Infitek

DM-3004/DM-3005A/DM-3005

DENSITY METER

USER MANUAL

INFITEK CO., LTD.

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1. Applications and Features

Density is one of the important physical properties of matter. Each substance has a certain density. The density can help to understand the purity and doping conditions of the substance. With the development of science and technology, rapid measurement of density has been widely used in many fields, e.g., physics, chemistry, medical analysis and food safety fields. The density meter has a wide range of uses and is one of the indispensable common equipment in factories, schools and related scientific research units in the petroleum industry, oil industry, pharmaceutical industry, food industry, daily chemical industry, sugar industry, etc.

The automatic density meter is an instrument that quickly measures the density of liquids based on the vibration principle of U-shaped tubes. It has the characteristics of small sample volume, automatic measurement, fast test speed, and good repeatability. It uses quartz glass U-shaped tube and photoelectric detection technology. The Control temperature system uses high-precision platinum resistors and semiconductor refrigeration chips, and applies digital PID adjustment and PWM Control temperature technology to achieve high-precision constant Control temperature functions.

The automatic density meter uses a 10.1-inch industrial smart touch screen and is based on the Android operating system. The high-performance operating system can meet the various needs of users: batch data collection and storage.

The automatic density meter uses a 1080P high-definition camera for video display. Users can intuitively and clearly observe the entire process of sample injection, and quickly and easily observe whether there are impurities or bubbles mixed into the sample. After each measurement is completed, clear sample pictures can be saved for query. Other functions:

1. The instrument contains an air pump, which can provide continuous dry air when connected to the drying barrel. Suitable for condensation drying, equipment cleaning and other applications.

2. Measurement results can be printed using thermal printer or stylus printer.

3. Measurement results can be saved as PDF reports and exported directly to a USB flash drive.

4. Through the serial port combined with the user equipment open interface, seamless data connection and data sharing between the density meter and the user system can be achieved, and the LIMIS system can be easily connected.

2. Working Principles

The U-shaped vibration tube is made of quartz glass and is stuck in the support hole through adhesive, which is close to the ideal fixed boundary condition. At the same time, assuming that the vibration tube structure and material are uniform and the excitation force acts on its center line, the vibration tube Vibrates up and down without torsional vibration. When the liquid to be measured is injected into the vibrating tube, after the temperature is equalized, the liquid to be measured will vibrate along with the vibrating tube, causing the total mass of the vibration system to change, thereby changing the natural vibration frequency of the system. After proper calibration, the resonance period will be a certain corresponding relationship with the density of the measured liquid such as formula (1).

By measuring the self-excited vibration frequency of the vibrating tube, the density value of the liquid to be measured can be determined, and then the density of the sample to be measured is displayed digitally.

Calculation formula: $\rho = A \times T^2 - B$ (1)

In the formula: ρ — density;

T — Vibration period;

A, B — Constant.

The working principle of the instrument (Figure 1). The thermostatic controller provides a stable constant temperature measurement environment. An electromagnetic excitation system provides the vibration source of the glass tube. The sample to be tested is injected into the U-shaped tube, and the vibration system is started to excite the U-shaped tube at a certain frequency to make it vibrate at the set frequency. The frequency detection system sends the detected frequency and other parameters to the control system. After MCU calculation, compensation and correction, the density value is calculated.
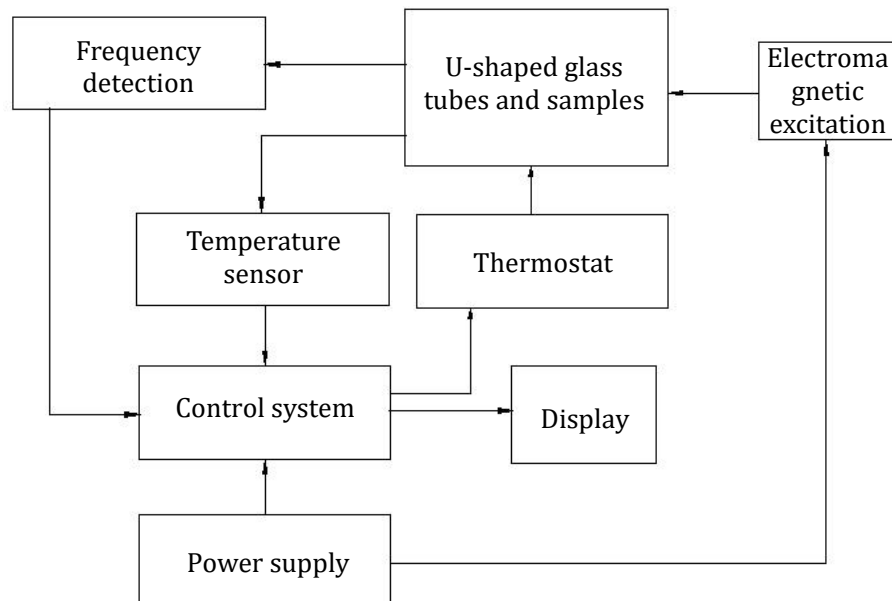
Figure 1

3. Instrument Interface

3.1 The Front and Side View
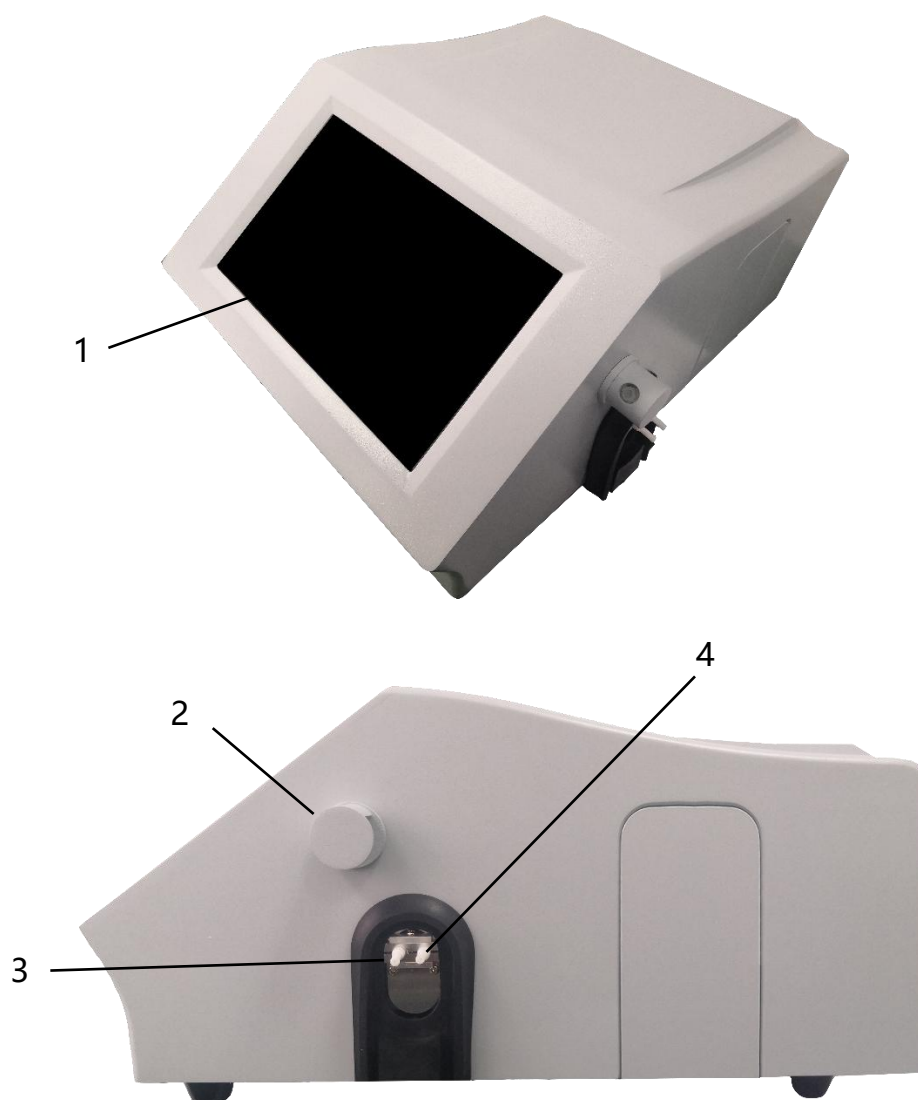

Figure 2

SN	Name	Function
1	Touch display	Display information and used to enter information
2	Syringe holder	Insert the syringe into the holder to facilitate manual injection
3	Sample inlet	shaped tube from this port
4	Waste liquid outlet	shaped tube from this port

3.2 The Back View

Figure 3

SN	Name	Function
1	Switch	Starting and shutting down the instrument
2	Power outlet	Connect 100~240VAC, 50/60Hz power cord
3	Air pump air inlet	Connect the drying barrel to obtain dry air
4	Air pump outlet	Dry air outlet generated by air pump
5	Measurement chamber air inlet	When the control temperature is lower than the dew point, dry the measuring chamber through this port to avoid air condensation.
6	Cooling fan	Heat dissipation when the instrument is running
7	USB-A interface x 2	USB2.0 , connect USB devices, such as mouse, keyboard, U stick, code reader, etc.
8	USB-B interface	Connect to PC , LIMIS system
9	Micro printer interface	DB9 female connector, connect thermal printer or stylus printer
10	RS232 interface	DB9 male connector, connect to PC , LIMIS system
11	Ethernet interface[1]	RJ45 interface to connect to the network

Note: 1) Only available on DM-3005A/DM-3005.

4. Operation Instructions

4.1 Power on

1. **Place the instrument on the workbench . Make sure the workbench is stable and free of shaking.**
2. Connect the power cord to the instrument and power source.
3. Turn on the instrument power switch.
4. The instrument display screen shows the operation interface.

4.2 Shutdown

1. **Thoroughly clean and dry the U- shaped tube and silicone connecting tube.**
2. Turn off the instrument power switch.
3. If the instrument will not be used for a long time, cover the instrument with a dust cover.

4.3 Login

1. The user turns on the computer, the program will automatically start. After the self-test is completed, the user can log in, as shown in Figure 4.

   DM-3004 requires no user login and can directly enter the function menu.

2. The instrument has two built-in users when it leaves the factory. **One is named "Admin" and the initial password is "Ad1234". It is the system administrator and is provided to users. Users should change their passwords as soon as possible after use**; the other is named "Debug ", which is for factory debugging users and is only used for maintenance and debugging. After selecting the user name and entering the correct password, click the [Login] button to log in to the system, as shown in Figure 5.
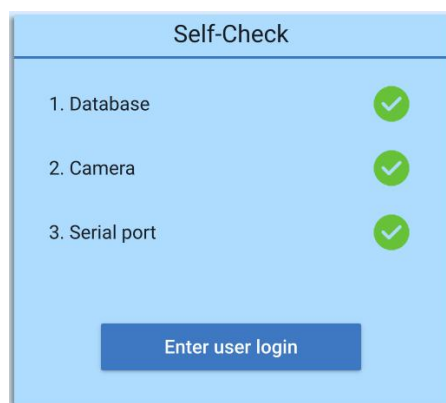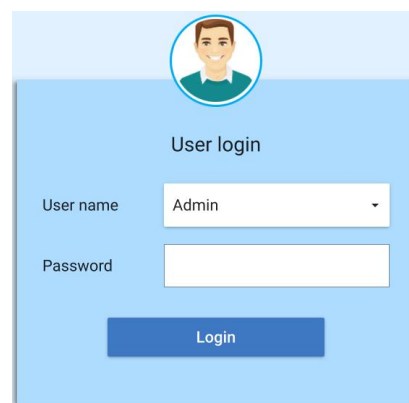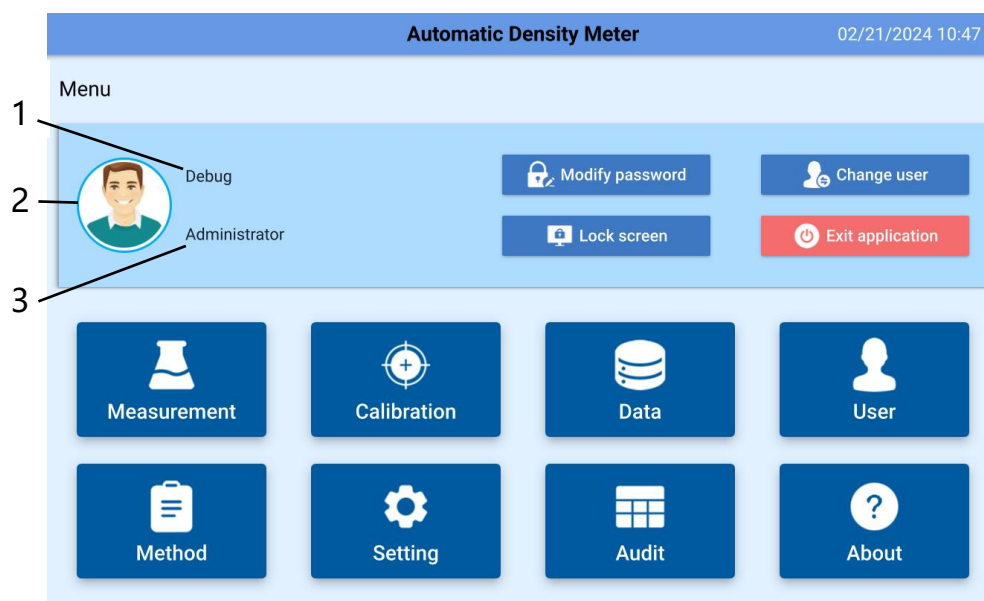

Figure 4

Figure 5

4.4 Menu

Figure 6

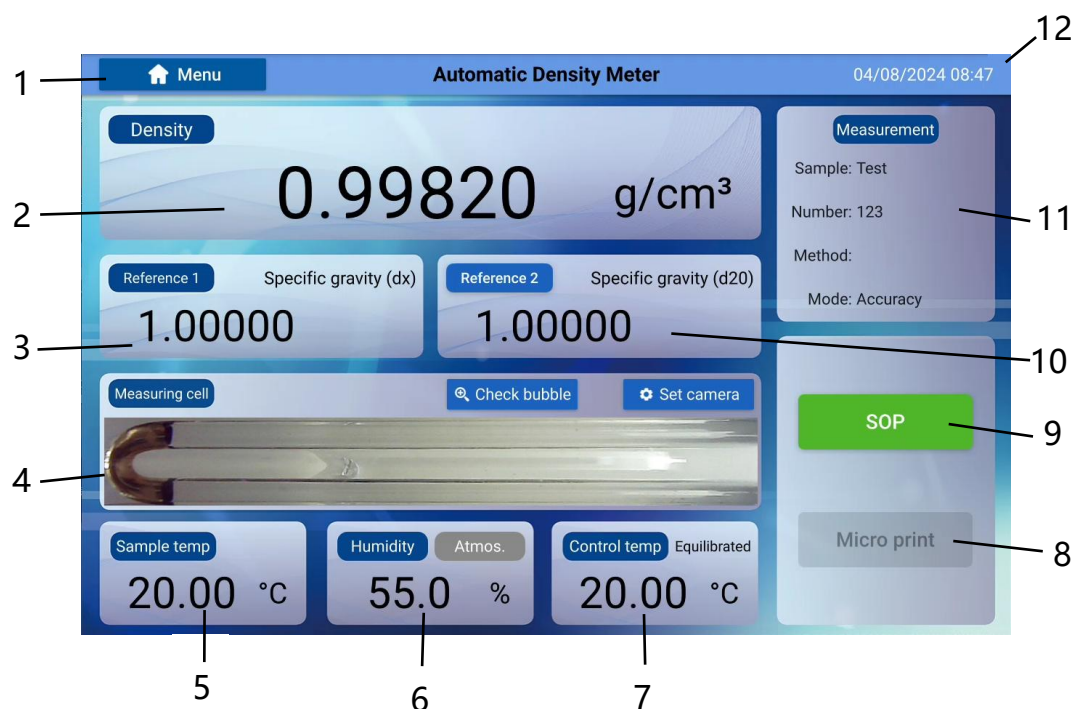| SN	Name	Function
1	Username [1]	The username of the currently logged in user
2	Avatar [1]	Avatar of the currently logged in user
3	User group [1]	The group of the currently logged in user
4	Modify password [1]	Enter the password change page
5	Change user [1]	Re-enter the user login page
6	Lock screen [1]	Enter the lock screen page. **Only the logged-in user before locking the screen can unlock it.**
7	Exit application	Enter the system desktop. **DM-3005 and DM-3005A only "Admin" users can exit; DM-3004 requires password verification.**
8	Measurement	Enter the sample measurement page
9	Calibration	Enter the instrument calibration page
10	Data	Enter the data management page
11	User [1]	Enter the user management page
12	Method	Enter the measurement method management page
13	Setting	Enter the system settings page
14	Audit [1]	Enter the audit trail page, **only available for the FDA version software**
15	About	Go to about page

Note: 1) Only available on DM-3005 and DM-3005A.

4.5 Measurement Page

Figure 7

SN	Name	Function
1	Menu	Enter the menu page
2	Density display area	Displays the currently measured density, and the upper right corner area displays the instrument status.
3	Reference 1	Display the name, value and unit of the set measurement unit 1·
4	Measuring cell area	Display measuring cell video screen
5	Sample temperature	Display the current sample temperature
6	Humidity and Atmosphere	Display the current humidity and atmosphere of the measuring cell
7	Control temperature	Displays the currently set control temperature, **and the upper right corner displays the control temperature status.**
8	Micro print	Print the current measurement record through a micro printer
9	SOP	When in standby mode, enter the workflow page; **in non-standby mode, such as measuring, drying, etc., the [Stop] button is displayed. Click to abort the process.**
10	Reference 2	The name, value and unit of the set measurement unit 2; **click the [Reference 2] button in the upper left corner to enter the Reference Value 2 setting form; the Reference Value 2 is only displayed and not saved in the measurement record**
11	Measurement parameters	Displays the currently set sample name, sample number, method name and measurement mode
12	System time	Display current system time

4.6 Measurement Parameters

Navigation: Menu > Measurement > SOP > Setup are as shown in Figure 8.

Figure 8

Name	Function	Value/Others
Sample name	Enter a sample name or select a used name from the drop-down list	
Sample number	Enter sample number	
Use method	Use measurement method after activation	Activate / Inactivate
Method name	Select the method name to use from the drop-down list	It takes effect after activating the calling method.
Measurement mode [1]	Select measurement mode	Accuracy / Fast
Control temperature [2]	Set the control temperature of the sample to be tested	DM-3005/DM-3005A: 5 ~ 70 ° C DM-3004: 5 ~ 50 ° C
Reference 1	Set the measurement unit that needs to be saved in the measurement record	Built-in units/User-defined
Save sample image	After activation, the sample image is saved together with the measurement record.	Activate / Inactivate
Scan code	Enter the sample name, sample number and measurement method through QR code and barcode	The QR code scanning setting in the system settings needs to be activated.
Apply	After the above parameter settings are completed, click this button to take effect.	

Notes:

1) Measurement mode:

   a) **Accuracy mode**: When users need to obtain high-precision, accurate measurement values, please choose "Accuracy". The measurement takes a long time, please be patient.

   b) **Fast mode**: When users measure some unknown samples and need to quickly measure the rough density range of the sample, they can select "Fast". The instrument can measure the density value in a short time.

   c) **Note: "Quick pre-check" is only used as a rough measurement of the sample and cannot reach the measurement accuracy indicated by the instrument.** For high-precision measurement, please select "Accurate Measurement".

2) Control temperature:

   a) **The lowest temperature that can be reached is (room temperature - 20°C),** If the control temperature is 5°C, the room temperature should not exceed 25°C.

   b) **After modifying the control temperature, you need to wait until the instrument shows that the control temperature is equilibrated before injecting the sample for measurement.** After injecting the sample, the measurement process can be started without waiting for the control temperature to stabilize.

4.7 Filling

Navigation: Menu > Measurement > SOP > Fill

1. Connect the silicone tube as shown in Figure 9. The lower port of the syringe holder is connected to the sample inlet, and the waste liquid outlet is connected to the waste liquid bottle.

2. The measuring cell and silicone tube must be thoroughly cleaned and dried before injection.

3. Use a syringe to draw 2 to 5 ml of sample and remove air bubbles.

4. Insert the syringe tightly into the syringe holder, push the syringe slowly, and wait for the sample to fill the U- shaped tube and flow out from the waste port.

5. You can click the **[Check bubble]** button to enlarge the measurement cell area screen.

Figure 9

Drag to observe the tiny bubbles. If there are obvious bubbles or leaks, the sample needs to be re-injected.

If you install the automatic sampling device, refer to [5.23 Automatic sampler] operation.

4.8 Camera Settings

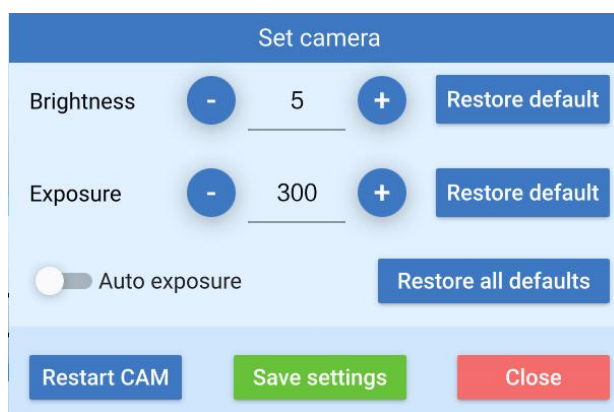**Navigation: Menu > Measurement > Camera settings**, as shown in Figure 10.

Figure 10

Name	Function	Value/Others
Lighting brightness	Set light brightness level	0 ~9, default 5
Exposure	Set camera exposure	0 ~5000
Auto exposure	The camera automatically exposes when turned on	Activate/deactivate
Restart CAM	If the camera is abnormal, try restarting the camera.	
Save settings	Save the above parameters as boot default values	

4.9 Measurement

Navigation: Menu > Measurement > SOP > Measurement

4.9.1 Accurate measurement

a) Measurement new sample: **For the first measurement after injecting the sample, click the [Measurement new sample] button to start measurement.**

b) Measure again: After the measuring new sample is completed, the sample in measuring cell is not replaced. Click [Measure Again] to perform a retest.

4.9.2 Fast measurement

Start measurement: After the user injects the sample, when the sample temperature reaches the measurement temperature ±1.00°C, the instrument starts measurement immediately without temperature stabilization, and a rough density value can be measured in a short time.

4.9.3 Measurement Process

a) Before the sample temperature is balanced, the instrument displays control temperature and detects at fixed time intervals (Figure 11).
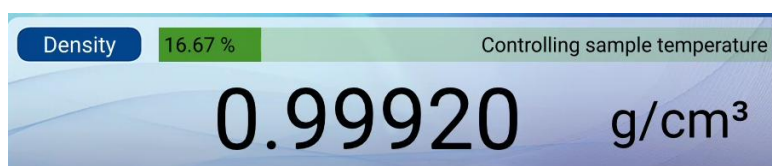
Figure 11

b) The sample temperature enters the equilibrium state, the instrument displays equilibrium, and is detected at fixed time intervals (Figure 12).
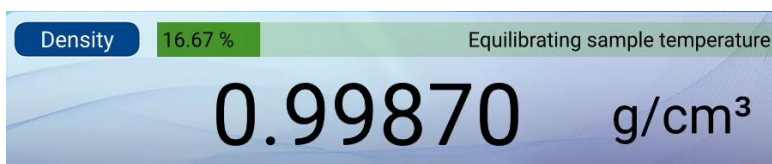
Figure 12

c) After the sample temperature stabilizes, the instrument displays that the control temperature is stable and enters the vibration measurement state (Figure 13).

Figure 13

4.9.4 Save measurement result

After waiting for the measurement to be completed, the **FDA version software automatically saves the measurement record.** If the regular version of the software does not set automatic saving, the save measurement record form will be displayed (as shown in Figure 14), and the measurement results can be saved or abandoned.

Figure 14

4.10 Recycling

Navigation: Menu > Measurement > SOP > Recycle

Slowly pull the syringe to suck out the sample in the U-shaped tube.

If you install the automatic sampling device, refer to [5.23 Automatic sampler] operation.

4.11 Cleaning

Navigation: Menu > Measurement > SOP > Clean

4.11.1 Select cleaning solvent

(1) Generally, two different cleaning solvents should be selected.

(2) The first cleaning solution should be able to dissolve the sample residue in the U-shaped tube, and it should be easily soluble in the samples being measured.

(3) The second cleaning liquid can remove the first cleaning solvent and is easily volatile under air flow, which can speed up the drying of the U-shaped pipe. Cleaning solvent 2 must have good mutual solubility with cleaning solvent 1.

(4) It is recommended to use water samples and beverages: water as cleaning solvent 1 and analytical pure alcohol as cleaning solvent 2.

(5) For petrochemical samples, it is recommended to use naphtha as cleaning solvent 1 and acetone as cleaning solvent 2.

(6) If you are not sure whether the cleaning solution is suitable for the sample being measured, you can conduct a preliminary experiment with a test tube to see if there is any precipitation, separation or protein.

4.11.2 Cleaning operation process

(1) Use silicone tubing to connect the syringe holder, sample inlet, waste outlet, and waste bottle. Insert the syringe containing the cleaning solution into the syringe holder (Figure 15).

(2) Rinse and drain the U-tube with at least 10ml of cleaning solution 1. If the sample is viscous or contains particles, it is necessary to increase the amount of cleaning solution. **Repeat cleaning at least twice**.

(3) Rinse and drain the U-tube with at least 10ml of cleaning solution 2.

Repeat cleaning at least twice.

Figure 15

   If you install the automatic sampling device, refer to [5.23 Automatic sampler] operation.

4.12 Drying

Navigation: Menu > Measurement > SOP > Dry as shown in Figure 16.

Figure 16

Name	Function	Value/Others
Duration	Set the running time of the air pump	1~20 minutes
Start drying	Start the air pump	
Quick start	Press the shortcut key to start the air pump with one click	

4.12.1 Drying U-shaped pipe

(1) Use silicone tubes to connect the air pump outlet, syringe holder, sample inlet, waste outlet, and waste bottle, as shown in Figure 17.

(2) Use a silicone tube to connect the drying barrel and the air inlet of the air pump, and use dry air to reduce drying time.

Figure 17

(3) Set the running time of the air pump. The drying time depends on the evaporation speed of cleaning solution 2 and the temperature of the U-tube (about 5 minutes for ethanol at 20°C and about 3 minutes for acetone at 20°C).

(4) Click the [Start Drying] button to start the air pump. The air pump automatically stops after waiting for more than the running

If you install the automatic sampling device, refer to [5.23 Automatic sampler] operation.

4.12.2 Dry measurement chamber

Chamber inside the instrument is not completely sealed, so water vapor from the environment may penetrate. When the measurement temperature is lower than the ambient temperature and the air humidity is high, it is very easy to form condensation around the U-shaped tube, causing measurement errors.

In order to prevent condensation, users are advised to refer to the following table for suggestions. After turning on the instrument, immediately use a drying barrel to dry the inside of the measuring chamber of the instrument and always connect the drying barrel during the entire measurement process.

Measure temperature	Ambient temperature	Relative humidity
20°C	20°C	> 70%
	25°C	> 50%
	30°C	> 35%

Especially in the following cases, no matter how much the air humidity is displayed, drying is required before measurement:

a) The humidity of the measurement environment changes greatly (such as experiencing rain or fog).

b) The instrument has not been used for a while or the new instrument is being used for the first time.

c) When the measuring temperature is lower than the ambient temperature or

the measuring temperature is low (<16℃).

Operation process of dry measuring room:

(1) Use a silicone tube to connect the air outlet of the air pump and the air inlet of the measurement chamber, as shown in Figure 18.

(2) Use a silicone tube to connect the drying barrel and the air pump inlet, and use dry air to reduce drying time.

(3) Set the running time of the air pump and click the [Start Drying] button to start the air pump.

Figure 18

(4) Wait for the humidity value to decrease and then manually stop the air pump or automatically stop the air pump when the running time is exceeded.

4.12.3 Replace dry particles

The color of the silica gel particles in the drying barrel is dark blue when not in use. After being used for a period of time, the silica gel particles gradually turn light blue after absorbing moisture. **When the silica gel particles turn pink and reach a state of moisture absorption and saturation**, the blue cap at one end of the drying barrel should be unscrewed, all the silica gel particles should be taken out, and **new silica gel particles should be replaced or the silica gel particles should be dried before filling**.

4.13 Calibration Page
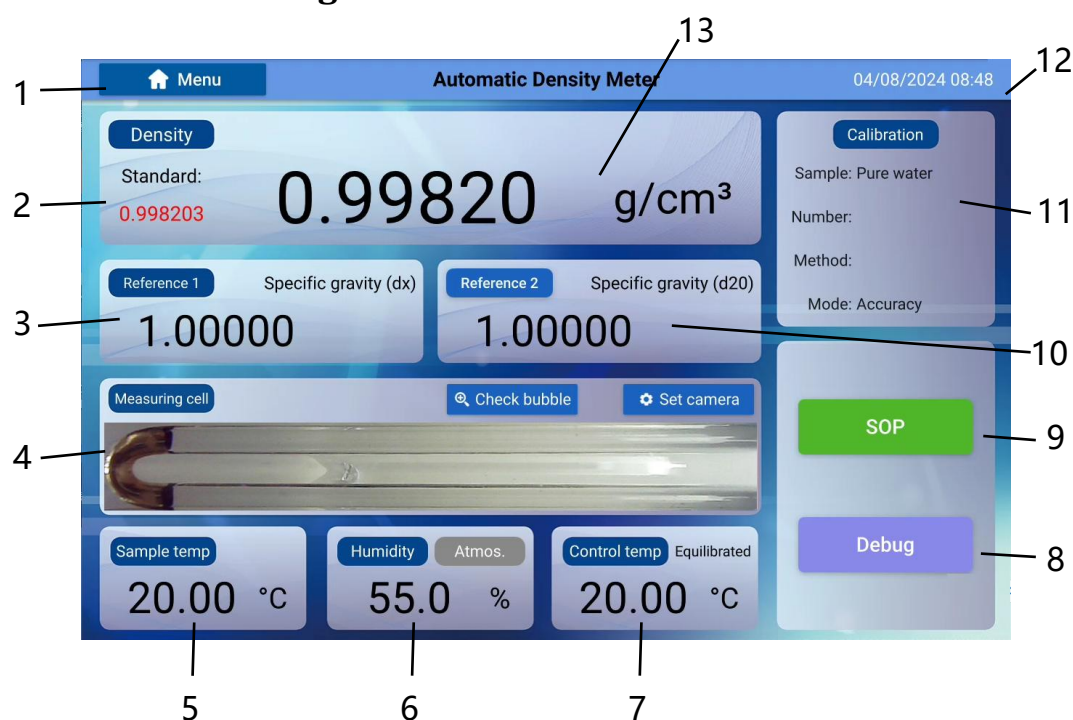
Figure 19

SN	Name	Function
1	menu	Enter the menu page
2	Standard density	The theoretical density of the current calibration sample
3	Reference 1	Display the name, value and unit of the set measurement unit 1·
4	Measuring cell area	Display measuring cell video screen
5	Sample temperature	Display the current sample temperature
6	Humidity and Atmosphere	Display the current humidity and atmosphere of the measuring cell
7	Control temperature	Displays the currently set control temperature **and the upper right corner displays the Control temperature status.**
8	Debug	Maintenance and debugging entrance, for manufacturer use only
9	SOP	When in standby mode, enter the workflow page; **in non-standby mode, such as measuring, drying, etc., the [Stop] button is displayed. Click to abort the process.**
10	Reference 2	the name, value and unit of the set measurement unit 2; **click the [Reference Value 2] button in the upper left corner to enter the Reference Value 2 setting window;**
11	Calibration parameters	Displays the currently set sample name, sample number, method name and measurement mode (**the mode is fixed to accuracy measurement mode**)
12	System time	Display current system time

		Displays the currently measured density, and the
13	Density display area	upper right corner area displays the instrument status.

4.14 Calibration Parameters

Navigation: Menu > Calibration > SOP > Setup, as shown in Figure 20.

Figure 20

Name	Function	Value/Others
Calibration sample	Set up the samples to be calibrated	Dry air; Pure water; High density samples (1.3-2.0]; High density samples (2.0-3.0]; Low density samples [0.6-0.8];
Calibration temperature	Set the temperature to be calibrated	DM-3005/DM-3005A contains six temperature points : 15.00°C; 20.00°C; 25.00°C; 35.00°C; 50.00°C; 60.00°C; DM-3004 contains five temperature points : 15.00°C; 20.00°C; 25.00°C; 35.00°C; 50.00°C;
Standard density	Enter the density of the standard	**Only the density of high-density standards needs to be entered;** Dry air and pure water densities are fixed and do not need to be entered.

4.15 Calibration

Navigation: Menu > Calibration> SOP > Measurement

The density meter has been strictly calibrated before leaving the factory. If the user needs to calibrate, the calibration operation should be performed strictly in accordance with the instructions or under the guidance of the manufacturer's

technical personnel to avoid misoperation that may cause the instrument to reduce its accuracy.

4.15.1 Inspection instruments

(1) Clean and dry the U- shaped tube repeatedly to ensure that there is no residual attachment in the U-shaped tube.

(2) Confirm that the sample is fully filled in the U-shaped tube and there are no bubbles or impurities.

(3) Multiple injections and measurements avoid accidental errors.

After completing the above steps, if the measured density does not meet the requirements, you can perform calibration operations.

4.15.2 Preparation before calibration

(1) The measured sample density is below 1.3 g /cm3 , and only dry air and pure water (or degassed distilled water) are required for calibration.

(2) **DM-3005/3005A**: A complete calibration requires dry air and pure water calibration at six temperature points: 15.00℃, 20.00℃, 25.00℃, 35.00℃, 50.00℃ and 60.00℃.

   DM-3004: A complete calibration requires dry air and pure water calibration at five temperature points: 15.00℃, 20.00℃, 25.00℃, 35.00℃ and 50.00℃.

(3) **DM-3005/3005A**: The complete calibration process is: 15℃ air -> 20℃ air -> 25℃ air -> 35℃ air -> 50℃ air -> 60℃ air -> 60℃ pure water -> 50℃ pure water -> 35℃ pure water -> 25℃ pure water -> 20℃ pure water -> 15℃ pure waters.

   DM-3004: The complete calibration process is: 15℃ air -> 20℃ air -> 25℃ air -> 35℃ air -> 50℃ air -> 50℃ pure water -> 35℃ pure water -> 25℃ pure water -> 20℃ pure water -> 15℃ pure waters.

(4) **If the user does not need to perform measurements in the full temperature range in daily use, he or she can also perform a dry air and pure water calibration only for the sample control temperature point.**

(5) **It is recommended to perform a complete calibration operation to correct the accumulated error after long-term use.**

(6) **Calibration procedures should be followed strictly to avoid calibration errors.**

4.15.3 Calibration steps

(1) Thoroughly clean and dry the U-tube.

(2) In the parameter settings, **set the calibration sample, calibration temperature, and standard density**, and [Apply] takes effect.

(3) **After the control temperature of the instrument has stabilized**, inject the sample. After confirming that there are no bubbles or leaks, click the [New Product Measurement] button to start measurement.

(4) After the measurement is completed, the calibration result saving form is displayed, as shown in Figure 21. Click [Save Result] to save the calibration data, click [Abort Save] to not save this calibration data.

Figure 21

4.16 Measurement records

Navigation: Menu > Data > Measurement record, as shown in Figure 22

Figure 22

4.16.1 Measurement record form

1. **Select measurement records:** You can select the [Page] checkbox in the upper left corner of the measurement record form to select all records on the current page; you can select the [Select All] checkbox in the lower left corner of the measurement record form to select all records in the table; you can Change the selected state of the check box before the record to modify the selected state of the record.

2. **Turn measurement record page:** You can click the [-] button and [+] button on the left and right sides of the page number to turn pages forward and backward. You can also directly click the page number input box and **directly enter the page number to be jumped through the keyboard to turn the page.**

4.16.2 Query measurement record

The measurement record form queries all measurement records of the day by default.

Name	Function	Value/Others
Content filter	After activation, content can be filtered based on fields	Activate / Inactivate
Filter field	Set filter field name	Measurement number; sample name; sample number; signature status; reference name; sample picture; Experimenter **Only valid if content filtering is activated**
Filter content	Filter content based on filter field settings	Can be selected from a drop-down list or entered using the keyboard **Only valid if content filtering is activated**
Time range	Set the time range of the query	today; this month; this year; All (display all records); Custom
Start time	Set start time	**only after the time range is set to custom**
End Time	Set end time	**only after the time range is set to custom**
Sort by time	Set how records are sorted by time	Descending/Ascending

Figure 23

4.16.3 Export measurement record

Name	Function	Value/Others
File format	Set the export format of the file	PDF report; EXCEL report; sample picture; Measurement reports (one record corresponds to one report) Summary report (multiple records are summarized to generate a report)
File path	Set the export path of the file	USB stick (**only supports FAT32 format**); FTP (**FTP needs to be configured in system settings**)

4.16.4 Upload measurement record

Name	Function	Value/Others
Uploading mode	Set the upload mode of data	USB (**4.2 back of instrument 8**) RS232 (**4.2 back of instrument 10**) TCP (**Socket** mode; the instrument needs to be connected to the Internet; **TCP needs to be configured in the system settings**)
Data format	Set the format of data	XML format (Figure 24) TXT format (Figure 25) JSON format (Figure 26)

```xml
<?xml version="1.0"?>
<measurementRecord>
  <sampleInformation>
    <measurementNumber>00000001</measurementNumber>
    <sampleName></sampleName>
    <sampleNumber></sampleNumber>
    <experimenter>Debug</experimenter>
    <measurementTime>04/08/2024 10:20:48</measurementTime>
    <printDate>04/08/2024</printDate>
  </sampleInformation>
  <measurementMethod>
    <instrument>Density Meter</instrument>
    <instrumentNumber>000000000001</instrumentNumber>
    <methodName></methodName>
    <controlTemp>20.00</controlTemp>
    <measurementMode>Accuracy</measurementMode>
  </measurementMethod>
  <testResult>
    <measurementTemp>20.00</measurementTemp>
    <density>0.99820</density>
    <referenceName>Specific gravity (dx)</referenceName>
    <reference>1.00000</reference>
  </testResult>
</measurementRecord>
```

Figure 24 XML format

```
Measurement record
--------------------------------
<Sample information>
Measurement number: 00000001
Sample name:
Sample number:
Experimenter: Debug
Measurement time: 04/08/2024 10:20:48
Print date: 04/08/2024

<Measurement method>
Instrument model: Density Meter
Instrument number: 000000000001
Method name:
Control temperature: 20.00 °C
Measurement mode: Accuracy

<Measurement result>
Sample temperature: 20.00 °C
Density: 0.99820 g/cm3
Reference name: Specific gravity (dx)
Reference: 1.00000
```

```json
{
  "measurementMethod": {
    "controlTemp": "20.00",
    "instrument": "Density Meter",
    "instrumentNumber": "000000000001",
    "measurementMode": "Accuracy",
    "methodName": ""
  },
  "measurementResult": {
    "density": "0.99820",
    "measurementTemp": "20.00",
    "reference": "1.00000",
    "referenceName": "Specific gravity (dx)"
  },
  "sampleInformation": {
    "experimenter": "Debug",
    "measurementNumber": "00000001",
    "measurementTime": "04/08/2024 10:20:48",
    "printDate": "04/08/2024",
    "sampleName": "",
    "sampleNumber": ""
  }
}
```

Figure 25 TXT format   Figure 26 JSON format

4.16.5 Print measurement record

First select the measurement record, then click the [**Print**] button to enter the measurement record print preview page (Figure 27). When the printer is connected normally, the [**Printer**] button will appear on the preview page. Click this button to print the measurement record. If you need to cancel printing, click the [**Return**] button to cancel.

Select the printer to be connected if printing report type records, such as measurement records and warning records. To operate the record, you need to set the paper orientation to landscape.

Before printing, make sure that the instrument WLAN is turned on. The instrument can connect to the printer's own WLAN to achieve direct connection printing, or the printer and the instrument can be connected to the same LAN to achieve LAN printing.
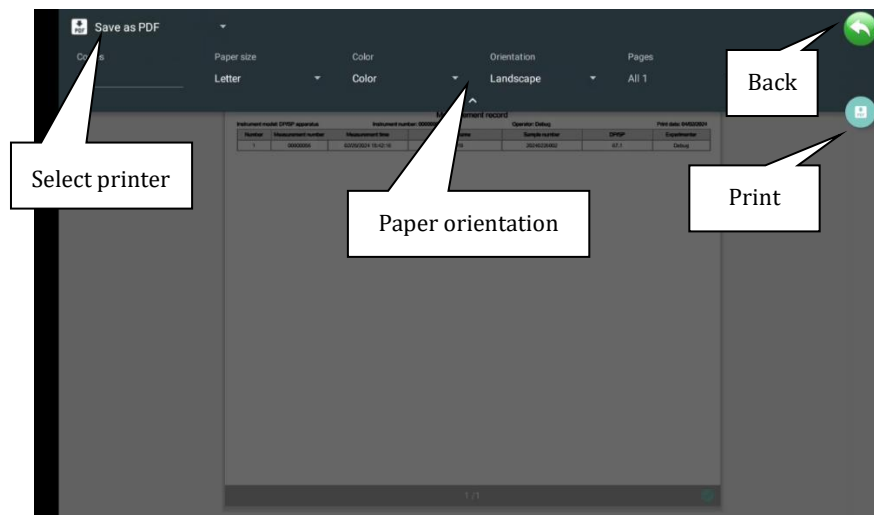
Figure 27

4.16.6 Delete measurement record

First select the measurement record, then click the [**Delete**] button to display the deletion confirmation form. After confirmation, delete the record.

4.17 Measurement details

Navigation: Menu > Data> Measurement record > Measurement details

In the measurement record table, double- click the measurement record you want to view to generate the corresponding test details, as shown in Figure 28.

Figure 28

4.17.1 View sample image

Click the [**View sample image**] button to display the sample pictures saved in the current record. You can **zoom in and out of the picture by using two fingers**.

4.17.2 Electronic signature

Click the [**Sign**] button to display the electronic signature form (Figure 29). **The electronic signature is automatically linked to the measurement record, and the signature cannot be revoked**.

The signature consists of four parts**: the time of signing, the reason for signing, the name of the signer, and the description of the signature.** Generated electronic signature, for example: **12/20/2023 16:13:55: Confirm [Debug] passed.**

Figure 29

Name	Function	Value/Others
Verification mode	Set the signature verification method	password
Signature password	Enter the password to verify your identity	Same as user login password
Reason for signature	Reason for setting signature	Confirm (**signed only by the Experimenter of this measurement record**) Review (**signed by management other than the confirmer**) Approve (**signed by the most senior administrator**) **Signature Level: Approve> Review > confirm**
Signature description	Set signature information	Keyboard input, such as pass, fail

4.17.3 Export measurement details

Name	Function	Value/Others
File format	Set the export format of the file	Report (PDF format); Sample image (PNG format);
File path	Set the export path of the file	USB stick (**only supports FAT32 format**); FTP (**FTP needs to be configured in system settings**)

4.17.4 Upload measurement report

Name	Function	Value/Others
Uploading mode	Set the uploading mode of data	USB (**4.2 back of instrument 8**) RS232 (**4.2 back of instrument 10**) TCP (**Socket** mode; the instrument needs to be connected to the Internet; **TCP needs to be configured in the system settings**)
Data format	Set the format of data	XML format (Figure 24); TXT format (Figure 25) JSON format (Figure 26)

4.17.5 Print measurement report

Name	Function	Value/Others
Printer type	Select printer type	Universal printer (WIFI printing) Micro printer (thermal printer (Figure 30) Stylus printer (**only supports English picture 31)**)

```
MEASUREMENT RECORD
-------------------------------
Sample Name: test
Sample No.: 001
Meas. Date : 04/08/2024
Meas. Time: 11:33:24
Temp.    : 20.00
Density  : 0.99820
Ref. Name : Specific gravity (dx)
Ref. Value : 1.00000
```

```
MEASUREMENT RECORD
- - - - - - - - - -
Meas. Date : 2023-12-20
Meas. Time : 11:33:24
Temp.      : 20.00
Density   : 0.00111
Ref. Name  : Specific gravity (dx)
Ref. Value : 0.00111
```

| Figure 30 | Figure 31 |

4.18 Data backup

Navigation: Menu > Data> Backup data, as shown in Figure 32. **All backups are full backups.**

Figure 32

4.18.1 Common backup

Name	Function	Value/Others
Back up to USB stick	Back up data to USB stick	USB stick (**only supports FAT32 format**)
Backup to FTP	Back up data to FTP	FTP (**FTP needs to be configured in system settings**)

4.18.2 Set regular backup

Name	Function	Value/Others
Regular backup reminder	After activation, the software periodically reminds you to back up.	Activate/Inactivate

Backup interval	Set backup interval	1 ~366 days
File backup path	Set backup method	USB stick (**only supports FAT32 format)** FTP (**FTP needs to be configured in system settings)**
Next backup time	Calculate backup time based on backup interval	Effective after activating regular backup reminder

4.19 User Management

Navigation: Menu > User, as shown in Figure 33.
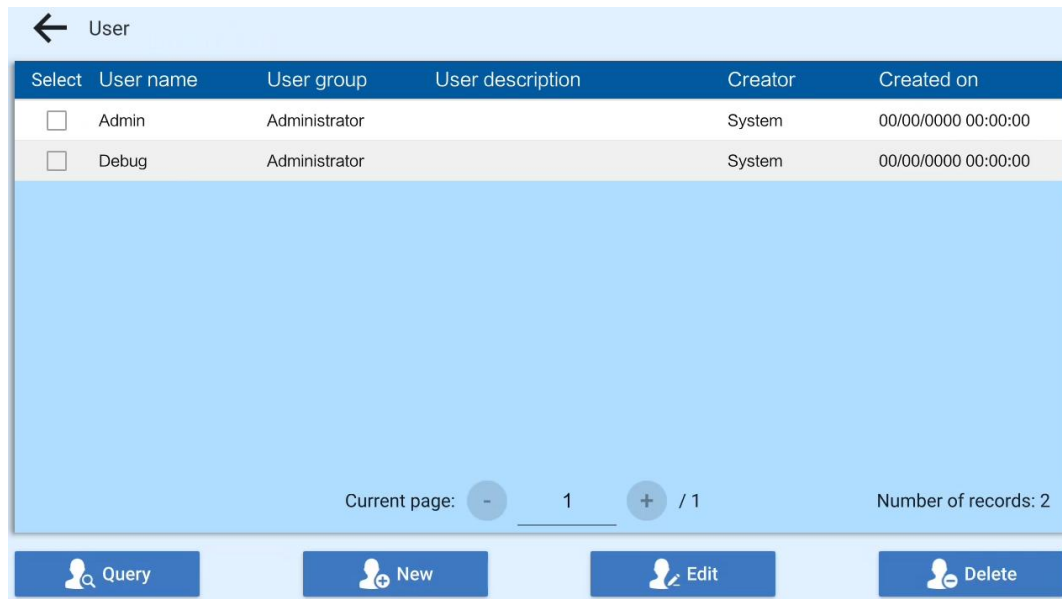
Figure 33

45.19.1 Query user

Name	Function	Value/Others
Query by name	After activation, you can query according to the name	keyboard input
Query by status	After activation, you can query according to the status	Activate/Inactivate
Show all data	Show all data	**Show all data by default**

4.19.2 New user

Navigation: Menu > User > New, as shown in Figure 34.

Figure 34

Name	Function	Value/Others
Select avatar	Select user avatar	The instrument has built-in male and female avatars; custom avatars (PNG pictures are placed in the root directory of the USB stick and imported)
User name	Set user name	Keyboard input, **no modification is allowed after the name is saved.**
User password	Set user initial password	**Only input 0 ~ 9 a ~ z A ~ Z@#$%^& is allowed**
User description	Set user description	User identification information can be entered
User group	Set the group the user belongs to	**Keyboard input (create new group) Drop-down box selection (previously created group)**
User status	Set user usage status	Activation/inactivation (**if a user leaves his job, he can set the status to inactivation and prohibit the user from using it**)
Login status	Set the user's login status	Activation/inactivation (**when the user enters the wrong password multiple times and the login is restricted, the administrator can modify the status to restore it**)
Authority management	Set user permissions	Activate/Inactivate various permissions Permission list (see **6. User permission list**)

4.19.3 Edit user

First select the user to be edited, and then click the [**Edit**] button to enter the edit user page.

a) **"Admin" and "Debug" are built-in users with the highest authority and cannot be edited.**

b) **Even if a user has edit user rights, he or she cannot edit users in the same group.**

4.19.4 Delete user

First select the user, and then click the [**Delete**] button to display the deletion confirmation form. After confirmation, delete the user.

4.20 Method Management

Navigation: Menu > Method, as shown in Figure 35.
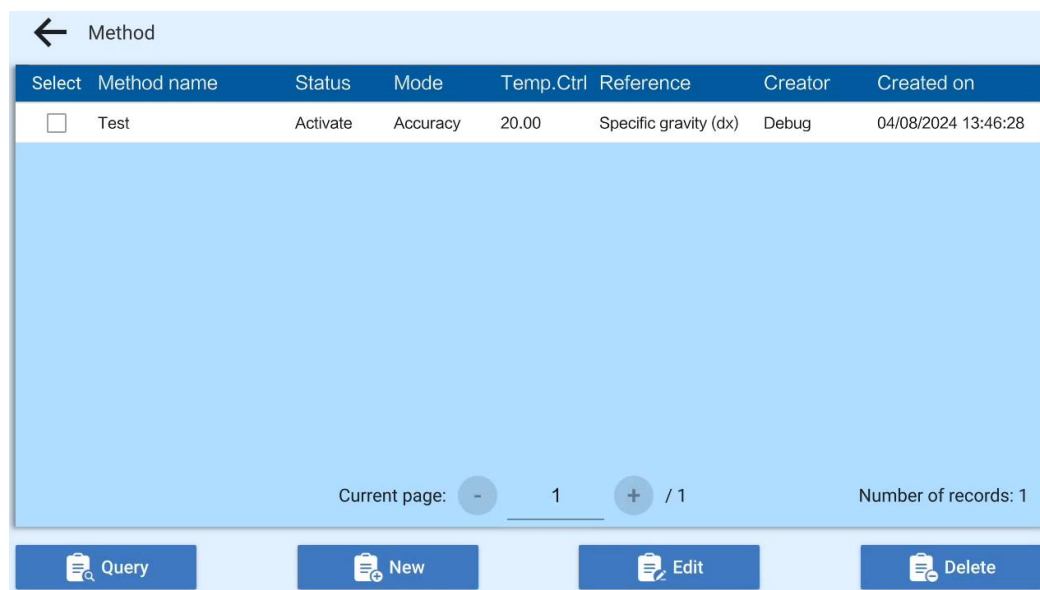
Figure 35

4.20.1 Query method

Name	Function	Value/Others
Query by name	After activation, you can query according to the name	keyboard input
Query by status	After activation, you can query according to the status	Activate/Inactivate
Show all data	Show all data	**Show all data by default**

4.20.2 New method

Navigation: Menu > Method > New, as shown in Figure 36.

Figure 36

Name	Function	Value/Others
Method name	Set method name	Keyboard input, **no modification is allowed after the name is saved.**
Method status	Set method status	Activate/ deactivate, **This method can no longer be used after it is set to inactive.**
Sample name	Set sample name	Set the sample name when calling the method
Measurement mode	Set measurement mode	Accuracy / Fast
Control temperature	Set control temperature	DM-3005/DM-3005A: 5 ~ 70 ° C DM-3004: 5 ~ 50 ° C
Reference	Set measurement units	Built-in units/custom formulas
Coefficient A	Set polynomial 5th degree coefficients	Enter a value, **0.0012 can be entered as 1.2e-3.** **Only the reference value set to custom is valid.**
Coefficient B	Set polynomial 4th degree coefficients	Enter a value. **Only the reference value set to custom is valid.**
Coefficient C	Set polynomial cubic coefficients	Enter a value. **Only the reference value set to custom is valid.**
Coefficient D	Set polynomial quadratic coefficients	Enter a value. **Only the reference value set to custom is valid.**

Coefficient E	Set polynomial 1st degree coefficients	Enter a value. **Only the reference value set to custom is valid.**
Coefficient F	Set polynomial constant terms	Enter a value. **Only the reference value set to custom is valid.**
Minimum value	Set the minimum value of the formula result	Enter a value. **Only the reference value set to custom is valid.**
Maximum value	Set the maximum value of the formula result	Enter a value. **Only the reference value set to custom is valid.**
Decimal places	Set the number of decimal places retained in formula calculation results	Enter a value. **Only the reference value set to custom is valid.**
Unit	Set the units of the formula	keyboard input
Filling status[1]	Set whether automatic sampling is required	Activate/deactivate
Filling speed[1]	Set filling speed	From low to high: 1~9
Filling duration[1]	Set filling duration	1~300 seconds
Recycling status[1]	Set whether automatic recycling is required	Activate/deactivate
Recycling speed[1]	Set recycling speed	From low to high: 1~9
Recycling duration[1]	Set recycling duration	1~300 seconds
Solvent 1 status[1]	Set whether solvent 1 is required	Activate/deactivate
Solvent 1 name[1]	Set solvent 1 name	keyboard input
Solvent 1 speed[1]	Set solvent 1 speed	From low to high: 1~9
Solvent 1 cleaning duration[1]	Set solvent 1 cleaning duration	1~300 seconds
Solvent 2 status[1]	Set whether solvent 2 is required	Activate/deactivate
Solvent 2 name[1]	Set solvent 2 name	keyboard input
Solvent 2 speed[1]	Set solvent 2 speed	From low to high: 1~9
Solvent 2 cleaning duration[1]	Set solvent 2 cleaning duration	1~300 seconds
Dry state	Set whether drying is required	Activate/deactivate
Drying time	Set drying time for method	1 ~20 minutes, only effective when activated in dry state

Note: 1) Only the automatic sampler is installed.

4.20.3 Edit method

First select the method to be edited, and then click the [**Edit**] button to enter the editing method page.

4.20.4 Delete method

First select the method, and then click the [**Delete**] button to display the deletion confirmation form. After confirmation, delete the method.

4.21 System Settings

Navigation: Menu > Setting, as shown in Figure 37.
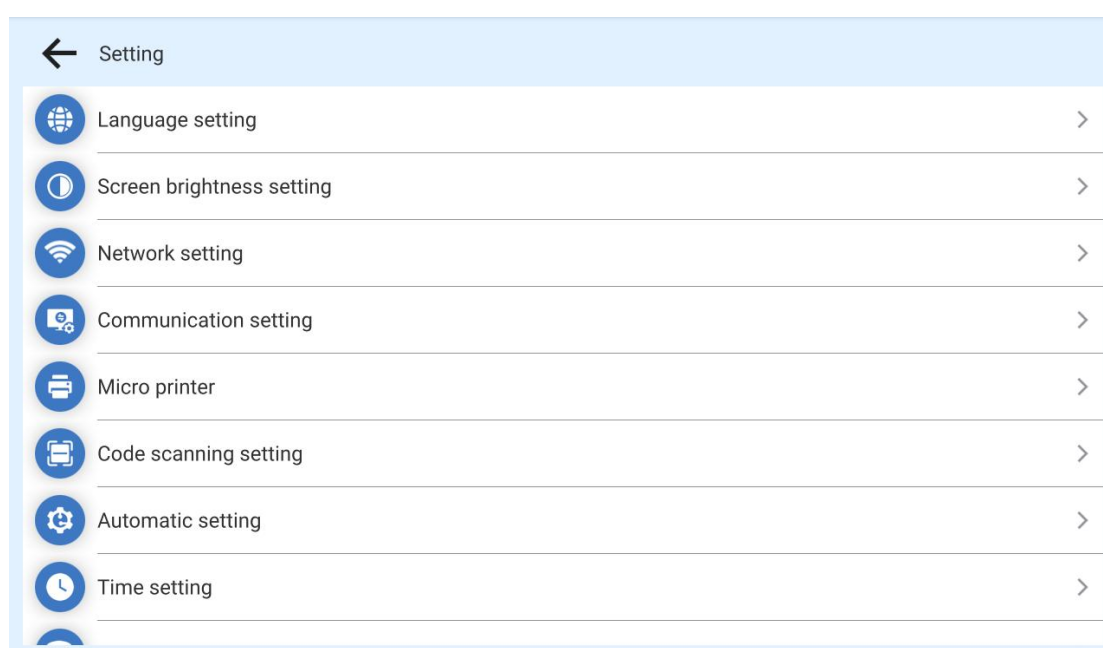
Figure 37

4.21.1 Language settings

Navigation: Menu > Setting > language setting

Name	Function	Value/Others
language	Set system language	Chinese / English (**The instrument automatically restarts after language setting**)

4.21.2 Screen brightness setting

Navigation: Menu > Setting > Screen brightness setting

Name	Function	Value/Others
Screen brightness level	Set screen brightness level	0 ~10

4.21.3 Network setting

Navigation: Menu > Setting> Network setting, as shown in Figure 38.
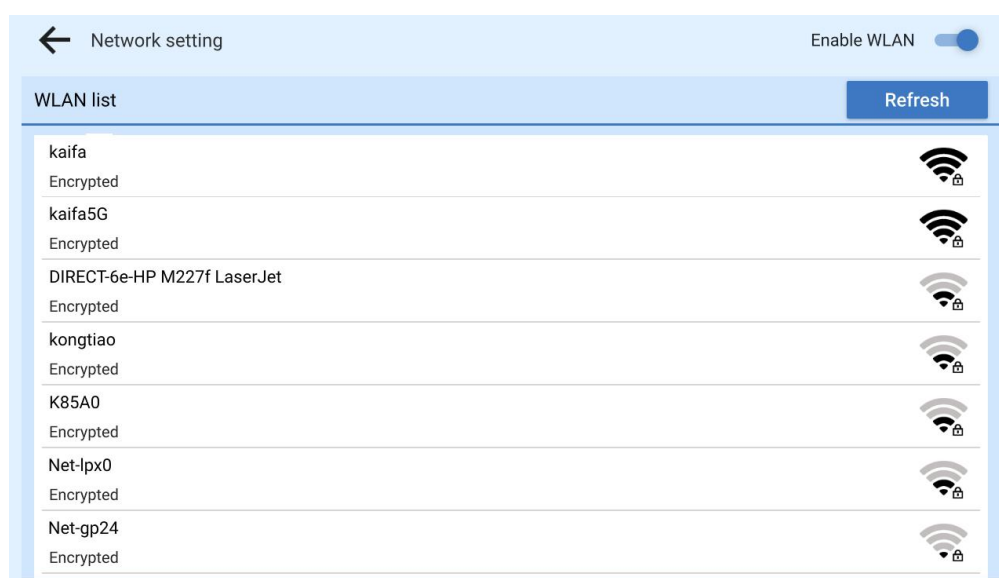
Figure 38

Name	Function	Value/Others
Enable WLAN	Set WLAN status	Activate/Inactivate
WLAN list	Display WLAN name, encryption status, signal strength	
Refresh	Refresh WLAN list	
Connect Network	Click on the WLAN name and enter the WLAN password (no need to enter if there is no password) to connect to the WLAN	
Delete configuration	Click on the connected WLAN and click [Delete Configuration] to delete the saved WLAN password	

4.21.4 Communication setting

Navigation: Menu > Setting > Communication setting

1. Serial port setting

Name	Function	Value/Others
USB baud rate	Set USB port baud rate	1200; 2400; 4800; 9600; 19200; 38400; 57600; 115200;
RS232 baud rate	Set the RS232 port baud rate	1200; 2400; 4800; 9600; 19200; 38400; 57600; 115200;

The serial port defaults to 8 data bits; 1 stop bit; no parity bit; and no hardware flow control.

2. TCP setting

Name	Function	Value/Others
IP address	Set the IP address of the TCP server	keyboard input
Port number	Set the port number of the TCP server	0~65535

3. FTP setting

Name	Function	Value/Others
User name	Enter FTP server username	keyboard input
Password	Enter FTP server password	**Set to empty if there is no password**
IP address	Set the IP address of the FTP server	keyboard input
Port number	Set the port number of the FTP server	0~65535

4.21.5 Micro printer

Navigation: Menu > Setting > Micro printer

Name	Function	Value/Others
Micro printer type	Set micro printer type	Thermal printer/Stylus printer

4.21.6 Scan code setting

Navigation: Menu > Setting > Code scanning setting

Name	Function	Value/Others
Decode mode	Set how to parse data	Location segmentation; Character segmentation

1. Location segmentation (**suitable for fixed-length methods**)

Name	Function	Value/Others
Sample name	Set whether to parse sample names	Activate/Inactivate
Start index of sample name	Set the starting position number of the sample name	Enter value

Character length of sample name	Set the length of sample name characters	Enter value
Sample number	Set whether to parse sample number	Activate/Inactivate
Start index of sample number	Set the starting position number of the sample number	Enter value
Character length of sample number	Set the length of sample number characters	Enter value
Method name	Set whether to parse method names	Activate/Inactivate
Start index of method name	Set the starting position number of the method name	Enter value
Character length of method name	Set the length of method name characters	Enter value

For example: the data to be analyzed is "ABC1234DE", where "ABC" is the sample name, "1234" is the sample number, and "DE" is the method name.

The data corresponds to serial numbers 0, 1, and 2 increasing from left to right, and the serial numbers start from 0.

The starting position of the sample name is 0, and the character length of the sample name is 3; the starting position of the sample number is 3, and the character length of the sample number is 4; the starting position of the method name is 7, and the character length of the method name is 2.

2. Character segmentation **(suitable for non-fixed length)**

Name	Function	Value/Others
sample name	Set whether to parse sample names	Activate/Inactivate
Index of sample name	Set the index of the sample name	Enter value
Sample number	Set whether to parse sample number	Activate/Inactivate
Index of sample number	Set the index of the sample number	Enter value
Method name	Set whether to parse method names	Activate/Inactivate
Index of sample method name	Set the index of the method name	Enter value

For example: the data to be parsed is "ABC # 1234 # DE", where "ABC " is the sample name, "1234" is the sample number, and "DE" is the method name.

The data field is separated by the "#" character, and the corresponding serial numbers 0, 1, and 2 increase from left to right, and the serial number starts from 0.

The sample name serial number is 0; the sample number serial number is 1; the method name serial number is 2.

3. Parsing test

Click the content area to be parsed, and then start the code reader after the input cursor is displayed. After the code reading is completed, click [Parse].

4.21.7 Automatic setting

<u>**Navigation: Menu > Setting > Automatic setting**</u>

1. Auto save

Name	Function	Value/Others
Automatically save records after measurement is completed	Records can be saved automatically after activation	Activate / Inactivate

2. Automatic printing

Name	Function	Value/Others
Micro printer automatically prints measurement report	Automatically print after saving records after activation	Activate/Inactivate

3. Automatic upload

Name	Function	Value/Others
Automatically upload measurement records	After activation, the record will be saved and uploaded automatically.	Activate / Inactivate
Uploading mode	Set the uploading mode of data	USB (**4.2 back of instrument 8**) RS232 (**4.2 back of instrument 10**) TCP (**Socket** mode; the instrument needs to be connected to the Internet; **TCP needs to be configured in the system settings**)
Data Format	Set the format of data	XML format (Figure 24) TXT format (Figure 25) JSON format (Figure 26)

4.21.8 Time setting

<u>**Navigation: Menu > Setting > Time setting**</u>

1. Time format

Name	Function	Value/Others
Time	Set the time	"yyyy-MM-dd hh:mm:ss" ; "MM-dd-yyyy hh:mm:ss" ;

format	display	"dd-MM-yyyy hh:mm:ss" ; "yyyy/MM/dd hh:mm:ss " ;
	format	"MM/dd/yyyy hh:mm:ss" ; "dd/MM/yyyy hh:mm:ss" ;
		"yyyy.MM.dd hh:mm:ss" ; "MM.dd.yyyy hh:mm :ss" ;
		"dd.MM.yyyy hh:mm:ss"

yyyy: year; MM: month; dd: day; hh: hour; mm: minute; ss: second.

2. Set system time

Name	Function	Value/Others
System time	Calibrate system time	manual setting; **Automatically synchronize network time when connected to the Internet**

4.21.9 Restore factory setting

<u>Navigation: Menu > Setting > Restore factory setting</u>

Name	Function	Value/Others
Password	Verify identity	keyboard input

When the user makes a calibration error and saves abnormal data, the factory calibration data can be restored by restoring factory settings. **This operation only restores calibration data. Stored user data, Measurement records, etc. will not be affected.**

4.21.10 Default setting

<u>Navigation: Menu > Setting > Default setting</u>

Name	Function	Value/Others
Measurement mode	Set the default measurement mode at startup	Accuracy / Fast
Control temperature	Set the default control temperature at startup	DM-3005/DM-3005A: 5 ~70℃ DM-3004: 5 ~50℃
Reference 1	Set the default measurement unit 1 at startup	built-in unit
Reference 2	Set the default measurement unit 2 at startup	built-in unit
Save sample image	Set whether to activate saving sample pictures by default at startup	Activate/deactivate
Density retains decimal places	Set the number of decimal places for density retention in measurement results	DM-3005: 1~5 DM-3005A/DM-3004: 1~4
Drying time of U-shaped tube	Set the default boot time for drying U- shaped tube	1~20 minutes
Dry measuring chamber duration	Set the default drying measurement chamber duration at startup	1~20 minutes
Density Unit	Set density unit	g/ml; g/cm^3

4.21.11 Password policy

Navigation: Menu > Setting > Password policy

Name	Function	Value/Others
Minimum character length	Set the minimum character length of password	6 ~16
Activate expiration date and history management	Set whether to activate expiration date and history management	Activate/Inactivate **(FDA version software is forced to activate)**
Expiration date	Set password expiration date	1 ~999 days
Historical management times	The last few times the password has been set are not allowed to be repeated.	0~36 times
The initial password must be changed after login	Set whether the initial password must be modified after login	Activate/Inactivate
Password must meet complexity requirements	Set whether the password must meet complexity requirements	Activate/Inactivate

Complexity requirements: The password contains at least three of the uppercase letters A-Z, lowercase letters a-z, numbers 0-9, and special characters # $ % ^ &.

4.21.12 Login policy

Navigation: Menu > Setting > Login policy

Name	Function	Value/Others
Allowed login mode	Set allowed login methods	password
Activate login policy	Set whether to activate the login policy	Activate/Inactivate **(FDA version software is forced to activate)**
Lock check time	Set the time for counting the number of password errors, **After this time is exceeded, the number of errors will be reset to zero.**	1 ~1440 minutes
Number of password errors allowed	Set the number of allowed password errors	1~10 times
Login recovery time	the time to resume login after locking	1 ~1440 minutes **(Effective when user lock is not activated and must be unlocked by an administrator)**
Once locked, the user must be unlocked by the administrator	Set whether the user must be unlocked by the administrator after being locked	Activate/Inactivate

4.21.13 Lock screen policy

Name	Function	Value/Others
Activate automatic screen lock	Set whether to activate automatic locking of the screen when there is no operation for a long time and no tasks are being performed.	Activate/Inactivate
Wait for lock screen time	Set the time to wait for the lock screen	1 ~120 minutes

4.22 Audit Trail

4.22.1 Warning record

, as shown in Figure 39.

The warning record consists of four parts: date and time, warning event, warning object, and warning information. **Record errors and fault information that occur during the use of the instrument, such as sensor abnormalities, measurement failures,** etc.

Warning records can be queried and sorted according to time, fields, etc. Warning records can be exported to PDF and EXCEL files; warning records can be printed through WIFI printers. The relevant operations are similar to the [**5.16 Measurement records**], please refer to the operations.
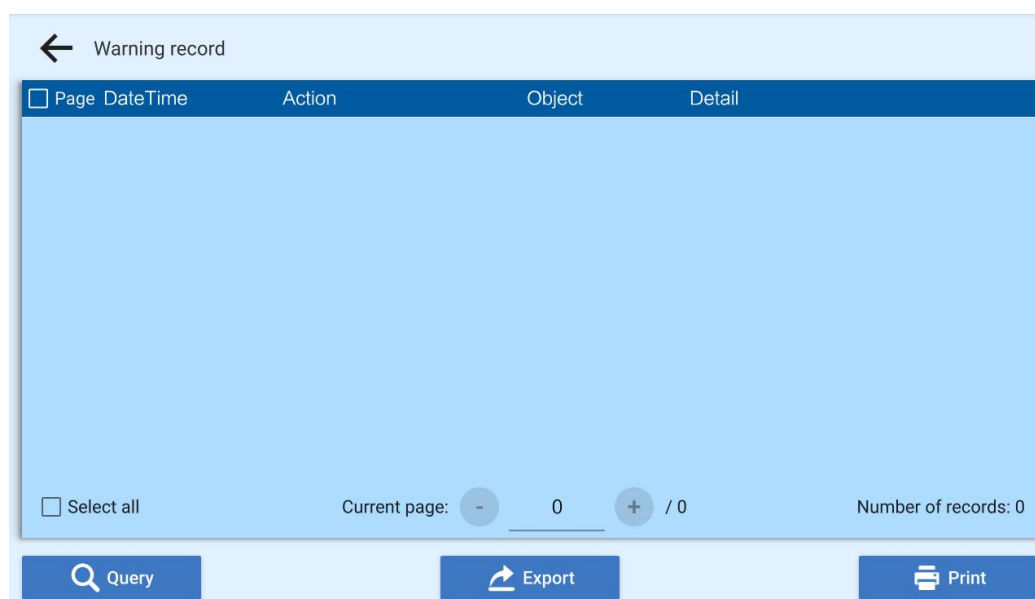
Figure 39

4.22.2 Operation record

Navigation: Menu > Audit> Operation record, as shown in Figure 40.

Operation records consist five parts: date and time, operator, operation event, operation object, and operation result. **Record the user's various operations on the instrument to facilitate data traceability.**

Operation records can be queried and sorted according to time, fields, etc.; operation records can be exported to PDF and EXCEL files; operation records can be printed through WIFI printers. The relevant operations are similar to the [**5.16 Measurement records**], please refer to the operations.
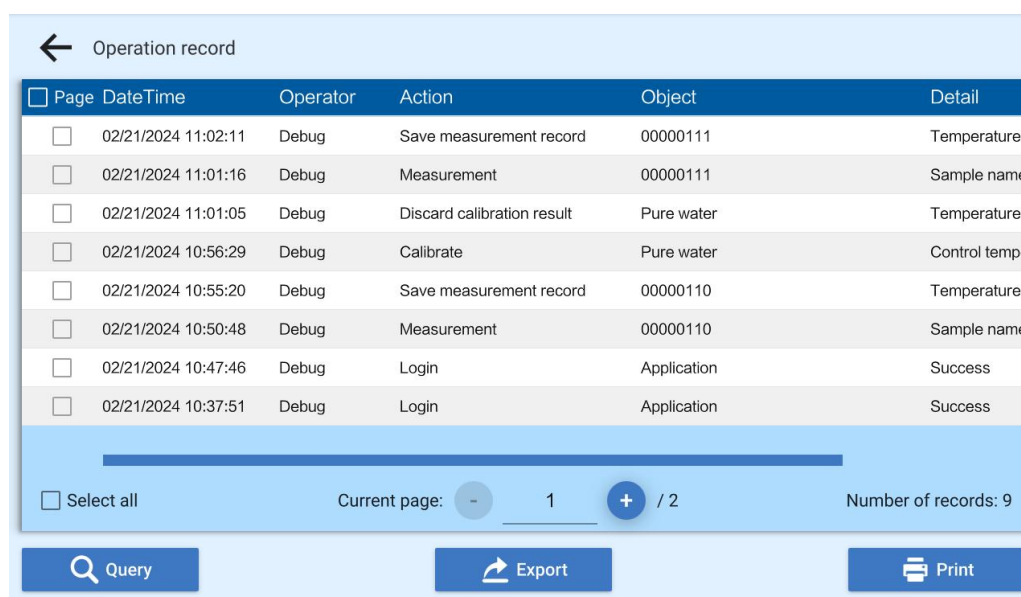

Page	DateTime	Operator	Action	Object	Detail
☐	02/21/2024 11:02:11	Debug	Save measurement record	00000111	Temperature:
☐	02/21/2024 11:01:16	Debug	Measurement	00000111	Sample name
☐	02/21/2024 11:01:05	Debug	Discard calibration result	Pure water	Temperature:
☐	02/21/2024 10:56:29	Debug	Calibrate	Pure water	Control tempe
☐	02/21/2024 10:55:20	Debug	Save measurement record	00000110	Temperature:
☐	02/21/2024 10:50:48	Debug	Measurement	00000110	Sample name
☐	02/21/2024 10:47:46	Debug	Login	Application	Success
☐	02/21/2024 10:37:51	Debug	Login	Application	Success

☐ Select all   Current page: - 1 + / 2   Number of records: 9

🔍 Query   ↗ Export   🖶 Print

Figure 40

4.22.3 Operation details

Navigation: Menu > Audit> Operation record> Operation detail are shown in Figure 41.

When an operation event involves many parameters and cannot be directly displayed in the operation record table, you can **double-click the record to view the operation details.** Through the operation details, you can view the changes in parameters before and after the operation. Operation details are exported to PDF files and can also be printed via WIFI printer.

Figure 41

4.23 Automatic sampler

4.23.1 Model parameters

Model	AS-310	AS-320
Sample types	Similar samples injected by replacement samples	Differential samples that need to be cleaned after each measurement
Maximum sample viscosity	3000 mPa.s	
Peak flow	300 ml/min	
Sampling mode	Industrial grade peristaltic pump	
Pump tube	BPT material, acid and alkali corrosion resistance	
Sample volume	About 20mL	
Automaticity	Fill/Recycle	Fill/Recycle/Clean/Dry

4.23.2 AS-310 Automatic sampler

1.　Main features：

(1) **It is suitable for the simple operation of sample injection by displacement**, such as alcoholic beverages, soft drinks and syrups, diluted polymer solutions. Beer and wort, petrochemical samples, acid and alkali, etc.

(2) The new industrial grade peristaltic pump can realize one key injection. Once the parameters of the automatic sampler are set, the injection does not depend on the operation of the user, which can reduce the operation error.

(3) The peristaltic pump pipe uses corrosion-resistant materials and can be used to treat corrosive samples.

(4) The flexible injection speed ensures the optimization of sample processing to obtain ideal measurement results.

2.   Interface definition：

Figure 42

SN	Name	Function
1	U-tube inlet	The sample flows from the orifice into the U-tube.
2	U-tube outlet	The sample flows out of the U-tube from the outlet.
3	Peristaltic pump inlet	The sample flows from the orifice into the peristaltic pump.
4	Peristaltic pump outlet	The sample flows out of the peristaltic pump from the orifice.

3.   Silicon tube connection：

(1) One end of the silicone tube is used to connect the U-tube inlet (No. 1), and the other end is suspended.
(2) One end of the silicone tube is connected to the U-tube outlet (No. 2), and the other end is connected to the peristaltic pump inlet (No. 3).
(3) One end of the silicone tube is connected to the peristaltic pump outlet (No. 4), and the other end is connected to the waste liquid bottle.

4.   Filling：

   Navigation: Menu > Measurement > SOP > Fill
(1) The suspended end of the silicone tube connected to the inlet of the U-tube is inserted into the sample liquid surface.
(2) Set the speed and duration of filling.
(3) Click the [**Start filling**] button to start the injection process, wait for the injection to be completed, and confirm that the sample in the U-tube has no bubbles.

5.   Measurement：

   Navigation: Menu > Measurement > SOP > Measurement
   Execute the measurement procedure according to [5.9 Measurement].

6. **Recycling：**

   <u>**Navigation: Menu > Measurement > SOP > Recycle**</u>

(1) Set the recycling speed and duration.
(2) Click the [**Start recycling**] button to start the recycling process and wait for the recycling to be completed.

7. **Cleaning：**

   <u>**Navigation: Menu > Measurement > SOP > Clean**</u>

(1) Insert the suspended end of the silicone tube connecting the inlet of the U-tube into the cleaning solution 1.

(2) Set the name of solvent 1, the speed and duration of operation.

(3) Click the [**Start cleaning 1**] button to start the cleaning process, waiting for the cleaning to be completed.

(4) The suspended end of the silicone tube connecting the inlet of the U-tube was inserted into the cleaning solution 2.

(5) Set the name of solvent 2, the speed and duration of operation.

(6) Click the [**Start cleaning 2**] button to start the cleaning process, waiting for the cleaning to be completed.

8. **Dry U-tube：**

   <u>**Navigation: Menu > Measurement > SOP > Dry**</u>
(1) Push the peristaltic pump chuck up and loosen the peristaltic pump pipe.
(2) The outlet of the air pump (No. 4 in Fig. 3) is connected with the suspension end of the silicone tube at the entrance of the U-tube by a connecting head.
(3) Set the drying duration under the ' Dry U-tube ' tab.
(4) Click the [**Start drying**] button to start the drying process and wait for the drying to complete.

4.23.3 AS-320 Automatic sampler

1. **Main features：**

(1) **It is suitable for various samples that need to be cleaned after each measurement. It is suitable for continuous measurement of single samples with wide differences**, such as petrochemical samples, flavors and fragrances, alcoholic beverages, chemical samples, inks, etc.
(2) The new industrial grade peristaltic pump can realize one key injection. Once the parameters of the automatic sampler are set, the injection does not depend on the operation of the user, which can reduce the operation error.
(3) The peristaltic pump pipe uses corrosion-resistant materials and can be used to treat corrosive samples.

(4) After the measurement is completed, the sample will be emptied or recycled, and up to two cleaning solutions will be used for automatic cleaning and drying systems.

(5) The flexible injection speed ensures the optimization of sample processing to obtain ideal measurement results.
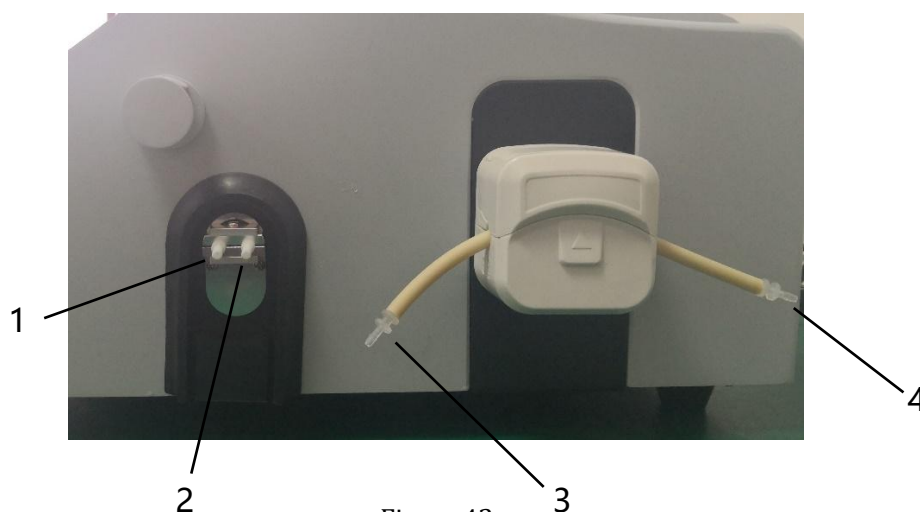
2.　Interface definition：
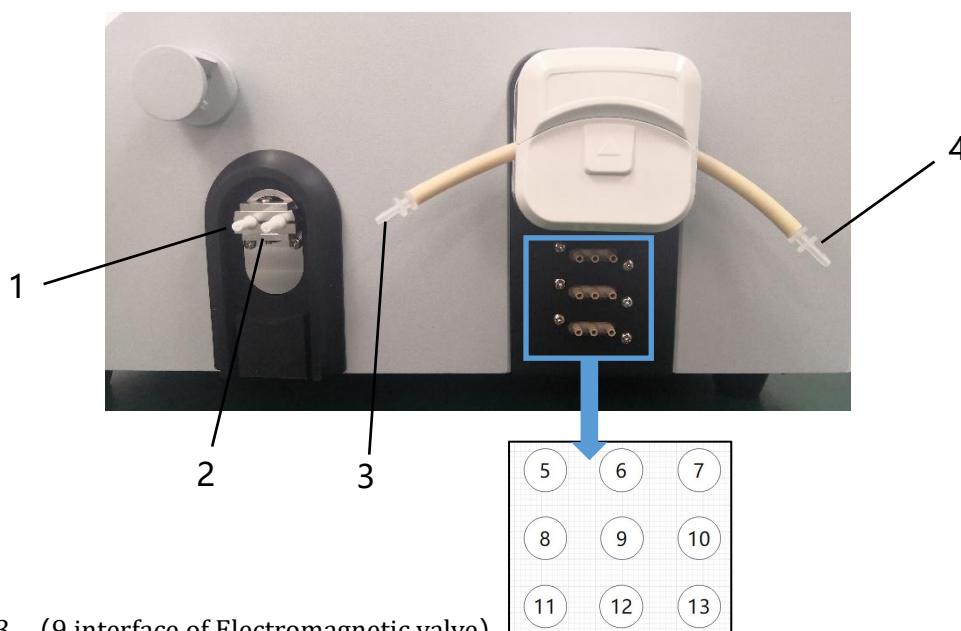
Figure 43　（9 interface of Electromagnetic valve)

SN	Name	Function
1	U-tube inlet	The sample flows from the orifice into the U-tube.
2	U-tube outlet	The sample flows out of the U-tube from the orifice.
3	Peristaltic pump inlet	The sample flows from the orifice into the peristaltic pump.
4	Peristaltic pump outlet	The sample flows out of the peristaltic pump from the orifice.
5	Cleaning liquid outlet 1	The cleaning fluid flows out of the solenoid valve from this port.
6	Cleaning liquid 2 inlet	Cleaning liquid 2 from the mouth into the solenoid valve.
7	Cleaning liquid 1 inlet	Cleaning liquid 1 flows into the solenoid valve from the port.
8	Solenoid valve inlet 1	The sample flows from the U-tube into the solenoid valve.
9	Solenoid valve outlet	The sample flows from the solenoid valve into the peristaltic pump tube
10	Inlet of solenoid valve	The dry air produced by the air pump enters the solenoid valve from this port.
11	Solenoid valve inlet 2	The sample flows from the peristaltic pump into the solenoid valve.
12	Cleaning liquid outlet 2	Connected to the cleaning solution outlet 1

13	Waste liquid export	The waste liquid flows into the waste liquid bottle from the mouth.

3. **Silicon tube connection**：

(1) Use one end of the silicone tube to connect the U-tube inlet (No. 1), and the other end is suspended.

(2) One end of the silicone tube is connected to the U-tube outlet (No. 2), and the other end is connected to the solenoid valve inlet 1 (No. 8).

(3) One end of the silicone tube is connected to the solenoid valve outlet (No. 9), and the other end is connected to the peristaltic pump inlet (No. 3).

(4) One end of the silicone tube is connected to the peristaltic pump outlet (No. 4), and the other end is connected to the solenoid valve inlet 2 (No. 11).

(5) One end of the silicone tube is connected to the outlet of the waste liquid (No. 13), and the other end is connected to the waste liquid bottle.

(6) Use a silicone tube to connect one end of the cleaning solution 1 inlet (No. 7), and the other end is connected to the cleaning solution bottle 1.

(7) Use a silicone tube to connect one end of the cleaning solution 2 inlet (No. 6), and the other end is connected to the cleaning solution bottle 2.

(8) Use one end of the silicone tube to connect the cleaning solution outlet 1 (No. 5), and the other end to connect the cleaning solution outlet 2 (No. 12).

(9) A silicone tube is used to connect the air pump outlet (No.4 in Fig. 3) with the solenoid valve inlet (No. 10).

4. **Filling**：

   Navigation: Menu > Measurement > SOP > Fill

(1) The suspended end of the silicone tube connected to the inlet of the U-tube is inserted into the sample liquid surface.

(2) Set the speed and duration of filling.

(3) Click the [**Start filling**] button to start the injection process, wait for the injection to be completed, and confirm that the sample in the U-tube has no bubbles.

5. **Measurement**：

   Navigation: Menu > Measurement > SOP > Measurement
   Execute the measurement procedure according to [5.9 Measurement].

6. **Recycling**：

   Navigation: Menu > Measurement > SOP > Recycle

(1) Set the recycling speed and duration.

(2) Click the [**Start recycling**] button to start the recycling process and wait for the recycling to be completed.

7. **Cleaning**：

   Navigation: Menu > Measurement > SOP > Clean

(1) **The cleaning solution is in reverse flow from the inlet of the U-tube, and if the sample is not recycling, it is directly flowed into the sample cup. If the sample needs to be recycled, the U-tube inlet silicone tube needs to be connected to the waste liquid bottle before cleaning.**

(2) Set the name of solvent 1, the speed and duration of operation.

(3) Click the [**Start cleaning 1**] button to start the cleaning process, waiting for the cleaning to be completed.

(4) Set the name of solvent 2, the speed and duration of operation.

(5) Click the [**Start cleaning 2**] button to start the cleaning process, waiting for the cleaning to be completed.

8.　Dry U-tube：

Navigation: Menu > Measurement > SOP > Dry

(1) Set the drying duration under the ' Dry U-tube ' tab.

(2) Click the [**Start drying**] button to start the drying process and wait for the drying to complete.

9.　Automatic cleaning & & drying：

Navigation: Menu > Measurement > SOP > Clean > Auto clean && dry

Compared with single-step cleaning and drying, peristaltic pump combined with solenoid valve group can realize one-button automatic cleaning and drying system. The operation process is as follows：

(1) Click the [**Auto clean && dry**] button to display the settings popup.

(2) Set the activation state, name, running speed and duration of solvent 1.

(3) Set the activation state, name, running speed and duration of solvent 2.

(4) Set the activation state and duration of the air pump.

(5) Click the [**Apply**] button to start the automatic cleaning & & drying process, waiting for the end.

5. User Permission List

The following user permission list is also the function configuration list of each model and version of the instrument.

SN	Permission name	DM-3005/3005A (FDA version)	DM-3005/3005A (Standard version)	DM-3004 (Standard version)
1	Measure sample	√	√	√
2	Calibrate instrument	√	√	√
3	Query measurement record	√	√	√
4	Export measurement record	√	√	√
5	Upload measurement record	√	√	√
6	Print measurement record	√	√	×
7	Delete measurement record	×	√	√
8	View measurement detail	√	√	√
9	View sample image	√	√	√
10	Electronic signature [Confirm]	√	√	×
11	Electronic signature [Review]	√	√	×
12	Electronic signature [Approve]	√	√	×
13	Export measurement detail	√	√	√
14	Upload measurement report	√	√	√
15	Print measurement report	√	√	√
16	Back up data to USB stick	√	√	√
17	Back up data to FTP	√	√	×
18	Set regular backup	√	√	√
19	Query user	√	√	×
20	New user	√	√	×
21	Edit user	√	√	×
22	Delete user	×	√	×
23	Query method	√	√	√
24	New method	√	√	√
25	Edit method	√	√	√
26	Delete method	×	√	√
27	language setting	√	√	√

28	Screen brightness setting	√	√	√
29	Network setting	√	√	×
30	Communication setting	√	√	√
31	Micro printer	√	√	√
32	Code scanning setting	√	√	√
33	Automatic setting	√	√	√
34	Time setting	√	√	√
35	Restore factory setting	√	√	√
36	Default setting	√	√	√
37	Password policy	√	√	×
38	Login policy	√	√	×
39	Lock screen policy	√	√	×
40	Query warning record	√	×	×
41	Export warning record	√	×	×
42	Print warning record	√	×	×
43	Query operation record	√	×	×
44	Export operation record	√	×	×
45	Print operation record	√	×	×
46	View operation detail	√	×	×
47	Export operation detail	√	×	×
48	Print operation detail	√	×	×

6. Built-in Measurement Units

Built-in measurement units are converted from density and are for reference only.

SN	Name	DM-3005	DM-3005A	DM-3004
1	Density g/cm^3	√	√	√
2	Density kg/m^3	√	√	√
3	Specific gravity (d4)	√	√	√
4	Specific gravity (d20)	√	√	√
5	Specific gravity (d25)	√	√	√
6	Specific gravity (dx)	√	√	√
7	Brix (20°C)	√	×	×
8	Ethanol (%v/v 20°C)	√	×	×
9	Ethanol (%w/w 20°C)	√	×	×
10	Maltose concentration (20°C)	√	×	×
11	Fructose concentration (20°C)	√	×	×
12	Sucrose concentration (20°C)	√	×	×
13	Citric acid concentration (20°C)	√	×	×
14	Ethylene glycol concentration (20°C)	√	×	×
15	Formic acid concentration (20°C)	√	×	×
16	Sulfuric acid concentration (20°C)	√	×	×
17	Nitric acid concentration (20°C)	√	×	×
18	Hydrochloric acid concentration (20°C)	√	×	×
19	Ammonia concentration (20°C)	√	×	×
20	Methanol concentration (20°C)	√	×	×
21	Chemical urea concentration (20°C)	√	×	×
22	Acetone concentration (20°C)	√	×	×
23	Hydrogen peroxide concentration (25°C)	√	×	×
24	Sodium sulfate concentration (20°C)	√	×	×
25	Glucose concentration (20°C)	√	×	×
26	Glycerol concentration (20°C)	√	×	×
27	Human urea concentration (20°C)	√	×	×

28	Sodium chloride concentration (20°C)	√	×	×
29	Mannitol concentration (20°C)	√	×	×
30	n-Propanol concentration (20°C)	√	×	×
31	Isopropyl alcohol concentration (20°C)	√	×	×
32	API degree (15.6°C)	√	×	×
33	Twaddle degree	√	×	×
34	Osler degree (15°C)	√	×	×
35	Baume (15°C)	√	×	×
36	Baume (15.6°C)	√	×	×
37	Platonic degrees (17.5°C)	√	×	×
38	Sake content (15°C)	√	×	×
39	Beer extract (20°C)	√	×	×
40	Milk consistency number	√	×	×
41	Custom formula	√	√	×

7. Ethernet Settings

It is recommended that the Ethernet settings be set by the network manager. Only DM-3005/DM-3005A settings are valid. Operation steps:

1. **Menu> Exit the application**. Only "Admin" users can exit and enter the system desktop.

2. Click **[bottom icon]** to enter all function pages (Figure 44).
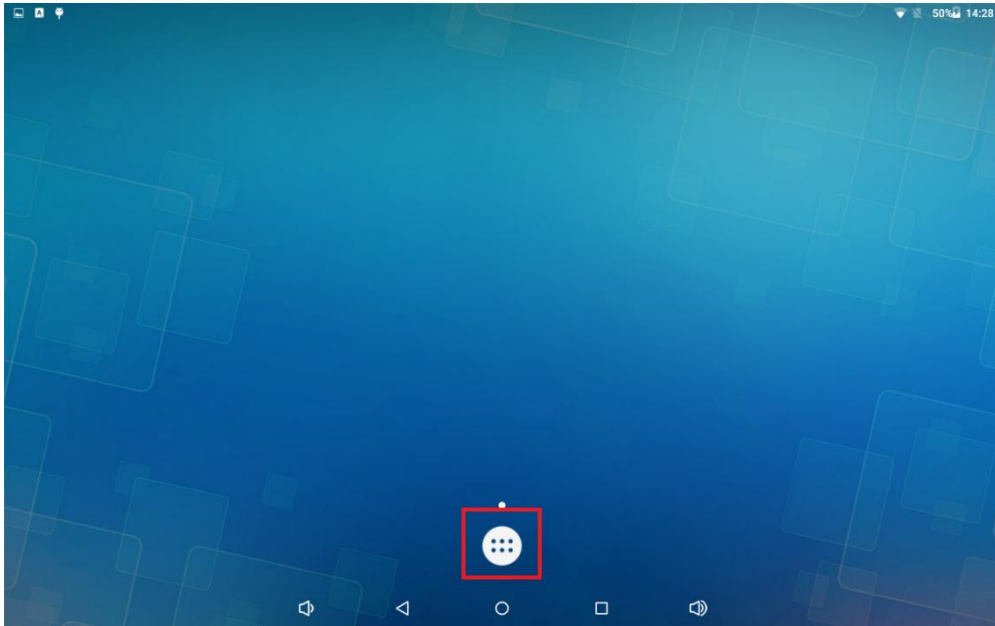

Figure 44

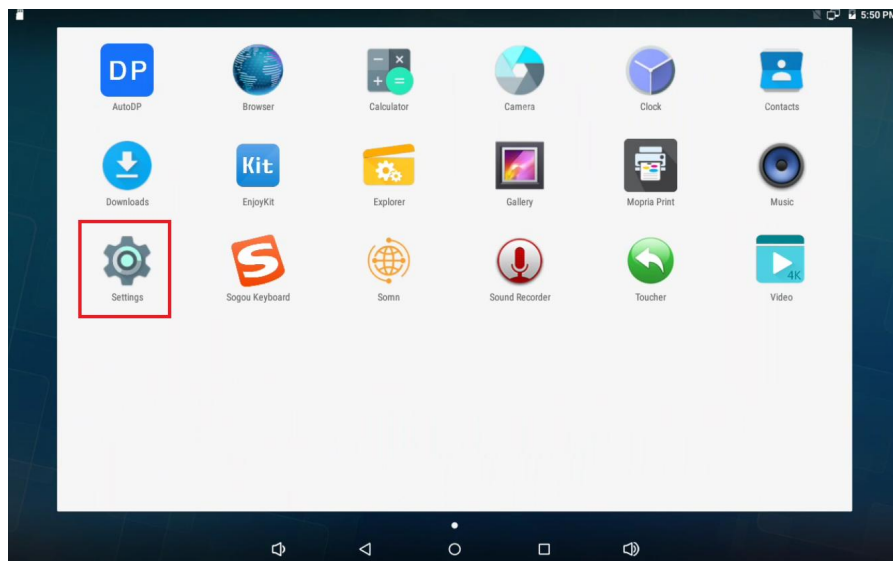3. Click the **[Settings]** button to enter the setting page (Figure 45).

Figure 45

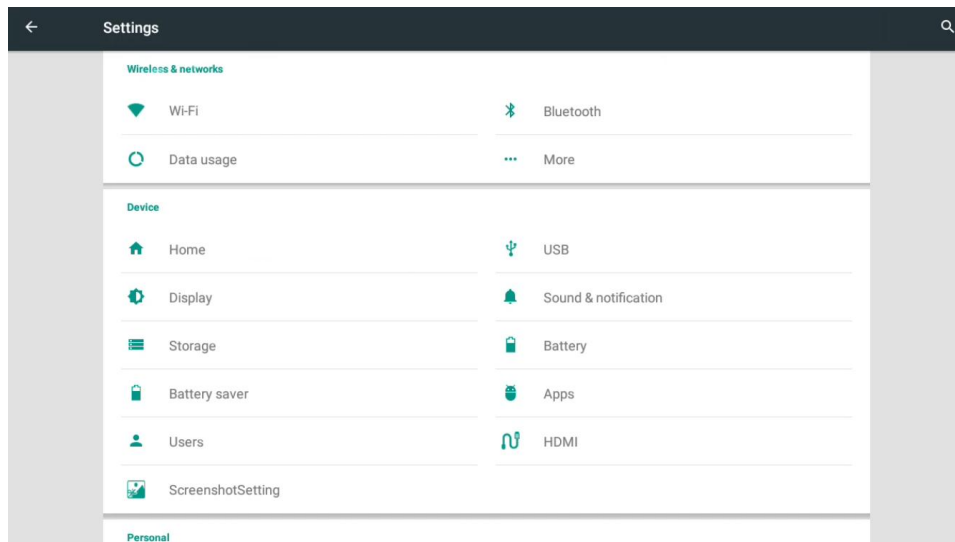4. Click the [**More**] button to enter more pages (Figure 46).

Figure 46

5. Click the [**Ethernet**] button to enter the Ethernet page (Figure 47).

Figure 47

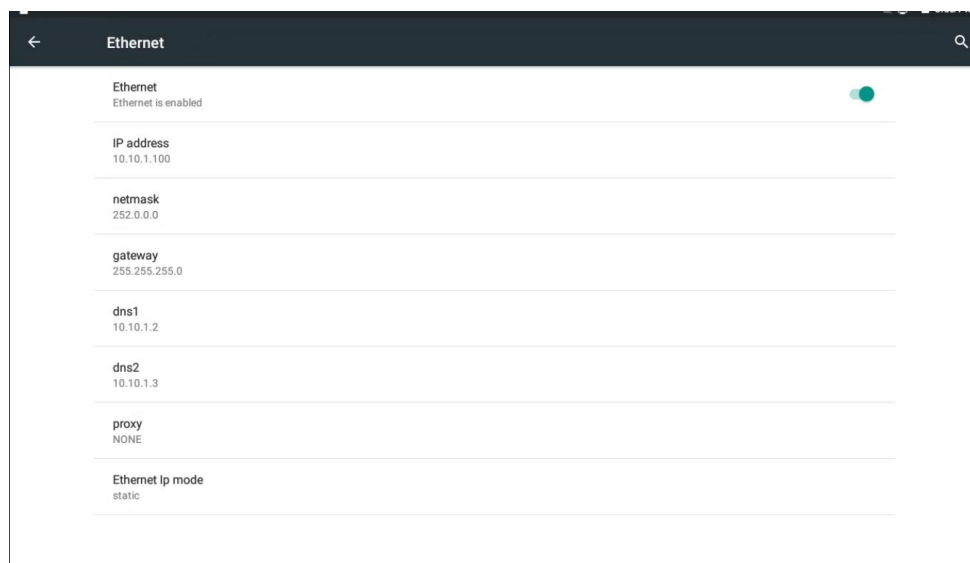6. Plug the network cable into the instrument's Ethernet interface. If it is the static address mode, you need to set the IP address, subnet mask, gateway, DNS, Ethernet mode and other parameters before enabling Ethernet; if it is the dynamic acquisition mode, enable Ethernet directly, and the system will automatically obtain the relevant parameters.

After the Ethernet settings are completed, restart the instrument.

8. Appendix

Ways to get more accurate measurement data

The density of liquids is closely related to temperature. Therefore, paying attention to the following aspects can help users obtain more accurate measurement data.

1.   Before measurement, the density meter should be placed horizontally in the same environment for more than 6 hours. Make the instrument and sample exactly the same as room temperature. In this way, when the sample is injected into the U-shaped tube, the measurement results will not change due to temperature changes.

2.   During the test, try to keep the room temperature constant.

3.   When the measurement temperature is lower than the ambient temperature and the air humidity is high, a drying barrel must be used to dry the measurement chamber.

4.   **To ensure measurement accuracy, please clean the U-shaped tube carefully before loading and measuring.**

5.   If measuring the sample will produce bubbles, you can remove the bubbles in the sample before measurement by: boiling the sample; stirring the sample; ultrasonic water bath, etc. (see Appendix 2). Ensure that there are no bubbles in the sample to be tested in the U-shaped tube.

6.   condensation may occur on the U-shaped tube and the measurement area. A drying cylinder can be used to provide dry air to eliminate condensation.

7.   If there is a large difference between the sample temperature and the instrument temperature, there must be a gradual temperature equilibrium process after the sample is injected into the U- shaped tube. And the greater the temperature difference, the longer the equilibrium time. At this time, if the user performs measurement operations, the results will continue to change with temperature changes. It is recommended that the user delays the measurement time as much as possible and waits for the temperature to stabilize before measuring again. The data will be more accurate at this time.

8.   When measuring under constant Control temperature conditions, the water vapor in the air condenses into the measurement sample and dilutes the sample when cooling down. When controlling temperature, the effect of water evaporation on the measurement sample needs to be considered. Therefore, after injecting the sample and waiting for temperature equilibrium, please measure in time and do not leave the sample in the instrument for a long time.

B.   Special sample handling

1.   foaming sample

Liquid samples can be degassed in different ways, and the best method will depend on the sample type and the amount of gas in the sample . Please note that in order to meet the repeatability of test data, the sample processing methods must be consistent ; if the volatile components in the sample evaporate during the pre-treatment process , the composition of the sample may change slightly.

(1)   Boil the sample : Boil the sample for a few minutes to remove any gases dissolved in it. Pour the sample into a clean glass flask and secure the lid. Wait for the sample to

cool down close to the measurement temperature.

NOTE: Do not boil any flammable liquids to avoid risk of fire. If the sample contains volatile toxic components, handling must be carried out in a suitable environment (such as a fume hood), especially when boiling.

(2) Stir the sample : Stir the sample vigorously for 5 to 10 minutes until no more bubbles are produced. You can also use filter paper to obtain a better degassing effect after stirring .

(3) Ultrasonic water bath : Place the sample in the ultrasonic water bath for about 5 to 10 minutes until bubbles no longer occur.

2. Suspensions and emulsions

may stratify in the U-shaped tube , resulting in increased measurement errors . The shorter the time such samples remain in the sample cell, the better. The temperature can be adjusted in advance before injecting the sample to reduce the measurement time.

3. High viscosity samples

Highly viscous samples require heating to reduce viscosity. The heating temperature is generally approximately 15 °C higher than the measurement temperature.

4. Paste sample

Paste samples such as ketchup or toothpaste can be injected with a syringe. When injecting, push the plunger very slowly and continuously. If the sample viscosity is very high, pull the plunger out, add sample from the back of the syringe with a spoon, and replace the plunger.

C.   Air and water standard density table

Dry air density table

Temp.℃	Density at different atmospheric pressures (KPa) g/cm3							
	90	92	94	96	98	100	**101.325**	105
0	0.001152	0.001177	0.001203	0.001228	0.001254	0.001279	**0.001296**	0.001343
5	0.001129	0.001154	0.001179	0.001204	0.001229	0.001254	**0.001271**	0.001317
10	0.001107	0.001131	0.001158	0.001181	0.001206	0.001230	**0.001246**	0.001291
15	0.001085	0.001110	0.001134	0.001158	0.001182	0.001206	**0.001222**	0.001267
20	0.001065	0.001088	0.001112	0.001136	0.001160	0.001184	**0.001199**	0.001243
25	0.001045	0.001068	0.001091	0.001115	0.001138	0.001162	**0.001177**	0.001220
30	0.001025	0.001048	0.001071	0.001094	0.001117	0.001140	**0.001158**	0.001198
35	0.001007	0.001029	0.001052	0.001075	0.001097	0.001120	**0.001135**	0.001176
40	0.000989	0.001011	0.001033	0.001056	0.001078	0.001100	**0.001115**	0.001156

45	0.000971	0.000993	0.001015	0.001037	0.001059	0.001081	**0.001095**	0.001135
50	0.000954	0.000976	0.000997	0.001019	0.001040	0.001062	**0.001076**	0.001116
55	0.000938	0.000959	0.000980	0.001001	0.001023	0.001044	**0.001058**	0.001097
60	0.000922	0.000943	0.000964	0.000984	0.001005	0.001026	**0.001040**	0.001079

Distilled water density table

Temperature °C	Density g/cm^3	Temperature °C	Density g/cm^3	Temperature °C	Density g/cm^3
10	0.999699	20.5	0.998099	31	0.995339
10.5	0.999654	21	0.997991	31.5	0.995182
11	0.999605	21.5	0.997882	32	0.995024
11.5	0.999553	22	0.997769	32.5	0.994863
12	0.999497	22.5	0.997654	33	0.994700
12.5	0.999438	23	0.997537	33.5	0.994535
13	0.999377	23.5	0.997417	34	0.994369
13.5	0.999312	24	0.997295	34.5	0.994200
14	0.999244	24.5	0.997170	35	0.994029
14.5	0.999173	25	**0.997043**	35.5	0.993856
15	0.999099	25.5	0.996914	36	0.993681
15.5	0.999022	26	0.996782	36.5	0.993504
16	0.998942	26.5	0.996648	37	0.993325
16.5	0.998860	27	0.996511	37.5	0.993144
17	0.998774	27.5	0.996373	38	0.992962
17.5	0.998686	28	0.996232	38.5	0.992777
18	0.998595	28.5	0.996088	39	0.992591
18.5	0.998501	29	0.995943	39.5	0.992402
19	0.998404	29.5	0.995795	40	0.992212
19.5	0.998305	30	0.995645	40.5	0.992020
20	**0.998203**	30.5	0.995493	41	0.991826

9. Instrument Care and Maintenance

In order to ensure the accuracy of the density meter and prevent damage, users are requested to pay attention to maintenance and the following points are put forward for reference:

1. The instrument should be placed in a dry, well-ventilated room to prevent the optical parts from becoming moldy due to moisture.

2. After using the instrument and when replacing samples, the U-shaped glass tube must be cleaned and dried first to ensure that no sample remains.

3. When measuring corrosive liquids, cleaning work should be done in time to prevent corrosion damage. It is strictly prohibited to measure highly corrosive samples, and the instrument must be cleaned after use.

4. There should be no bubbles or particulate impurities in the sample being tested. Otherwise it will affect the measurement accuracy.

5. Condensation may occur on the U-shaped tube and the measurement area, affecting measurement accuracy. The dry air from the drying cylinder can be used to provide complete drying of the instrument .

6. The plastic part of the instrument should be prevented from being damaged by corrosive samples.

7. When the instrument is not in use, cover it with a plastic cover or place the instrument in a box.

8. There are high-voltage components inside the instrument, and users are strictly prohibited from disassembling and assembling the instrument without permission. If the instrument fails, it should be sent for repair in time.