Labotronics

Oil Particle Counter

LB-110PC

Index

1. Introduction

Oil Particle Counter LB-11OPC used a light blockage measuring principle to determine solid particles in oil. Features semi-conductor laser as a light source to provide 4 or 1 μm of sensitivity. Designed with a syringe sampling system and positive/negative air pressure chamber device, allows arbitrary setting of 16 channels of particle size to facilitate analysis.

2. Features

1. Utilize light blockage measuring principle for fast detection
2. Semi-conductor laser as a light source for high reliability
3. High-precision syringe sampling system for consistency
4. Positive/negative air pressure chamber device
5. Allows arbitrarily setting of 16 channels of particle size
6. Large LCD color screen display for convenient operation
7. Data testing with storage for easy data analysis
8. Built-in printer with RS232 interface for data processing
9. Single-chip microcomputer control system for easy operation
10. Offers high test speed, high accuracy and repeatability

3. Specifications

Model No.	LB-11OPC
Light source	Semiconductor laser
Particle size range	1 to 400 μm
Detection channels	16
Sensitivity	1 μm or 4 μm
Resolution	>10%
Repeatability	RSD < 2%
Sampling system	High-precision syringe bottle
Sampling volume	0.3 to 100 ml, 0.1 ml interval
Sampling speed	5 to 60 ml/min
Sampling accuracy	<±1%
Sample detection viscosity	<350 cst
Air pressure chamber	Positive/negative air pressure chamber
Maximum vacuum	0.08 mPa
Maximum pressure	0.8 mPa
Maximum particle concentration	10000 particles/ml
Error limit	5% coincidence error
Display	LCD screen display
Interface	RS232
Storage	100 group
Printer	Built-in printer with external output
Power supply	100 to 245 V, 49 to 62 Hz
Power	<80 W
Packaging dimension (W×D×H)	300×400×500 mm
Gross weight	23 kg

4. Applications

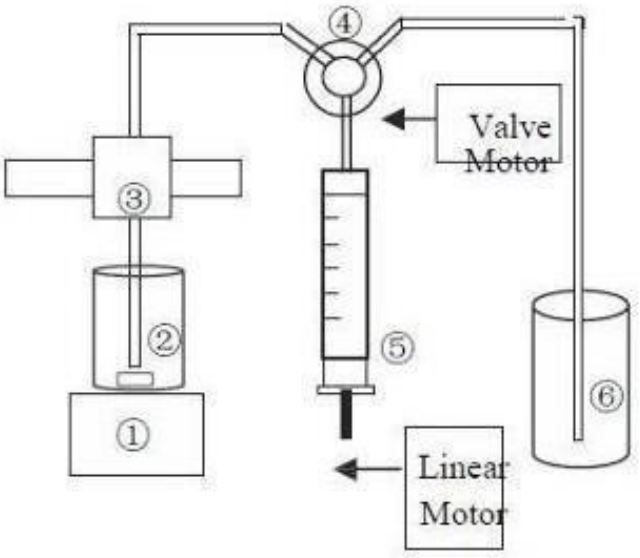
Oil particle counter is used for oil contamination analysis across aviation, aerospace, electric power, petroleum, chemical industry, transportation, port, metallurgy, machinery, automobile manufacturing etc.

5. Instrument Introduction

The instrument mainly consists of a laser light blockage sensor, sampling system, amplifying circuit, and single-chip control system (which comprises MPU, counter, LCD touch screen, printer,etc.).

5.1 Sampling System

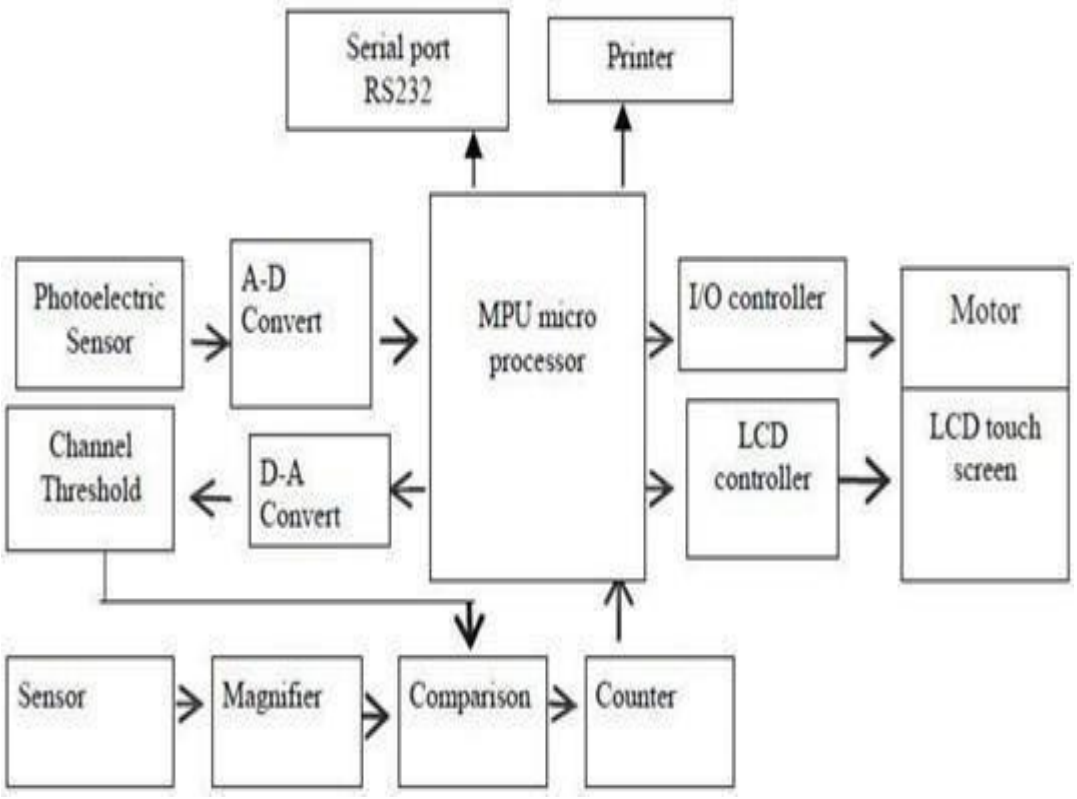
As the test begins, the valve motor starts driving the three-way valve④ to spin, and thereby connecting precise syringe⑤ with sensor③, tested liquid in sample bottle ② is drawn into thetest area of sensor ③ by syringe ⑤, single-chip control counter will start counting when the certain volume (preset to 0.3 to 1ml, this amount is set by user) of liquid is drawn by syringe⑤, the solution will be continually drawn by syringe ⑤ till sampling volume set by user is reachedand counter will stop counting till then. The valve motor drives a three-way valve④ to spin andthereby connects syringe ⑤ with effluent tube⑥, from where effluent is discarded.



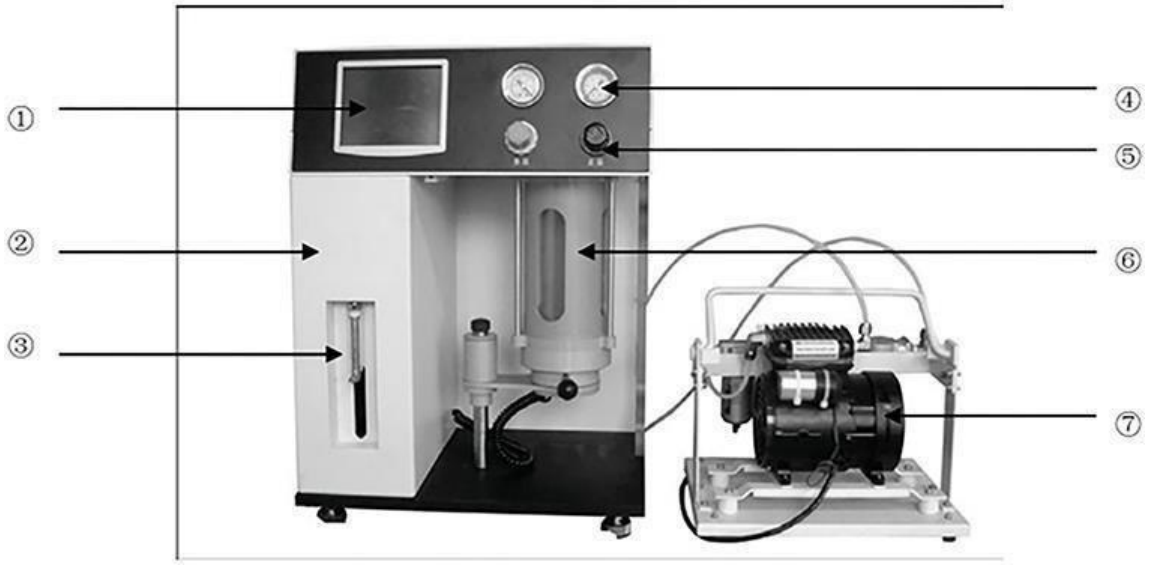
1. Stirrer
2. Testing vessel
3. Laser sensor
4. Three-way valve
5. Precise syringe
6. Effluent vase

5.2 Single-chip microcomputer control system

The microcomputer control system is shown in the figure below as the test begins, Single chip microcomputer (MPU) will first detect the laser sensor for normal conditions by using an analog-to-digital converter, and then the I/O controller will control the operation of the motor,and thereby put sampling system in normal operation. For counting, signal input by the sensor will be amplified to proper amplitude and compared to channel threshold voltage output by an analog-to-digital converter, digital impulse generated hereby will be accumulated by counter. Data will be read by MPU, and the test result will be displayed by 640*480 dot matrix color LCD.Upon completion of the test, data may be printed by micro-printer or transmitted to the computer via an RS232 serial port.

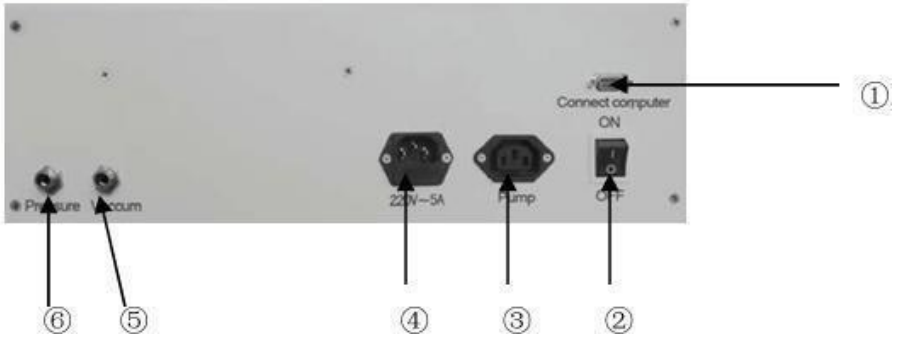


6. Installation



1. LCD touchscreen
2. Mainframe
3. Precise syringe
4. Positive/Negative Pressure Meter
5. Positive/Negative pressure regulating valve
6. Air pressure chamber
7. Pneumatic pump

6.1 System Connection



1. RS232 interface (Connect computer)
2. Power switch
3. Pneumatic pump power socket
4. Power socket
5. Vacuum interface
6. Pressure interface

1) **Mainframe**
   Insert the power cable into the power socket on the rear panel of the mainframe.

2) **Connection between mainframe and pneumatic pump**
   - Connect the power cord of the pneumatic pump to the power socket of the pneumatic pump on therear panel of the mainframe.
   - The pressure tube of the pneumatic pump is connected to the pressure interface on the rear panelof the mainframe.
   - The vacuum tube of the pneumatic pump is connected to the vacuum interface on the rear panel ofthe mainframe**.**

3) **Discharging Tube**
   The connector for the discharging tube is located on the lower right corner of the mainframe's rear panel, which shall relate to the connector on the discharge tube; the end of the discharge tube shall be inserted into a container for waste.

6.2 Use the method of pressure chamber

1) **Open the method of the pressure chamber**
   - A total of two handles of the pressure chamber will be removed as shown in the figure. When the instrument leaves the factory, handles should be installed before use.
   - Two handles of the pressure chamber are twisted clockwise into the mounting holes as shown in the figure below.
   - Two mounting holes differ by 180 degrees.

   - Both hands hold two handles of the pressure chamber respectively and turn clockwise to the limit position.
   - Both hands hold the test bench and slowly put the test bench down to the lowest position.

2) Shut method of the pressure chamber

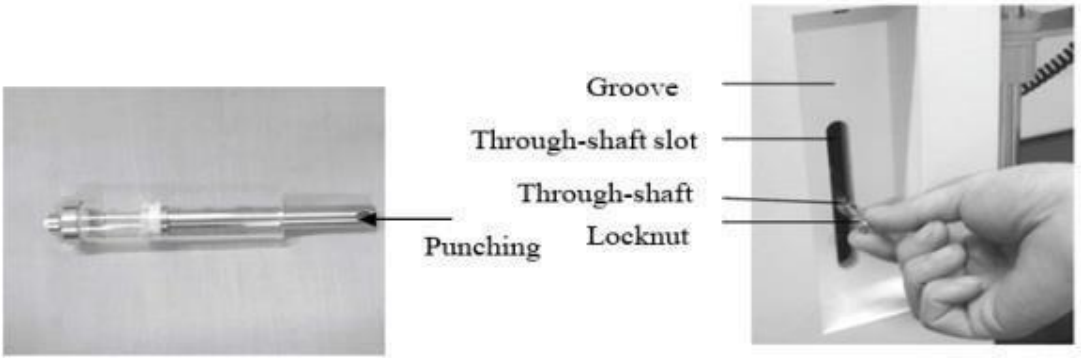
- Both hands hold two handles of the pressure chamber respectively and turn clockwise to thelimit position.
- Both hands hold the test bench and slowly put the test bench up into the pressure chamber(Move up to the highest position).
- Both hands hold two handles of the pressure chamber respectively and turn counterclockwise to the limit positioning order to complete the airtight pneumatic chamber.

3) Use the method of magnetic field spacer

- The test bench as shown in the figure as interior is equipped with a magnetic stirrer if the sample contains ferromagnetic particles, ferromagnetic particles in magnetic force.
- Under the action of a magnetic stirrer in a magnetic field, ferromagnetic particles rapidly settle,affecting test results.
- A magnetic field spacer is round steel whose diameter is about 65 mm, which will be placed directly on the test bench when used as shown in the figure.
- A magnetic field spacercan play a role in shielding the magnetic field of the magnetic stirrer and preventing ferromagnetic particles from settling fast in the samples.

6.3 Installation method of syringe

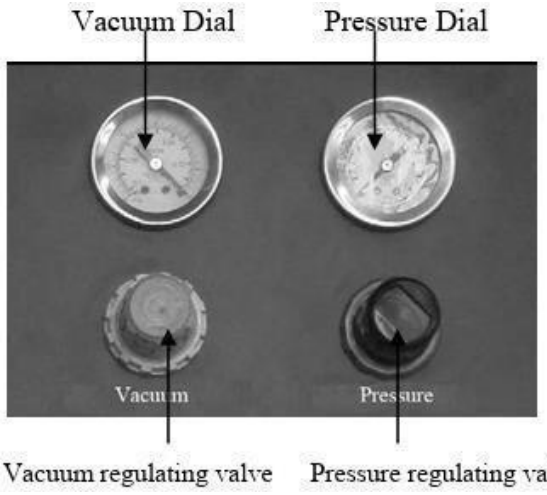
1) Precision syringe is a fragile part.
2) Demount the precision syringe for separate packaging before the delivery of the instrument.
3) The syringe shall be installed before use.
4) Make the through-shaft in half of the through-shaft slot.



5) Hold the locknut by hand and remove it from the through-shaft via counterclockwise rotation.
6) Make the punch of the syringe pass through the through-shaft, hold the metal part of the top of the syringe by hand and lift slowly, thus, to make it connect to black threaded connector at the top of the groove and tighten the syringe counterclockwise.
7) Finally, tighten the locknut clockwise.

6.4 Generation and adjustment of pressure/Vacuum

- The main purpose of the positive pressure is that the syringe is assisted on suctionfor larger viscosity samples, which have a degassing function concurrently for samples at the same time.
- The pressure regulating valve is located on the right ofthe front panel.
- Increasing pressure when adjusting the pressure regulating valve in a clockwise direction; reducing pressure when adjusting the pressure valve ina counter clockwise direction.
- The instrument is switched on, pressure chamber will be airtight. In the main menu interface, click **[**Test**]** then click on the **[** Pressure**].**
- The pneumatic pump starts on and begins to add pressure, and the pressure table pointer rises gradually until it reaches the preset values.
- If it is needed for adjustment pressure, the regulating valve of pressure is pulled up outside, slowly adjust the pressure regulating valve, make the pressure stable to the expected value, press the pressure regulating valve inside, and lock it.



1) **Generation and Adjustment of Vacuum**
   - Vacuum is mainly used for degassing samples; the value of the vacuum can be adjusted according to the actual situation.
   - Increasing vacuum when adjusting the vacuum regulating valve in a clockwise direction; reducing vacuum when adjusting thevacuum valve in a counterclockwise direction.
   - The instrument is switched on, pressure chamber will be airtight. In the main menu interface, click **[**Test operation**]** then click on the **[**Vacuum**]** Pneumatic pump start on and begin to add vacuum, The vacuum table pointer rises gradually until it reaches the preset values.
   - If there is a need for adjustment of the pressure of the vacuum, the regulating valveof the vacuum is pulled up outside, slowly adjust the vacuum regulating valve, makethe pressure stable to the expected value and press the vacuum regulating valve inside and lock it.

2) **Deflate and pressure relief**
   In pressurized condition, click **[**Exhaust**]** the pneumatic up outside, slowly adjust the vacuum regulating valve, make the pressure stable to the expected value, pressthe vacuum regulating valve inside, and lock it.

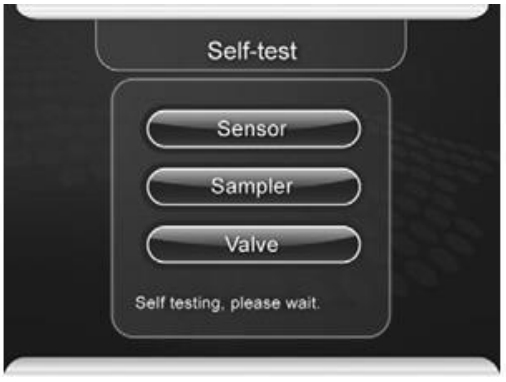
6.5 Working Environment

1) The instrument shall be placed in a clean laboratory, clean bench is preferred.
2) Temperature and working voltage shall be by technical requirements.
3) The instrument shall be prevented from being operated alongwith equipment that intensively interferes with the power supply.
4) If the pneumatic pump noise is too big, a layer of foam mat can be placedunder the bottom pneumatic pump to reduce noise.

6.6 Major Functions and Setup

1) **Self-test**
   - Switch the **ON** power of the instrument to activate the self-test.
   - During the process, the instrument will perform detection on the sensor, sampler (precise syringe), and valve and display relevant results.
   - **"×"** will be displayed when abnormal conditions are found in the self-test.
   - Thefollowing procedures shall be performed.
   - **Abnormal** "**Sensor":** Perform Loop Rinse】 twice with pure petroleum ether, then turn the power off and restart self-detection to verify if the abnormal condition is eliminated.
   - **Abnormal Sampler Valve:** the instrument will not be operated normally.

2) **Main menu interface**
   - The instrument will automatically enter the main menu interface when normal conditions of the self-test Main menu interface consist of **[**Test**]**, **[**RunSet up**]**, 【Channel Set-up】, 【Flush], 【Other Set-up】, 【Channel Calibration】 and 【Stirrer speed adjustment】 touch control zones, etc.
   - The stirrer is mounted inside the test bench, click on the bottom of the screen **[**Stirrer speed adjustment**]** and Click **[+]** or **[** -] to adjust the stirrer speed.



3) **Run stop**
   - Click [Run setup] on the main interface and enter the setup interface.
   - Run setup contains the following items, the test will be performed accordingto the set for the sub-items.
   - **Run mode**: Auto/Manual/Volume cal. The **"Volume cal"** operation method sees Section.
     - —**Numbers of Sample:** 01~05 times.
     - —**Prime volume:** 0.3~1ml, interval is set to be 0.1ml, the volume of the pre-test flow drawn by syringe.

—**Sample volume:** 0.3~100.0ml, interval is set to be 0.1ml.
—**Unit**: "XXX" or "XXX/ML".
—When choosing "XXX", the count displays the total number.
—When choosing "XXX/ML", count displays the number of particles per ml.

- **Pressure:** 0000 – 0100S
  When the **"Run mode"** is set to **"Automatic"**, this item is effective: this item is used to set adding pressure time of pressure before the sample testing and raise pressure continuously during the process of testing until the end of testing. If it is set to 0000, do not increase pressure without pre-pressure operation in the process of testing.

- **Vacuum:** 000 – 0100S
  When the "Run mode" is set to "automatic", this item is effective: this item is used to set adding pressure time of the vacuum before the sample testing. If it is set to 0000, no increases in vacuum.
  The setting method of any of the above items: Click the item that needs to be set up first, then click on【◂】or【▸】to set, the digital can be input by clicking on the right side ofthe digital area of the screen for the "**Number**", "**Prime volume",** "**Sample volume**" and "**Pressure**" and "**Vacuum**" of the five items. Click on 【Enter】 key after the completion ofthe input. All items set up are completed, click on the 【Return】 key, Save the Settings, and return to the main menu interface.

4) Channel Setup

Inspection standard setup

- Click【Channel Setup】on the main menu interface and enter the channel setup interface.
- Click【◂】or【▸】to select the standard as required, these standards include NAS 1638, GJB 420A-96, ISO 4406-99, ISO 4406-87, SAE749D, AS4059, and custom set-up.

- which to "**custom set-up"** criteria by continually clicking 【◂】 or 【▸】 It is allowed to select any one from the 16 channels by user.
- **Method of selection:** Click 【○】 beside the demanded particle channel, the channel is selected when 【○】 is changed into 【⊙】 (This function is very flexible and convenient; users may set frequently used
- particle size in "**custom set-up"** criteria and switch test standard to "custom set-up" for testing.

5) Custom particle size setup

- Click 【Enter】 on the interface as shown in the figure to enter the custom particle sizesetting interface, the particle size and corresponding threshold set by the user will be shown on the screen.
- Test particle size for **"Custom**" criteria may be set by the user.
- The value of particle size and corresponding threshold for the 16 channels will be shownon the screen.
- Click any box in the column of "**Particle size"** to select *"***Particle size value",**and input by clicking the num pad on the right-hand side of the screen, click 【Enter】 to finish input, and the value of the corresponding "**Threshold**" will be changed automatically.
- The range of particle size is contained in the range of the calibration curve, which means that particle size could be set as a value between the minimum calibration pointand maximum calibration point.
- If the ACFTD method is adopted for the instrument calibration, the range of particle size is normally 1.00μm - 100.00 μm, to 2 decimal places (e.g. 99.99).
- If the MTD method is adopted for the instrument calibration, the range of particle size is normally 4.00μm (c) ~ 70.00μm (c); If the latex spheres method isadopted for calibration, the range of particle size is normally 2.00μm ~100.00μm.
- Upon completion of all particle size setups, click **[**Return**]** to save the settings and return to the previous system.

6) **Other setup**

Click 【Other Setup】 on the main menu interface to enter the corresponding interface this function consists of 3 sub-items which are 【Clock Setup】 Backlight Setup】 and 【Touch Screen Calibration】

7) **Clock setup**

- Click 【Clock Setup】 on 【Other Setup】 interface to accomplish date and time setting for the built-in electronic clock

- **Method of Setting:** To adjust year, month, date, hour, minute, or second, click the corresponding box to select corresponding digits, input by clicking the num pad on theright side of the screen, and click 【Enter】 to finish.
- Save the settings and exit the clocksetup interface by pressing 【 Return 】 upon finishing modifications on all sub-items.
- The electronic clock is real-time and will operate normally after the instrument is shut down.
- If the instrument electronic clock stops running after shutdown, the display screen 's battery needs replacement, replacement method is as follows:
  - Shut down, to raise the machine head: Press around the two fixed axes of the head respectively with the index fingers of both hands, press inward until to lift the head at the same time, and raise its head to see the back of the LCD screen.

— The battery is located on the lower left corner of the back on the display screen, themodel is a CR1220 button battery.
— Gently part the reed on the battery with the tool, the battery can be removed. Take anew battery and carefully mount it.

8) Backlight setup

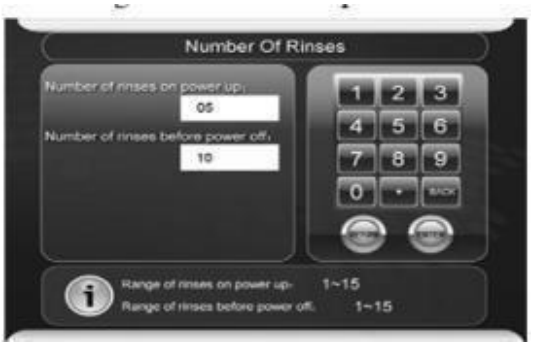
- Click 【Backlight Setup】 on 【Other Setup】 interface to enter the corresponding interface and set the lightness of the backlight.

- Select a "**Backlight Level**" by clicking the digit behind it, and input by clicking the num pad on the right side of the screen (this value shall be within the range of 01~63, the greater the value is, the lighter the backlight will be and the less the value is, the darker the backlight will be.
- Click 【Enter 】 to finish.
- Pressing 【Return】 to save the settings and exit the backlight setup interface.

6.7 Flush Operation

- Click 【Flush】 on the main menu interface to enter into the corresponding interface which mainly consists of 5 sub-items including 【Loop **Rinse**】 **[Power On]** Power **Off] [Reversing flush]** and **[Setup]** Flush and reversing flush sensor, injector and tubes can be performed by using this function.
- The clean particle-testing solution shall be used for flush.
- Cleaning operation, for example, clean deionized water should be used for water quality samples and filtered petroleum ether (below level 6 and boiling range is 90-120 ℃) should be used for oil-based qualitativesamples.
- Sample adhered to slits in the sensor and tubes could be dissolved by using a clean particle-testing solution and the purpose of cleaning the sensor and tubes can thereby be accomplished.

1) **Number of rinse setup**
Users may set numbers for "**Power On**" and "**Power Off**" rinse as required. Press [Setup] pm flush operation interface to enter the setup interface elect the demanded digit, and input by clicking the num pad on the right side of the screen (the value could be set within the range of 1~15), press [Enter] upon completion. Press [Return] to save the setting and exit the setup interface.



2) **Loop rinse**
By clicking [Loop rinse] injector will execute flush for once with a sampling volume of 10ml [Abort] may be pressed to suspend the operation.

3) **Rinse after Power ON**
By clicking [Power ON] injector will perform a "**power-on rinse**" for preset times. [Power ON] rinse shall be performed in the first place after starting the instrument to clean the sensor, injector, and tubes and thereby leave the instrument in clean condition.

4) **Rinse after Power OFF**
By clicking [Power ON] injector will perform "**power OFF rinse**" for preset times. [Power OFF] rinse shall be performed in the first place after starting the instrument to clean the sensor, injector, and tubes and thereby leave the instrument in a clean condition.

5) **Reversing flush**
In using the process of the instrument, the foreign matter might be inhaled into the sensor slotdue to the uncleanness of the sample and lead to the sensor blocking, then the bounce-back function can be used to bounce back the sensor slot to clean up the foreign matters. Press the [Reversing flush] button in the interface of Flush Operation as shown in the figure, the syringe can suck clean cleaning fluid from the sampling head at this time, push back the syringe after 10 ml of the suction full in the syringe and discharge the cleaning liquid from sampling head and complete a bounce- back blocking discharging procedure. Repeat this procedure if the nextbounce-back is necessary.

6) **Empty liquid road**
Use cleaning liquid to perform several times of cleaning procedures, extract the cleaning liquidfrom the Air Pressure Chamber, and perform several times of cleaning procedures without any liquid in the Air Pressure Chamber, and then the liquid road in the instrument can be emptied.

7) **Test Operation**
Test operation has two kinds "**Ordinary pressure detection**" and "**Pressurized detection**" and the "**Ordinary pressure detection**" is divided into "**Ordinary pressure manual detection"** and **"Ordinary pressure automatic detection**" two kinds. In the same way, "**Pressurized detection**" is divided into "**Manual pressurized detection"** and **"Automatic pressurized detection**" two kinds.

Ordinary pressure detection

For some low-viscosity, good liquidity liquids (generally less than 20 cp), such as water, alcohol,gasoline, petroleum ether, isopropyl alcohol, etc., Ordinary Pressure Detection can be adopted for testing. The specific operation method is as follows:

1. **Manual Detection**
   - Enter [Test setup], [Set up Mode] is set to "Manual", the rest of the settings are as required.
   - Put the sample into the air pressure chamber, click [Test], and click [Start] again to performa testing operation (The pneumatic pump does not work now).
   - Click [Start] again to perform a testing operation again and click on the 【Start】 continuously until reaching the testnumber of setting.
2. **Automatic Detection**
   - Enter [Test setup], [Setup mode] is too Automatic.
   - Click [Pressure] and the pressing time of pressure is adjusted to 0000 s.
   - Click [Vacuum] the pre-pressing time of the vacuum is adjusted to 0000 s and the rest of the settings are as required.
   - Put the sample into the air pressure chamber, click [Test], and click [Start] again, perform N+1 times (N is the setup test number of times) testing operation (Pneumatic pump doesnot work now) and automatically delete testing data for the first time.

Pressurized Detection

For some high-viscosity, bad liquidity liquids (generally less than 20 ~ 350 cp), Such as hydraulic oil, lubricating oil, transformer oil, power turbine oil, etc., the auxiliary method of pressure should be adopted for testing. The specific operation method is as follows:

1. **Manual pressurized detection**
   - Enter [Test setup], [Setup mode] is set to "Manual", the rest of the settings are as required.
   - Put the sample into the air pressure chamber, click [Test], and click [Vacuum] If the samples need to vacuum degassing, observe the samples degassing with the naked eye, and click [Exhaust] after the bubble liquid level basically to finish the vacuum degassingprocess.
   - Click [Positive] after resting for a few seconds when the pressure slowly reaches the preset value (pressure can be adjusted by the pressure control valve) click on [Start] Instrument will perform a test operation.
   - Syringe pump samples should be observed in the process of testing. If there is a flow of air bubbles or evacuation phenomenon in syringes, because pressure is inadequate, pressure can be adjusted by the pressure control valve.
   - Increase the pressure and then click [Start] and observe until flow bubblesand evacuation phenomena do not appear in the syringe.
   - Once testing is completed, if you need the next test, click 【Start】 again and click on the[Start] continuously until reaching the test number of setting.
   - The pneumatic pump has been in an on-state throughout the testing process, click on the [Exhaust] after the test finishes and the pneumatic pump stops working and releases pressure.
2. **Automatic pressurized detection**
   - First you need to set a preset value of positive pressure, i.e. adjust the pressure regulating valve under the condition of manual pressurized pressure, make pressure constant to the desired pressure, and then lock the pressure regulating valve.
   - Enter [Test setup], [Setup mode] is to set "**Automatic**"
   - Click [Pressure], for example, the pressurization time of pressure is adjusted to 0020s (if the " pressure preset value" is higher, the pressurization time should be extended properly, the pressure can achieve preset value and stability should be guaranteed before testing).
   - Click [Vacuum] For example, the pressurization time of the vacuum is adjusted to 0030s (if the oil contains a lot of air bubbles, the pressurization time of the vacuumshould be extended properly, if you don't need to vacuum degassing of samples, thepressurization time of vacuum can be adjusted to 0000 s).
   - Put the sample into an air pressure chamber, click **[**Test**]** click **{**Start**}** again. The pneumatic pump starts, increases negative pressure, and vacuum degasses the samples according to a vacuum set time and then deflates (deflated time for 5 seconds), to start pressurizing pressure.

- when pressurized time reaches to preset pressurization time of pressure, the Instrument starts to automatically perform the N + 1 times (" N "for setting the testing number) detection operation and automatically removes the testing data of the first time.
- Pneumatic pump stops working after detection, automatically exhausts and releases pressure.

8) Test Operation Interface

- Click【Test】on the main menu interface to enter the test procedure interface. The test procedure interface consists of 【Start】, 【Results】, 【 History】, 【Print Setup】【Pressure】, 【Vacuum】 and 【Exhaust】 7 items.

- The current test setup and channel setup parameters are displayed at the bottom of the screen, if the displayed setup parameters are inconsistent with the test requirements, press 【 Return 】 button to return to the main menu interface and reset the parametersbefore conducting 【Test】 Procedure.

<u>Start Testing</u>

- Click 【Start】 on the test procedure interface, the instrument will start the test procedure with the contents of test setup items and channel setup items.
- **NAS1638 Test**:
  When the test standard is set to “NAS 1638”, the instrument will test the values of fivechannels 5μm, 15μm, 25μm, 50μm and 100μm.
- When the test standard is set the instrument will test the values of five channels 2.0μm, 5.0μm, 15.0μm, 25.0μm, and 50.0μm.
- **Test:** When the test standard is set to “ the instrument will test the values of six channels 1.0μm, 5.0μm, 15.0μm, 25.0μm, 50.0μm and 100.0μm. ISO4406-99).
- The test standard is set to “ISO 4406-99”, the instrument will test the values of three channels 4.0μm, 6.0μm, and 14.0μm(C).

ISO4406-87 (JB/T9737) Test:

When the test standard is set to "JB/T9737", the instrument will test the values of two channels 5.0μm and 15.0μm.

SAE749D Test:

When the test standard is set to "SAE749D Test", the instrument will test the values offive channels 5.0μm, 15.0μm, 25.0μm, 50.0μm and 100.0μm.

AS4059 Test:

When the test standard is set to "AS4059", the instrument will test the values of five
channels 4.0μm, 6.0μm, 14.0μm, 21.0μm and 38.0μm (C).

Custom Test

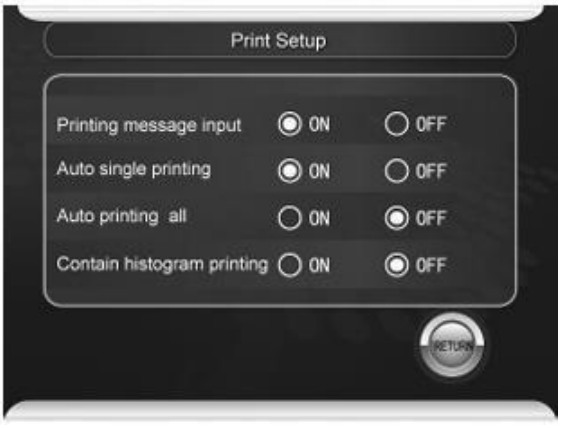
When the test standard is set to "**Custom**", the instrument will test the customized particle size and number of channels
The differential number and cumulative number of each channel will be shown in thefigure above.

Cumulative Number:

≥1μm;	≥2μm;	≥5μm;
≥40μm;	≥15μm;	≥25μm;
≥15μm;	≥50μm;	≥100μm;

Differential Number:

1~2μm;	2~5μm;	5~10μm;
10~15μm;	15~25μm;	25~40μm;
40~50μm;	50~100μm;	≥100μm;



Print Setup

Click the [Print Setup] button on the test procedure interface to enter the print setup interface consists of four subitems: print information input, automatic single print, automatic print all, and print with histogram. Select 【○】 before "**Open**" If you want toenable some subitem, it is ok to make【○】change into 【⊙】. select 【○】before "**Close**". If you want to disable some subitem, it is ok to make 【○】change into【⊙】. Click 【Return】 button after setup, save, and quit this interface.

Print Information input

If the subitem is enabled, the data query interface shows an input interface like "Samplename, Batch number of sample" While implementing the "print all" procedure, the user can input information via the touch screen, after the input, the input sample name, batchnumber of sample and test data can be printed out together.
If this subitem is disabled, the "print all" procedure is performed, the printer will print the test data directly and the blanks are left behind the sample name and batch number of the sample on the print report, which can be filled out by the user.

Automatic single print

If this subitem is enabled, the printer will automatically print the test result after each test.

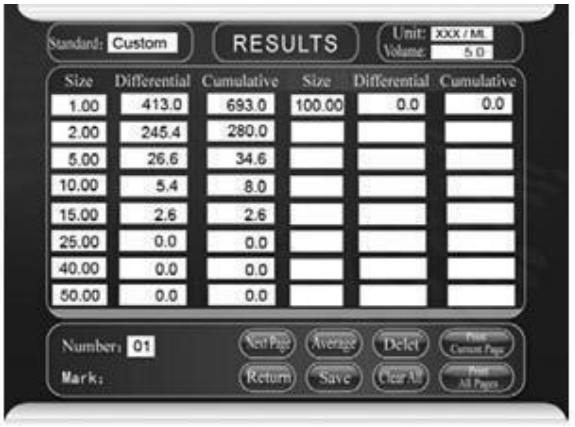
Print with histogram

If this subitem is enabled, the printer will print cumulative number and differential number distribution histograms while implementing the "**print all**" procedure.

Data Query

1) After the test, the function of the data query can be used to inquire about the test result, mean value, and distribution map of each test. Click 【Data Query】 and then click 【Next Page】, 【Mean Value】, 【Delete】, 【Save】, 【Clear】, 【Print Current Page】and 【Print All 】 on the bottom of the screen to perform variousprocedures.
2) **Next Page:** Continuously click 【Next Page】, the instrument will circularly displaythe test result, mean value, 100ml mean value, and cumulative/differential distribution map of each test
3) **Average:** Click 【Average】 to go directly to the interface of the mean value.
4) **Delete:** On the interface of the test result query of each test, click 【Delete】 and thecurrent query data is deleted.
5) This function can be used for the first time for data that requires deletion or a certain time of data that appears obvious abnormality.
6) **Save:** click 【Save】, the test data is stored in the instrument RAM, totally can store100 groups of data.

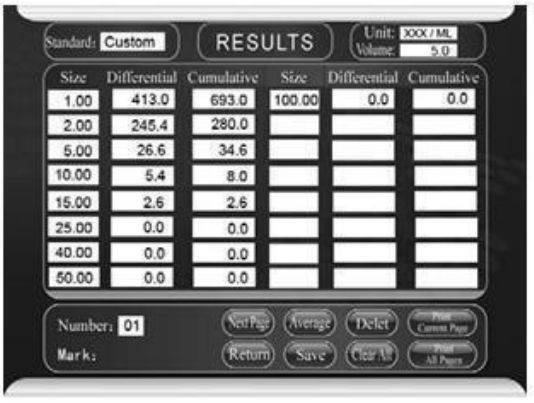
7) **Clear:** Click 【Clear】, then all the test data is cleared.
8) **Print current page:** Click 【Print Current Page】, the contents on the current screenwill be printed out.
9) **Print all:** click 【Print All】, the sample information, test result, mean value, 100mlmean value, cumulative/differential distribution map (only when the 【TestStandard】 is set to "**Custom**" and the "**Print with Histogram**" function of 【Print Setup】 is enabled, the cumulative/differential distribution map can be printed out).
10) If the "**print information input**" function of 【Print Setup】 is enabled, click 【PrintAll】, the interface will go to the input interface of "Sample name, Batch number".
11) The user can input information via the touch screen, afterthe input, the input name of the sample, batch number of the sample, and test data can be printed out together.
12) **Description of control keys:**
    - 【Cap】: Conversion between capital letters and small letters (small letters when selected); shift key (uppercase character when selected).
    - 【English】: conversion of English input method.
    - 【Back】: Delete the character in front of the cursor.
    - 【Esc】: Cancel.
    - 【Enter】: Confirm.
    - 【◄】or【►】:Page turning.



13) **Introduction of the english input method**
Click "**English**" and select, then input the full spelling of the characters (the input must be capital letters), click **"Space**" after input and the interface shows the character sets corresponding to this spelling, directly click the character you want. If it is not available on this page, you can click"【◄】or【►】.

Historical results

- Click 【History】 to enter the historical data query interface Historical data are sorted andnamed by the storage time, the stored historical data can be inquired on this interface and printed out.
- Click 【▲ or 【▼ key to select the data up and down on the current interface.
- Click 【Previous】 or 【Next】: If more historical data is stored that requires to be shown onmultiple pages, this function can be used to turn the pages forward and backward.
- Click 【Read】: When the currently selected data is read out, it will automatically go to the dataquery interface.

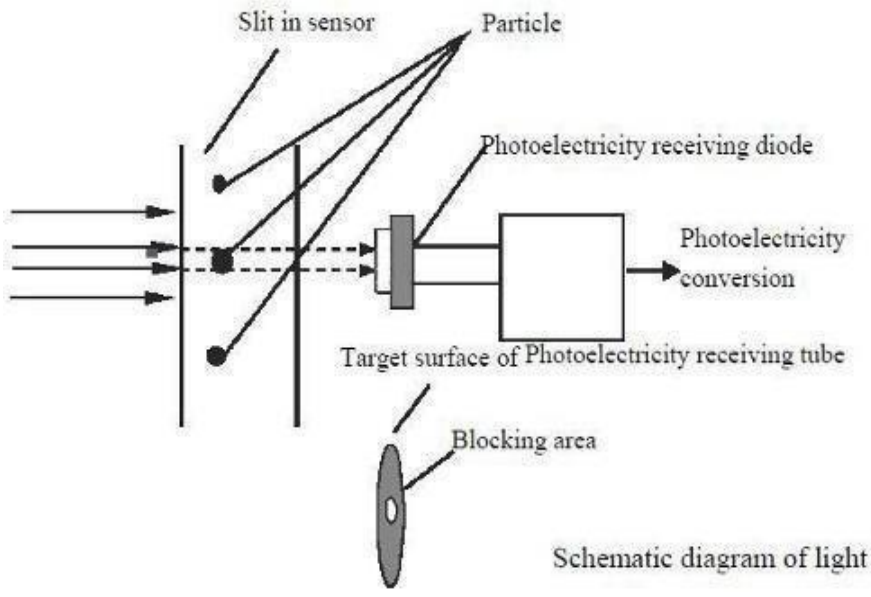


- This interface is the historical results query interface, thus 【Delete】, 【Clear】 and 【Save】 functions are unavailable; 【Next Page】, 【Average】, 【Print Current Page】 and 【Print All】 functions are available.

7. Working Principle

Particle Counter performs oil pollution detection by adopting the Light Extinction method. Light Extinction method, also known as Light Blockage method or Light Sheltering method. The minimum countable particle size is 1μm. The light Extinction method provides high test speed, strong anti-jamming capability, high accuracy, outstanding repeatability, and other advantages.

The working principle of the light Extinction method is shown in the figure Collimated light beams pass through a sample circulation cell, the sectional area of which is A, and reach to photoelectric receiver. Where no particle in liquid flow, the circuit will output voltage E; where a particle with a projected area of "a" passes through a sample circulation cell, blocks collimated light beams, and attenuates transmitted light, the circuit will output a negative pulse with an amplitude of E.



Schematic diagram of light blockage method

E。=(a/A) ×E….(2.1)

Where the particle is spherical or equivalent diameter "d" is used fordescribing it, and E equals to 10v

E。=7.854×d2/A… (2.2)

This means that the projected area of the particle is in linear relation with impulse voltage amplitude.

8. Operations

8.1 Operation Procedure

To detect the oil, for example, to state the operating steps of the apparatus.

1) Turn **ON** the power switch the instrument automatically enters the main menu interface after a normal self-test and the instrument shall be preheated for 30 minutesafter starting up
2) After cleaning a special sample bottle and drying it, add filtered petroleum ether solution (level below level 6). Placed them into the Air Pressure Chamber, and then sealed the Air Pressure Chamber. Click 【Flush】 and then click 【Rinse on power on】 to perform the 3-5 times flush procedure, click【 Return 】 after the flush to go back to the main menu interface.
3) **System setup**: the system setup is an important link of the test, so the channel setup,test setup, other setup, and stirring rotor speed shall be adjusted according to test requirements. (If the stirring rotor is added to the sample bottle, the stirring rotor speed shall be appropriately adjusted to prevent stirring bubble vortex).

8.2 Test Similar Samples

1) **Deal with the test samples**: Screw tightly the bottle cap and the test samples are placed into the ultrasonic cleaning tank (Power: 4000W/m2 at least).
2) The liquid ofthe ultrasonic cleaning tank should be consistent with the liquid level of the test sample bottles, vibrating for 1 minute at least.
3) Take out the test sample bottle anddry it. Shake vigorously the test sample bottle for 5 minutes by hand.
4) Loose bit thebottle cap of the sample and put it into an ultrasonic cleaning tank or adopt the method of vacuum (vacuum degree is not less than 53.5 KPa), remove air bubblesin the samples until air bubbles rise to the surface as far as possible short time, andthen standing for 2 ~ 3 seconds so that residual air rises to the surface.
5) Choose Ordinary pressure detection or Pressurized Detection according to sample viscosity.
6) The data query can be carried out after the test. For example, set-up standards are oil classification standards NAS1638, ISO4406-99, ISO4406 87 SAE749D, and so on.
7) Click 【Mean value】 in the interface of data querycan query to the level of the sample.
8) Click 【Print All】, the items set up in 【Print Setup】 can be printed out item by item.
9) Must use filtered petroleum ether solution (below level 6) and perform several cleaning operations after the test finishes.
10) A sample test can be carried out or the shutdown after cleaning.

8.3 Channel calibration

The equipment can complete the instrument calibration, alignment, and setup of some key parameters through the function of 【ChannelCalibration】.

Click 【Channel Calibration】 on the main menu interface, the EnterPassword interface.

1) **Exit the password input interface**: Directly click 【Esc】 interface canexit the interface and go back to the main menu interface.
2) **Enter Password**: Use the touch pen to click "KT-2" (Note: "KT" are capital letters), "******" shows on the input interface, click 【enter】 after the input to enter 【Calibration】 interface; if the input password isan error, the input interface will prompt you with "Password invalid!" and go back to the main menu interface.
3) After entering the system calibration interface, you can see six subitems: 【Cal curve Setup】, 【Calibration], 【Calibration Parameter】, 【Noise test】 【System Parameter】, 【Modify const】.

8.4 System Parameter

1) **System Parameter Setup**

- Click 【System Parameter 】to enter the system parameter setup interfacewhich can complete the setup of sampling speed, pushing-back speed, flush speed, and print setup.
- **Sampling speed (Flow rate):** The sampling speed of the syringe in performing the test procedure, the set range is 5ml/min- 60ml/min, and the factory default is 015.
- **Pushing-back speed:** The pushing-back speed of the syringe in performingthe test procedure, the set range is 5ml/min- 60ml/min, and the factory default is 040.
- **Rinse speed:** The sampling and pushing-back speeds of the syringe in performing the flush procedure, the set ranges are 5ml/min- 60ml/min and the factory default is 040.
- **Adjustment methods of the above three items:** click the number of the item to be set, and then click and input thenumber by use of the numerical area to the right of the interface, click 【Enter】 button to confirm after the input.

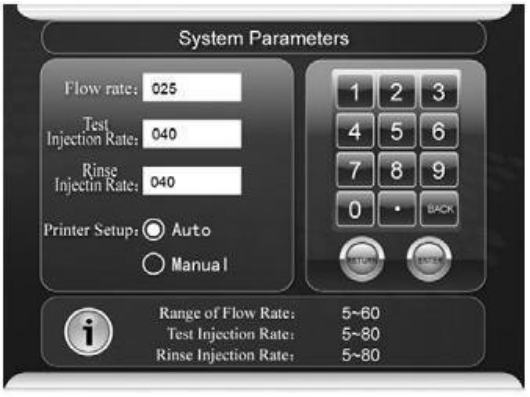
- **Print setup:** Click 【○】, it is selected when 【○】is changed into 【⊙】. If it is set to 【 Automatic 】, the printer will automatically print the current test result when performing each test procedure on the "Calibration" interface.

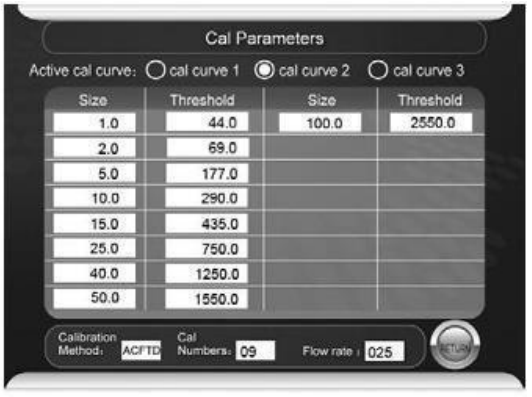
2) Impact of speed on test

- The test speed has a crucial impact on the test result, the faster the test speed, thelower the output pulse signal of the sensor, thus resulting in a smaller count value.
- Therefore, the set sampling speed must be consistent with the test speed set at the calibration of the instrument, which cannot easily be changed.
- For some samples with larger viscosity, the sampling speed must be set to low speed (i.e. 5-10ml/min) for normal sampling. For such samples, the test speed can be set to the appropriate sampling speed, but the instrument must be re-calibrated at this sampling speed.
- For these samples with larger viscosity, if the syringe cannot be moved in the pushing-back procedure, the pushing-back speed can be lowered appropriately, e.g. 5-20ml/min. Similarly, the Rinse speed can be lowered appropriately, if necessary.

3) Calibration Parameter

- Click【Calibration Parameter】 to enter the calibration parameter interface.
- Choose one of the options from three sets of calibration curves "cal curve 1", "calcurve 2" and "cal curve 3", click 【○】, it is selected when 【○】 is changed into 【⊙】 The screen displays the calibration particle size of this set of thresholds,threshold value, calibration method, calibration points, and sampling speed.
- Click【Return】 after selection to exit this interface.





4) Noise Test

- Click【Noise Test】 to enter the noise measurement interface.
- Click the number of the scale, and then click and input the number by use of the numerical area to the right of the interface, click 【 Enter 】 button to confirm after the input.
- Click【Test】 and the noise value of the channels can be measured.

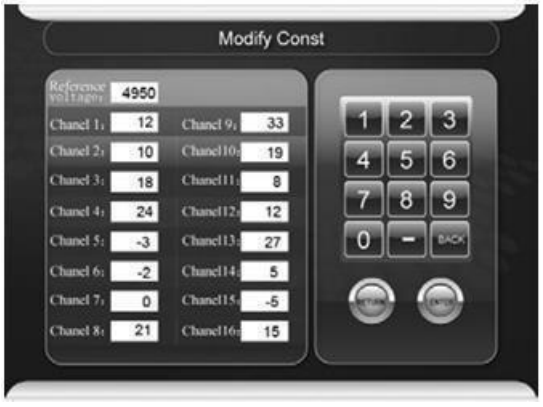
- The instrument shall be preheated for 30 minutes after starting up, firstly use cleaning liquid to flush the pipeline twice to ensure that the sensor is filled with cleaning liquid, and then enter the "**noise measurement**" interface to wait for 5 minutes to ensure the liquid in the sensor does not flow completely.
- Set the initial threshold value of the channels of the instrument to be 10mv click 【Test】, the instrument will be timed 60 and record the count value of the channels, after the counting, check whether the count values are between 30 ~ 60.
- If not, the scale value of the channels shall be adjusted, and then click 【Test】 until the count value of the channels meets the above conditions at this moment,the threshold voltage of this first channel is the threshold noise level.
- Click 【Return】 after the measurement to exit this interface.

5) Modify constant

- Click 【Modify const】 to enter the corrected parameter adjustment interface.There are a total of 17 parameters for adjustment including "criterion" and "channel 1 to channel 16".
- Click the number of the item to be adjusted and then click and input the number by use of the numerical area to the right of the interface, click 【 Enter 】buttonto confirm after the input. Click 【Return 】to exit this interface, if necessary.

8.5 Calibration Procedure

Click 【Calibration】 to enter the channel calibration interface this interface consists of 【 ACFTD】 and 【MOV】.



1) ACFTD calibration

ACFTD calibration function has not been set temporarily.

2) MOV calibration

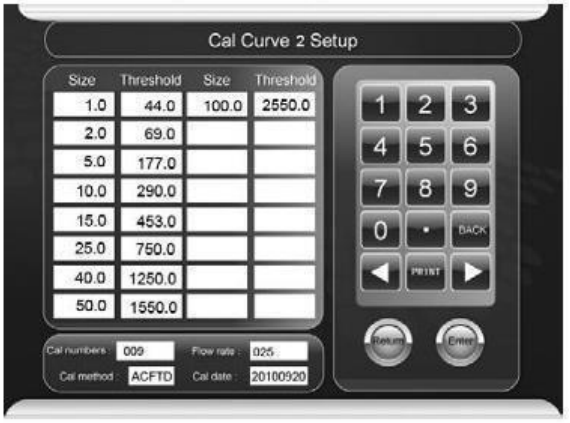
- MOV (moving window calibration) interface can complete the function of instrument calibration, which is usually carried out by use of standard particles in ACFTD, ISO MTD oil and mono disperse latex ball.
- The following takes the calibration particle standard material in the ACFTD oil asan example to explain.
- Click **[**Test setup**]** Set the primal quantity and sample quantity etc detection parameters.
- Prepare the particle standard material within ACFTD oil, Vibrating, jolting and degassing should be done according to the instructions before using it.
- If the pressure needs to be added when calibration, at first the particle standard substances within ACFTD oil have to be handled well this moment and put in an air pressure chamber, Sealed air chamber pressure chamber.
- Click 【 Test】, then click on the 【Pressure 】and adjust the pressure regulator to make the pressure constant to the expected value. Then click onthe 【 return】 to the main menu interface.
- Click【Calibration】, click 【Cal】, click 【MOV】 again, and enter the calibration interface of the moving window.
- The particle size of the fixed point (refer to ACFTD standard material certificate) and the corresponding threshold value can be modified in this interface.

- Click 【Manual】, perform a testing operation, and check the measured integralvalue after the test, making the measured integral value compare with ACFTD standard values of the standard material certificate.
- If the error between the measured integral value of all channels and the standard value is within± 10%, the calibration is complete.

- If not, can click on the scale number that needs to be adjusted and click again on the scale value in the digital area on the right side of the interface to adjust the scale value (The measured integral value is on the high side, raise the scale value; measured integral value is on the low side, lower scale value), click 【Enter】 key to confirm after the input, and then click the 【Test 】 for the next test after scale adjustment is completed.
- To compare the measured integral value with standard values after the test is over, if the error still is not within ± 10%, It is needed that appropriately adjust the scale and then click the 【 Test 】 for the next test until the error between measured values and standard values of all channels within ± 10%
- Click 【Print】 on the MOV calibration interface and the information on the current MOV calibration interface can be printed out. If the "**Print Setup**" item of 【 System Parameter】 is set to 【Automatic】, the printer will automatically print the current test result when performing each test procedure on the MOV calibration interface.
- After completion of calibration, record or print particle size and threshold values. Press 【Return】 key to quit the MOV calibration interface and enter the Calibration Curve Setup interface (refer to section 6.6), calibration points, particle size, threshold values, and the calibration method are inputted one by one to complete a MOVWIND calibration.

3) Calibration Curve Setup

- Click 【Cal curve Setup】 to enter the scale setup interface, the setup of three groups of scales can be completed on this interface.
- The following takes “Cal curve 2” as an example to explain the save method of the scale.
- Click 【 Cal curve 2 】 to enter the setup interface of Cal curve 2.



- **Setup of the number of calibration points**: Click the number after the calibration point at the left corner of the interface, and then click and input the number by use of the numerical area to the right of the interface, the number of calibration point can be set between 4-16.

- **The basic principles of calibration point to determine**: Choose generally 4 ~ 16 points in the test range according to the test scope, which must include a minimum particle size and maximum particle size of detection range. The instrument will automatically synthesize a calibration curve according to the sizeand the calibration value of each point. Any particle size scale can be obtained according to the calibration curve.
- **Sampling speed Setup**: Click on the number behind "sampling speed", input value on the right digital area, and input sampling speed value in the calibration that is for the remark information. For example: 025 means 25 ml/min.
- **Calibration method Setup:** Click the characters behind the "calibration method"and click 【◂】or【▸】 again. To shift the calibration method for which this calcurve is used. Three calibration methods are available, namely, emulsion ball, ACFTD, and MTD.
- **Calibration date Setup**: Click numbers behind "date of calibration". Input calibration date by inputting value on the right digital area. It is the note information. For example, 20100920, indicates September 20, 2010.
- **Particle size and calibration curve values of Setup**: Click on the number position of particle size value bar or calibration curve column value that needs to be modified, digital reverse display means it is selected, Clicking the right digital area on the interface to input digital, click 【Enter】 key to confirm after the input.
- **Printing**: Click 【 Print 】 on the right digital area, The printer will print the "**current calibration curve**" interface with all the calibration information (calibration point number, calibration method, sampling speed, and calibration date, and each point of the particle size and threshold values).
- Click 【Return】 after all setup is completed, the screen displays the words "Successfully saved" and exits the curve setup interface.

4) Volume Calibration

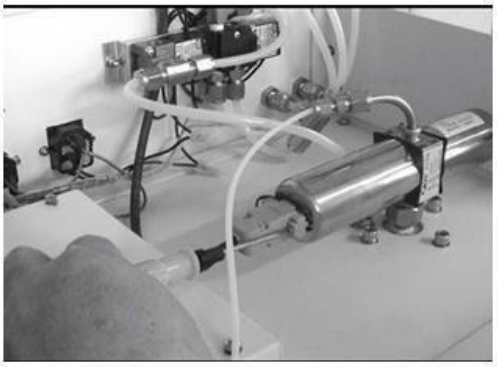
The volume calibration function is mainly used for measuring the sampling precision. Sampling accuracy directly affects the accuracy of the test data. The specific usage is as follows:

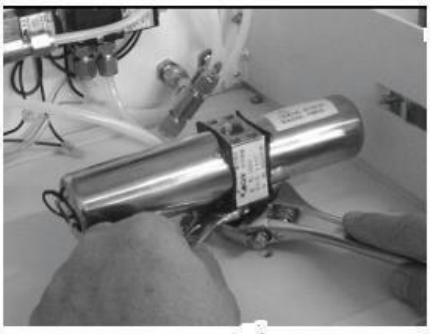
- Prepare for electronic balance whose precision is not less than 1mg, the range is not less than 200g; Clean fluid 100 ml that will be measured; 1 paper cup. Pour 100 ml of clean liquid into a paper cup and put it in the pressure chamber, perform several cleaning operations.
- Click 【Test Setup】, "sampling method" is adjusted for volume Calibration; Adjust the"sample volume" to the sampling volume that the test needs (e.g., 5 ml).
- Click 【Start】 and the syringe moves downward to sampling now. The syringe stops sampling when arriving at prime volume and a screen appears with the prompt "kindly weighing of the first time, then click Enter". Now place the papercup on the scales, weigh it, and record the value.
- Then put the paper cup back in the air pressure chamber, click 【Enter】 and the syringe continues to move downward to sampling now; after reaching the amount of set sampling, the syringe starts to move upward and discharge the waste liquid.

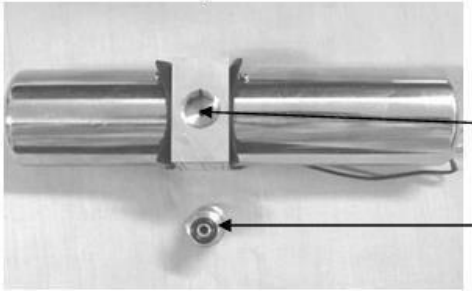
- The screen appears prompt “Kindly for the second weight, and then click Enter”.
- At this moment, placethe paper cup on the scales again, weigh it, and record the value.
- The difference between weighting is divided by the tested liquid density which is the actual sampling volume.

8.6 Removal method of sensor

1) Turn ON the instrument and perform a clean boot operation with a filtered petroleum ether solution (below level 6) then remove the petroleum ether fromthe pressure chamber, perform a clean boot operation again (not to put any liquids in the pressure chamber to empty the fluid pipeline within the instrument) turn OFF the instrument after completion of cleaning.
2) Using the index finger of both hands respectively press inward two fixed axes on the left and right sides of the machine head (as shown in Figure), While pressing to lift the machine head Raise the machine head and show the sensor.
3) Use a small Phillips screwdriver to unscrew fixed screws (counterclockwise) on both sensor connectors, the sensor connector is taken off.
4) Remove the sensor’s upper connector, one hand holds the metal elbow, and theother hand gets stuck in the lock net of the upper connector with a wrench to remove it counterclockwise.
5) Tear down a screw in front of the pressure chamber (Ready for the next operation, convenient for using a wrench): With a diameter of 5mm inner hexagon spanner to tear down the screw counterclockwise.
6) **Loosen the lock net of the sensors under the connector:** One hand stuck the sensors under the connector with an opening 15 mm wrench and the other hand loosened the lock net with an appropriate wrench counterclockwise, which stuck in the under the connector The sensor can be taken off from the instrument after loosen lock net.
   Note: There is a sealing ring under the under-connector.
7) **Disconnect the sensor under the connector:** One hand holds the sensor, and the other hand gets stuck the under connector of the sensor with a wrench to remove it counterclockwise after removing it as shown in the figure.
   Note: There is a sealing ring under the under-connector.



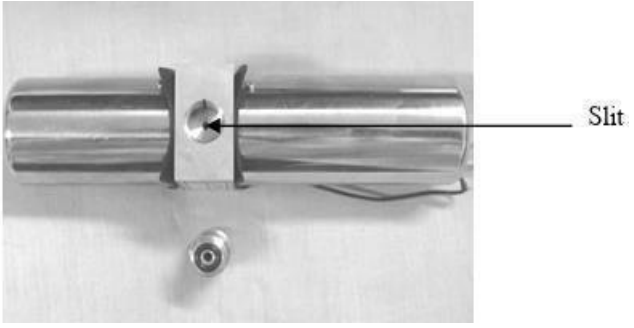



Slit
Under Connector and sealing rin

9. Troubleshooting

Inspection for blocking failure of sensor

1) The sensor is abnormal during the startup self-test process.
2) The syringe cannot pump the liquid in full during the cleaning or test process, some oil samples cannot be pumped now but they can be tested originally.
3) The test data of the sample is lower (a dirty sample test data is on the low side or some channels test data is zero) or higher (a clean sample test data is on the high side or chaotic irregularly).
4) If not mixed with water in a sample to be tested, blockagefailure of the sensor can be considered.
5) Remove the sensor from the instrument. Use a rubber pipette bulb to blow several times against the slit and place the sensor slit against the lightto check whether the slit can be seen clearly.
6) If failed to see the slit against the lightor see it clearly or some foreign matters are found, it should prove that the sensor isblocked.



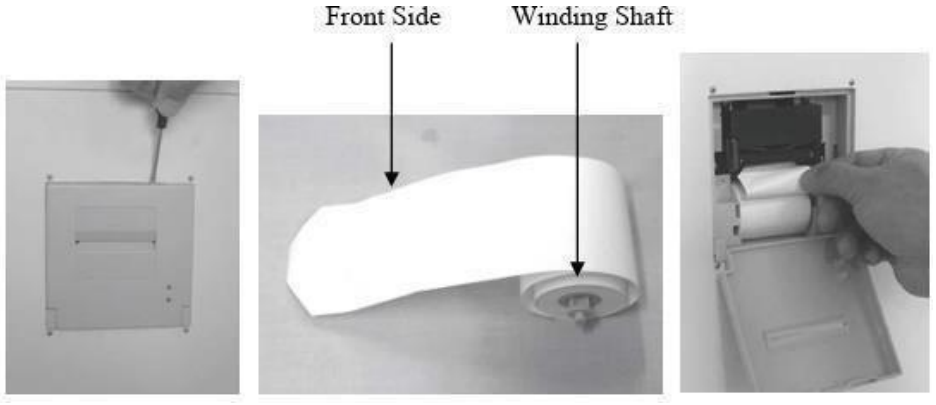
7) Use the filtered petroleum ether solution (below level 6) for particle inspection to flush the pipeline several times and then turn it off and restart to check whether the sensor is normal during the startup self-test process.
8) If the sensor is run normally, perform the test procedure to see whether the "**Baseline value**" is normal and the test data is normal at the same time.
9) If the failure is unsettled, use the petroleum ether solution clean the instrument and empty it at first, then lift the machine head of the instrument and screw off the upper connector of the sensor (Use the "**Cleaning rod**" equipped by the instrument to penetrate the sensor slit slowly and unblock back and forth several times, and then use the rubber pipette bulb to blow downward several times.
10) After that, connect theupper connector to perform the flush procedure, and then perform the test procedure to see whether the failure is eliminated.
11) If the failure is still unsettled, remove the sensor from the instrument for removal approach).

12) Obtain a metal wire with a diameter within 100um, both ends of the wirepenetrate the sensor slit, and then two wire heads appear at one end of the sensor and a ring forms at the other end of the sensor, obtain a cotton thread to penetrate the metal wire ring and flatten the ring.
13) Pull the two metal wire heads through the sensor slit with cotton thread and hold both ends of the cotton thread to pull back and forth several times (add a few drops of clean petroleum ether into the slit), to clear away the blockage in the slit.
14) Place the sensor slit against the light to check whether the slit can be seen clearly.
15) Reinstall the sensor after cleaning up the slit, perform the flush procedure, and then perform the test procedure to see whether thefailure is eliminated.

10. Replacement

Replacement of printing paper

1) Ensure that the instrument is switched ON.
2) The printer is located at the left side of the host, use tools or fingers to jam the card slot at the front cover of the printer and pull outward to open the front cover.



3) Cut the head end of the paper roll into shape and penetrate the winding shaft into the paper roll.
   (Note: the thermal printer paper has two sides, and the smooth side is the right side).
4) Load the paper roll and the thermal printer paper into the printer paper winding shafttrough and pull out a bit of paper roll to fill into the paper feed of the printer (see Fig.3,pay attention to the right and wrong sides of the printing paper).
5) The paper feed of theprinter will rotate automatically, and the printer paper will get into the printer head slowly until exposed from the right ahead of the printer head.
6) The right side of the paper (smooth side) should be facing up, check whether the paper is askew; if it is askew, hold the paper roll head by hand and slowly pull outward to make It aligned.
7) Let the head end of the printing paper roll come out from the paper exit of the front cover and well install the front cover.