After replace the silica gel or absorbent cotton, there is need to test air tightness again.

- Open the “Manual Detection” window to check if functions of agitation, crucible forward and crucible backward works properly.

- Sample weighing

a. The sample can be weighed either by on-line or by off-line weighing. If it is off-line weighing, directly input the weight into the sheet column. If it is on-line balance weighing, click On “Balance Weighing”, and follow the system prompt message to finish weighing. Please note that the dump sample is normally prepared with medium-sulfur coal.

b. Shake up the sample bottle before weighing. Use separate spoons for different types of coal samples. Don't touch the ceramic boat with hands. The coal should be spread evenly in the crucible. And the tungsten trioxide layer on the coal should be thin and even.

4. Enter Parameters and Load Crucibles

When the furnace temperature has increased to 1150°C or 900°C and kept constant, the status bar will display “System temperature constant”. Then test can be

started.

Test steps: Put crucibles on the sample delivering platform, and then enter data of sample number (If automatic numbering has been set up, it is no need to enter sample number), sample weight and $M_{ad}\%$ into the data column of the main interface.

NOTE: To ensure accuracy, test for one or two dump samples of medium-sulfur coal is needed.

5. Test Procedure

- Send sample continuously: Load the samples and input parameters. Click on test button at the shortcut bar to start testing automatically, then the operator is free. If there are weigh data at the data column before test for previous sample finishes, the system will continue the test automatically. Otherwise, the operator needs to click on test button to restart testing.
- Send a single sample: Switch the system into procedure of sending a single sample in the menu bar. Load a single sample and input parameters, click the "start test" option in the shortcut bar, and system will enter test state automatically. When test for one sample has finished, take the crucible away with tweezers, and place it at the heat-resisting ceramic plate. If there are weigh data at the data column before test for previous sample finishes, the operator only needs to load crucible, and then click on "Ok" to restart testing.

6. Results Display

After test for one sample has finished, the ceramic boat will automatically withdraw from the furnace, and the results will display at the data column of the main frame. Besides, you can open "Data Management" to check the test results.

7. Print Test Results

If the printer is correctly connected to the computer, the system will print according to the print settings. For detailed information, please refer to chapter 5.

8. Exit Test and Control Software

Click on “Exit” main menu, then the “Exit the Program” dialogue box will pop up. Click on “OK” to return to the desktop. Or click on “Cancel” to stay at the test and control program interface

9. Power off the Computer

Click on “Start” at the desktop to power off the computer.

6.2 Precautions

1. During the working status for SDS820/720, if the chain has rotated above 5 rounds or not used for over one month, when having started the test and control software, the system will detect the working conditions of crucible sending and chain rotation automatically. It takes about 3min.
2. Check gas tightness of the whole gas circuit if the absorbent cotton or silica gel has been replaced, or the electrolytic cell has been reassembled.
3. Make sure the sample delivering platform, crucible slot are tidy enough and with no foreign matters.
4. The ceramic boat must keep tidy and without any other sample substance. The ceramic boats should be cleaned and replaced regularly.
5. Shake up the sample bottle before weighing, and then spread the coal evenly at the ceramic boat. Add a thin cover of tungsten trioxide over the coal sample. Please note that $M_{ad}\%$ figure is only valid within 3 days.
6. When SDS820/720 is in test (After self-detection), load the crucibles on the sample delivering platform then input sample weight in the data field. Crucibles must be put at the sample delivering platform one by one and with no blank between two crucibles. Pay attention that the order of sending sample and the order of placing the sample on the platform must keep corresponding.
7. During testing, it is unable to modify data of sample number, weight, moisture etc.. But after the test has finished, the data can be modified at the database.
8. During testing, do not push or crash the crucible to avoid test interruption. After the test is over for SDS820, it is forbidden to fetch the crucible with tweezers in case of

causing system error.

9. The ceramic boat is with extremely high temperature. So please put the discarded boats in the heat-proof ceramic plate. Otherwise, instrument or experiment desk may be scorched. Meanwhile, only cooling crucibles are supposed to be placed at the foam box. The operator should pay high attention to this or take responsibility for the consequences.
10. After the whole test is finished, discharge the electrolyte and seal it in a light-resisting brown glass bottle for next use. Remember to clean the electrolytic cell with distilled water.
11. The absorbent cotton in the dust filter should be replaced or cleaned regularly. Otherwise, test results may be affected.
12. Regularly replace the absorbent cotton in the silencer.
13. Regularly lubricate the o ring on the upper and lower connections of the purification tube with vaseline for good lubricity to avoid o ring becoming dry.
14. Regularly change the electrolyte. Normally change the electrolyte after every 200 tests or when the test results have been affected. Regularly clean the electrolytic cell with cotton and alcohol before thorough washing of the cell electrode with distilled water. Before debugging, the cell should be cleaned completely.
15. If the crucible cracks or with coked substance, abandon it. Otherwise, test results may be affected.
16. For high-sulfur coal (S, % > 10), does not need to reduce weight for test sample when weighing, directly weighing around 50 mg is ok.
NOTE: The particle size of the high-sulfur coal is ≤ 0.1 mm.
17. If the particle size is too big, the test result with 50mg coal may with low accuracy. It is advised to grind the sample with agate mortar.

Chapter VII Instrument Maintenance

1. The computer and printer equipped with the sulfur analyzer should be maintained regularly according to their operating instructions. They also can be used for other purpose, but special care should be taken to prevent virus attack, which will affect the normal use of the instrument.
2. The instrument operator should carefully read the manual and operate in accordance with the stipulations in the manual. Casual operation or disassembly shall not be done in order to avoid damaging the instrument.
3. The complete set of the instrument should be placed and used in dry surroundings. It should also avoid dust or corrosive gas entry. In case of long-time(over 15days)out-of-service, dust preventing measures should be taken and the instrument should be electrified periodically for at least 30 minutes once every 15 days in the rainy season or once every month in the dry season.
4. When the PH value of the electrolyte is less than 1, it should be newly prepared. The electrolyte should be replaced after about 200 tests. After the electrolyte is replaced, one or two dump samples should be made before the formal tests.
5. Cleaning of the electrolytic cell: Every day after the test, the electrolytic cell should be cleaned.
6. Disassembly and cleaning of the dust filter: Before the test or after a certain amount of tests (normally 80-100 tests), the dust filter should be cleaned or the absorbent cotton should be replaced if the absorbent cotton is dusty or damp.
7. Replacement of the silica gel (desiccant): After using for a period of time, the hygroscopicity of the silica gel will decrease, which will affect the test results. Thus the silica gel should be changed if the color of 70% of silica gel is changed because of dampness.
8. The sample delivering motor and interlocking rod must be lubricated after a period of using.
9. Check gas circuit regularly (generally once a week, or once after 3 days of continuous working). If it is SDS516, turn on the exhaust pump, and then push the

gas tightness knob forward. If it is SDS-IVa, turn on the exhaust pump, and then pinch tightly the inlet tube in front of the dust filter. If the flow rate decreases to 250mL/min or below, the circuit is in good gas tightness condition.

10. The air tube should be inspected regularly, especially the air tube at the outlet of the quartz tube, which should be changed in time in case of aging.
11. When the electrolyte is being replaced, please don't spill the electrolyte onto other things to avoid corrosion. In case of any spillage, it should be cleaned with ethanol.
12. In case the electrodes of the electrolytic cell are not clean or dirty, they should be scrubbed timely with ethanol cotton to keep them clean.
13. The absorbent cotton in the air pump noise eliminator will become dirty after using a period of time, so it should be replaced in time.
14. Handle with care when moving the sulfur analyzer so as to avoid damage to the elements of the high-temperature furnace.

Chapter VIII Common Troubles and Solutions

Failures	Causes and solutions
1. The system displays that the tester is off-line.	<ul style="list-style-type: none"> a. The computer dose not power on. Switch on the computer. b. USB-CAN card is not well connected. c. Communication abnormal, please check and repair.
2. The heating system is already started, But the high-temperature furnace is not heated up.	<ul style="list-style-type: none"> a. Heating power not properly connected, connected it properly. b. Fuse is burnt. Please replace. c. Silicon carbide tube broken or poor connection of connecting wire. Check the circuit or replace the silicon carbide tube. d. The solid relay is damaged. Check or replace it. e. The control card is damaged. Repair it please.
3. Temperature displayed at the system is 0°C.	<ul style="list-style-type: none"> a. The thermocouple is counter-connected or damaged. Connect it correctly or replace it.
4. Heating up is too fast.	<ul style="list-style-type: none"> a. The thermocouple is damaged. Replace it. b. The heating silicon control is damaged. Please replace it (Measure voltage between two poles of high-temperature furnace with multi-meter, normal voltage will jump between 110V and 220V).

<p>5. The furnace temperature is too high. And the quartz boat and ceramic boat are burned out.</p>	<p>a. Thermocouple coefficient is too low. Increase the coefficient to reduce the actual furnace temperature.</p> <p>b. The relay is short circuited and should be replaced.</p> <p>c. Check if the thermocouple is correctly installed.</p> <p>d. The thermocouple is damaged and should be replaced.</p> <p>e. There is something wrong with the board card. Replace it.</p>
<p>6. There is gas leakage</p>	<p>a. Tube leakage:</p> <p>1). The tube is cracked or aged. Replace it.</p> <p>2). The tube is not connected tightly enough.</p> <p>b. Bad gas tightness of dust filter:</p> <p>1). Check if the lid is screwed tightly.</p> <p>2). Check if there is seal inside the lid.</p> <p>3). Check if the seal and the lid match well, or if it is damaged.</p> <p>c. Air leakage of electrolytic cell:</p> <p>1). The seal is not good enough. Replace it.</p> <p>2). The seal is too dry. Smear some Vaseline</p> <p>3). The lid is not screwed tightly.</p> <p>d. There is air leakage in the purification tube:</p> <p>1). The rubber seal is damaged. Replace it.</p> <p>2). The purification tube is damaged. Replace it.</p>
<p>7. The air flow is not stable or below 1000mL/min.</p>	<p>a. There is gas leakage of the circuit.</p> <p>b. The tube is folded.</p> <p>c. The absorbent cotton blocks the dust filter.</p>

	<p>Replace it.</p> <p>d. Silica gel blocks the gas tube.</p>
<p>8. When sampling, the sample delivering rod can not move to the proper position.</p>	<p>a. Sampling parameters are not correct. Reset the sampling time.</p> <p>b. The Sample sending device is too tight or too loose. Check it please.</p> <p>c. There is foreign matter in the sampling chute. Check the sampling mechanism.</p> <p>d. There is too much resistance against the sampling mechanism. Lubricate it.</p>
<p>9. The agitator is noisy, or the rotation speed is abnormal.</p>	<p>a. The speed is not well adjusted.</p> <p>b. The agitator is damaged. And the agitator should be replaced.</p>
<p>10. Electrolyte color becomes deep (red brown).</p>	<p>a. The electrode is dirty. Clean it.</p> <p>b. The agitation speed too slow. Adjust it.</p> <p>c. Signal connecting wire of the electrolytic cell is in bad connection. Check the connection.</p> <p>d. The electrolyte loses efficacy and should be re-prepared.</p> <p>e. There is controlling circuit failure. Ask the professional to repair it.</p>
<p>11. There is no curve after the test.</p>	<p>a. There is leakage. Check the air circuit.</p> <p>b. Electrolytic cell signal joint is loose or disconnected. Tighten it or connect it well.</p> <p>c. There is electrolytic problem. Test with dump sample test first or replace the electrolyte.</p>
<p>12. The test value of the sulfur content is on the lower side.</p>	<p>a. There is leakage of the air circuit. Check the air circuit.</p> <p>b. The furnace temperature is not high enough.</p>

	<p>Check the furnace temperature and the constant temperature.</p> <p>c. Sampling can not be in the proper position. The setting sampling distance is insufficient. Reset it.</p> <p>d. The electrolyte loses efficacy and should be re-prepared.</p> <p>e. Electrodes deformed or dislocated, calibrate the electrodes please.</p> <p>f. Electrolyte is too less and should be added more.</p> <p>g. The agitator speed is too slow. Accelerate the speed.</p>
<p>13. During the test, the electrolyte is pale for a long time.</p>	<p>a. Electrolytic cell signal joint is not connected well and should be checked.</p> <p>b. Indicating electrode disconnected, please check it.</p> <p>c. Weight of high-sulfur sample does not meet the requirements.</p> <p>d. The program is out of control. Restart the computer.</p> <p>e. There is controlling power circuit failure. Ask the professional to repair it.</p>
<p>14. Test results are not stable.</p>	<p>a. The absorbent cotton of the dust filter is blocked. Replace the absorbent cotton.</p> <p>b. Air circuit leakage, please check air circuit system.</p> <p>c. The electrode is dirty. Clean it with alcohol.</p> <p>d. Control supply circuit failure, replace it.</p>

<p>15. The printer cannot print or print incorrectly.</p>	<ul style="list-style-type: none"> a. Check if the printer signal wire is connected well or disconnected. b. There is some problem with the printer program problem. Reset the printer. c. There is some problem with the test control software. Change the software. d. There is some problem with the Printer. Go to the local service center with the guarantee card.
<p>16. System halted</p>	<ul style="list-style-type: none"> a. Reinstall the test software if need to check and modify computer CONFIG.SYS setting. b. There is virus in the computer. Delete the virus. c. The test software is damaged. d. There is some problem with the computer. Go to the local service center with guarantee card.