



**SDAC6000/SDAC6000u**  
**Bomb Calorimeter**  
**Operating Instructions**

**Hunan Sundy Science and Technology Co., Ltd.**

## **Attention**

- **Please read this instruction carefully before using Sundry instrument.**
- **Matters need attention when using the instrument.**
  - **Only high-temperature power cable provided with the instrument can be used.**
  - **Make sure that the electrical parameters of outlet and knife switch/air break switch meet the requirement of instrument.**
  - **Power of the instrument shall be cut off when instrument not been used for a long time.**
  - **Before using the instrument, the filling materials, such as foam, shall be taken out and instrument' cover cloth shall be taken off. It is prohibited to place any inflammable and explosive material near the instrument.**
  - **After use, cover cloth shall not be placed on instrument if instrument (inside and outside) temperature has not cooled down to room temperature.**
  - **The instrument shall be ground connected reliably.**
  - **It is not allowed to repair and dismantle the instrument if power is connected.**
  - **Vessel contained with water is prohibited to be placed on instrument.**
- **To ensure stable and reliable operation of instruments, spare parts and consumables provided by Sundry shall be used. If spare parts and consumables not provided by Sundry are used and result in reduction of performance, unstable test result or increase in malfunction, etc, Sundry will not provide service or guarantee and will not undertake any losses.**
- **Sundry shall not bear responsibilities for malfunction or damage due to auxiliary instrument and equipment not supplied by Sundry and misuse, negligence of users. Purchaser, users or successor shall take all the risk of their operation and mistakes.**

## CONTENTS

CHAPTER 1 INSTRUMENT PERFORMANCE AND CHARACTERISTICS .....	5
1.1 SCOPE OF APPLICATION.....	5
1.2 STANDARDS COMPLIANT .....	5
1.3 IMPLEMENTATION OF STANDARDS .....	5
1.4 PERFORMANCE INDEX.....	6
1.5 FEATURES.....	6
CHAPTER 2 WORKING PRINCIPLE AND INSTRUMENT COMPOSITION.....	7
2.1 WORKING PRINCIPLE .....	7
2.2 WORKING PROCESS .....	7
2.3 INSTRUMENT COMPOSITION.....	7
CHAPTER 3 SYSTEM INSTALLATION AND DEBUGGING .....	12
3.1 ENVIRONMENT REQUISITION .....	12
3.2 INSTALLATION PROCESS .....	12
3.3 THE INSTALLATION AND UN-INSTALLATION OF THE SOFTWARE .....	144
3.4 DEBUGGING .....	166
3.5 USAGE OF OXYGEN BOMBS.....	18
3.6 AUTOMATIC OXYGEN FILLING OR DEGASSING.....	19
3.7 ONLINE TEST .....	20
CHAPTER 4 TEST SOFTWARE USAGE .....	21
4.1 START-UP AND EXIT OF TEST-CONTROL SOFTWARE .....	21
4.2 MAIN WINDOW FRAME FUNCTIONS.....	21
4.3 SYSTEM MAIN MENU .....	215
4.4 VIEW MAIN MENU.....	216
4.5 TOOL MAIN MENU .....	216
4.6 MANAGEMENT MENU.....	35
4.7 HELP MAIN MENU .....	38
CHAPTER 5 DATA MANAGEMENT .....	39
5.1 MAIN WINDOW .....	39
5.2 ITEM MENU .....	41
5.3 SYSTEM MENU .....	42
5.4 EDIT MAIN MENU.....	48
5.5 SEARCH MENU .....	48

<b>5.6 MANAGEMENT MENU.....</b>	<b>511</b>
<b>5.7 HELP MENU.....</b>	<b>544</b>
<b>CHAPTER 6 OPERATING INSTRUCTIONS .....</b>	<b>57</b>
<b>6.1 PREPARATION WORK .....</b>	<b>57</b>
<b>6.2 TEST PROCEDURE .....</b>	<b>57</b>
<b>6.3 TEST NOTES .....</b>	<b>59</b>
<b>CHAPTER 7 INSTRUMENT MAINTENANCE.....</b>	<b>60</b>
<b>7.1 THE MAINTENANCE OF THE INSTRUMENT AND THE WATER TANK .....</b>	<b>60</b>
<b>7.2 MAINTENANCE OF OXYGEN BOMB .....</b>	<b>60</b>
<b>CHAPTER 8 FAQ AND SOLUTIONS.....</b>	<b>62</b>
<b>CHAPTER 9 DETERMINATION METHOD FOR HEAT CAPACITY AND CALORIFIC VALUE .....</b>	<b>65</b>
<b>CHAPTER 10 FORMULA AND DESCRIPTION.....</b>	<b>67</b>
<b>CHAPTER 11 INSTRUMENT DIAGRAM.....</b>	<b>68</b>
<b>APPENDIX I: CRITICAL SPARE PART LIST.....</b>	<b>72</b>
<b>APPENDIX II: ATTENTIONS FOR OXYGEN BOMB USAGE.....</b>	<b>75</b>

# Chapter 1 Instrument Performance and Characteristics

## 1.1 Scope of Application

This instrument is suitable for application to such industries or sectors as electric power, coal, paper-making, petrochemical industry, cement, agriculture & husbandry, pharmaceuticals, scientific research and teaching for measuring of calorific values of combustible of coals, coke, petroleum and cement raw materials.

## 1.2 Standards compliant

*GB/T213-2008 Determination of Calorific Value Coal*

*GB/T 384-1981 Determination of calorific value of petroleum products*

*GB/T 30727-2014 Determination of calorific value for solid biofuels*

*JC/T 1005-2006 Determination of calorific value of cement black raw meal*

*ASTM D5865-2013 Standard Test Method for Gross Calorific Value of Coal and Coke*

*ISO 1928 Solid Mineral Fuels Determination of Gross Calorific Value by the Bomb Calorimetric Method and Calculation of Net Calorific Value*

*JJG672-2001 Oxygen Bomb Calorimeter*

## 1.3 Implementation of standards

*Q/ADXH 003-2016*

## 1.4 Performance Index

- Test time < 10 minutes
- Humidity (10 ~ 85)% RH
- Temperature-measuring range (8-40)°C
- Rated voltage (198-242) V
- Temperature resolution 0.0001 °C
- Frequency 50/60 Hz
- Rated power 650W
- Overvoltage category: II
- Measuring range (16000~40000) J/g
- Product category Indoor use
- Heat capacity precision RSD≤0.1%
- Calorific value error: The difference between the test average value and the standard value of the secondary reference benzoic acid is within the range of (-60~60) J/g
- Ambient temperature : (15 ~ 30) °C
- Elevation: 2km Max.
- Dimensions: Main body size: 428mm\*565mm\*485mm

Thermostatic water tank size: 220mm\*565mm\*410mm

## **1.5 Features**

### **1.5.1 High automation and High efficiency**

1. Automatic oxygen filling & degassing, automatic bomb raising & lowering, automatic water temperature adjustment and water weighing as well as automatic detection of environmental temperature and humidity. (SDAC6000u bomb calorimeter doesn't have automatic oxygen filling & degassing device)
2. Fast speed. Test time per sample is less than 10 min.
3. External balance weighing connected to the calorimeter, automatic send and save the sample weight.
4. Automatic identification of the connection of oxygen bomb when starting the test as well as the function of automatic oxygen bomb identification.

### **1.5.2 High Precision and Accuracy**

1. The system is of high precision less than 0.1% and accuracy is in full compliance with the requirements of uncertainty of standard coal.
2. Good environment adaptability. The jacket water and the testing water are separated to isolate the influence of the environment to the testing water

### **1.5.3 Easy operation**

1. Light weight and excellent appearance. The shell and some of the parts are mould productions.
2. Triple-screw oxygen bomb. Tie fire wires with casing pressure method which is convenient, safe and reliable. Cotton ignition mode is available for option as well.
3. Automatic calculation of gross/net calorific values after entering corresponding parameters.
4. It can judge parallel samples automatically and give its average value and error. It also has many kinds of printing format.
5. Rich query functions, supportive to ambiguous inquiry.
6. Software featuring good error tolerance. During the test process there is real-time prompt. Follow the prompts to complete the test, and the experimental results can be automatically derived.

### **1.5.4 Automatic diagnosis system**

During tests, the system has self-diagnosis function, which can accurately judge if each functional part of the system performs normally. It also prompts the user clearly so as to facilitate the maintenance and ensure normal operation of system.

### **1.5.5 Asynchronous multi-control**

SDAC6000/SDAC6000u bomb calorimeter adopts network cable communication. Test software is acceptable to multi-control. Each principal machine of multi-control calorimeters is completely independent with one another without mutual interference.

## **Chapter 2 Working Principle and Instrument Composition**

### **2.1 Working Principle**

The SDAC6000/SDAC6000u bomb calorimeter adapted the principle of constant temperature oxygen bomb calorimeter, features the jacket water temperature keeping constant and judges the finishing of the test by the bucket temperature changes. Then correct the heat exchange between the bucket and jacket by the cooling correction formula. Semi-conductor chilling is used to cool water tank, which can solve the problem of temperature instability for the bucket when software temperature controlling point changing automatically due to high ambient temperature or raised tank water temperature because of prolonged test time.

Weighing some weight of the sample, place it into the bomb, and fill sufficient oxygen into the bomb, and place the bomb into a bucket with some volume of water, burn the sample completely in the bomb and the heat released by the sample are absorbed by the water around the bomb. Calculate the raised water temperature. When the jacket water temperature is constant, the heat capacity of the absorbing water and other parts in the water is constant. The calorific value can be calculated by the raised water temperature.

### **2.2 Working process**

After powering on and entering the test-control system, the system will do temperature balance automatically, after that the system will enter into test mode. Weigh some weight of sample in the crucible manually. Install oxygen bomb according to standard procedure (Add 10ml distilled water into the bomb and put samples into crucible supporter, fix the firing wire or cotton thread, put the oxygen bomb on the oxygen stand. Input the sample weight in the software, the system will automatically start the test. Test steps: Automatically lower the oxygen bomb, fill oxygen in the oxygen bomb, feed water into bucket and then, bucket begins to stir after finishing feeding. After a time of balancing, the system will enter into the fore-period of the test, then ignite, main period of the test, after-period, calculate the test result, bucket water drain and complete the test process. During the test, the other parts will synchronously or asynchronously control the system.

During test process, if any part of the system works abnormally, prompts message will be displayed on the screen, so that the user can make a simple maintenance.

### **2.3 Instrument Composition**

The SDAC6000 calorimeter is mainly composed of mainframe, thermostatic water tank, oxygen bomb, computer and so on (refer to Fig.2-1). In addition, users can have such optional devices as analytical balance, SD balance weighing software and relevant accessories. SDAC6000U has no automatic oxygen filling or degassing device.

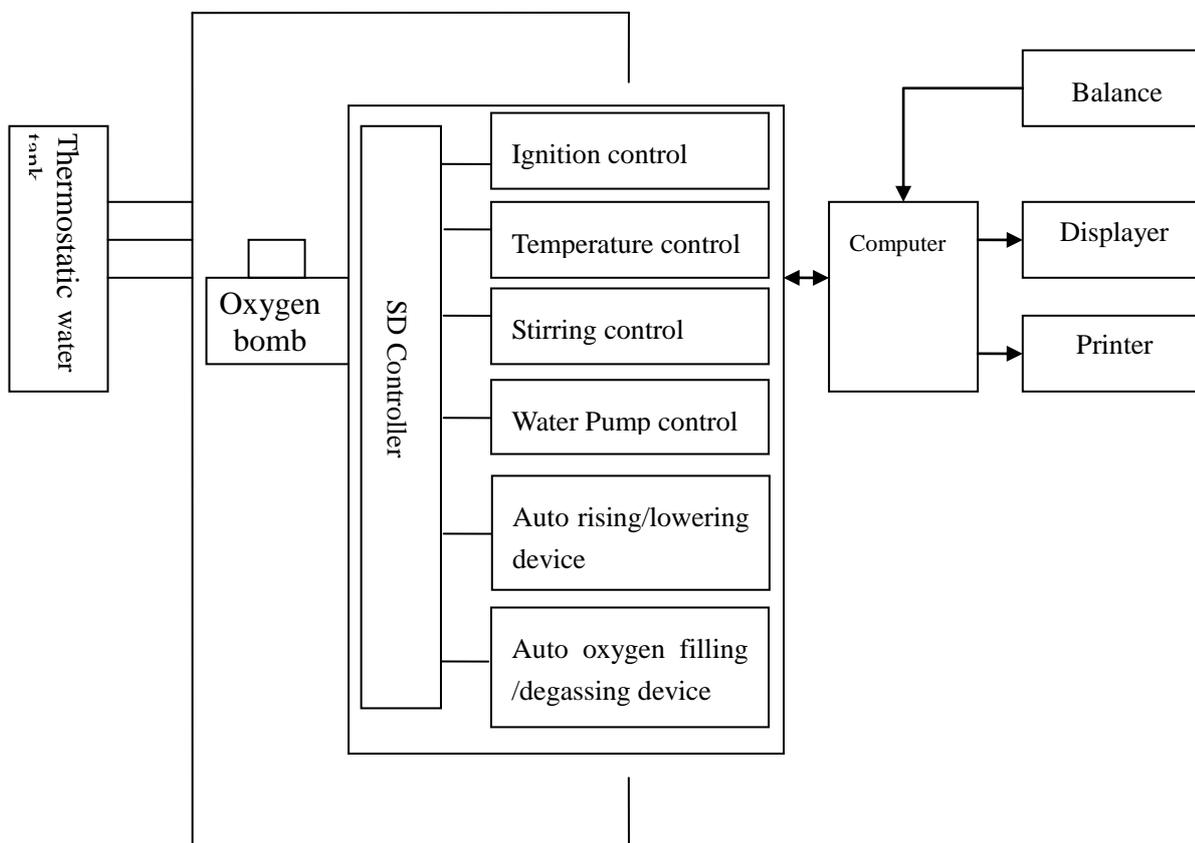


Fig. 2-1 SDAC6000 Calorimeter Composition

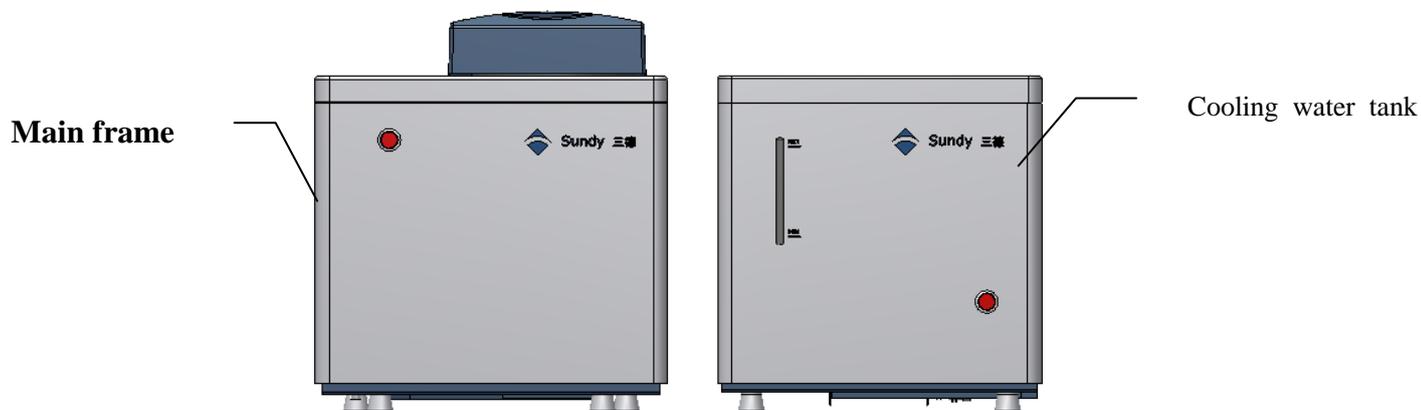


Fig. 2-2 SDAC6000 Calorimeter Appearance

### 2.3.1 Instrument structures

#### 2.3.1.1 SDC calorimeter main frame

SDC calorimeter main frame is composed of bucket, jacket, pump, heating parts, solenoid valve, temperature testing parts, heating parts and other controlling and protecting parts (Shown as Fig.2-3) .

Brief introduction of the internal parts:

1. Frame and shell: Frame and carrier of all spare parts inside the instrument, which structures the instrument appearance.
2. Bucket: Used to contain test water whose volume has been determined by the water level probe.
3. Jacket: Provide a stable environment for the bucket, to avoid the influence of the ambient temperature. The spray stirring way makes sure the outer jacket water temperature controllable and uniform.
4. Pump: is used for whole water circuit system, providing power for water feeding and draining.
5. Solenoid valve: Control water flow and timing during test.
6. Automatic raising or lowering device: After the oxygen bomb is installed in the stand, it will automatically rise or lower during the test.

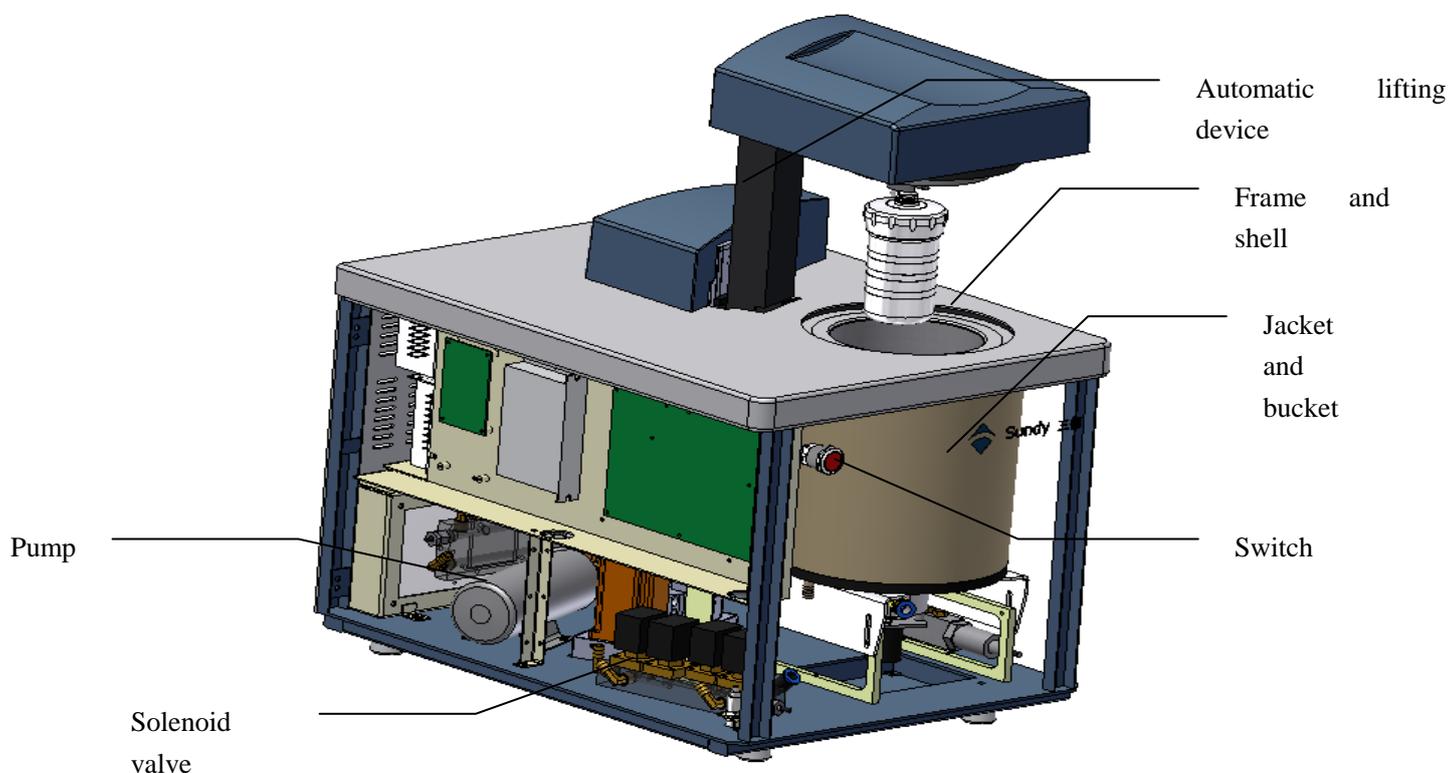


Fig.2-3 SDAC6000 Mainframe (Remove left plate and front cover)

### 2.3.1.2 Thermostatic water tank:

Thermostatic water tank is mainly composed of Semiconductor cooling film, water-storage tank, pump. (Shown as Fig.2-4)

1. Shell: It's the frame of all spare parts inside thermostatic water tank, which structures the instrument appearance with shell.
2. Water-storage tank: Capacity 14L, storing test water for the instrument, equipped with water volume judging device.

3. Semiconductor cooling film: Cooling test water to reach the required test temperature when the temperature is too high.

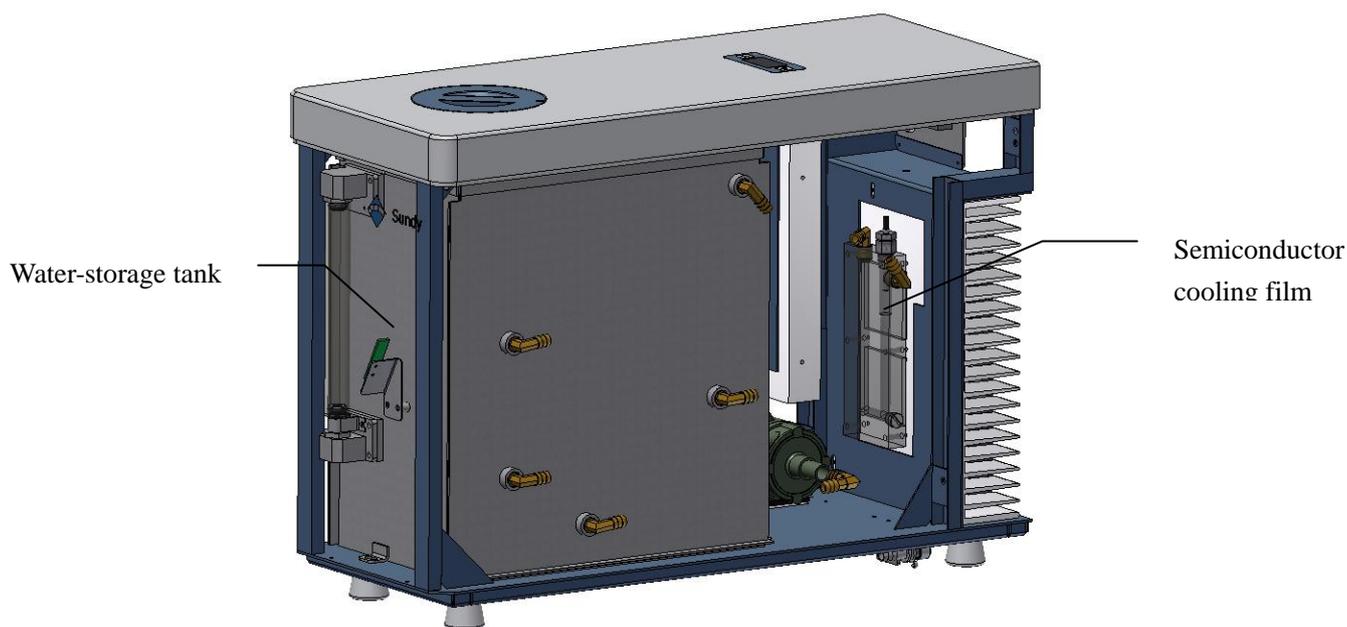


Fig.2-4 Cooling tank (remove shell)

### 2.3.2 Lab supplies and accessories

#### 2.3.2.1 Oxygen bomb (SDYDS6T)

SDYDS6T Oxygen bomb is composed of oxygen bomb core, oxygen bomb lid, oxygen bomb cylinder (Shown as Fig.2-5, Fig.2-6)

Features: Triple-screw oxygen bomb, install firing wire by casing pressure method, which is safe and reliable.

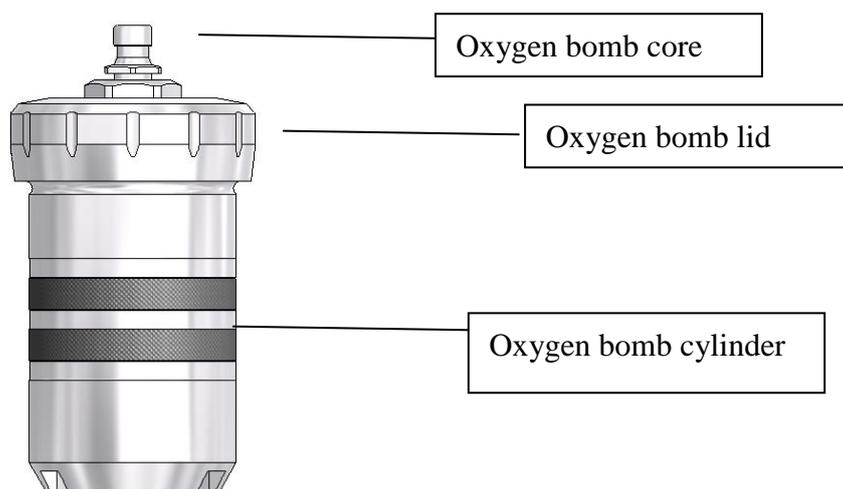


Fig.2-5 SDYDS6T Oxygen bomb appearance

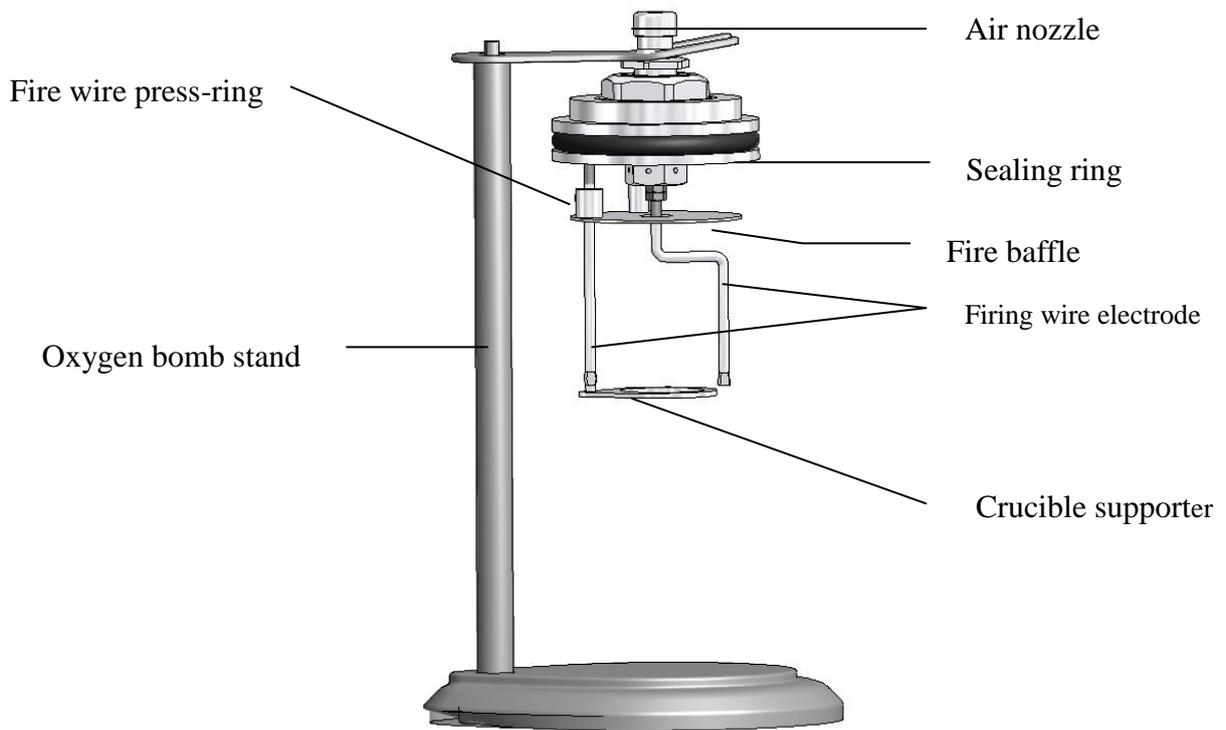


Fig.2-6 Inner structure of oxygen bomb and oxygen bomb stand

### 2.3.2.2 Crucible support and oxygen bomb handle

- Crucible support: can hold 16 crucibles with number, which is convenient for using and managing.

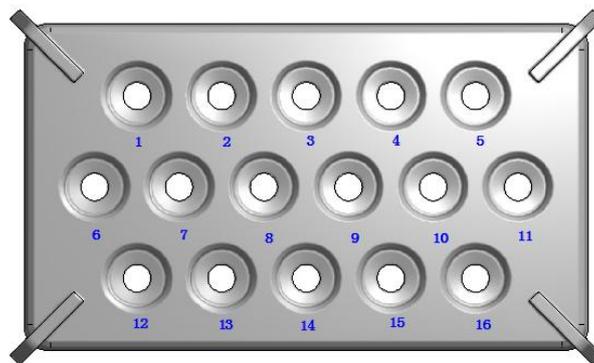


Fig.2-7 Crucible support

**Note: Working temperature of crucible support should not be higher than 60°C, and cannot be baked by drying machine, or else it will get deformed.**

## Chapter 3 System Installation and Debugging

### 3.1 Environment requirement

#### 3.1.1 Working requirement:

1. Room temperature should be stable, in the range of (15~30)°C.
2. No strong interference source or magnetic source around.
3. No strong air convection in the room. So there should not be strong heat source, cold source or fan. And windows or doors should not be opened during test.
4. If air conditioner is installed, set the wind speed to be low and prevent air flow generated by conditioner blows to the instrument directly. It is suggested to turn on air condition to control temperature for 24 hours every day.
5. Protect the instrument from direct sunlight.

#### 3.1.2 Power requisition

1. AC (198~242) V, 50/60 Hz, with good grounded wire.
2. Constant voltage transformer is suggested to be equipped.

#### 3.1.3 Gas requisition

Oxygen: purity $\geq$ 99.5%, Oxygen low pressure gauge pressure (2.8~3.0) MPa. Total pressure of gas source should not be less than 4MPa. It is prohibited to use electrolytic oxygen, oxygen with purity $\geq$ 99.99% is suggested to use.

#### 3.1.4 Software Condition:

1. Operation system: Windows7 Professional /Windows7 Ultimate/Windows10 Professional
2. Basic Configuration:

CPU	Over 2.0GHZ
Memory	Over 2GB
Video card	Standard VGA 1024*768 mode
Hard disc	80 GB required at least
Drive	CD-ROM drive
Other equipment:	Mouse, keyboard

### 3.2 Installation Process

#### 3.2.1 Pre-installation Preparations

1. Prepare suitable special-purpose laboratory, power and oxygen as 3.1.
2. Prepare about 30 Kg distilled water or deionizer water.
3. Prepare analysis balance with resolution not lower than 0.1 mg, and appropriate drying vessels.
4. Prepare nippers, scissors, spanners, screw-drivers, pincers, angle spoons and other basic tools.

#### 3.2.2 Layout

1. Test platform should be stable and reliable. Place the instrument reliably.
2. Typical Layout: Place computer (the host, monitor and keyboard) in the middle and with printer and mainframe of the calorimeter on their left and right side for convenient operation.
3. While connection between the water tank and mainframe of the calorimeter, place the mainframe firstly, and then place the water tank under or on the right side of it.
4. When install the instrument, the mainframe and water tank can be placed by reference to fig3-1. Please note to keep the distance to be 80mm or more between the instrument back plate and the wall. On the left and right sides to keep a distance of 80 mm or more in order to reserve the space for maintenance and inspection.

When the instrument or the thermostatic water tank be moved:

1. Lift up the instrument or cooling tank from the bottom horizontally and carefully, avoid collision or vibration, and put it smoothly on the horizontal support platform.
2. It is forbidden to place the hands on the rubber feet when carry instrument, because your fingers may be nipped when putting the instrument on the table.

### **3.2.3 The connection of the calorimeter**

1. Check the fuse box of the instrument power supply socket to see if the fuse tube has been installed. Check the instrument to see if short-circuiting has occurred among the machine shell, power line and ground line. Check if the voltage at instrument installation site is normal and if the instrument shell is grounded reliably.
2. Open the shell and cover of the calorimeter and take out the sponge and other fillings between the bucket and the shell.
3. Connect main frame with thermostatic water tank: First, connect quick coupling to I/O connector of mainframe and cooling tank, then connect mainframe I/O plate and connector on cooling tank I/O plate on the order from high to low. Shown as Fig.3-1.
4. Turn on the power of computer and instrument, and start to install test software.

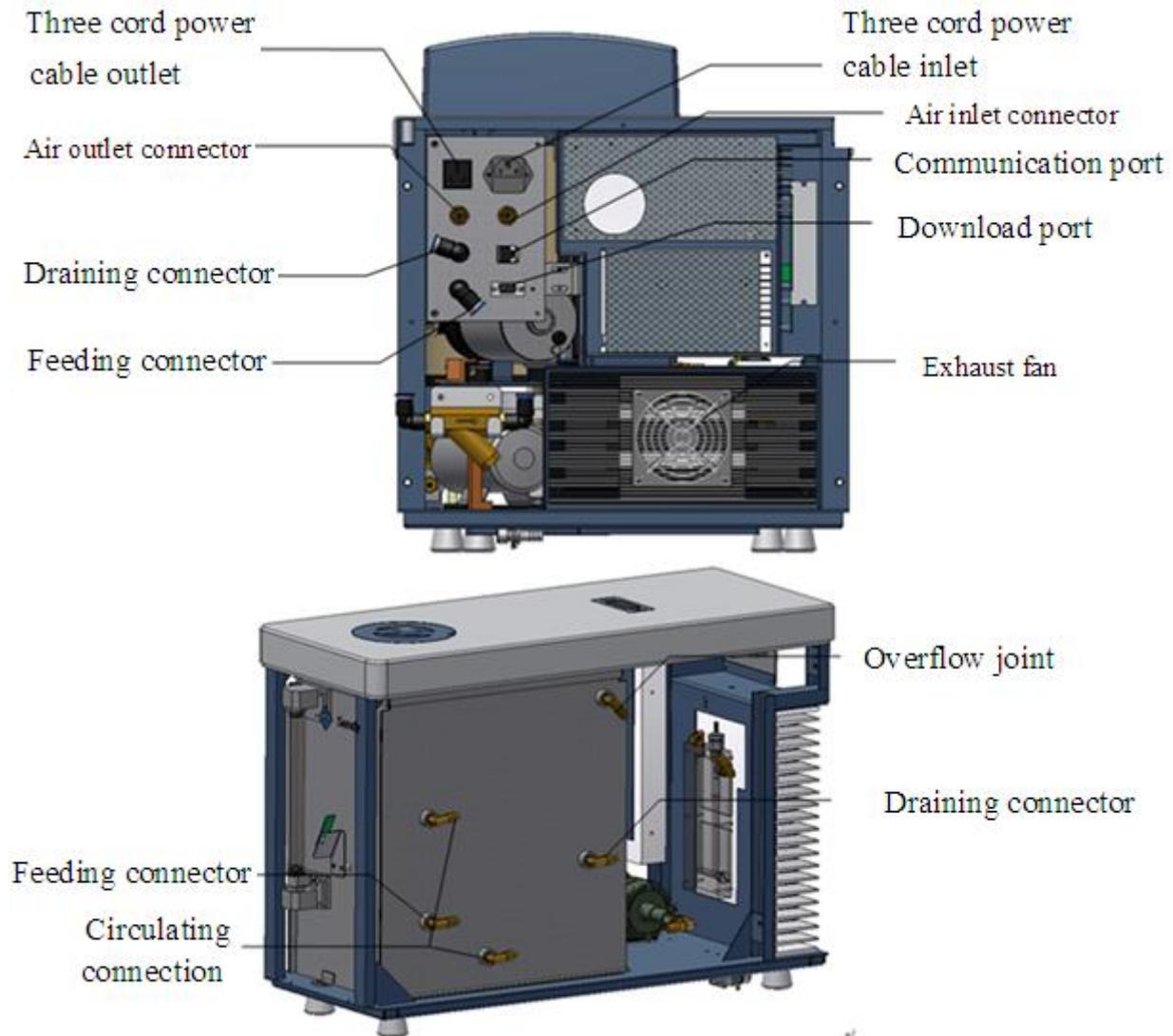


Fig.3-1 Connecting of cooling tank and mainframe

### 3.2.4 Check after installation:

1. Check if all installing parts are fastened well.
2. Check if all external signal cables and power cables are fastened well.
3. Check if all heating circuit is smooth.
4. Check if power and shell are well grounded and if they are in short circuit.

## 3.3 The installation and un-installation of the software

### 3.3.1 The installation of the software

Insert the CD marked “Test-control Software of SDAC Calorimeter” into the CD-ROM. Use “Resource Manager” to find CD-ROM and open it. Find “Sundy.exe” icon under root directory. Double click “Sundy.exe” icon, install the program of SDAC Calorimeter according to the prompt. After finishing the installation, the system will generate the shortcut of SDAC Calorimeter on the desktop.

After finishing the above steps, the software has been installed.

### 3.3.2 The uninstallation of the software

Click “Start” on the taskbar →“Control Panel” →Double click “Add/Delete Program” to open this window→Choose “Change or Delete Program” label, then click “SDAC Calorimeter” in program group→Click “Delete” button to unload the program. Program group and shortcut of SDAC6000 calorimeter system can be deleted safely and quickly according to the prompts on the screen. However, related parameter files and database files of SDAC calorimeter system couldn’t be uninstalled and will remain in the operating system.

### 3.3.3 Setting the online IP

1. Install the Sundry network card on the PC and set the IP address as 192.168.77.10;
2. Click “Start” on the taskbar →“Programs”→ “Sundry” →“SDAC Calorimeter” then choose the “IP address setup tools” to enter the window of common setting as shown as fig3-3.

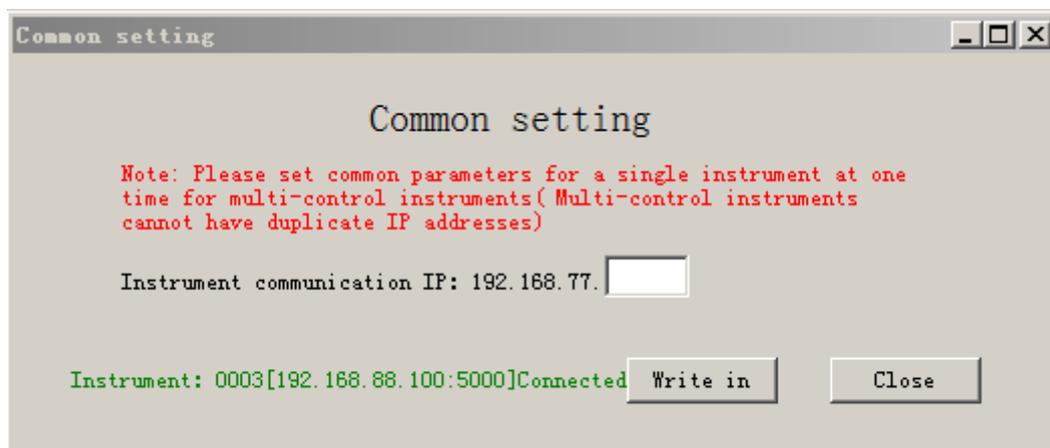


Fig3-2 communication parameter setting

Turn on the instrument, and set the IP address. Input the number 2-9 or 11-253 in the box. Click “Write in”. After the success of the read, the following window will prompt.

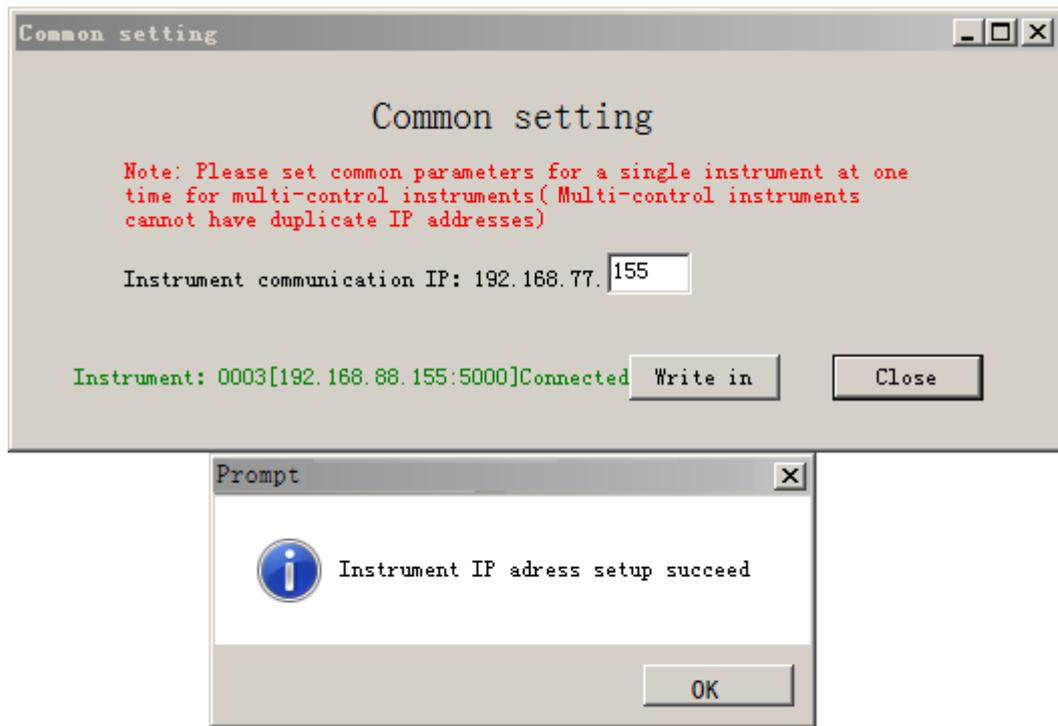


Fig3-3 Communication parameter settings

Note:

- ✧ When setting the communication parameters, only single instrument can be online. For multi-control instruments, it should be set separately.
- ✧ IP addresses for multi-control instruments cannot be repeated.
- ✧ Host and subordinate computer software must be used compatibly.

### 3.4 Debugging

After the installation of the hardware and software, fill sufficient water into the water tank, and then enter into the debugging step. Double click the icon of the “SDAC Calorimeter” on the desktop to enter into the test-control program, click “Tools” on the menu bar→ “System test” to do the following operations:

#### 3.4.1 Jacket water feeding test

Click “Jacket water feeding”, the system will automatically fill water into the jacket and the lid in a spiral circulation way(At the same time, please check if the operations of the pumps and valves are correct, and if there is any water leakage at the connection of the tubes) . When the water spills from the warning pipe of the jacket, it means that the jacket is fully fed. Click “stop water feeding” to stop water feeding and then click “Jacket stirring” to circulate the jacket water for about 5 minutes and check if the pumps and valves perform correctly and if there is any water leakage from the connections of all the water pipes.

#### 3.4.2 Bucket water feeding test, Bucket water draining test and Bucket stirring test

Click ‘Bucket water feeding’ → ‘Bucket stirring’ → ‘Bucket water draining’, after repeating it

for three times, check if the water pressure is normal, if the pumps and valves are correctly operated, if there is any water leakage at the connection of the tubes. If everything is in order, click “Bucket water feeding”, observe if in bucket inlet tube there is any water leakage at the joint. Then click ‘Bucket stirring’, check if the stirring is in order. After that, click ‘Bucket water draining’, Check if the pumps and the valves are correctly operated, if the bucket can be drained completely and if there is any water leakage at the joint.

### 3.4.3 Automatic oxygen filling, automatic oxygen degassing test

Click ‘Automatic oxygen filling’, the system will lower the oxygen bomb automatically and fill oxygen for it. Observe if there is any air leak (Caused by misalignment between the oxygen filling needle and the oxygen filling nozzle or o-ring off/worn). Click ‘Automatic oxygen degassing’, the program will automatically process oxygen degassing to raise the oxygen bomb, then remove oxygen bomb and observe if the oxygen has been degassed completely.

### 3.4.4 Jacket temperature controlling

Click ‘Jacket temperature controlling’, the system will start control the temperature according to the temperature point set in ‘Tools’ – ‘Setting’ – ‘Specific setting’ – ‘Jacket temperature controlling point’. At the same time, start jacket stirring, observe whether the program control temperature is in line with the setup temperature point, if the jacket stirring is normal.

### 3.4.5 Check the water level

After feeding water test for the jacket, check if the water volume is suitable. Generally, suitable level is 10mm lower than the highest water level of water tank, and the highest water level line is shown as Fig3-5.

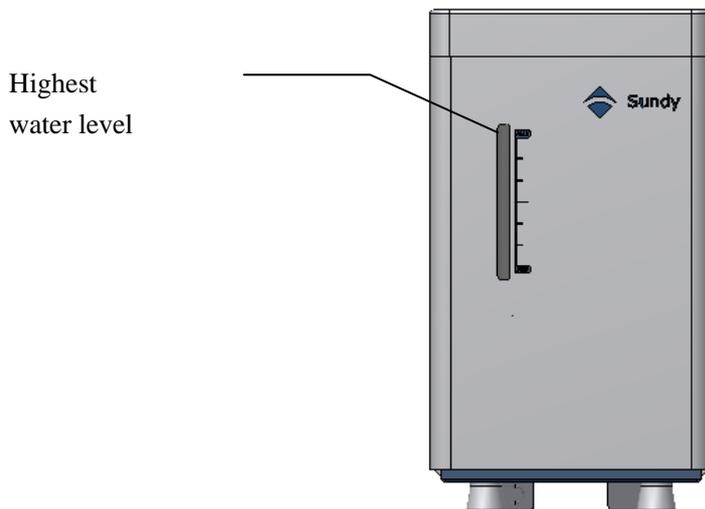


Fig.3-5 Thermostatic water tank

Note:

- ✧ The debugging technician should check the water level before the end users operate it.
- ✧ No need to add water every day. Add water according to system prompt information and pay attention to check if the water level is suitable.

## 3.5 Usage of Oxygen Bombs

### 3.5.1 Pre-use Check

Strict quality inspection has been done for oxygen bomb before delivery. It is unnecessary for the user to dismantle it. But quality re-inspection is essential. Following items shall be checked:

1. Check if the bomb is clean, if there is any scrap irons, greasy dirt or impurity.
2. Check oxygen nozzle and the insulation sleeve of the bomb core to see if it's loosened.
3. Check if the electrode rods are loosened and fire baffles (round stainless steel sheet) are tightly fixed.
4. Check if the crucible support is properly fixed.
5. Check if oxygen inlet hole is smooth passage (bomb core).
6. Check the threads on oxygen bomb cylinder and bomb cover as well as sealing rings are with foreign matters.
7. After oxygen is filled, put the oxygen bomb into water. In case of bubble observed, it means that this oxygen bomb leaks.
8. Check the bomb appearance if there are collision traces

### 3.5.2 Use of Oxygen Bomb

1. Hang the oxygen bomb core onto the bomb support.
2. Put the crucible with sample in it on the crucible support, then connect both ends of firing wire with two electrode rods of oxygen bomb and press them tightly by gland ring. Firing wire is prohibited to contact crucible or break. If using cotton ignition, 10 cm long thread shall be wrapped on the ignition wire
3. Bend the wire to circular arc shape to make firing wire close to or slightly contact sample (leave a space of 1~2mm). Do not insert the firing wire into coal if the sample is easy to splash or flammable.
4. After firing wire is installed, stably place the oxygen bomb core into oxygen bomb cylinder filled with 10ml of distilled water (Optional) , and fasten the oxygen bomb cover.
5. Stably place the oxygen bomb filled with sufficient oxygen into the bucket of instrument, and then fasten the bucket cover.
6. After test, open the bucket cover and take out the oxygen bomb, then release residual oxygen from oxygen bomb through release valve and wash it by the distilled water or deionized water, make sure there is no firing wire and dirt left in it. At last, clean the parts of the bomb by the bomb towel.

#### Caution:

- ✧ **Every oxygen cylinder and oxygen bomb core is fixed matching, random matching installation is strictly prohibited.**

- ✧ Please handle the bomb with care.
- ✧ Fire baffle is forbidden from short-circuiting to two electrode rods.
- ✧ Oxygen bomb must be cleaned and wiped up by a special-purpose towel before and after each test.
- ✧ Before installing firing wire each time, completely clean the firing wire and other foreign matters remaining on electrode rods and inside the gland ring.
- ✧ It is forbidden to fill oxygen at over pressure (normal pressure 2.8~3Mpa)
- ✧ Oxygen bomb cover shall not be over-tightened. After it reaches the position, slightly fasten it.
- ✧ Inspect oxygen bomb for quality at regular interval. Carry out hydraulic test at least once a year (to be presented to Sundy for inspection and testing).
- ✧ Restart the device if the ignition way is changed.

### 3.6 Automatic oxygen filling or degassing

#### 3.6.1 Installation and inspection

1. Carefully inspect each component for fixing is tightly fixed and appearance without damage before installation.

2. Connect the regulator, oxygen cylinder and oxygen filler as per Diadram.3-6. Then fasten the lock nut.

3. Turn on oxygen cylinder main valve, regulate pressure-regulating screw lever on pressure reducer to make low pressure gauge reading be 2.8~3Mpa. Be sure of no leakage throughout the gas circuit, otherwise it shall be re-installed until normal pressure is indicated.

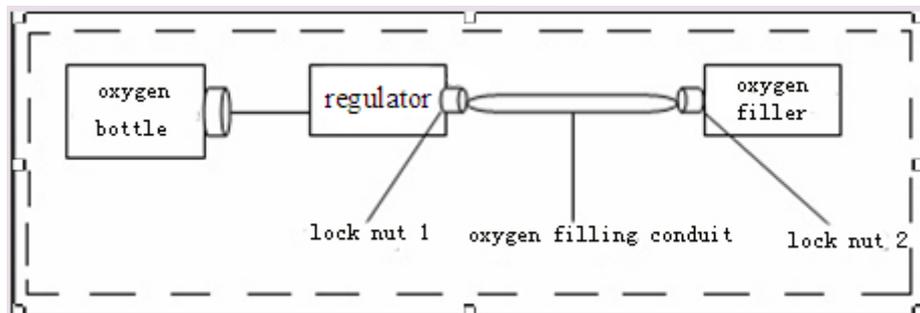


Fig. 3-6

#### Caution:

- ✧ The oxygen filling connector must be connected to the oxygen cylinder according to the diagram strictly.
- ✧ After finishing the test, turn off oxygen main valve and release residual oxygen from the circuit after test completion each day (Method: turn off oxygen cylinder valve for oxygen-filling through oxygen bomb up to zero indication by oxygen pressure gauge).
- ✧ Fire and smoke are prohibited at oxygen filler and oxygen cylinder disposition site.

- ✧ **Never bend and twist oxygen filling conduit.**
- ✧ **Don't use any oil or grease in nuts at the connections in whole oxygen circuit.**

### 3.7 Online test

After overall completion of hardware and software installation, cover the shell and carry out system on-line test. If no abnormal matter happens, it will be regarded as installation completion after testing a group of qualified heat capacity and calorific value test. If not, carry out itemized inspection of hardware installation and software setup according to malfunction-shooting procedure. Carry out correct malfunction-shooting or reinstallation just in case.

Do repeat tests for 5 times for heat capacity calibration, calculate average values and relative standard deviation of repeat test results for 5 times. And the relative standard deviation should be less than 0.1%. If relative standard deviation is over 0.1%, do test once again. And take the average value of five results which can meet requirements as the heat capacity of this instrument.

Repeatability limit and Reproducibility critical difference of calorific value test is shown as follows:

Repeatability limit and Reproducibility critical difference

Gross calorific value (J/g)	Repeatability limit	Reproducibility critical difference
	$Q_{gr,ad}$	difference $Q_{gr,d}$
	120	300

## Chapter 4 Test Software Usage

(This section describes the SDAC6000 bomb calorimeter as an example, and the SDAC6000U bomb calorimeter is similar.)

### 4.1 Start-up and exit of Test-control Software

#### 4.1.1 Start-up of Test-control Software

1. Important information: When installing the calorimeter control software and starting the instrument at the first time, the system will pop up a selection dialog box regarding the calorimeter model automatically (as shown in figure 4-1). The debugging personnel please check according to the user's actual purchase model, and click ok.

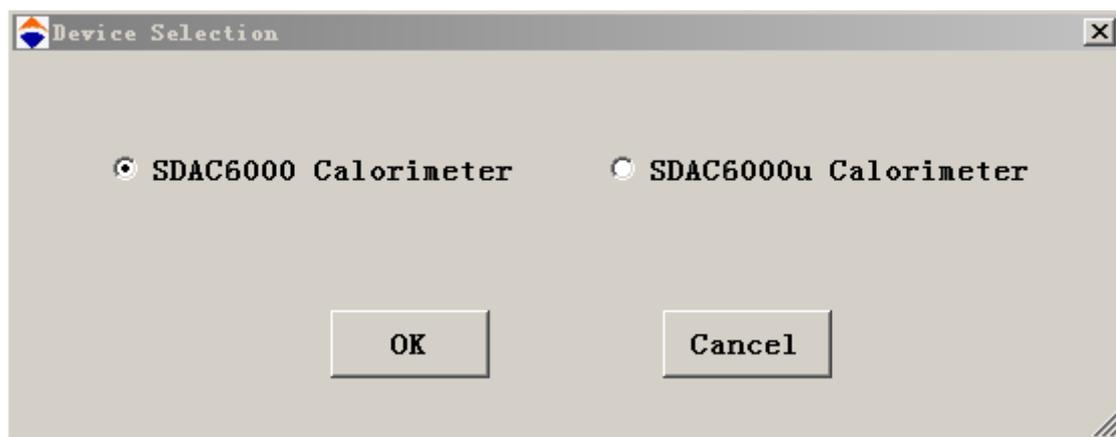


Fig 4-1 Instrument model choosing interface

2. To start up the test-control software of SDAC6000/SDAC6000U calorimeter: After setting up of test-control software a shortcut will be automatically generated on Windows desktop and menu item in Windows program group. Directly click the shortcut named “SDAC calorimeter”, or start up from “Start-up-> Program-> SDAC Calorimeter”.

#### 4.1.2 Exit of test-control software

Before Windows Exit or computer shutdown, exit the test-control system to ensure no damage to the test data and parameter files.

1. Click “Exit” menu under “System” main menu to Exit SDAC6000/SDAC6000U calorimeter test-control software and return to the desktop.
2. Click “Shut down Computer” under “System” main menu to Exit SDAC6000/SDAC6000U calorimeter test-control software and Windows directly, besides it will automatically shut down computer.

### 4.2 Main window frame functions

The main window body of SDAC6000 calorimeter test-control system is mainly composed of headline column, quick push-button column, window body and status column.

Fig. 4-2 shows the main interface of SDAC6000 calorimeter. Parameter entering interface is shown as Fig.4-3, 4-4.

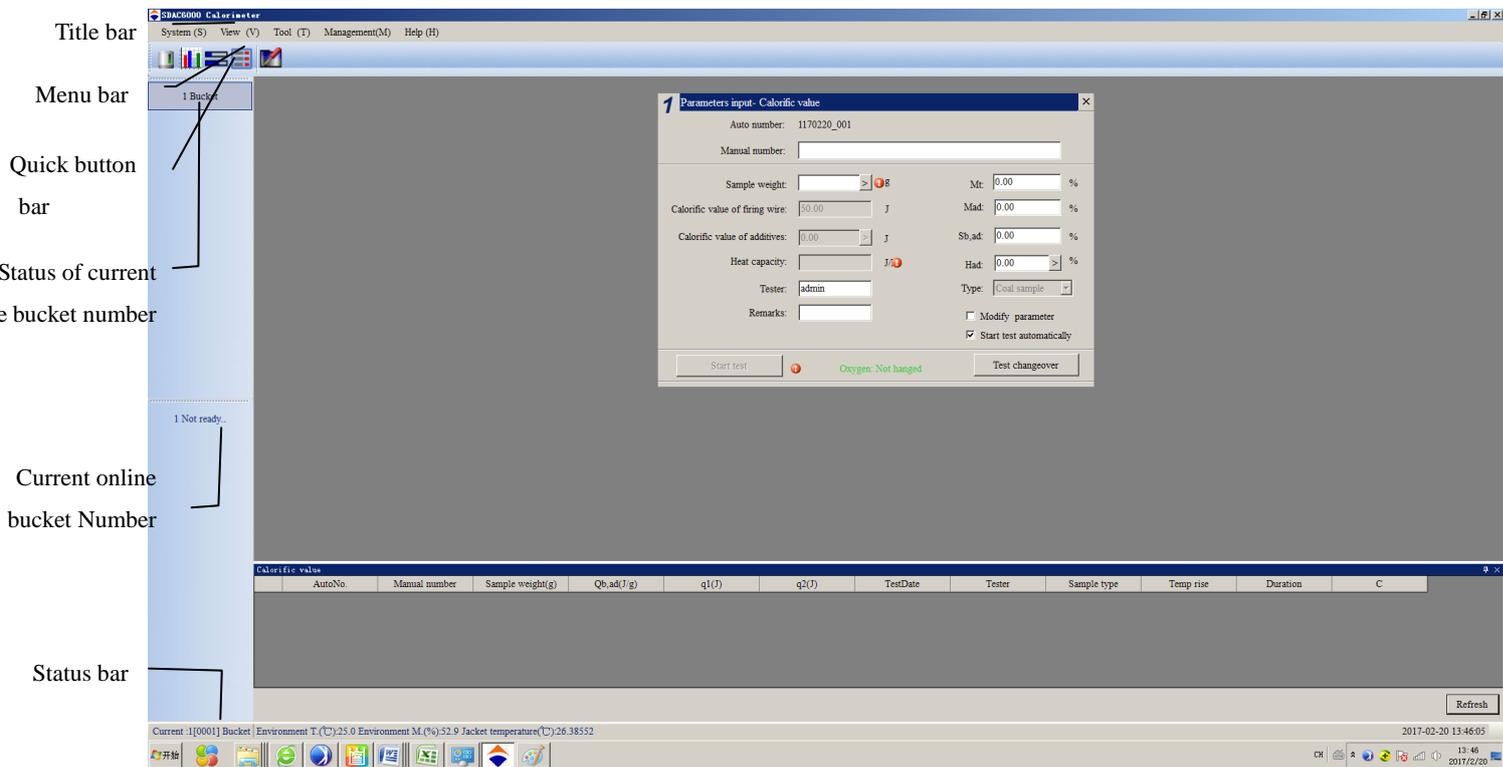


Fig. 4-2 Calorimeter main window

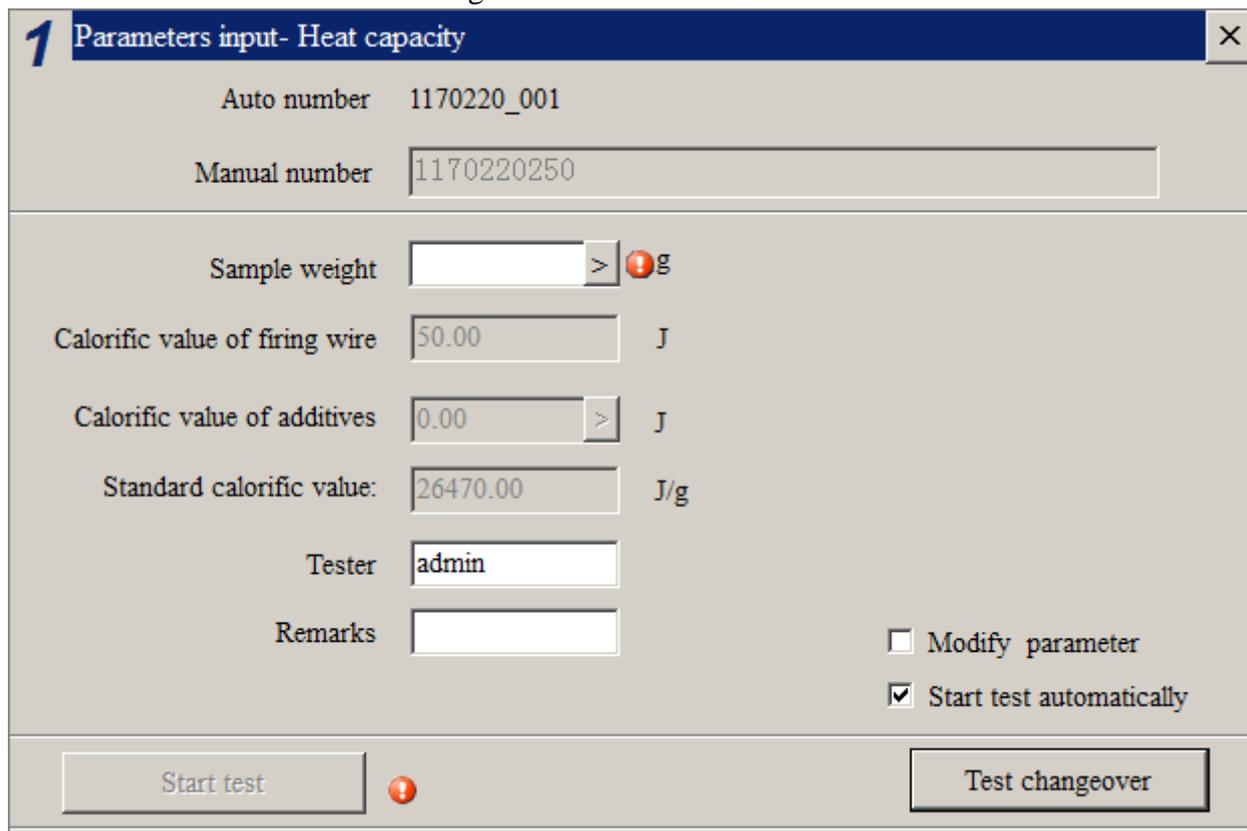


Fig. 4-3 Heat capacity parameter input window

Fig. 4-4 Calorific value parameters input window

**Description of parameter input window:**

1. Automatic coding with values as "bucket No. (1-digit) + year (2-digit) + month (2-digit)+date(2-digit)+sample number(3-digit)". During heat capacity test, it is unnecessary to input the manual number, which will be generated by the system itself. Manual number is composed of "bucket" No.(1-digit) + year (2-digit) + month (2-digit) + date (2-digit) + jacket control temperature (2-digit) + oxygen bomb number (default number "0")". Manual number of calorific value test consists of at most 50 characters (one Chinese character or letter is implied as one character).
2. Sample weight: Can be input manually or click ">" to send the sample weight of the "weight management" window to the sample weight column.
3. Input of Calorific value of Additives: When the test sample contains additives, you can input the calorific value of additives directly, or you can click ">" button in "Calorific value of Additives" input frame. A window as shown in Fig. 4-5 will appear. Input the additives weight, then click "OK". System will automatically convert the additives weight into calorific value of additives and transmit this value to the input window of calorific value of additives. Clicking "Cancel" will return to parameter input window directly and no conversion will be done.

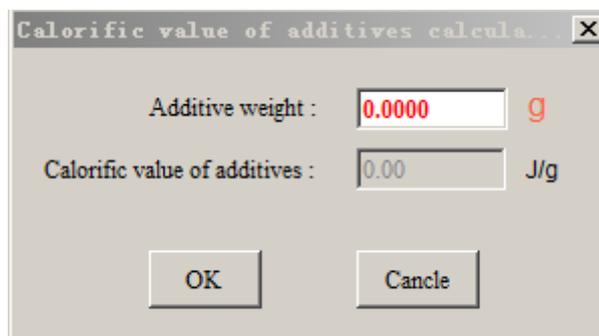


Fig. 4-5 Additives calculation

4. Input of Had: You can input Had value directly, or you can click “>” button in “Had” input frame. As shown in Fig. 4-6, you can input Mad, Vat and Aad, then click “OK”. System will automatically calculate Had according to empirical formula and transmit it to Had input window. Clicking “Cancel” will return to parameter input window directly.

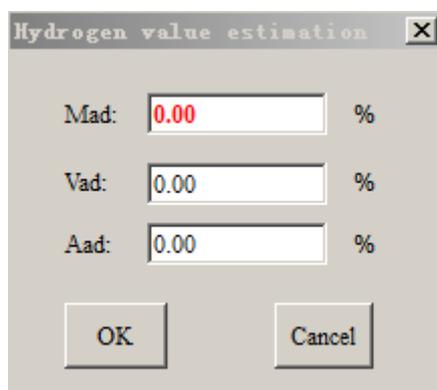


Fig. 4-6 Hydrogen value estimation

5. Type: Different types of samples can be selected for testing, and the corresponding quality of different types of samples is limited. For example, if the type is biomass, only the sample weight of (0.3~2.5) is allowed to input.
6. Test Changeover: Clicking this button before test can shift between calorific value test and heat capacity test. Changeover is prohibited during test.
7. Start Test: After load the oxygen bomb and enter the sample weight, click on this button, the system will enter the test state automatically. At the same time, the button will change into “stop test” . “Stop Test”: During the test, if click this button, the test will be stopped after confirmation.
8. Automatic test: Check "Automatic test" in the parameters input window, in the parameter setting - common parameters setting interface, check "Judge whether there is oxygen bomb ", and in the Settings-Parameter setting- Sub control set the interval time for starting test automatically, load the oxygen bomb, and input the sample weight. After the set interval time, the test will begin automatically.
9. Modify parameters
  1. You can modify the test sample weight, remarks, manual number, calorific value of

ignition wire, additive, CRM, test type, etc. This modification is valid before test result is obtained.

2. If a wrong parameter or no parameter is input, the system will display a red mark. Use the mouse to point at this mark to get the related information on allowable input range. After correct parameter is input, the red mark will disappear automatically.

### 4.3 System Main Menu

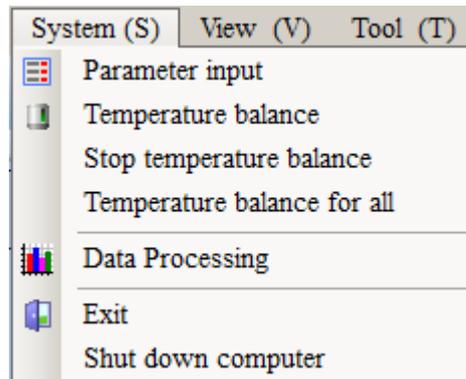


Fig. 4-7 System main menu

System main menu is mainly composed of parameter input, temperature balance, stop temperature balance, data processing and exit etc.

1. Parameter Input: If you choose this submenu or click “Parameter Input” button in quick button column, system will automatically open the parameter input window of current selected bucket.

2. Temperature Balance: If you choose this submenu or click “Temperature Balance” button in quick button column, system will automatically conduct temperature balance for the current selected bucket.

3. Stop Temperature Balance: If you choose this submenu, system will stop temperature balance for the selected bucket.

4. Temperature Balance for All: If this submenu is selected, the system will start temperature balance for all the calorimeters that are online normally.

5. Data Processing: This system is designed to manage the test data better and more effectively. It includes the management of heat capacity data and calorific value data. During test, it is allowed to login the database. Choosing this submenu or clicking “Data Management” button in quick button column can enter the window as shown in Fig. 5-2. Details refer to Chapter 5.

6. Exit: If you chose “Exit” menu or click “Exit” button in quick button column, you can exit the test system.

7. Shut down Computer: If you choose this menu, you can not only exit this test system, but also you can exit windows system and automatically shut down the computer.

## 4.4 View Main Menu

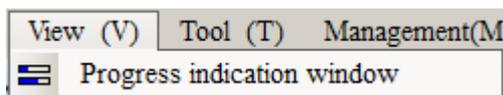


Fig. 4-8 View Main Menu



Fig 4-9 Progress bar

Progress Indication Window: Clicking this menu once will open this window, which is displayed in main window (Implicit position of progress window is the leftmost row). This window displays all bucket numbers which are on-line with system and their running status of each bucket during test. If you click this menu once again, this window will automatically close.

## 4.5 Tool Menu

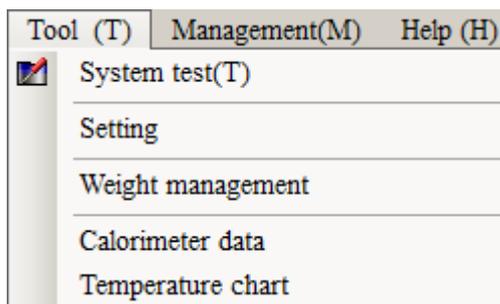


Fig. 4-10 Tool Menu

### 4.5.1 System Test

After you choose this submenu or click “system test” button once in quick button column, system will enter login window ( as shown in Fig.4-10), where you can test each functional parts of the system.

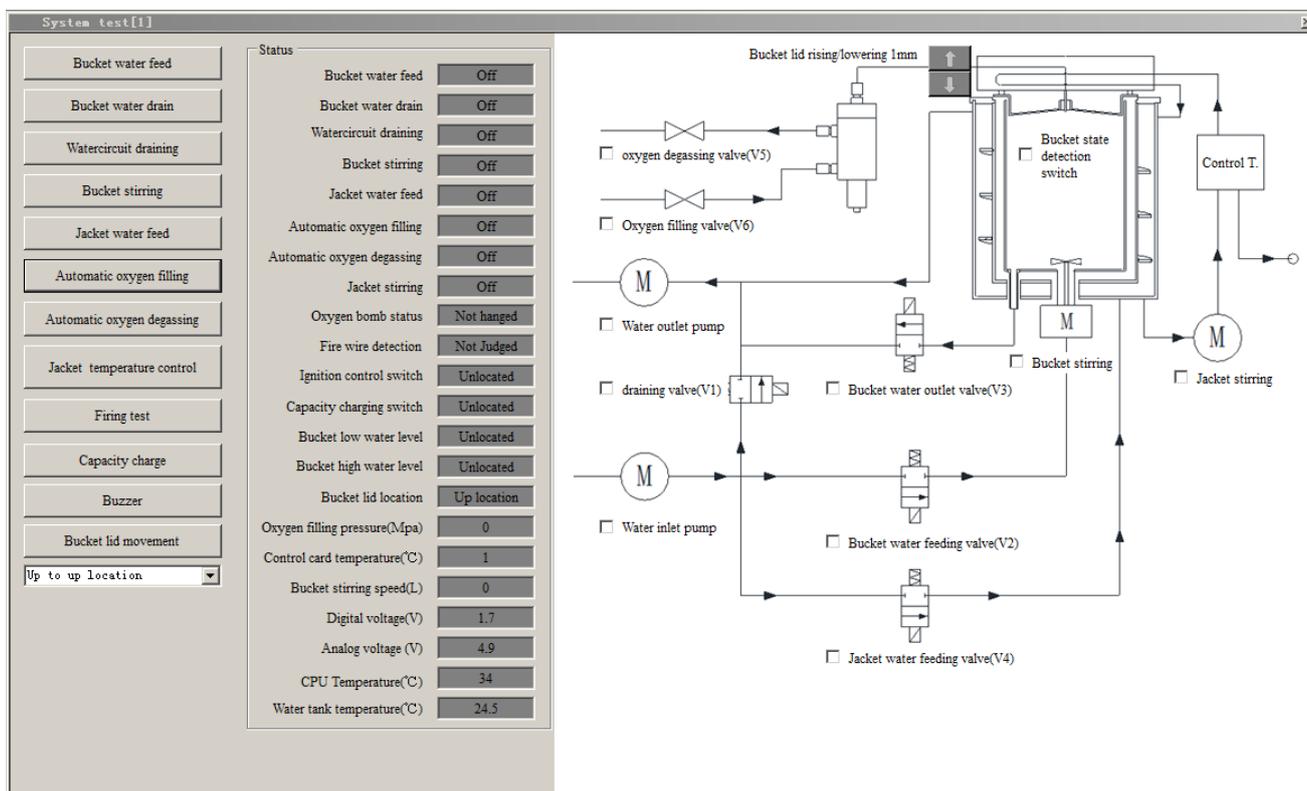


Fig. 4-11 System test interface

Detail Description of System Test:

1. Bucket water feed: Click this button, system will feed water into water tank from bucket. Then it will drain water from the water tank into the bucket. The button will change into “Stop bucket water feeding” at the same time. Click the button again, it will stop feeding water.
2. Bucket water drain: Click this button, the system will drain water from bucket to water tank. The button will change into “Stop bucket water draining” at the same time. The process will last about 50S and stop automatically. Click the button again, it will stop bucket water draining.
3. Water circuit draining: Click the button, the system will process water circuit draining automatically, and the button will change into “Stop water circuit draining” at the same time. Click on the button again, it will stop draining.
4. Bucket stirring: Click this button, the system will start bucket stirring automatically and button will change into “Stop bucket stirring” at the same time. Click the button again, it will stop stirring.
5. Jacket water feeding: Click this button, the system will start jacket water feeding automatically, draining water from the water tank into the jacket. The button will change into “Stop Jacket water feeding” at the same time. The process will last about 100s and stop automatically. Click the button again to stop the jacket water feeding. If temperature equilibrium has finished, it cannot process jacket water feeding.
6. Jacket temperature controlling: Click this button, the system will start control the jacket temperature according to the set temperature point in Tools-Setting-Specific control- Jacket temperature controlling point, and start the jacket stirring at the same time. After clicking on the button, it will change into “Stop jacket temperature controlling”. Click on the button again, it will stop.
7. Automatic oxygen filling: Click this button to lower the oxygen bomb to down location, then automatic oxygen filling will start. At the same time, the button will change into “Stop automatic oxygen filling”. Click on the button gain, it will stop.
8. Automatic oxygen degassing: Click this button to degas the oxygen from the oxygen bomb, lift the oxygen bomb to up location. The button will change into “Stop automatic oxygen degassing” at the same time. Click this button again, it will stop automatic oxygen degassing.
9. Ignition control: Click the button, there will be a short buzzing indicating that a ignition instruction has been processed..

10. Capacity charge: Click the button to charge the capacitor and the button will change into “Stop capacity charging” at the same time. Click the button again, it will stop capacity charging.
11. Buzzer: Click the button, can hear the buzzer give a long buzzing.
12. Bucket lid movement: To move the bucket lid upward or downward. There are four types of positions for choosing which are “Up to up location”, “Up to initial position”, “Down to down location”, and “Down to initial position”. Click on the button, it will change into “Stop lid movement”. Click the button again lid movement will stop.

In order to ensure system safety, system automatically locks some related operations while conducting one operation. After this operation is completed successfully, system will automatically release them.

#### 4.5.2 Setting

This menu can be used to setup testing parameters in the main interface. It is divided into common setting option lab (Fig. 4-12-1) and specific setting option lab (Fig. 4-12-2), Weighting manager read configuration tab (Fig. 4-12-3).

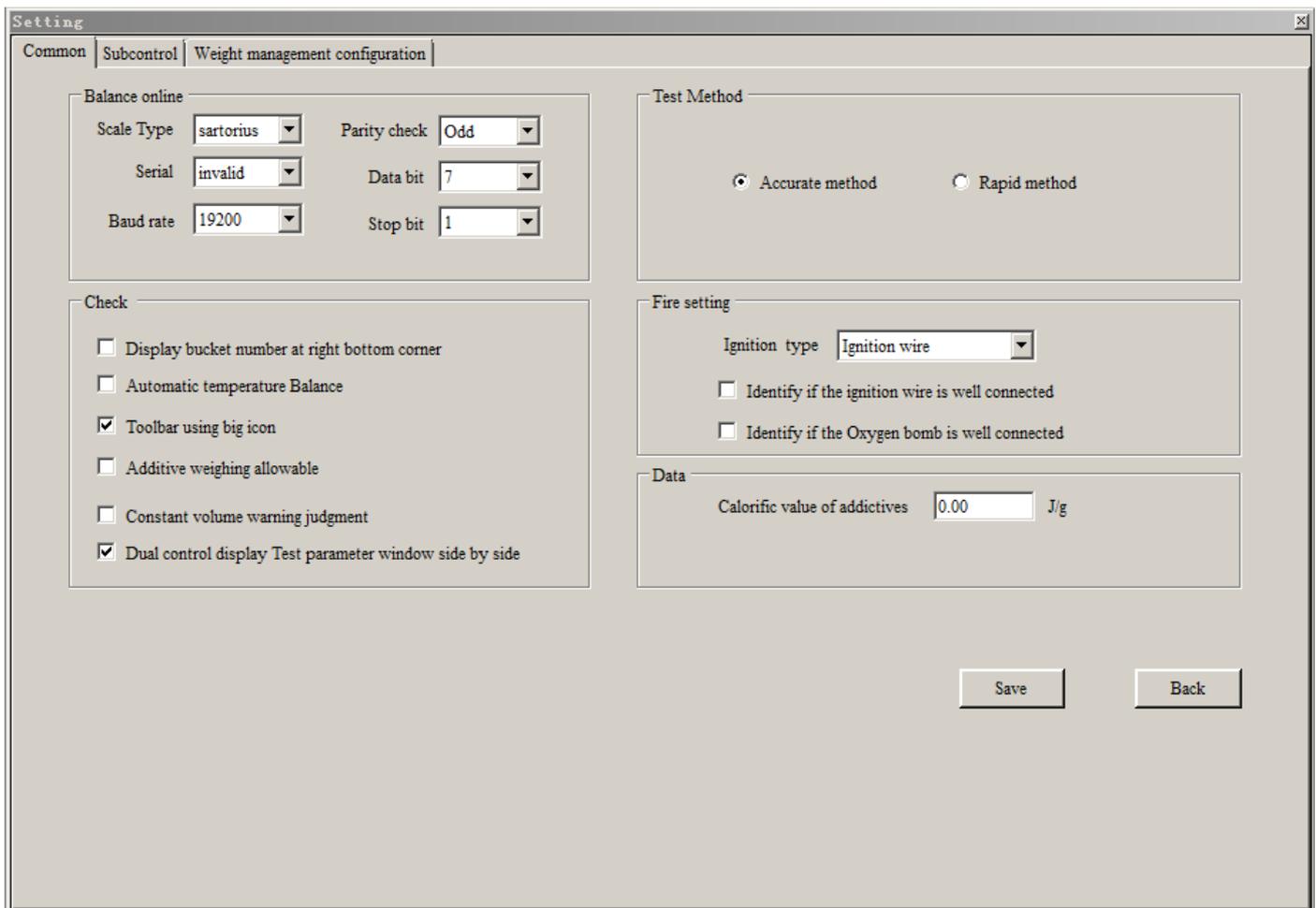


Fig. 4-11-1 Common setting interface

#### Description of Common Setting:

1. Balance online:
  - 1) Serial port setting: Serial port of the computer and the balance. Please set COM as the serial port for the communication between the computer and the balance.
  - 2) Baud rate: For this parameter, please refer to the code of the balance menu, make sure the baud rate of the code can be in conformity with the software (Such as Sartorius balance, code 514 refers to Baud rate 1200, code 515 is 2400, code 516 is 4800, code 517 is 9600 and code 518 is 19200).
  - 3) Parity check: Please refer to the code of the balance menu.
  - 4) Data bit: Please refer to the code of the balance menu.
  - 5) Stop bit: Please refer to the code of the balance menu.
2. Multiple-choice: Choose the desired items and Exit after saving
  - 1) Display bucket number at right bottom corner: If you choose this option, number of current bucket will be displayed at right bottom of main interface.
  - 2) Automatic Temperature Balance: After you start the test-control software, system will check the running status or conditions firstly to see if they are normal or meet the requirement, then it will automatically conduct temperature balance, otherwise automatically temperature balance will not be carried out.
  - 3) Toolbar using big icon: you can change the size of tool column icon.
  - 4) Allow weighing additives: If checked, it will allow weighing the additives in the weight management interface.
  - 5) Constant volume warning judgment: If checked, it will make constant volume early warning judgment. Water level probe failure will be reported as "Constant volume warning".
  - 6) Dual control parameters input windows display side by side: Select this option, dual control parameters input windows will display side by side in the software interface. Otherwise only a single control parameter input window will display and to switch to dual control parameters input window, it needs to click on the bucket number in the status bar.
3. Data: Calorific value of additives. If you input or modify the calorific value of additives and save it, calorific value of additives in calculation window of calorific value of additives (Fig.4-4) will change correspondingly. If you input the additives weight in this window, system will automatically calculate the calorific value.
4. Test mode: There are two optional test mode, precision mode and fast mode, customer can choose the test mode accordingly.
5. Ignition setting:
  - 1) You can choose the ignition wire or cotton thread ignition. Changing ignition mode

setting will take effect after rebooting the device.

- 2) Identify if the ignition wire is well connected or not: Judge the oxygen bomb open circuit or not. If ignition wire is not connected well, there will be a prompt information that oxygen bomb is open circuit, click “OK” , the prompt information will be disappeared.
- 3) Judge whether there is oxygen bomb: To judge whether the oxygen bomb is hanged before the experiment. If there is no oxygen bomb hanged, the system will give prompt information that there is no bomb, click “OK” , the prompt information will be disappeared.

**Note: To change the above settings, please click "save" button to make it active.**

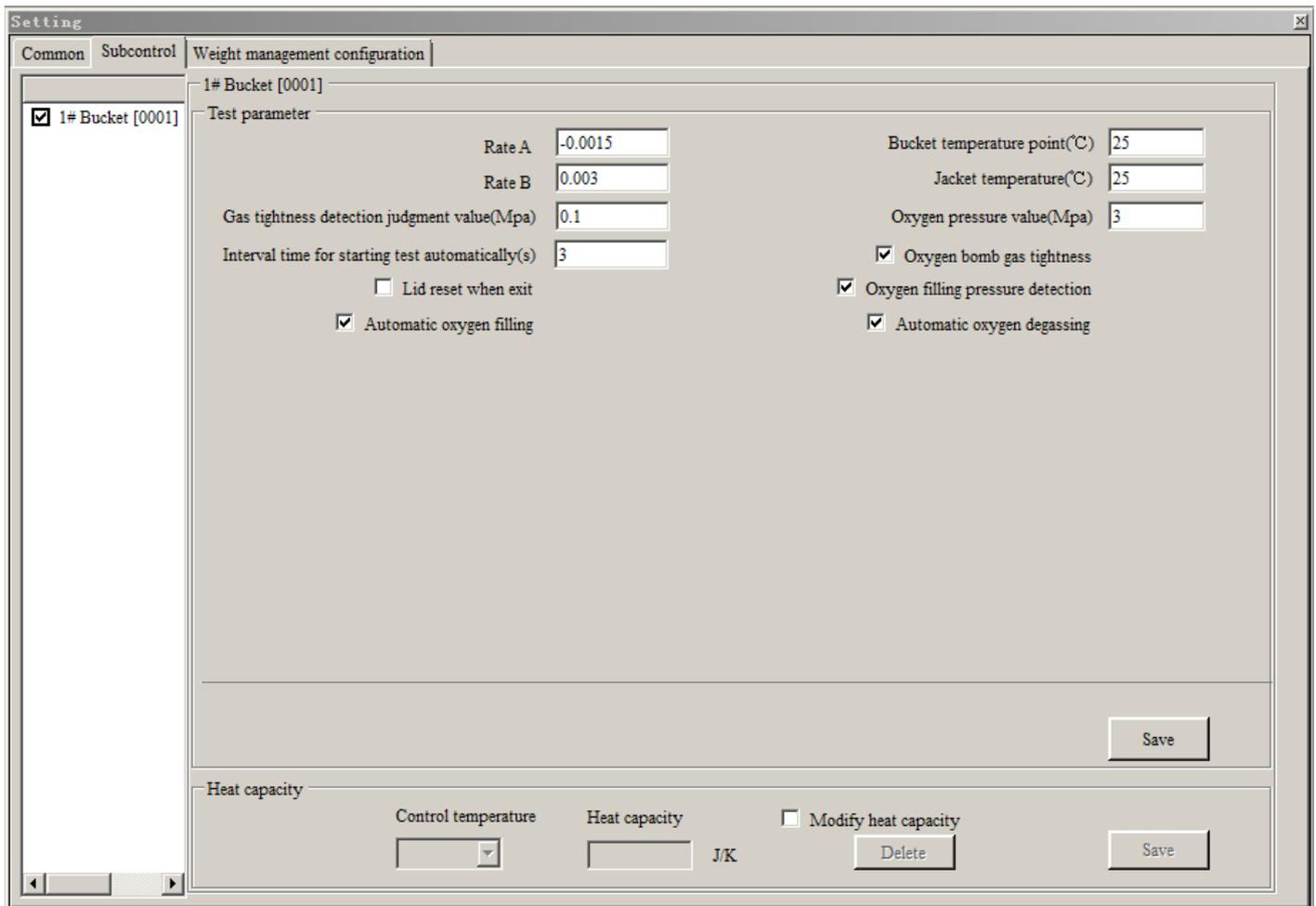


Fig. 4-11-2 Sub-control setting interface

### Description of Sub-control setting:

In sub-control setting, you can separately set several buckets. As shown in Fig. 4-11-2, if you choose No.1 bucket multiple-choice frame, you can modify the related test parameters of No.1 bucket. Now, we introduce the sub-control setting in detail as following:

#### 1. Test Parameter

Rate A, Rate B: After parameter test can meet the requirements, system will update A,B value automatically. (Default A, B value is -0.0015 and 0.003).

- Temperature A, Temperature B value: System parameters, which cannot be changed, (Factory default A, B value is 0.008)
2. Bucket temperature control point(°C)  
Set the initial temperature of the bucket, the range is 15.0-35.0 and default value is 25.
  3. Jacket temperature control point(°C)  
Set the initial temperature of the jacket, the range is 15.0-35.0 and default value is 25.  
After changing the temperature control point, it is need to do temperature balance again.
  4. Oxygen pressure value (MPa)  
Generally the oxygen filling pressure is set as 2.8-3.0. When test biomass the oxygen filling pressure should be adjusted to 1.4-1.6. The input range is 0.5-3.5 and with 3.0 as default value.
  5. Gas tightness detection judgment value (MPa)  
It is the judgment value for gas tightness detection. When the initial test pressure value minus the secondary test pressure value is less than set air tightness detection judgment value, it is considered as oxygen bomb leakage and air tightness is unqualified, the oxygen bomb should be checked in the situation. Input range is 0.05-1.00 and the default value is 0.10.
  6. Oxygen bomb gas tightness detection  
When this option is checked, it will process gas tightness detection for the oxygen bomb during temperature equilibrium.
  7. Interval time for starting test automatically  
Input range for waiting time before starting automatic test is 0.0-30, and default value is 3.  
When all the following four conditions have been satisfied, which is oxygen bomb has been hanging in, sample quality have been input, "Automatic test" has been checked in the parameter input window, "Judge if there is oxygen bomb" has been checked in Parameter Settings – Common setting interface, the instrument will start test automatically after the set interval time.
  8. Oxygen filling pressure detection  
Select this option, the status bar in the lower left of the software interface will show the oxygen filling pressure value.
  9. Automatic oxygen filling  
Select this option, automatic oxygen filling will start during test. The option is defaulted as checked for SDAC6000 calorimeter
  10. Automatic oxygen degassing  
Select this option, it will finish oxygen degassing automatically during the test. The option is defaulted as checked for SDAC6000 calorimeter

## 11. Bucket lid restoration

When this option is selected and after finishing the test and exit the software, the bucket lid will be lowered to the initial position, and when starting the software next time, the bucket lid will be raised automatically.

### Note:

**To change the above settings, please click "save" button to make it active.**

## 12. Heat Capacity

- 1) After a group of heat capacity is qualified for one jacket control temperature, the jacket control temperature and its corresponding heat capacity will be automatically saved in the individual setting.
- 2) When doing calorific value test, system will get the corresponding heat capacity according to the jacket control temperature automatically.
- 3) Delete: Select the jacket control temperature, the system will automatically delete the corresponding heat capacity accordingly when not in testing mode; if the system is under testing, it is not allowed to delete the heat capacity.
- 4) Save: Click this button, system will automatically save the modified heat capacity.

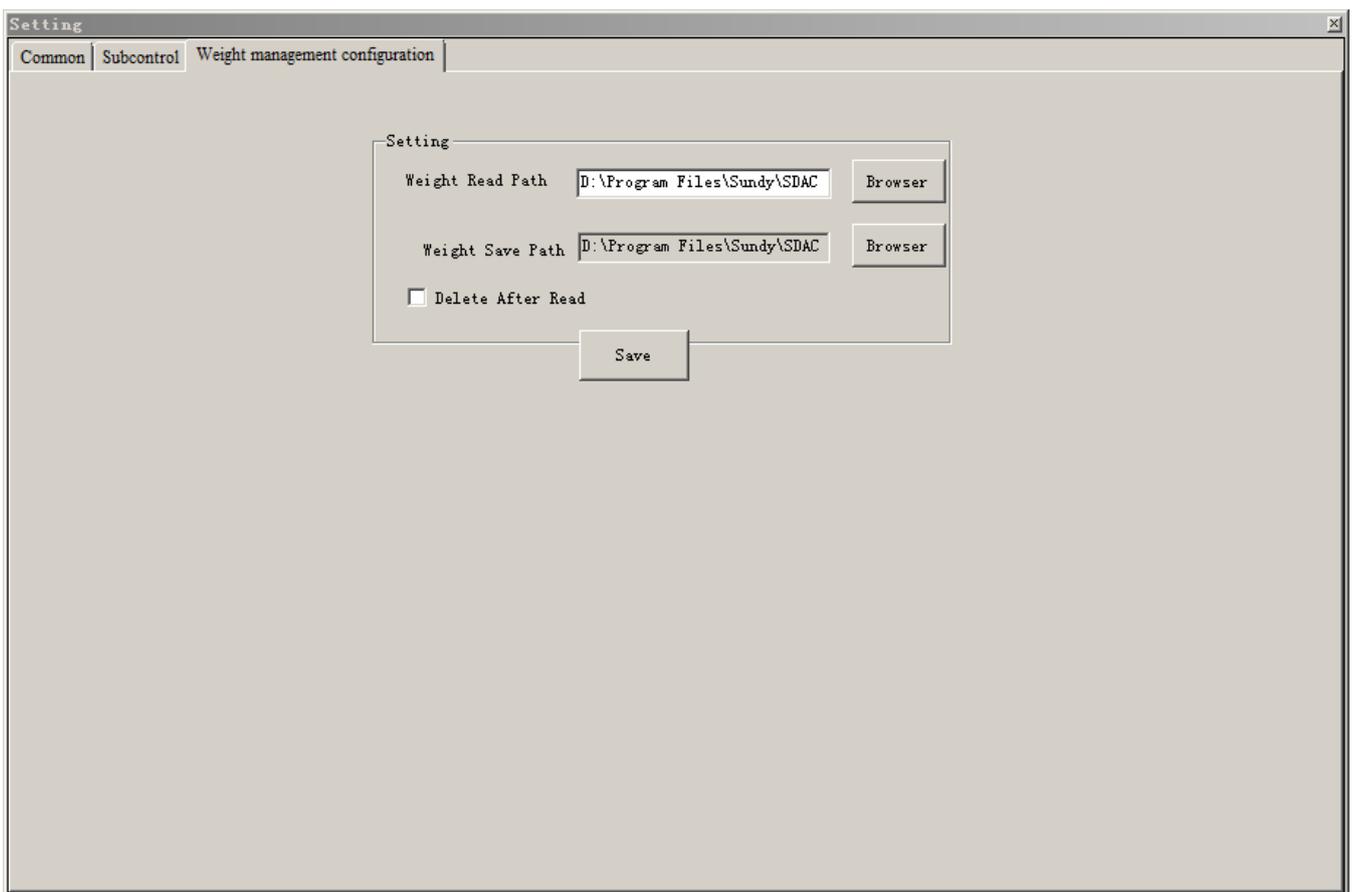


Fig. 4-11-3 Weighing manager read configuration interface

### Description of weighing manager read configuration

In the weighing manager read configuration function, you can set the storage address of the

sample and the processing methods of the sample data read from the weighing manager, as shown in figure 4-11-3. Specific features of the project are as follows

1. Sample weight file storage address

This option is used to set the address linked to the sample weight file stored by the weighing manager. The user can manually enter the address, or click on the "open" button to select the address. And only the correct address is entered, the sample weight in the weighing manager can be transferred to the weight management interface of the calorimeter software normally. If the sample weight file address is input incorrectly, click on the "Refresh" button in weight management interface, the software will prompt 'Network name not found'. In this condition the sample weight in the weighing manager cannot be transferred to the weight management interface of the calorimeter software. If do not enter the address, and click on the save directly, the system will prompt 'please set it completely'.

2. Access data storage address

This option is used to set the storage address for sample weight data in the calorimeter software. The sample weight includes the weight data transferred from the weighing manager as well as the weight data from the balance online weighing or manually added. Users can click on the "open" button to select the address.

3. Delete the sample weight file after read

If check this option, the sample weight will be deleted from the storage address automatically after the calorimeter software read the data. If not check, it will not be deleted.

**Note: To change the above settings, please click "save" button to make it active.**

### 4.5.3 Weight management

The instrument has remote online weighing, automatic transfer of sample weight function. The window and function as shown below

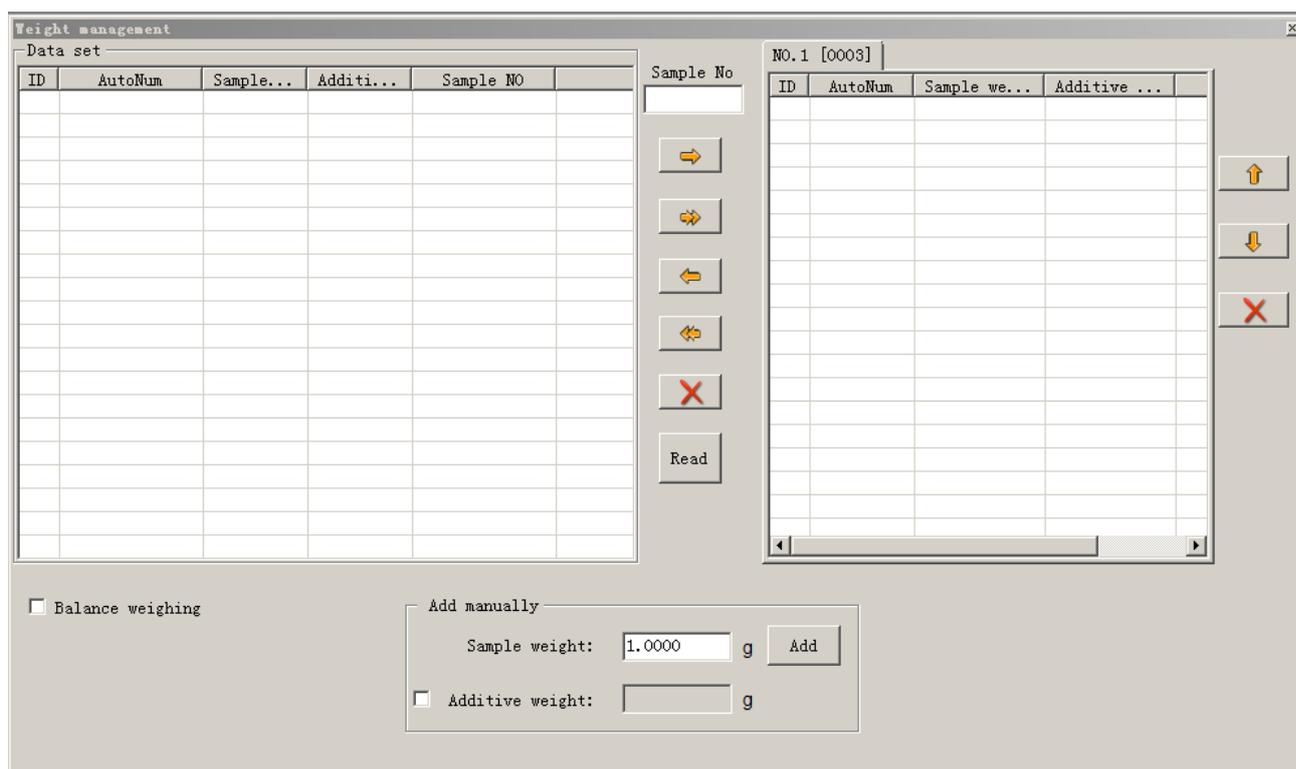


Fig. 4-12 Weight management interface

The 'data set' interface is mainly used to display the sample weight and sample weight number read from the weighing manager, as well as the weight data from the balance online weighing or manually added. The sample weight shows in the Data set information column, can be transferred by clicking  or  on the interface between the data set column and the control number data column; or by clicking on  or  in the middle of the interface, all the sample weight data can be transferred between the data set column and the control number data column. Click  in the middle of the interface, delete the selected sample weight in the data set column.

'The No. \*\*\*' interface mainly shows all untested sample data assigned from the data set to one certain control instrument. By clicking  or  on the middle of interface, the selected sample weight can be moved up and down in the order to adjust the test order for the selected sample weight (The top one has priority to test). By clicking  in the interface, delete the selected sample weight assigned from the date set to a certain control instrument.

Balance weigh: Set the balance on-line parameters correctly in the public setting interface and make the balance online normally. If check this option, it can weigh the sample through the online balance. The sample weight will be transmitted automatically to the data set interface according to the weighing order. If not checked, weighing sample through the on-line balance will not work.

Add manually: Input sample weight or check the option of additive weight then input the additive weight in the input field. Click 'Add' button, then the normal sample weight which meet the software conditions and additive weight will be transferred to the data set automatically. When

the input sample weight does not meet the conditions, click the Add button, the software will prompt the corresponding sample weight range.

**Note:** If there is sample weight record waiting for test in the window, when close the window, the record will not be lost, and keep in the window. For the already done test, the record will be deleted automatically.

#### 4.5.4 Calorimeter data

Run the software, it is defaulted to open the Calorimeter data interface, which will show the current date calorific value test data, and in the down of the software will show the range and average of the latest group tests data. (The group of tests should manually numbered as the same)

#### 4.5.5 Temperature curve

Open the temperature curve, the temperature curve of the bucket in real time during the test can be observed. Click the refresh button, the abscissa of the curve which represents test time will reset and draw the real-time temperature curve.

### 4.6 Management Menu

Through this menu, the user can re-login, modify password, parameters backup and restore. Backup. Its operating interface is as shown in Figure 4-13.

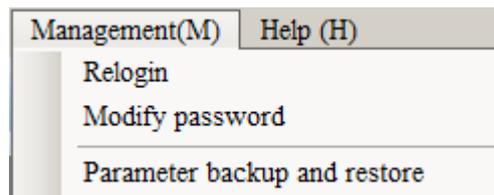


Fig 4-13 Management Menu

#### 4.6.1 Re-login

When a user has login in the system, and another user (must be configured correctly in the user management database) want to log in again, please click the 'relogin' button in the interface, the software will pop up the login interface automatically (as shown in figure 4-14). After input correct user name and password, it will log in correctly. When the user name or password is not correct, system will pop up a corresponding error message Login through this way, users can operation software without exiting the software.

**Note:** During the test, the system does not allow users to login.



Fig. 4-14 Relogin

#### 4.6.2 Modify password

Currently logged user to modify the login password, can click the modify password button in the interface, the software will automatically pop up ‘user login password’ interface (as shown in figure 4-15). After the user entered original password and new password correctly, it can modify the password; when input incorrect password, system will pop up a corresponding error message.



Fig 4-15 User password modification

#### 4.6.3 Parameters backup and restore

All the parameters can be backup and recovered by clicking the parameters backup and restore button. In the corresponding interface, automatically or manually backup or restore the parameters. (As shown in figure 4-16)

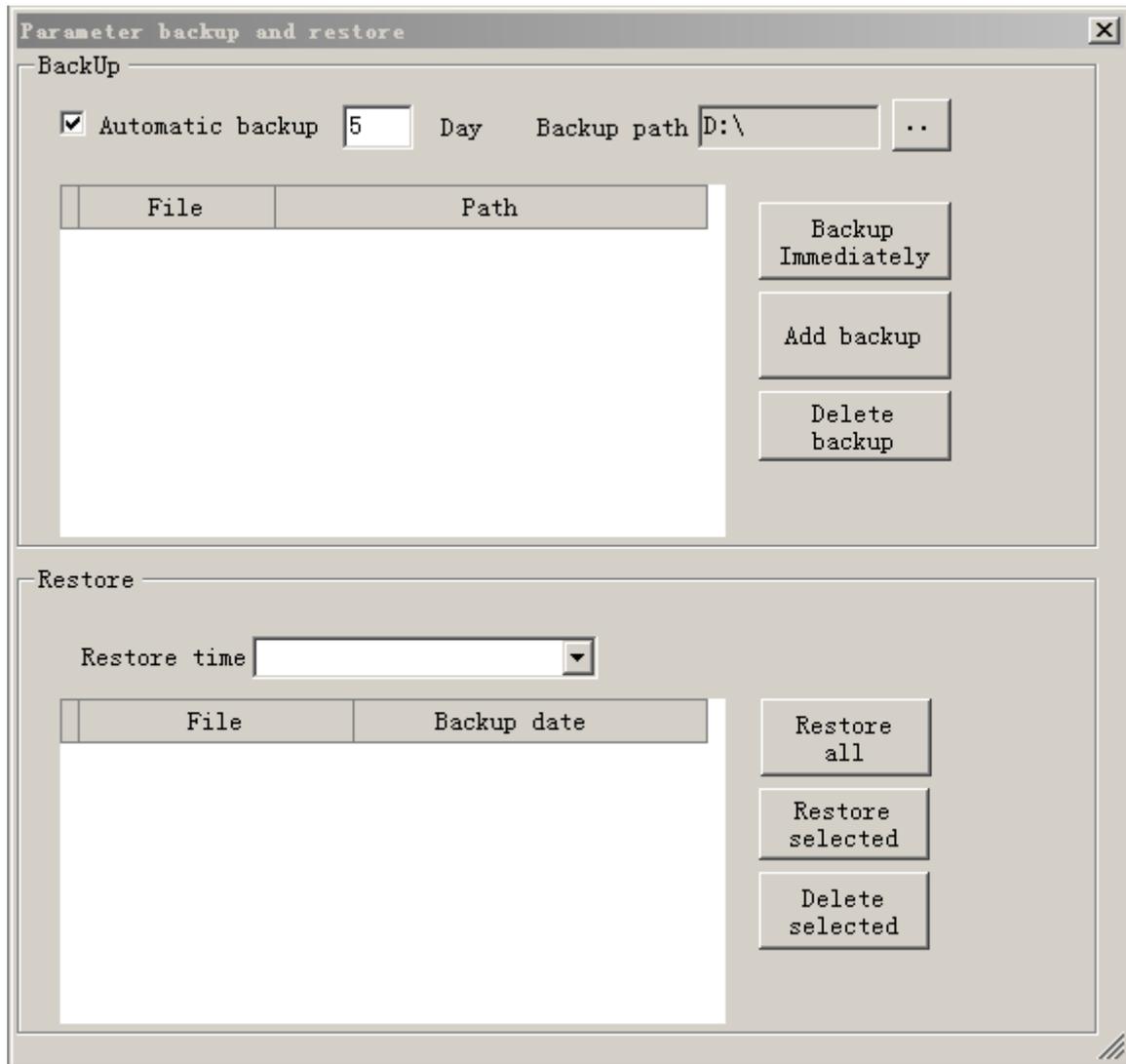


Fig 4-16 Parameters backup and restore

1. Backup function

- 1) Automatic backup XX days: By inputting parameter values, set up automatic backup cycle for the parameters file.
- 2) Back up path: By clicking on the icon , select parameters backup save path
- 3) Add backup: Click on this option, the software will automatically open the parameters file directory for the user to select parameters to the backup.
- 4) Backup immediately: Click on this option, the software will automatic backup the parameters file selected by the user. The backup file will be stored under the setup backup path and generate a backup file named after the backup time (The format is as the system date and time when clicking 'Backup immediately', such as 2015-02-09 08:17:27). At the same time, in the 'restore time' column, there will generate a same file name, and in the data field will show the backup file name and the backup time.
- 5) Delete backup: Click on this option, the software will automatically delete the selected parameters record from the backup parameter list.

## 2. Restore function

- 1) Restore all: Click on this option, the software will automatically restore all the currently shown parameter files in the restore window.
- 2) Restore selected: Click on this option, the software will automatically restore the selected backup parameter files in the restore window
- 3) Delete selected: Click on this option, the software will automatically delete the selected backup parameter files in the restore window.

### Note:

**In consideration of the safety of the parameter file, operators should be careful to use the parameter backup and restore function.**

## 4.7 Help Main Menu

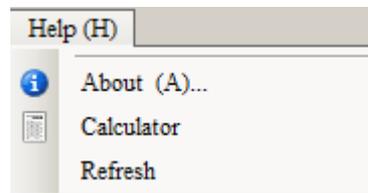


Fig. 4-17 Help menu

Help main menu is mainly composed of about, calculator etc.

1. About: Click this, you can get the information on edition.
2. Calculator: It will invoke the calculator function of the computer.

# Chapter 5 Data Management

## 5.1 Main window

Data management main window of SDC calorimeter test software is composed of headline column, menu column, quick column and data display column. The menu column in detail as follows.

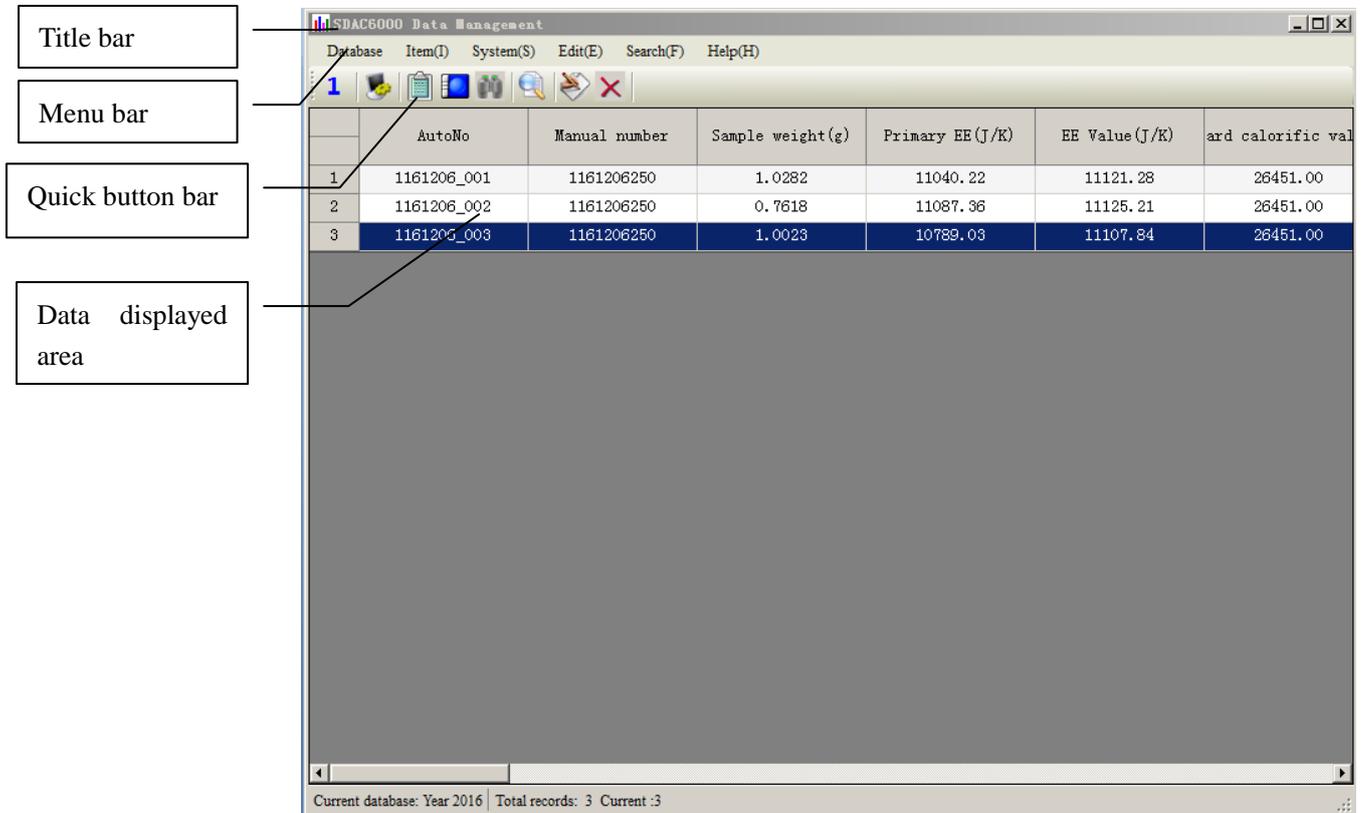


Fig.5-1-1 Data Management (Take heat capacity as an example)

In data displayed area, right click the mouse, then following function menu will pop up. (Shown as Fig.5-1-2)

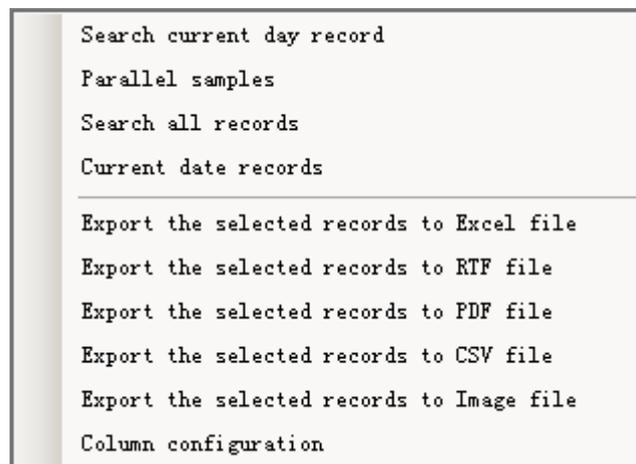


Fig.5-1-2 Database right click menu

Right click function introduction:

1. Search current day record: Click this item, the data display area shall show all the data on the day.
2. Parallel sample: Click this item, the data display area shall show the parallel sample data for the currently selected data.
3. Search all records: Click this item to display all the experimental data in the data display column.
4. Current day record: Click this item, in the data column shall show all test data for the same day as the currently selected data.
5. Export the selected records: After selecting records, export the statements or reports to different file format.
6. Column management: For login user that has a column management authority, can manage the display column for heat capacity and calorific value. The operating interface is shown in the diagram below as Fig 5-1-3. The specific functions are introduced below:
  - 1) Column to be displayed: To display the data temporarily not needed to display in the window..
  - 2) Displayed column: To display the already displayed column in the window.

After the user chose the specific display column, click the left  or right  arrows on the interface, it can switch between the column to be displayed or displayed column. At the same time, by clicking the up  or down  arrows on the column has shown, can adjust the display position of the selected column in the interface (The first column displayed in the column heading is numbered No.1 and so on )
  - 3) Show the detail information of the column: Used to modify the column header name, display width, display type, display format, maximum and minimum value, and can be edited or not. After modifying the parameters, click “Update” button to make the modification be valid.

**Note:**

**For all the above parameter settings, you need to click “save” button to make them valid.**

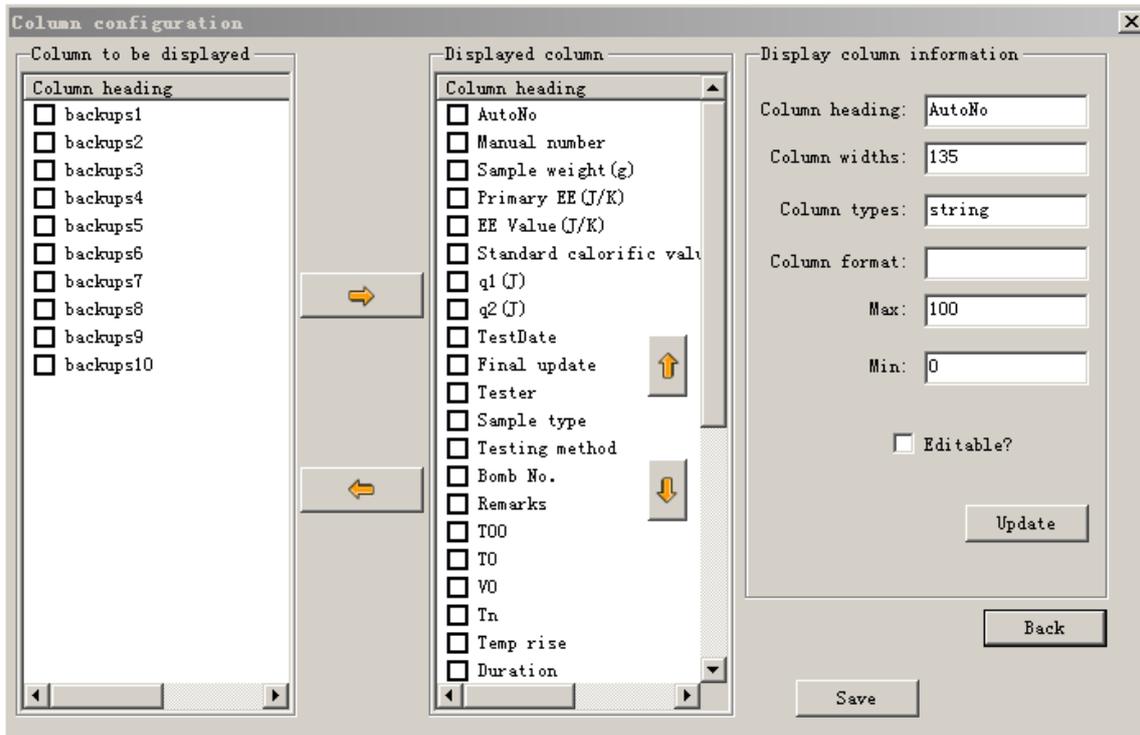


Fig.5-1-3 Column configuration interface

## 5.2 Item menu

This menu can switch between calorific value and heat capacity, shown as Fig.5-2-1. Fig.5-1-1 is heat capacity data window, Fig.5-2-2 is calorific value window.

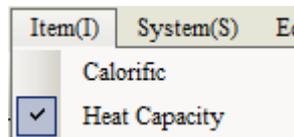


Fig.5-2-1 Item Menu

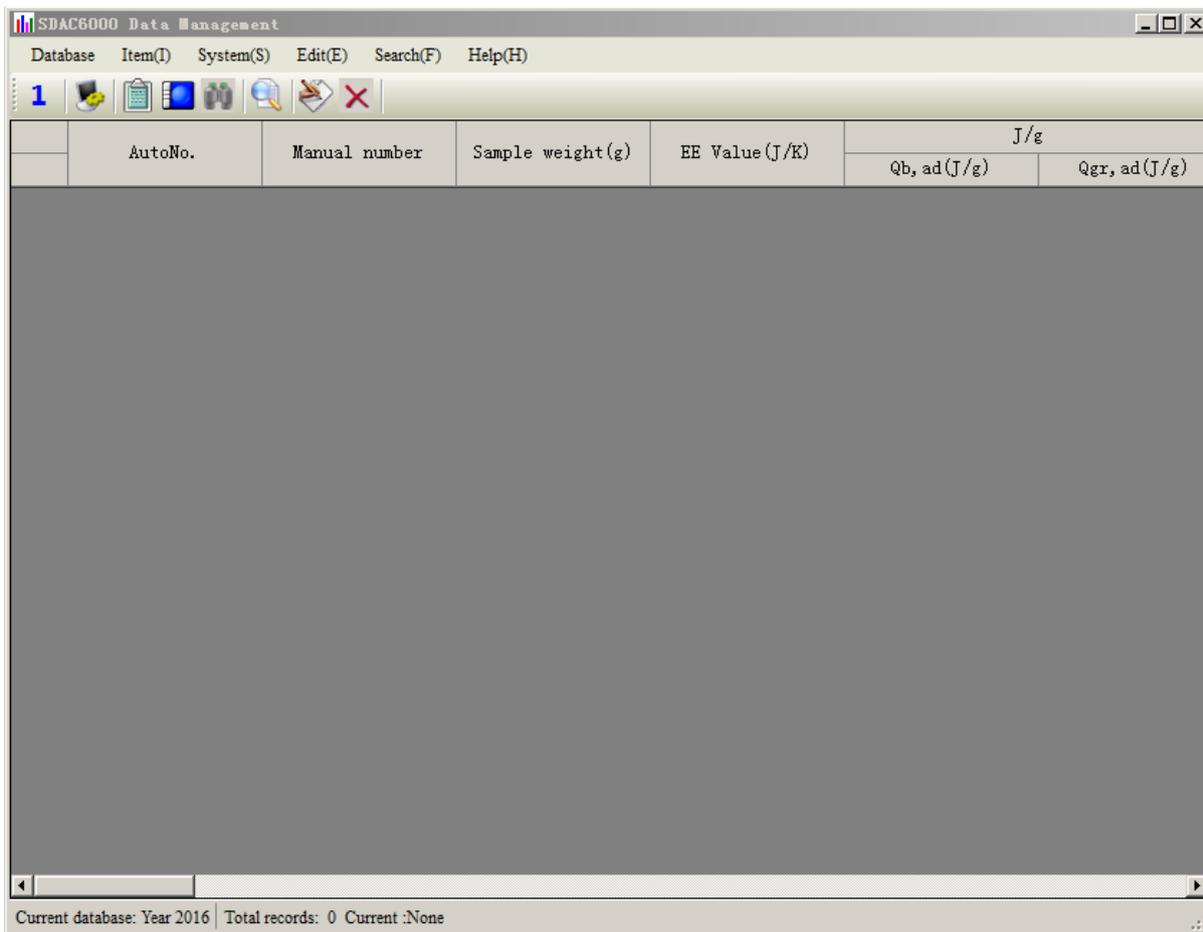
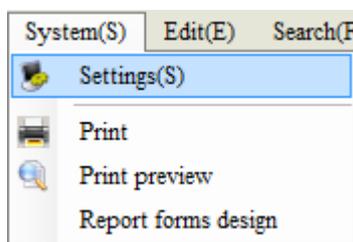


Fig. 5-2-2 Calorific value interface

## 5.3 System menu



5-3 System menu

### 5.3.1 Setting

#### 5.3.1.1 Basic setting (Fig.5-3-1)

This page is mainly used to set print content and print type.

In print type, take calorific value as an example. Select report sheet, there are three types of report form: calorific report, calorific balance sample 1, calorific balance sample 2. Select report sheet, report sheet with configurable columns can be printed. For details about configurable columns, please refer to calorific value sheet configure/ heat capacity sheet configure.

Among printed parameters, users can add/ delete common parameters of report sheet, such as test unit, standards and so on.

**Note: Parameter name should be corresponded with lumped parameters in report sheet. This function should be done by Sundry professions.**

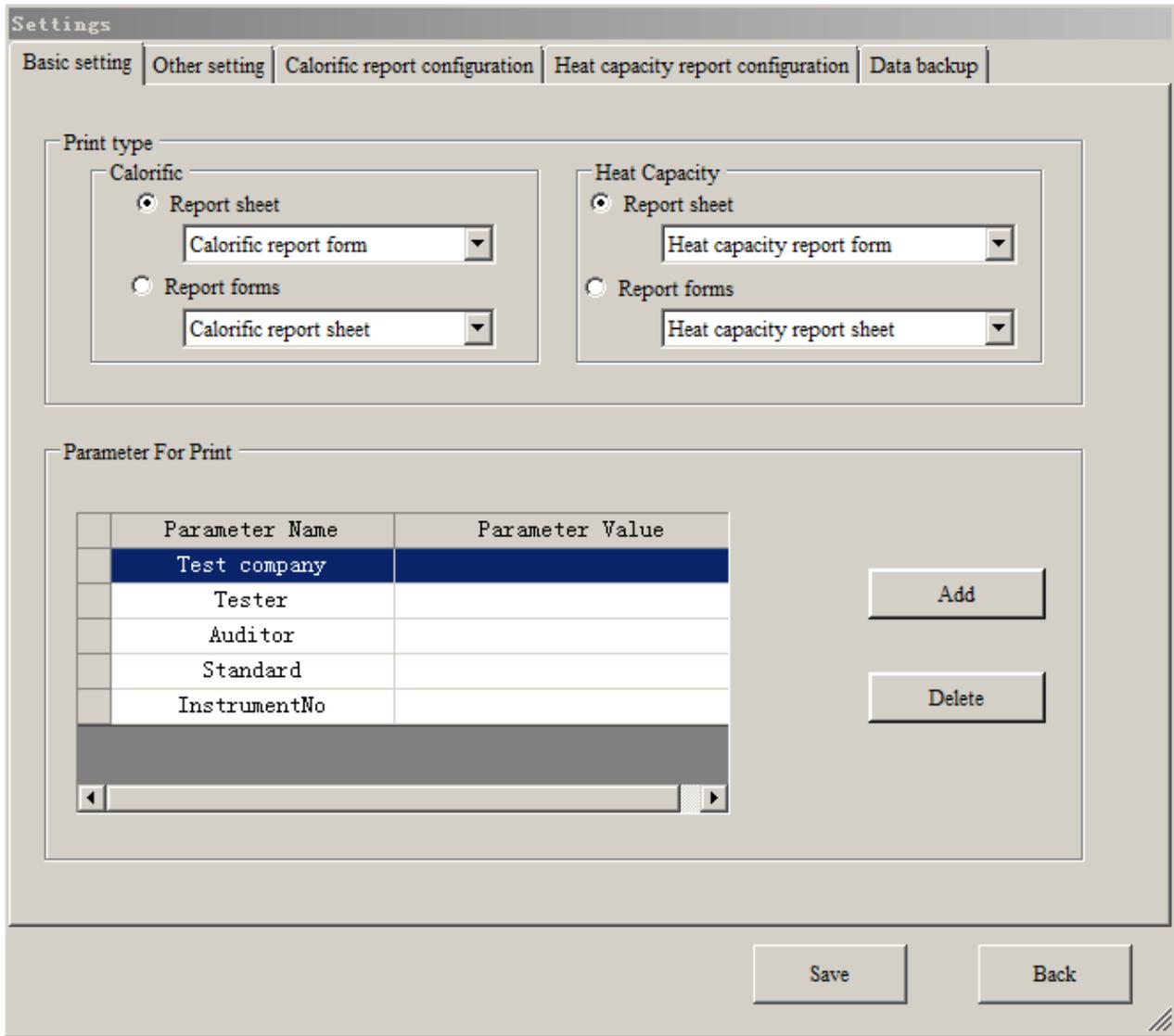


Fig.5-3-1 Basic setting interface

### 5.3.1.2 Other settings (Fig.5-3-2)

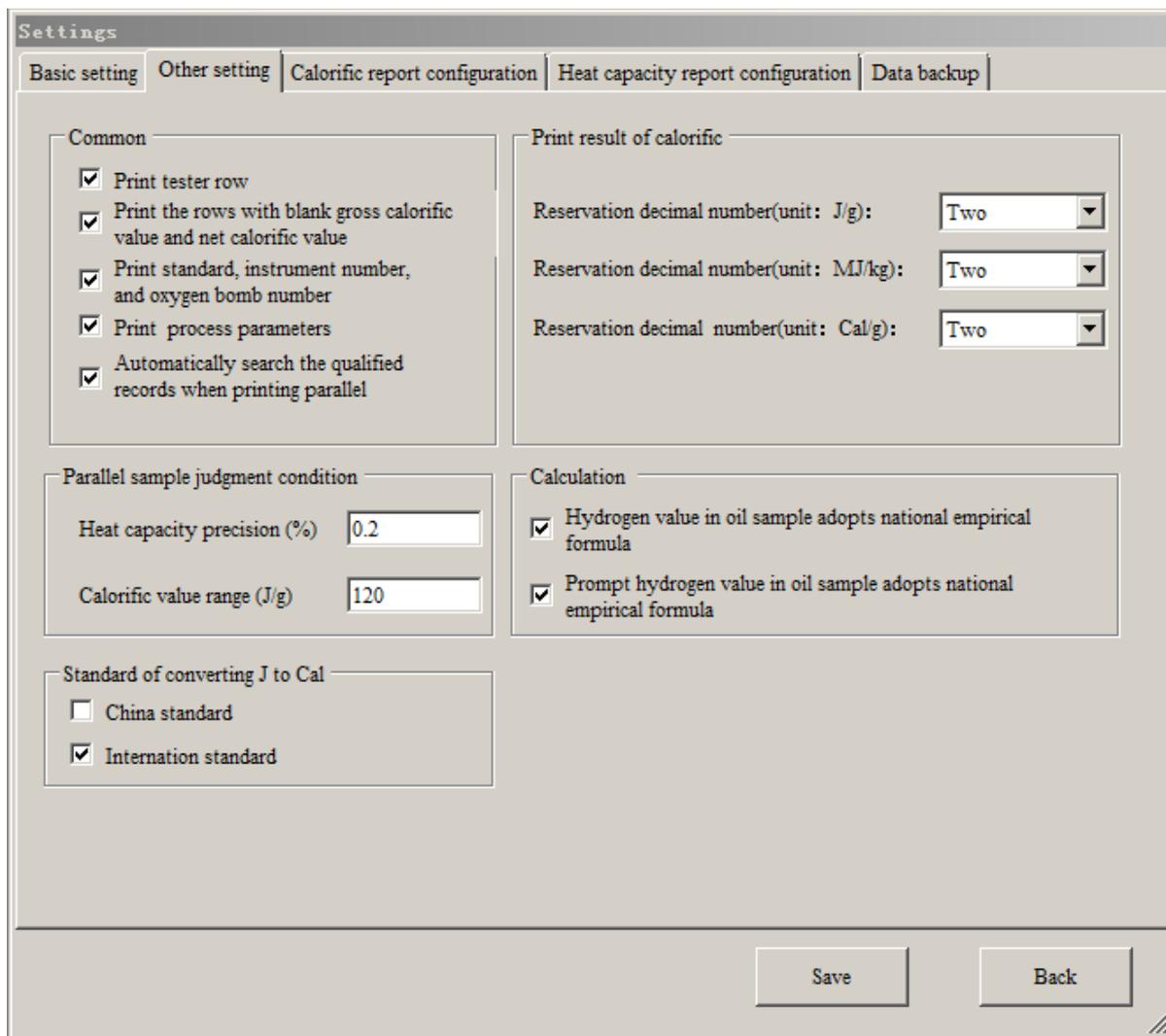


Fig.5-3-2 Other setting interface

- Print tester row: Print Tester row: If you choose this, it will print the analysis unit, analyst, auditor column if print parameters include this three items, otherwise it will not be printed.
- Print Standard, Instrument Number, and Oxygen Bomb Number: it shall print out the standard; instrument number and oxygen bomb number after you choose this function.
- Print the rows with blank gross calorific value and net calorific value: If choose this, it will automatically print the blank gross and net calorific value when both preview and print.
- Print Process Parameters: If you choose this, system test process parameters will be printed while print preview and automatic print.
- Automatically search the qualified records when printing parallel: If you choose this item, only qualified records will be printed, otherwise, all parallel samples will be printed.
- Print results of calorific: reservation decimal number can be set for printing.
- Parallel sample judgment condition: Parallel Sample Judgment Condition: Default value is usually used to judge if parallel sample is qualified.
- Hydrogen value in oil sample adopts national empirical formula: If you choose this option, hydrogen value will be automatically calculated while the test of light oil or heavy oil

according to corresponding standards.

- Prompt Hydrogen value in oil sample adopts national empirical formula: If you choose this option as well as Hydrogen value in oil sample adopts international empirical formula, the system will automatically show prompt message while the test result of light oil or heavy oil are saved in the database or recalculate.
- Standard converting J to Cal: It is used to choose China standard or International standard for the conversion for different units.

### 5.3.1.3 Calorific report configuration (Fig.5-3-3)

If calorific report is selected in print type of basic setting, then report will be printed as this configuration, among which, print (Y/N), print name, print width can be modified.

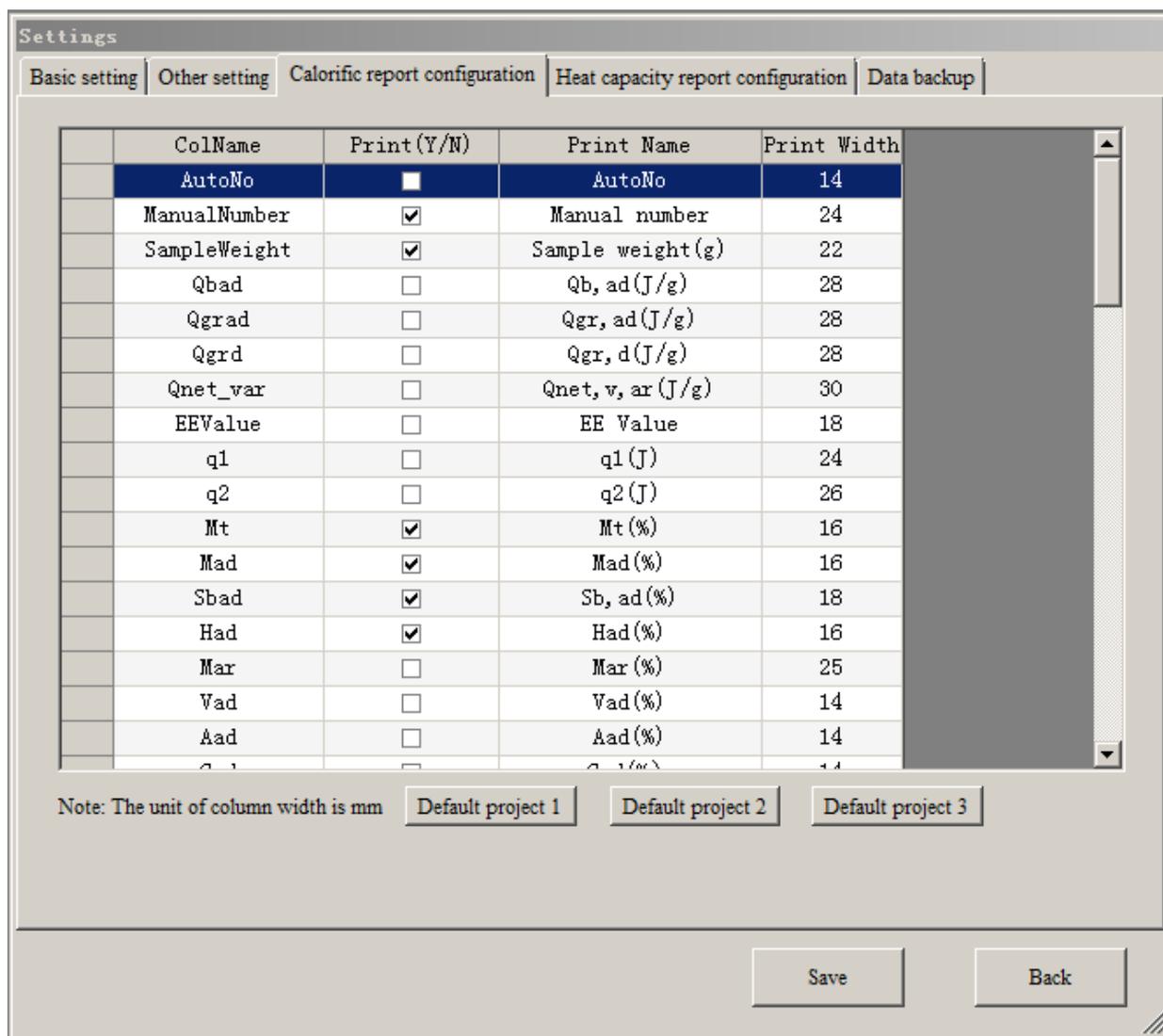


Fig.5-3-3 Calorific report configuration

- Print (Y/N): if this column will be printed in sheet. There are three default scheme given by system: default scheme I, default scheme II, default scheme III.
- Print Name: Display this column name in report sheet.
- Print Width: width of all columns in report sheet, unit is mm.

### 5.3.1.4 Heat capacity report configuration (Fig.5-3-4)

If heat capacity report is selected in print type of basic setting, then report will be printed as this configuration. Specific operation method is similar to the above mentioned method for calorific value statements.

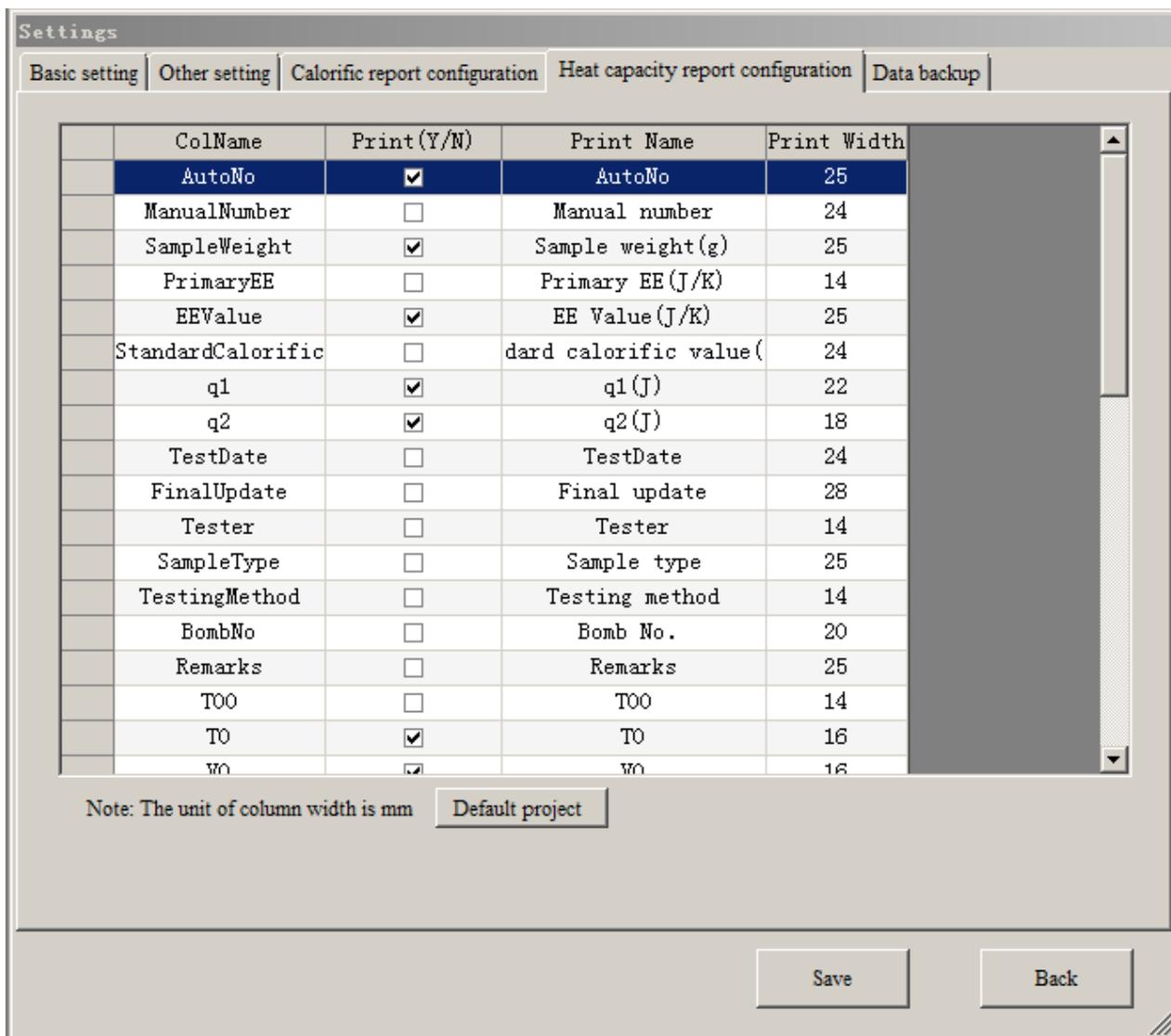


Fig.5-3-4 Heat capacity configuration

### 5.3.1.5 Data backup (Fig.5-3-5)

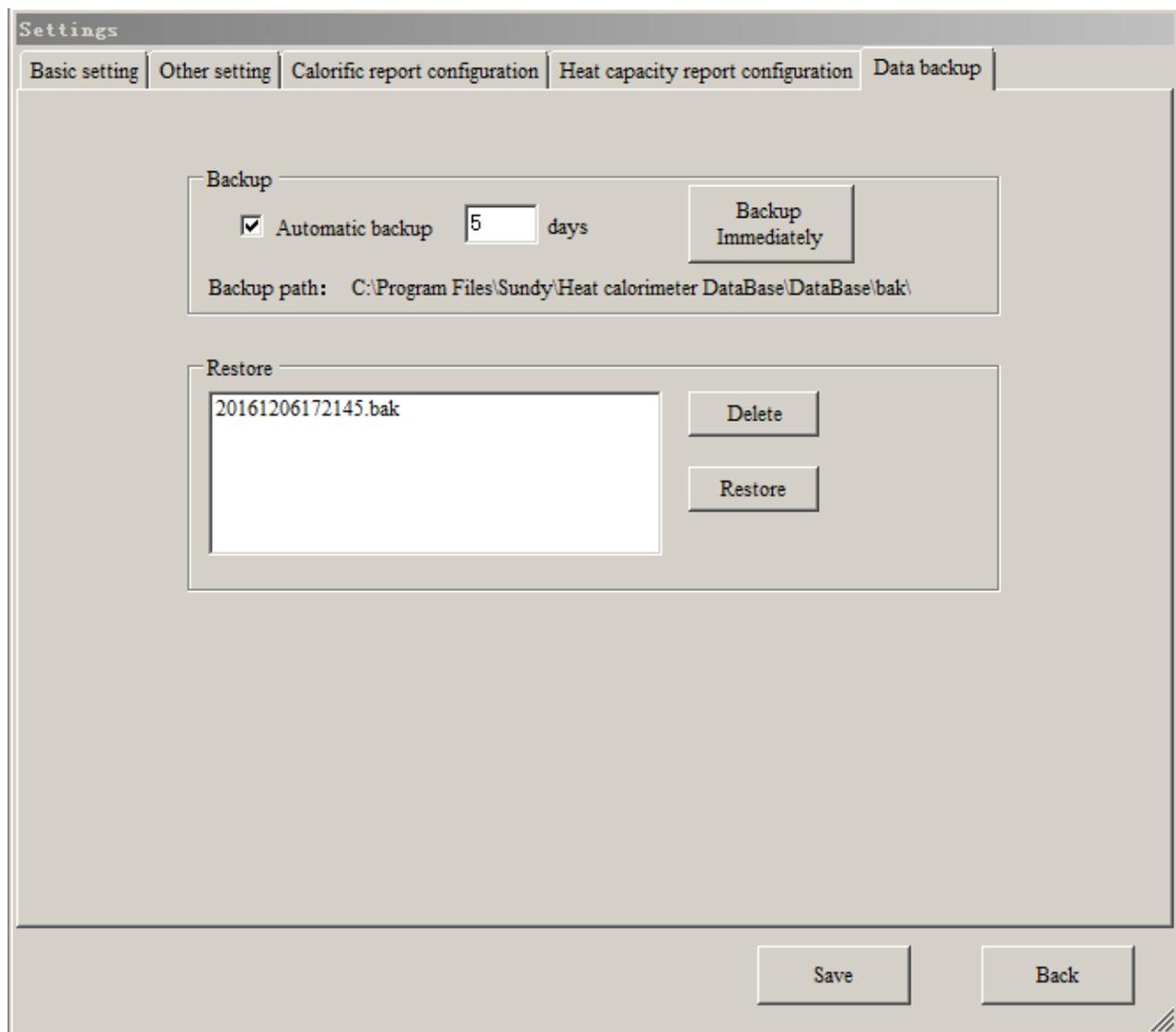


Fig.5-3-5 Data backup

1. Set the automatic backup time, and select the Backup automatically, system will do data base backup automatically according to days set.
2. Click Backup now, system will backup data base immediately.
3. Select the backup files in the Restore window, click Delete or Restore, system will delete or restore the selected file.

**Note: In consideration of the data safety, the operator should be careful to use the data backup and restore function**

### 5.3.2 Print

Print selected record in data sheet according to selected report form or report sheet.

### 5.3.3 Print preview

Preview selected records in data base according to selected report sheet and report form.

### 5.3.4 Report sheet designation

User can modify or add report form and report sheet according to his requirement. Operating interface is shown as Fig.5-3-6.(For details about report sheet designation, please refer to instruction

in software package.)

As shown in following interface, customs report sheet or report form designation can be done. After that, click “Save” to save root directory and overwrite the existing file or rename the new file.

**Note: This function is suggested to be done by Sundry professions.**

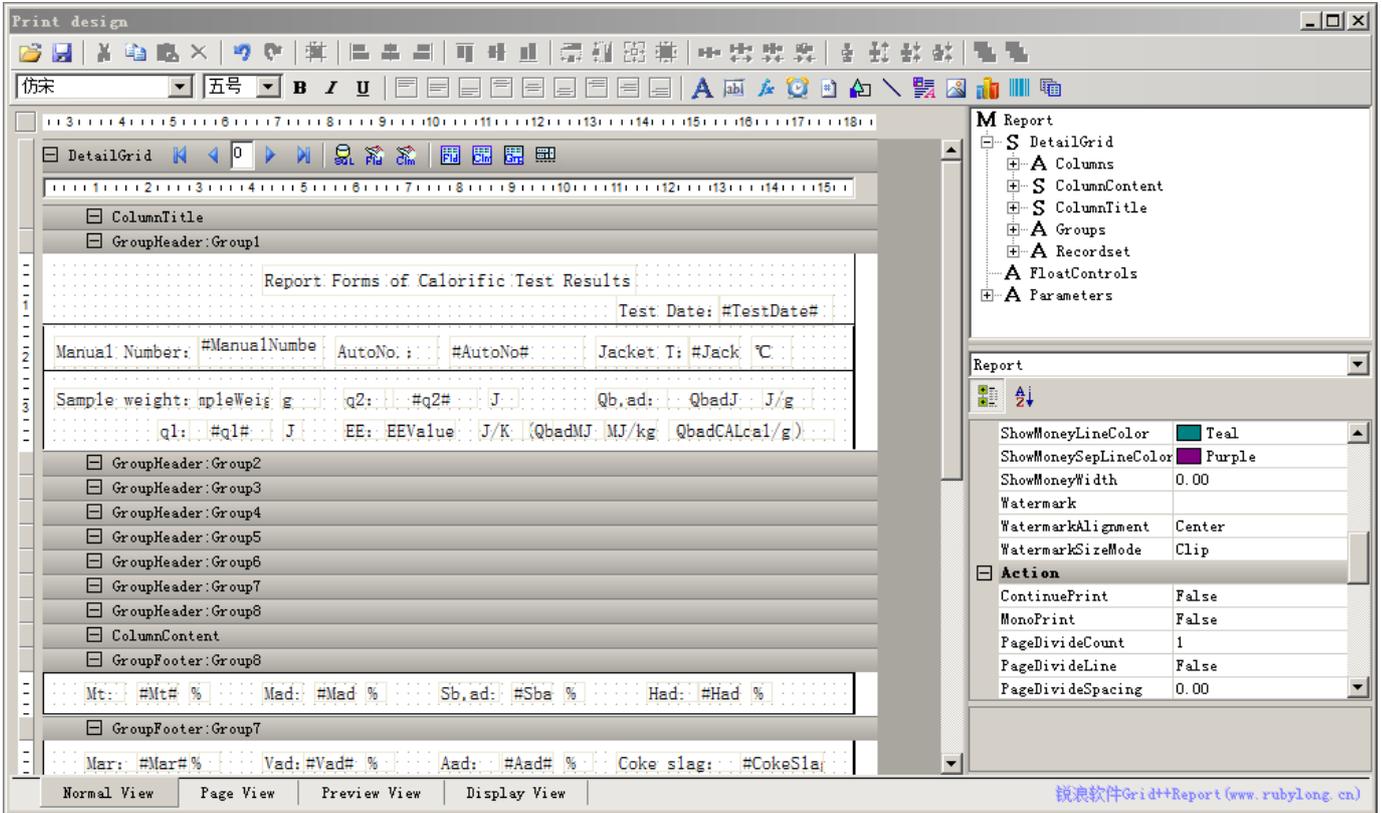


Fig.5-3-6 Print design interface

## 5.4 Edit Main Menu

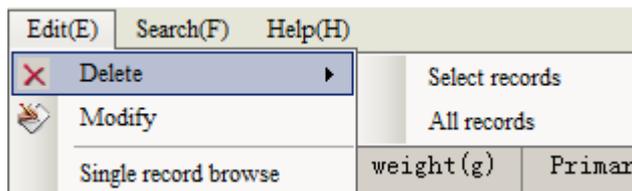


Fig.5-4 Edit Menu

1. Delete select records: Delete the Selected Records: Delete all records selected in the data displayed area.
2. Delete all records: Delete all records displayed in the data displayed area.
3. Modify: After clicking this option, it will automatically open the single record for review after entering correct passwords and then enter the editing status.
4. Single record browse: to open single record browse window.

## 5.5 Search Menu

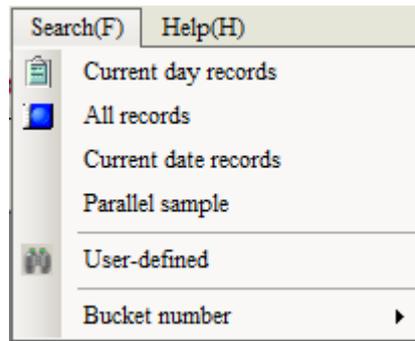


Fig.5-5 Search menu

1. Current Day Record: To display all the records of current bucket on the test day same as computer day.
2. All Records: To display all records of current bucket in current year in the data displayed area.
3. Current date Record: To display the record data of all buckets on the same day as selected record.
4. Parallel Sample: To display all records at current day with same number as manual number and to display the related parallel sample information such as average value, precision etc.
5. User-defined: If current item is calorific value, click this item to display window shown as Fig.5-6-1. If current item is heat capacity, click this item to display window shown as Fig.5-6-2.
6. Bucket No.: Display all test data of the selected bucket number on the current day.

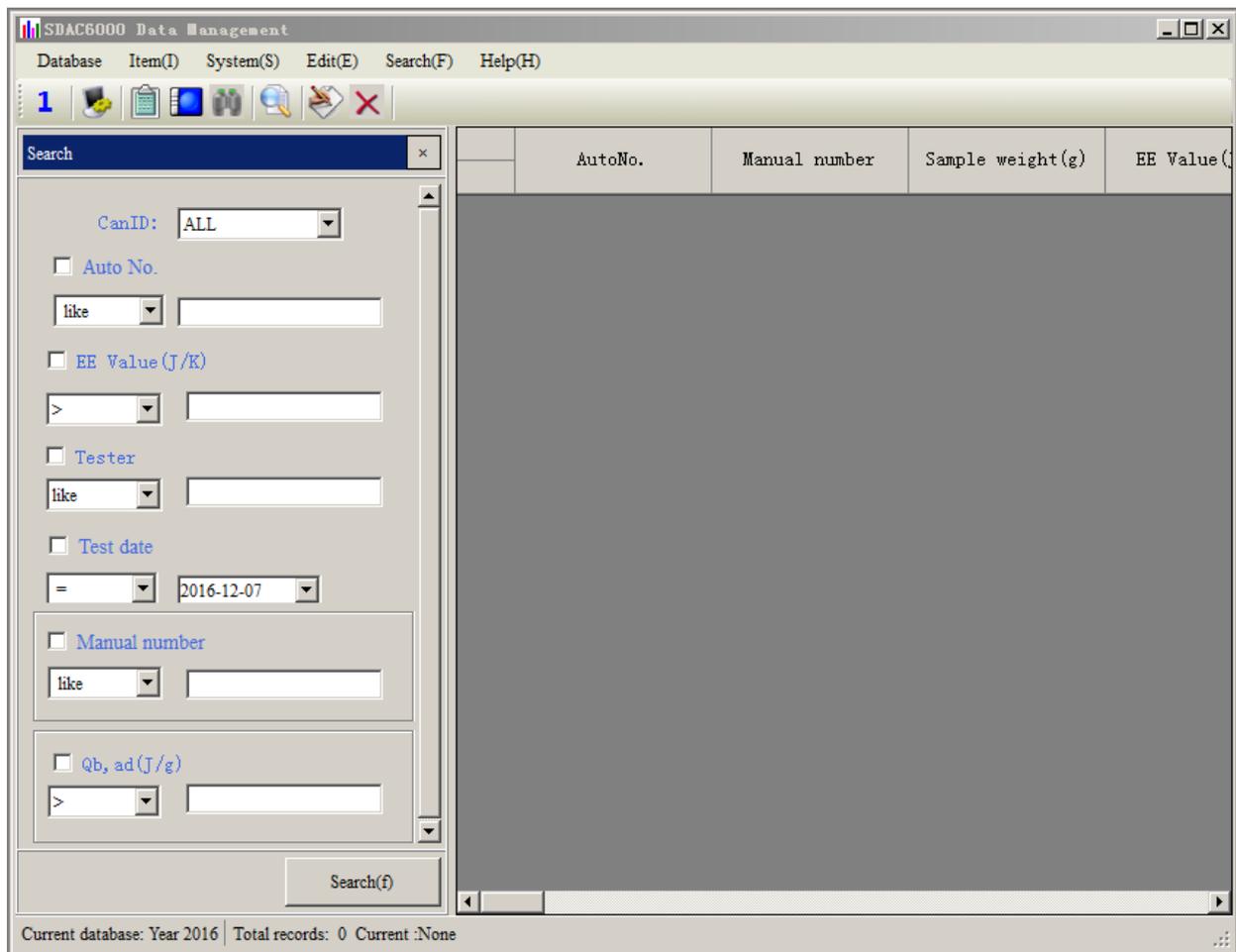


Fig.5-5-1 Calorific value user-defined search

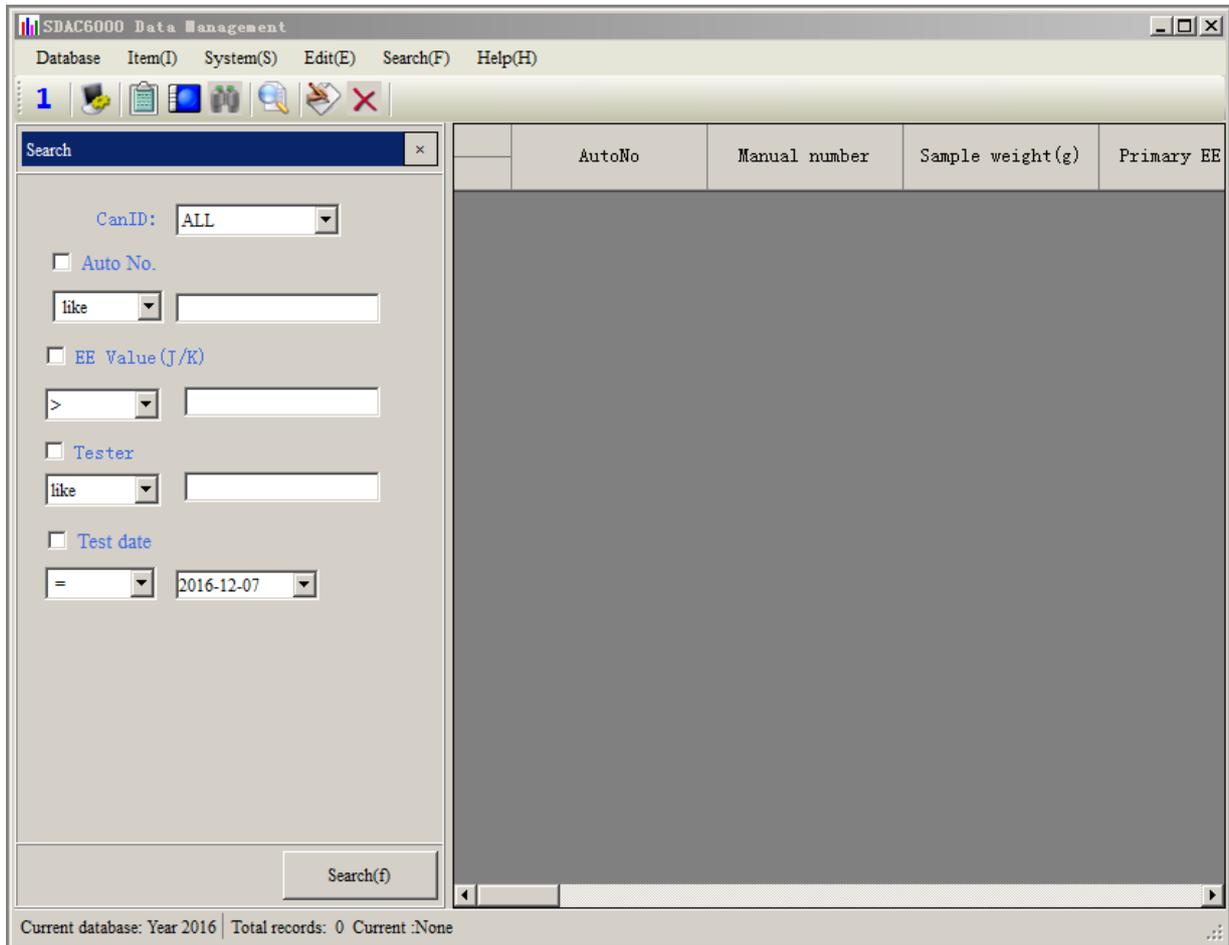


Fig.5-5-2 Heat capacity user-defined search

Search by one or more conditions, select all fields needed to search, then select search conditions, and input corresponding conditions in the text, finally, click “search” button, then all records meet the conditions will be displayed in the data displayed area.

For example, search by auto number:

Set search method: click “Auto No.” check box to select it.

Set search condition: Click“▼” and select one (Such as “like” )according to the needs. Then input search content in the right box, such as 2140701.

Search: click this button, the system will display all records whose auto numbers contain 2140701 in data displayed area.

## 5.6 Management menu

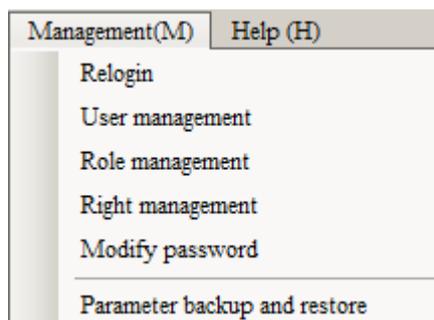


Fig 5-6 Management menu

Management menu mainly provides the user with a privilege management function, as shown in Fig 5-6. Through this function, the deferent user pays deferent role has different usage and management rights. Specific operation method is as follows

### 5.6.1 Right management

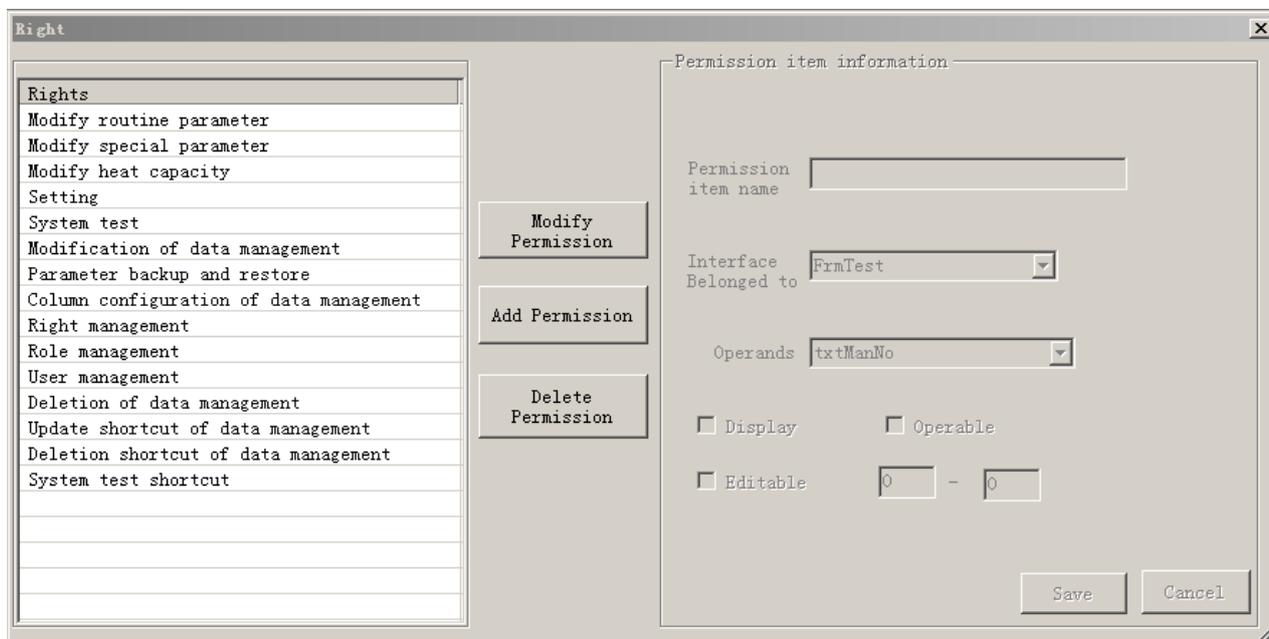


Fig 5-6-1 Right management

1. Rights list: The list includes some options for software operation, corresponding to different operating rights. Clicking the option of modify, add, or delete, related operations will be done for the list.
2. Permission item information: Click the options in the rights list, can scan the information of the right item in the data column. In this interface can set the visibility and operability of the right items as well. Check-mark means visible and operable.

**Note: Right management is a professional configuration work, if you are not Sundry debugging personnel, please do not operate.**

### 5.6.2 Role management

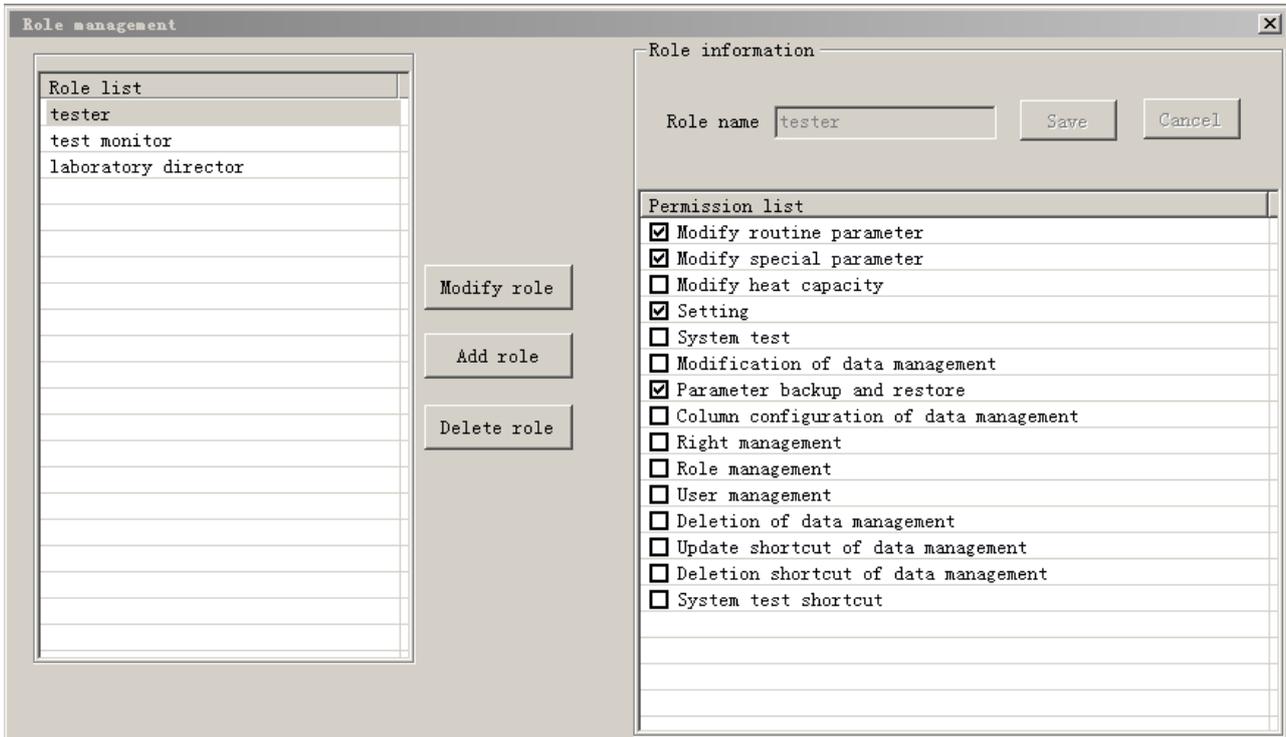


Fig 5-6-2 Role management

1. Role list: The list is mainly used for role configuration, different roles have different privileges.
2. Modify role: Select a certain role in the list and click 'Change role', you can configure the role in the role list on the right side of the interface.
3. Add role: Click the 'Add role' button, then role name will be in editable state, in this column the user can input the new role name, and configure the privilege for it in the privilege list.
4. Delete role: Select a certain role in role list and then click 'Delete role', a delete confirmation dialog will pop up, then click ok to delete this role, click cancel will not.
5. Role information: When the user click to select a role in the role information column, the corresponding configured permissions list of the role will be shown. When modify or add a certain role, the permissions list in the information column will be in the editable status and the user can check different permission items in the list to configure the permissions for the role. If checked, the corresponding permission is effective; if unchecked, the permission is not working.

### 5.6.3 User management

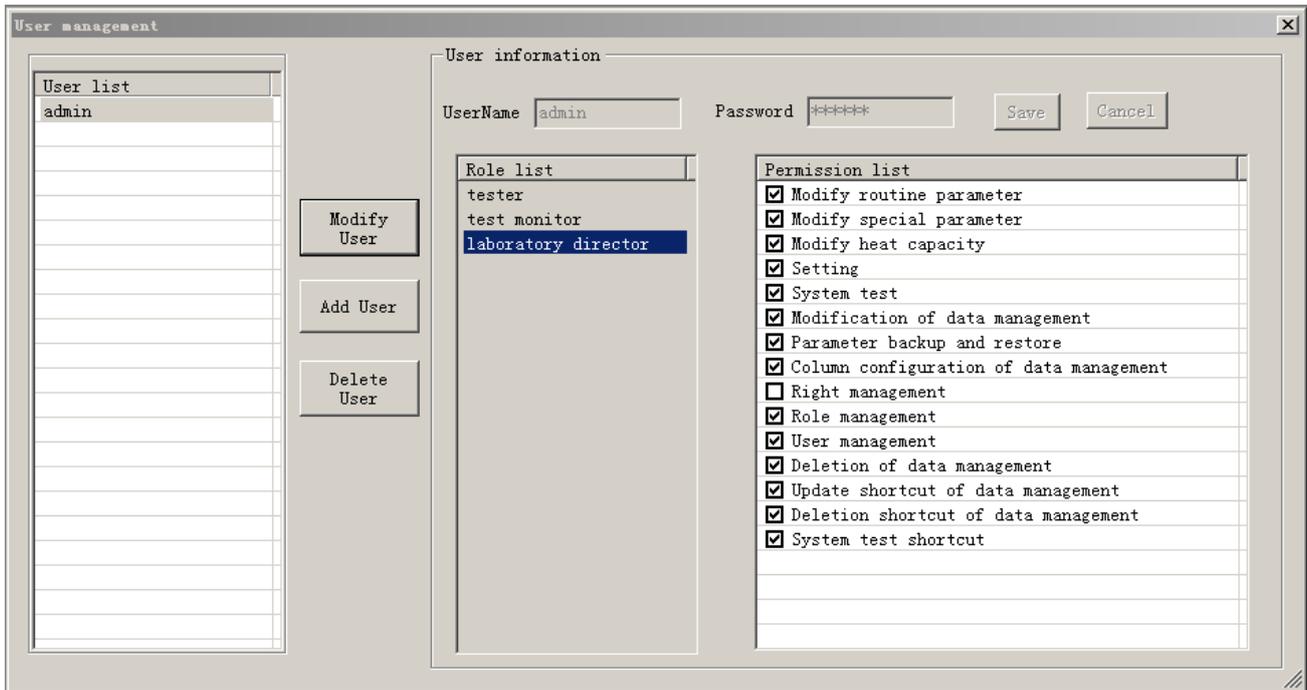


Fig 5-6-3 Role management

1. User list: The list is mainly used to configure role for the user. Different user corresponds to of different role.
2. Modify user: Select one user in the user list and click modify user button, then can configure the user's role in the list on the right side of the interface and modify the user's password as well.
3. Add user: Click 'Add user' button, the user name and password field will be in editable status, where the user can input the new user name, set password, and configure the role for it in the role list.
4. Delete user: Select one user in the user list then click the delete user button, there will pop up a delete user window, click ok to delete this user, click cancel, will not.
5. User information: When the user clicks on a certain user, the corresponding role configuration of the user can be viewed in the user information column. When modify or add user, the role list in the information column will be in editable status, and the user can configure role for each user by clicking on a certain role.

**Note: The above modifying or adding operation regarding the permissions, role and user management, will be effective only after clicking save button.**

## 5.7 Help menu

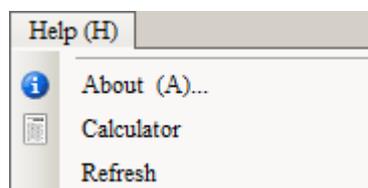


Fig.5-7 Help menu

1. Help: click it to get online help file of data management.
2. About: To display the information on data edition number etc.
3. Calculation tool: To call out the system calculator for calculation including calculation of calorific value, gross heat capacity and so on.

## Chapter 6 Operating Instructions

This chapter introduces how to finish a complete test procedure, including preparation work, system check, heat capacity and calorific test.

### 6.1 Preparation work

1. Turn on conditioner to control ambient temperature. (The temperature is set according to customer's site temperature and recommended temperature is 22°C) The jacket control temperature should be higher than ambient temperature for about 3°C .
2. Preheat the balance for 30min.
3. Gas source check: Turn on oxygen cylinder, check the indicated on high pressure gauge of the cylinder. If the pressure is less than 4Mpa, please replace oxygen. And adjust low pressure gauge of oxygen cylinder to point at 2.8~3.0MPa.
4. Check water volume of water tank. (The suitable water level is 10mm lower than the highest water level line).
5. If new crucible is used, it should be burn in the oven heated at 800 °C for 30 minutes. For old crucible, it should be cleaned before use. If the crucible cracks or the bottom is uneven, please abandon it.
6. Set the temperature of the water tank lower than the Jacket temperature control point for 3 °C. The water tank temperature setting method: Two fingers press the water tank panel key "△ ▽" at the same time, the screen will flash. Press the △ key to adjust temperature up, press ▽key will adjust jacket temperature down. After the temperature adjusted to the set value, the screen flashes 5S indicating the temperature is set and saved successfully.

### 6.2 Test procedure

1. **Start the instrument and computer:** Power on the instrument and computer, enter into windows desktop and double click "SDAC6000 Calorimeter" quick icon to enter into main program window.
2. **Temperature balance:** Select Bucket No. on the progress indication window of main program window, and click "System"-> click "Temperature balance" or "Temperature balance for all" on menu bar. (Or, click "Tools" ->"setup" on menu bar->"common" window, select "Automatically run program" and "Automatic temperature balance". Next time when starting computer, program will run automatically and enter into temperature balance automatically.) When the interface display "System ready", it indicates that temperature balance is done and test can be started. Temperature balance procedure may take 15min.

**Note:** While temperature balance which will take about 15 minutes, it is suggested to put oxygen bomb inside bucket to avoid first test result deviation due to temperature difference of bucket and oxygen bomb.

3. **Test settings:** click “Test changeover” on “Parameter input” window. Then the test method can be changed between calorific value and heat capacity test.

**Note: For the first time to run the instrument, do heat capacity calibration before calorific test. For details, please refer to 3.7.**

4. **Sample weighing:** Place constant weight crucible on balance tray, zero clear, then thoroughly stir the sample, then add  $1.0 \pm 0.1$ g sample into crucible with sample spoon and correct to 0.1mg.

**5. Install oxygen bomb:**

a) Hang oxygen bomb core on oxygen bomb support. Place crucible with samples on the crucible supporter of oxygen bomb core.

b) Connect two ends of firing wire to the two electrode rod of oxygen bomb and press it tightly with pressure rings. The firing wire should not connect with crucible or be broken by pressure rings. Firing wire should be bent into a circular form or connect sample slightly. If the sample is coal, firing wire should not be inserted into the coal.

c) After installing the firing wires, place oxygen bomb core into oxygen bomb cylinder with 10ml distilled water and tightened oxygen bomb cover slowly.

d) Place the oxygen bomb into the oxygen bomb stand under the bucket lid stably and gently. Enter sample weight and other parameters, such as Mad, additives and so on.

6. **Start test:** Hang the oxygen bomb on the oxygen bomb stand. When the red indicator light on the infrared sensor of the lift arm lights up, indicating that the oxygen bomb has been detected. the parameter input interface shows "Oxygen bombs: hanged " at the same time (when the oxygen bomb is not hanged is shows "Oxygen bombs: not hanged", and the sensor only has the green light on), the mouse cursor will stay in the sample quality input field where to enter the sample quality. Click “Start test” button, program will enter into test status automatically. If “Start automatically” is set, then program will enter into test status automatically after entering qualified sample mass, at the same time, test progress bar will be displayed in progress displayed window. During tests, you can click “Modify Routine parameters” and “Modify special parameters” to modify corresponding parameters and can click “Stop test” button to stop test.

7. **Test is finished.** After the test is finished, the test data will be saved in the database. Open the bucket cover and take out the bomb from the calorimeter, open the bomb, check the burning status, and clean the bomb. If necessary, please repeat step four to step seven. User can enter into database to check or export test results, for details, please refer to Chapter 5.

8. **Printing results:** After finishing all the tests of the current date, enter into database and select the records, and click Edit->Print, the system will print the selected records

9. **Exit:** After test, take out oxygen bomb core and crucible, dry oxygen bomb core, clean and bake crucible, exit test software, shut off computer and instrument, turn off oxygen cylinder,

discharge remained oxygen in oxygen filler circuit.

### 6.3 Test notes

Standard operation or not will affect the test result, so please follow the details when operating.

1. Requirement for samples and crucibles: Mix the samples thoroughly, the crucible should be clean and of constant weight. If there is sprinkled sample, it should be treated as waste; it's prohibited to use the samples weighed the day before testing and the samples failed to ignite.

2. When weighing benzoic acid please note: If the benzoic acid pill has powder on its surface, please brush the powder away gently using a clean brush; If the benzoic acid is observed having obvious impurity on it, please abandon it.

3. The bomb should be taken carefully, when put samples, please tight up the bomb cap, pay attention the position of the crucible and the firing wire be changed by the any shock.

4. The cleaning of the bomb: The water to clean the bomb should be sufficient, the water temperature should be suitable, it's better if it's close to the water tank temperature. Every time when cleaning the bomb, the cleaning time should be almost the same. The residues of the bomb cylinder should be cleaned, there should be no firing wire or dirt left in the electrode rod, the fire baffle should be clean too. There should be no short circuit of the firing baffle and the electrode rod. When doing the first test after starting the calorimeter, please wash the bomb (or place it in the bucket for temperature balance), then use it; Every test, 10ml of distilled water should be added into the bomb, the surface of the bomb should be cleaned by special towel in order to avoid poor contact of electrode due to dirty surface of the oxygen bomb.

5. Oxygen filling pressure and time requirement: The oxygen filling pressure should be (2.8~3.0)MPa to ensure complete combustion of samples and reliable results. If the pressure is higher than 3.2 MPa, then release oxygen in oxygen bomb, reinstall oxygen bomb and re-fill oxygen. The oxygen filling time should be (20~45)s.(When test biomass samples, the oxygen filling pressure should be adjusted accordingly.)

6. After finishing the test, take the bomb out gently and stably, and release the waste gases through the releasing valve, then to check the burning condition of the sample.

7. Check if the bucket and the filter screen are clean, if there is any dirt, please deal with it and make sure the filter screen is correctly installed.

8. Take the bomb out from the oxygen bomb stand, if some water dropped out on to the cover of the bucket shell, please wipe it promptly.

9. Clean the bomb after finishing the current day test and close the oxygen bomb cylinder, release the gas remained in the oxygen tube and make sure the high pressure of the pressure gauge indicates 0Mpa.

**Note: When the computer is under use, do not remove the board card, or it may hurt your computer as well as the relevant cards.**

## Chapter 7 Instrument Maintenance

Calorimeter is a precision measuring instrument, the daily maintenance will directly have influence on the stability and accuracy of the instrument. So the daily maintenance is very important, please pay attention to following points during the daily maintenance.

### 7.1 The maintenance of the instrument and the water tank

1. The instrument must be reliably ground to avoid any influence of test result not stable caused by the un-ground or not reliably ground.
2. Check if bucket and filter screen are clean every day before tests. If not, clean them timely and make sure filter screen is installed properly.
3. After finishing the test every day, the bomb is prohibited to be placed in the bucket. Take out the bomb from the bucket and clean and wipe it and place it in the proper place.
4. Keep the shell of the instrument clean.
5. Never carry any foreign matter or impurities into bucket so as to avoid pollution of water quality and blockage of pipes.
6. Change water in the water tank at least once half a year
7. Use “System Check” to check each parts of system if abnormal incident happens.
8. Wipe the shell of the instrument after cutting off the power supply when it's dirty, use the wet towel with some detergent (soap) to wipe the shell and the bucket slightly, then wipe it by a clean towel to remove the detergent. When operating, please follow the attentions below:  
( Or else it will be all on the user's risk):
  - 1) Before wiping, make sure the power supply is cut off in order to avoid the electric shock and damages to the instrument.
  - 2) When wiping the bucket, block the inlet hole and the filter hole by the clean towel in order avoid the detergent to enter into the water pump and water tank thus to effect the test result.
  - 3) When wiping, avoid any water into the instrument thus lead to the malfunction.
9.  Fuse models: 217 series. Manufacturer: Littelfuse. Specification: F10AL/AC250V 5 \*
20. Make sure it meet the requirements as mentioned when replace it.
10.  The input power wire and plug cannot be replaced unless the wire or plug is provided by Sundy or meet the local standards.

### 7.2 Maintenance of Oxygen Bomb

1. After test completion each time, be sure to flush bomb components with distilled water and wipe them dry with special towel.
2. Change the sealing ring in use by standby ring if oxygen leakage from bomb has been found, otherwise bomb cannot be used any longer.

3. Never use oxygen bomb when its screw threads have failed.
4. Inspect oxygen bomb at regular interval. Carry out hydraulic test at least once each year (to be presented to Sundry for such test).
5. Be sure to carefully take out and place oxygen bomb from and into bucket to avoid bucket damage due to collision or drop.
6. Be sure to clean the crucible after use. Better bake it at high temperature of electric oven for 3-5 minutes.
7. The crucibles and the oxygen bombs are prohibited to be placed in corrosive environment.

## Chapter 8 FAQ and solutions

In this chapter, some knowledge for the maintenance and malfunction solutions will be introduced, if the user cannot solve it, please contact Sundy.

### 8.1 Cannot be on-line

---

If there is no bucket number shown in the progress indication window of the main window, the reasons may be as follows:

1. The power supply was off, check if the power switch and the air switch on the back panel of the calorimeter were on and check if the inverter was in order.
2. Instrument communication IP is not set in the computer.
3. Online router switch is stuck. Restart the router switch.
4. The communication cable on the main board card was loosened.
5. The program was damaged by the virus, reinstall the software after running the antivirus.
6. The firewall prevents the program from running. Turn off the firewall or set the firewall to allow testing program running.

If the bucket number shown and disappear alternately in the progress indication window of the main window

1. Some parts of the instruments was poor contacted.
2. The software edition didn't match.
3. Some problem with the main board card.

### 8.2 Cannot enter test status

---

If the calorimeter was online but cannot enter the test status, the reasons may be as follows:

1. The jacket temperature was not in the temperature controlling range, please wait for a moment.
2. Sample parameter abnormal. Such as: The sample weight was not input, or the sample weight in not qualified or corresponding heat capacity is not existed.
3. Oxygen bomb status is wrong. Firing wire is not connected. Bucket cover ignition electrode is not connected with oxygen bomb properly.
4. System abnormal prompted.

### 8.3 Prompt "Oxygen bomb open circuit abnormal"

---

Identify if the ignition wire is well connected or not after filling oxygen automatically. When the oxygen bomb is open circuit, raise the oxygen bomb after automatic oxygen degassing and check

if the fire wire comes off.

#### **8.4 No stirring**

---

1. Stirring pump wiring is not connected well.
2. The deairing valve or the stirring pump was broken.

#### **8.5 Ignition failure**

---

First please check if the sample was burned:

The sample was burned:

1. The calorific value of the sample is too low or not flammable: Please add additives to the samples and test again.
2. If the stirrer worked in order.
3. If the temperature probe was damaged.

The sample was not burned:

1. No oxygen or oxygen insufficient.
2. Leakage with the bomb.
3. The firing wire is not fixed.
4. Check if the firing wire was fused: If yes, the firing wire was fixed far away from the sample, or the sample was not flammable; If not, the contact resistance between the electrode rod on the cover and the bomb is too large, or the contact resistance between the firing wire and the bomb is too large.
5. Driving card may be damaged.

#### **8.6 Gas leakage with the oxygen bomb**

---

If the bomb was not badly damaged, four places should be checked for the leakage:

1. Air nozzle leakage or cannot be filled or released: Open the air nozzle and clean the valve core in it, and replace the sealing ring on the cut-off valve and clean it, at the same time clean the air nozzle of the bomb.
2. The joint of air nozzle and bomb core: twist the air nozzle tightly again.
3. The insulation covering of the bomb core: twist it tightly or change the insulation covering.
4. The cap of the bomb: change the sealing ring of the bomb core.

## **8.7 Too long time for temperature balance or cannot enter into temperature balance**

---

1. The water in the jacket was not enough or no water in it.
2. The heater of the jacket was damaged or the power was not enough.
3. There was no power supply for the heater.
4. The jacket semiconductor chilling efficiency is low.

## **8.8 Test result is not ideal**

---

Please check if the operation is correct.

1. If the weighing balance is in order and if the weighing is accurate.
2. If the sample weight is correctly input.
3. The sample particle size and the uniformity is according to the standard.
4. If the sample was deflagrated or if the sample was spilled out from the crucible or the sample was not completed burned.
5. The oxygen in the bomb was not enough or the oxygen filling time was not the same, or if the bomb was leaked.
6. The water of the bucket was not determined correctly or the temperature probing not stable. (Please call for service).
7. Stirring efficiency was low.
8. Sometimes added 10ml water into the bomb and sometimes not.
9. The calorimeter was not well ground.

## **8.9 Cannot be printed**

---

1. Printer is not turned on or connection is wrong.
2. Printer driving is not installed or is damaged. Please re-install the driving program.
3. Printer error, such as paper is stuck. Please restart the computer.
4. The set print format doesn't match with the selected record, such as the selected record doesn't match when printing the parallel sample。

## **Chapter 9 Choosing Method for Heat Capacity and Calorific value**

**When automatically printing parallel samples or set “choose qualified records when printing parallel samples” in database, the determination method for parallel samples heat capacity and calorific value is as follows:**

- **Choosing Method for Heat Capacity**

If there are more than 7 heat capacity data provided that bucket number at current day, the oxygen bomb number and the controlling temperature are the same, choose 5 data with the min precision from the latest 7 data. That is, when 7 data, arrange them in order firstly. Choose the min average value among 1-5, 2-6 and 3-7 provided that precision is  $\leq 0.20\%$ . The same way to calculate in case there are 5-6 data.

- **Choosing Method for Calorific value**

If the calorific values with same sample number are more than 4, choose the latest 4 data. Arrange them in order firstly. If range of 1-4 is  $\leq 156\text{J/g}$ , then choose the average value, otherwise average value between 1-3 and 2-4 shall be chosen provided that range is  $\leq 144\text{J/g}$ . If it doesn't meet the condition yet, when range of 2-3 is  $\leq 120\text{J/g}$ , average value shall be chosen. Otherwise qualified average value is not displayed. If there are 3 data, the rest can be done with the same manner.

**If there is no setting mentioned above, the heat capacity and the calorific value of the determination for parallel samples is as follows:**

- **Heat capacity**

The heat capacity data whose bucket number at current day, the oxygen bomb number and the controlling temperature are the same are treated as parallel samples to calculate the average value only, it will not be treated as the heat capacity of the instrument.

- **Calorific value**

All the calorific value data in the data list are treat as the parallel samples to calculate the average value.

## Chapter 10 Formula and Description

### 1. Cooling calibration value $C = nV_0 + (V_n - V_0) / (T_n - T_0) [ (T_0 - T_n) / 2 + \text{integral value in principal period} - nT_0 ]$

Among  $V_0$  — bucket temperature-fall speed while firing, K/min;

$V_n$  — bucket temperature-fall speed at final point, K/min;

$T_0$  — bucket temperature while firing, K;

$T_n$  — bucket temperature at final point, K;

Integral value in principal period = existing integral value + current temperature\* (time lasting for current temperature — time lasting for previous temperature)

### 2. Formula for heat capacity

Instrument heat capacity  $E = (1.0015 * Q * m + q_1 + q_2) / (T_n - T_0 + C)$

Among  $Q$  — calorific value of benzoic acid, J/g;

$m$  — weight of benzoic acid, g;

$q_1$  — calorific value of firing wire, J;

$q_2$  — calorific value of additives, J.

### 3. Formula for calorific value

- calorific value of determination in oxygen bomb

$$Q_{b,ad} = [ E ( T_n - T_0 + C ) - q_1 - q_2 ] / m$$

(If “calorific value of determination in oxygen bomb includes nitric acid formation heat” is cancelled in system setting,  $Q_{b,ad} = Q_{b,ad} - 0.0015 * m * Q_{b,ad}$ )

- gross calorific value  $Q_{gr,ad} = Q_{b,ad} - (94.1 S_{b,ad} + a Q_{b,ad})$

- constant-volume net calorific value

$$Q_{net,v,ar} = ( Q_{gr,ad} - 206 H_{ad} ) ( 100 - M_{ar} ) / ( 100 - M_{ad} ) - 23 M_{ar}$$

- gross calorific value as dry basis  $Q_{gr,d} = 100 Q_{gr,ad} / ( 100 - M_{ad} )$

- sulfur in oxygen bomb  $S_{b,ad} = ( C * V / m - a Q_{b,ad} / 60 ) * 1.6$

Among:

$C$  — mole concentration of sodium hydroxide solution, about 0.1 mol/L;

$V$  — volume of sodium hydroxide solution used by titration, mL;

60 — formation heat equivalent to 1 mmol of nitric acid, J.

$Q_{b,ad}$  — calorific value of determination in oxygen bomb, MJ/kg

$a$  — calibration coefficient of nitric acid:

when  $Q_b \leq 16.70$  MJ/kg,  $a = 0.0010$ ;

When  $16.70$  MJ/kg  $< Q_b \leq 25.10$  MJ/kg,  $a = 0.0012$

when  $Q_b > 25.10$  MJ/kg,  $a = 0.0016$ ;

- conversion of additives weight

heat value of additives = calorific value of additives \* additives weight

#### 4. Formula for calorific value of CWM

- The formula for calorific value of CWM Dry sample is the same with the formula for calorific value of air dry basis coal sample.

- Formula for CWM:

- ◆ calorific value of determination in oxygen bomb

$$Q_{b,cwm} = [ E (T_n - T_0 + C) - q_1 - q_2 ] / m$$

(“Calorific value of determination in oxygen bomb includes nitric acid formation heat” is cancelled in system setting,  $Q_{b,cwm} = Q_{b,cwm} - 0.0015 * m * Q_{b,cwm}$  )

- ◆ gross calorific value  $Q_{gr,cwm} = Q_{b,cwm} - (94.1S_{b,cwm} + a Q_{b,cwm})$

The two parameter  $S_{b,cwm}$  and  $a$ , the determination is the same with air dry basis coal sample.

- ◆ constant-volume net calorific value  $Q_{net,v,cwm} = Q_{gr,cwm} - 206H_{cwm} - 23 M_{cwm}$

In it,  $H_{cwm}$ 、 $M_{cwm}$  represents the mass fraction of CWM hydrogen and moisture, %

**Note: CWM sample doesn't have the parameter index of Gross calorific value air dry basis.**

# Chapter 11 Instrument Diagram

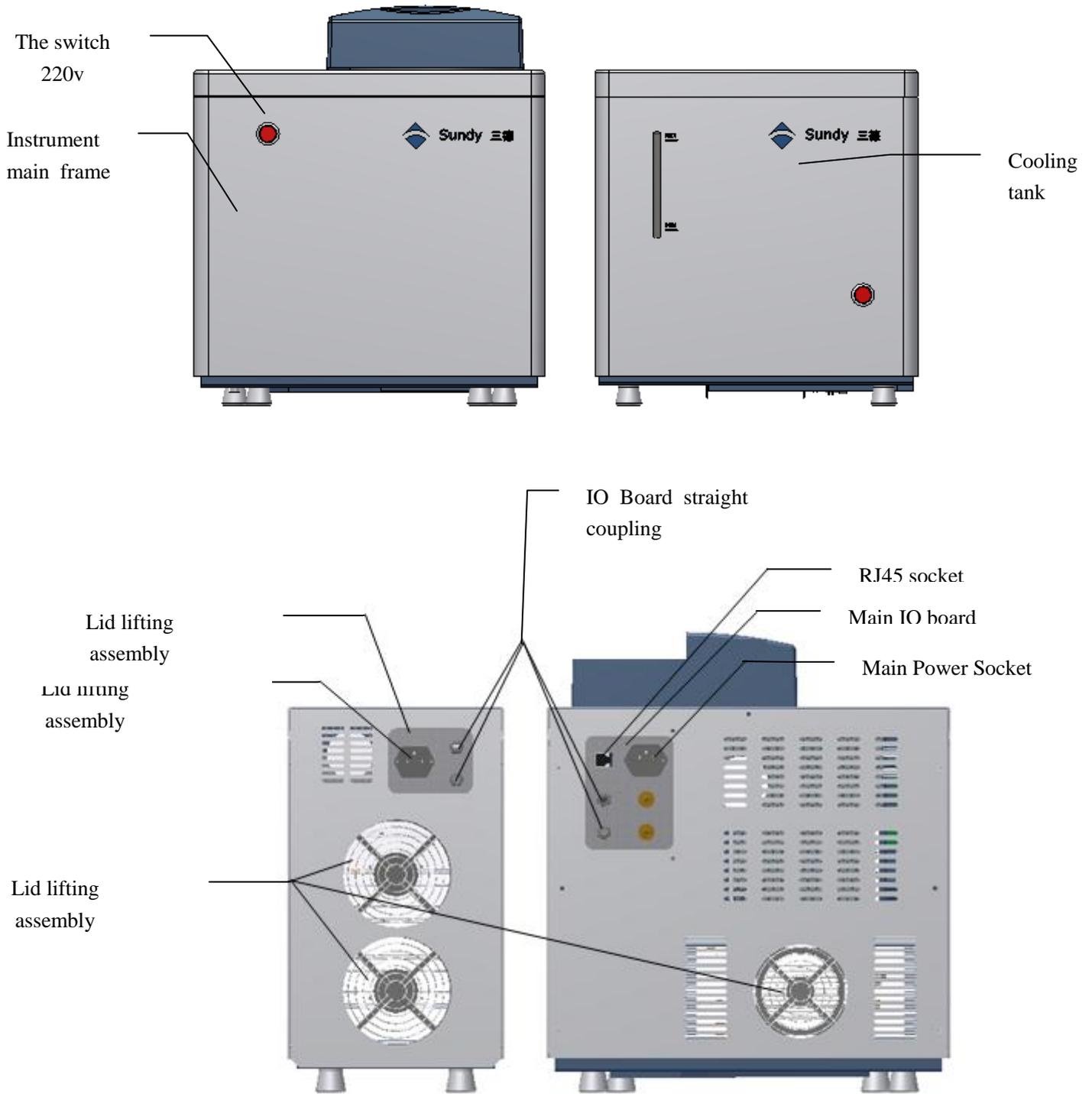


Fig.9-1 Instrument front and back diagram

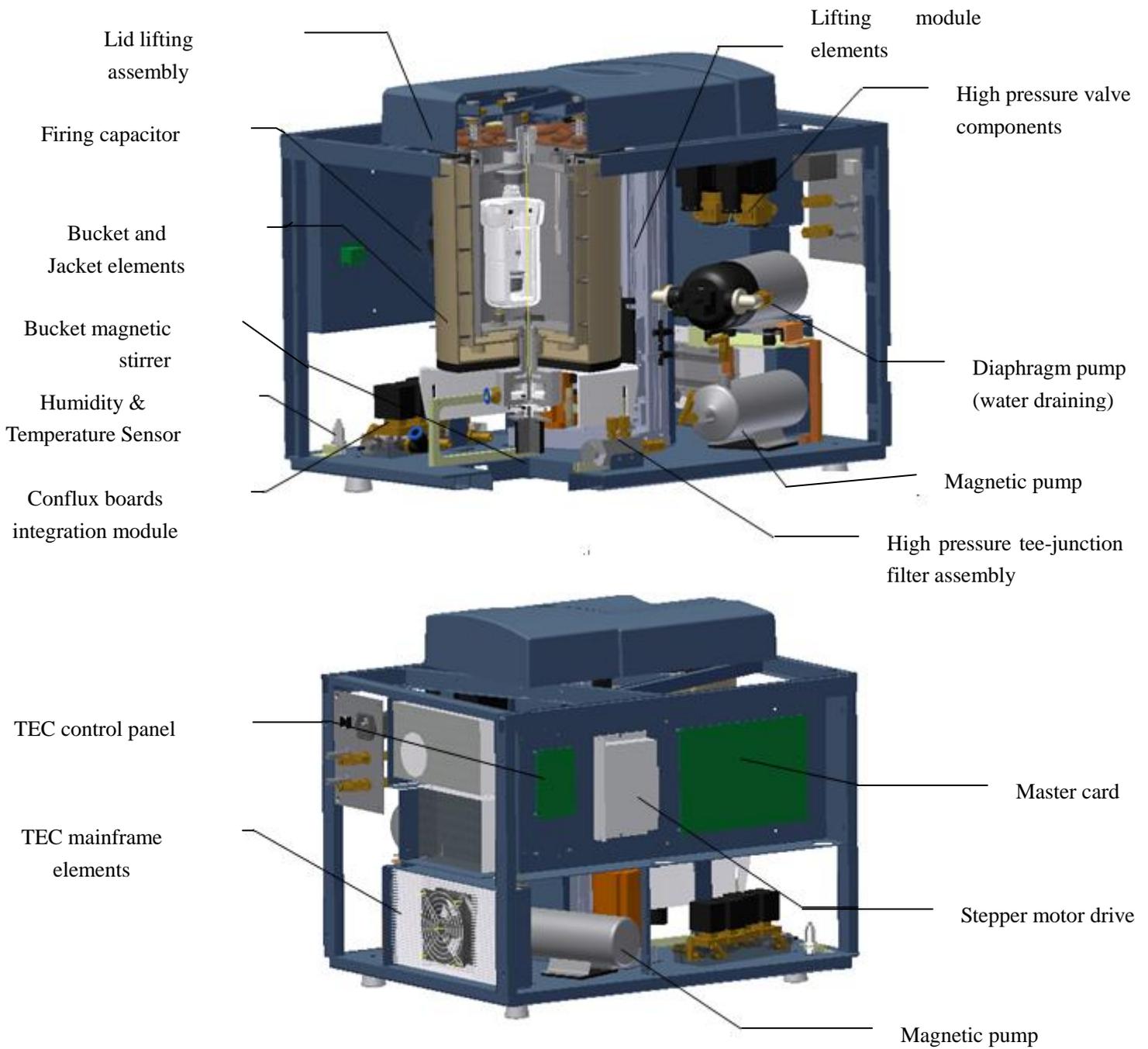


Fig 9-2 Structure of the mainframe

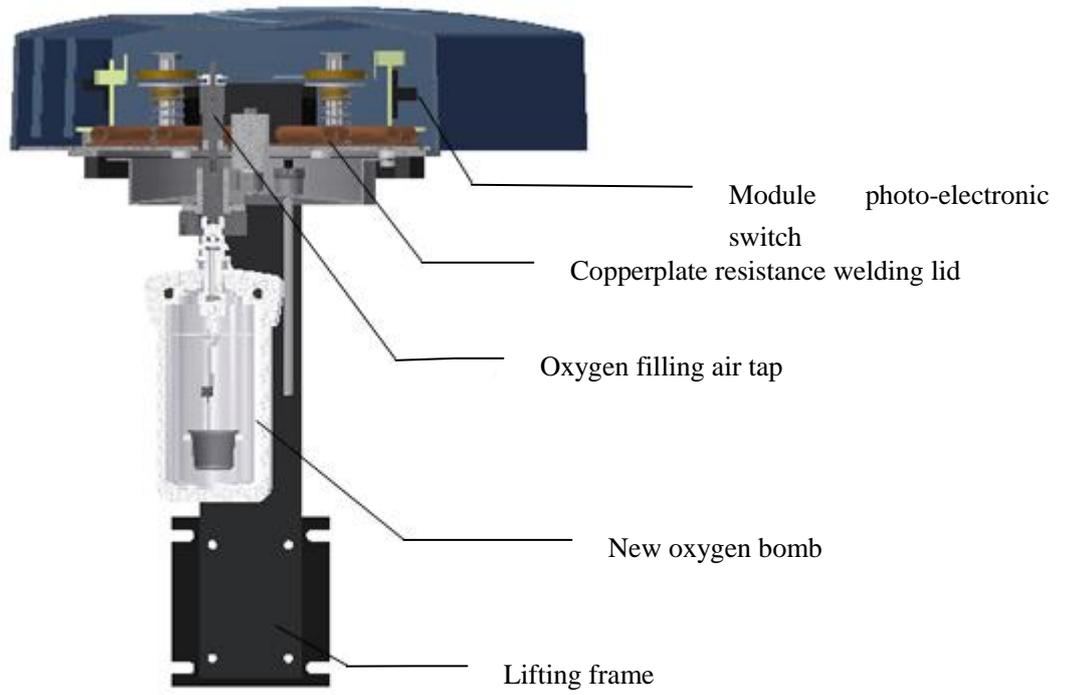


Fig 9-3 Lid lifting assembly

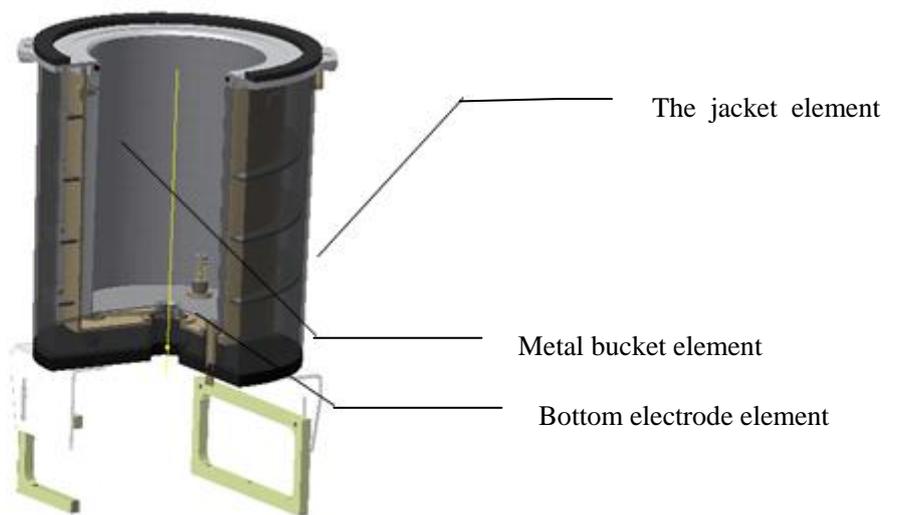


Fig 9-4 Jacket and bucket elements

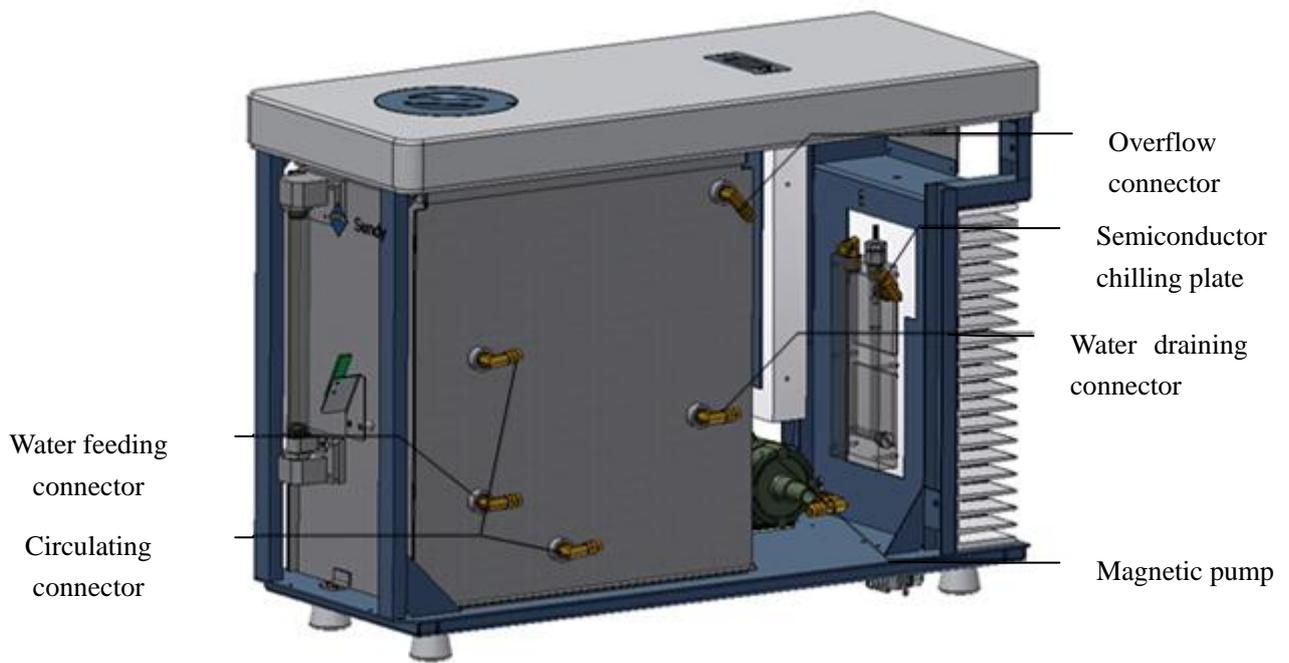


Fig 9-5 Inner structure of water tank

## Appendix I: Critical spare part list

NO.	Name	Code	No.	Name	Code
1	Framework components	3.02.01.9043	26	Oxygen bomb hanging board	3.02.01.9063
2	Top shell	3.02.01.9044	27	Pumping block	3.02.01.9064
3	Framework weld side plates	3.02.01.9048	28	Calorimeter cover	3.02.01.9065
4	Framework side plate	/	29	Upper cover heat insulation pad	3.02.01.9066
5	Reinforced aluminum plate 1	/	30	Upper cover heat insulation pad 2	3.02.01.9067
6	Reinforced aluminum plate 2	/	31	Optical axis reset spring	3.02.01.9068
7	Reinforced aluminum plate 3	3.02.01.9049	32	Optic axis	3.02.01.9069
8	Back cover plate	3.02.01.9045	33	Water level probe weldment	3.02.01.9070
9	Fixed temperature and humidity sensor	3.02.01.9047	34		
10	Bottom cap	3.02.01.9046	35	Upper cover plate welding	3.02.01.9071
11	IO board	3.02.01.9050	36	Cap copper	/
12	Inlet connector	3.02.01.9051	37	Top brass	/
13	Copper lock nut	3.02.01.9052	38	locating plate	3.02.01.9150
14	IO board through joint	3.02.01.9020	39	Light medallion fixed plate	3.02.01.9072
15	Gas mouth joint 1	3.02.01.9053	40	Optical axis fixed screw	3.02.01.9073
16	Gas mouth union nut 1	3.02.01.9054	41	Insulation mat 1	3.02.01.9074
17	Gas mouth union nut	3.02.01.9055	42	Insulation mat 2	3.02.01.9075
18	Reinforced fixed block	3.02.01.9056	43	Up cover	3.02.01.9113
19	Lift column fixed plate	3.02.01.9057	44	Metal module cover	3.02.01.9114
20	Movable interlayer	3.02.01.9058	45	Pipe spring	3.02.01.9076
21	Oxygen filling mouth piston	3.02.01.9059	46	Line bracket	3.02.01.9077
22	Oxygen filling nozzle gasket	3.02.01.9060	47	Wire line board	3.02.01.9078
23	Oxygen filling nozzle	3.02.01.9061	48	Bottom electrode pole 2	3.02.01.9079

24	Up cover plate weldment	3.02.01.9127	49	Bottom electrode pole guide sleeve2	3.02.01.9080
25	Oxygen bomb hanging stand	3.02.01.9062	50	Stop collar 2	3.02.01.9081
NO.	Name	Code	No.	Name	Code
51	electrode cap	3.02.01.9082	76	Gas mouth	3.02.01.9108
52	Jacket plate	3.02.01.9084	77		
53	external brace	3.02.01.9085	78	Diaphragm pump fixing plate	3.02.01.9103
54	Stirring bar	3.02.01.9086	79	Diaphragm pump pagoda joint	3.02.01.9104
55	Stirrer	3.02.01.9087	80	Manifold board	3.02.01.9105
56	搅拌套	3.02.01.9088	81		
57	搅拌套 2	3.02.01.9089	82	Main body supporting leg	3.02.01.4792
58	Stirring sleeve	3.02.01.9090	83	IO board straight coupling nut	3.02.01.4720
59	Stirring motor fixing plate	3.02.01.9091	84	Joint lock nut	3.02.01.1092
60	Stirring ring	3.02.01.9092	85	Gas pipe joint	3.02.01.1094
61	Cooling plate	3.02.01.9093	86	Air pipe lock nut I	3.02.01.1095
62			87	Gas nipple connector	3.02.01.1641
63	Platinum resistance fixing seat 1	3.02.01.9033	88	Gas nipple nut	3.02.01.1640
64	Platinum resistance fixing seat 2	3.02.01.9034	89	Diaphragm limiter I	3.02.01.0146
65	TEC fixing plate	3.02.01.9094	90	Diaphragm pump pad 1	3.02.02.0203
66	Fixing plate 1	3.02.01.9095	91	Diaphragm pump pad 2	3.02.02.0204
67	High pressure valve fixing plate	3.02.01.9097	92	Diaphragm pump pipe joint sealing ring (φ11.5)	3.02.02.0155
68	High pressure valve fixing plate support	3.02.01.9098	93	Diaphragm pump pipe joint sealing ring (φ12)	3.02.02.0140
69	High pressure valve adapter	3.02.01.9099	94	Diaphragm pump joint	3.02.01.1227
70	Electric separator 1	3.02.01.9100	95	Diaphragm pump connector gasket	3.02.02.0005

71	Capacitor fixing plate	3.02.01.9101	96	Diaphragm pump inner support	3.02.01.0144
72	Hand screw		97	Principal part	3.02.01.9133
73	Electric separator 2	02.01.9102	98	Oxygen bomb cover	3.02.01.9134
74	Three way high-voltage adapter	3.02.01.9106	99	Oxygen bomb head	3.02.01.9135
75	Three way fixed plate	3.02.01.9107	100	Oxygen warhead	3.02.01.9136
NO.	Name	Code	No.	Name	Code
101	Axial column	3.02.01.9137	126	Stainless steel bearing	3.01.01.1240
102	Axial column 2	3.02.01.9138	127	PC Plastic screw	3.01.05.1514
103	Valve core	3.02.01.9139	128	Straight line module	3.01.05.1515
104	Pressure ring	3.02.01.9140	129	O ring	3.01.02.0603
105	Fireproof plate	3.02.01.9141	130	O ring	3.02.02.0187
106	Insulation sleeve 1	3.02.01.9142	131	O ring	3.01.02.0604
107	Insulation sleeve 3	3.02.01.9143	132	O ring	3.01.02.0605
108	Straight electrode 1	3.02.01.9144	133	O ring	3.01.02.0606
109	Straight electrode 2	3.02.01.9145	134	O ring	3.01.02.0607
110	Straight electrode I	3.02.01.9146	135		
111	Straight electrode II	3.02.01.9147	136		
112	Straight electrode III	3.02.01.9148	137	Water tank framework weld components	3.02.01.9012
113	Pressure nut	3.02.01.9149	138	Water tank up cover	3.02.01.9013
114	Linear bearing;	3.01.01.1236	139	Water tank framework side plates weld components	3.02.01.9014
115	Optic axis	3.01.01.1237	140	Reinforced aluminium plate 6-1	3.02.01.9015
116	Quick coupling	3.01.02.0070	141	Reinforced aluminium plate 6-2	3.02.01.9016
117	Quick coupling	3.01.02.0050	142	Reinforced aluminium plate 7	3.02.01.9017
118	Quick coupling	3.01.02.0053	143	Water tank back cover plate	3.02.01.9018
119	Cooling fan	3.01.05.0052	145	Water tank IO board	3.02.01.9019

120	90°pagoda joint 10-02	3.02.01.4424	146	IO board straight coupling nut	3.02.01.9020
121	90°Variable diameter pagoda connectors 14-10	3.02.01.4834	147	IO board straight coupling nut	3.02.01.4720
122	90°pagoda joint 10-10	3.02.01.4879	148	Tank welding parts	3.02.01.9021
123	Straight pagoda joint 10-02	3.02.01.4421	149	Tank cover	3.02.01.9022
124	High pressure two-way valve	3.01.05.1512	150	Filler pipe	3.02.01.9023
125	Solenoid valve	3.01.05.1513	151	Filter base	3.02.01.9024

## Appendix II: Attentions for Oxygen Bomb usage

1. Oxygen filling pressure is (2.8 ~ 3.0) MPa when using the Oxygen bomb normally. In consideration of the factor of safety, for the new oxygen bomb or oxygen bomb after repairing, it is required to pass safety performance inspection before using. Inspection may meet several aspects below.
  - 1) After filling oxygen for the oxygen bomb, choose Automatic oxygen degassing in the System Test interface. After oxygen degassing, the valve core shall slide down smoothly, and the oxygen bomb cover shall spin out smoothly.
  - 2) Have a hydraulic test. When under 20 Mpa hydrostatic pressure for 5 minutes, the oxygen bomb have no leakage.
2. According to theoretical analysis, the temperature produced by the heat released after combustion and the pressure released will not burn or hurt a person.
  - 1) Put (1 ± 0.1)g sample in the oxygen bomb and get it burn abundantly. The heat released is about (16000~40000)J. (Note: Generally the samples are in this range. For unknown samples with high heat value, it will usually reduce the sample weight for test. ) The sample material in the oxygen bomb will burn and release heat, which will be absorbed by the oxygen bomb and the surrounding water. The temperature will increase about <math>< 4^{\circ}\text{C}</math>. While the temperature of the jacket will keep constant and its highest temperature will not over 35 °C. When the test is over, the temperature of the jacket and bucket will achieve equilibrium and the oxygen bomb temperature will be (20~40 °C), so it will not burn a person.
  - 2) When the test is finished, the gas in the oxygen bomb will exhaust through the automatic air vent valve slowly and the exhaust gas will be extracted to the outdoor

via the gas-guide tube, so the air pressure inside the oxygen bomb will not cause harm to human.

3. During the test, how to resolve the related problems of oxygen bomb.

- 1) If you change your mind during the test, it can be terminated directly. No matter the sample in the oxygen bomb burns out or not, the test can be terminated. Terminating the test is the same as ending the test normally.
- 2) If the oxygen bomb leaks, the oxygen bomb o-ring should be replaced.
- 3) If the oxygen bomb does not deflate in the end of the experiment, choose Automatic oxygen degassing in the System Test to process automatic oxygen degassing, and contact Sundry technology personnel to identify the cause.

[www.sandegroup.com](http://www.sandegroup.com)

Hunan Sundry Science and Technology Co.,Ltd

Add: No.558 West Tongzipo Road, Changsha, Hunan Province,  
P.R.China

P.C.:410205

Tel: +86 731 88112150

Fax: +86 731 88134650

Service: +86 731 89864000