Operating Manual
for DV-H Series Digital Viscometer

Main Installing Chart
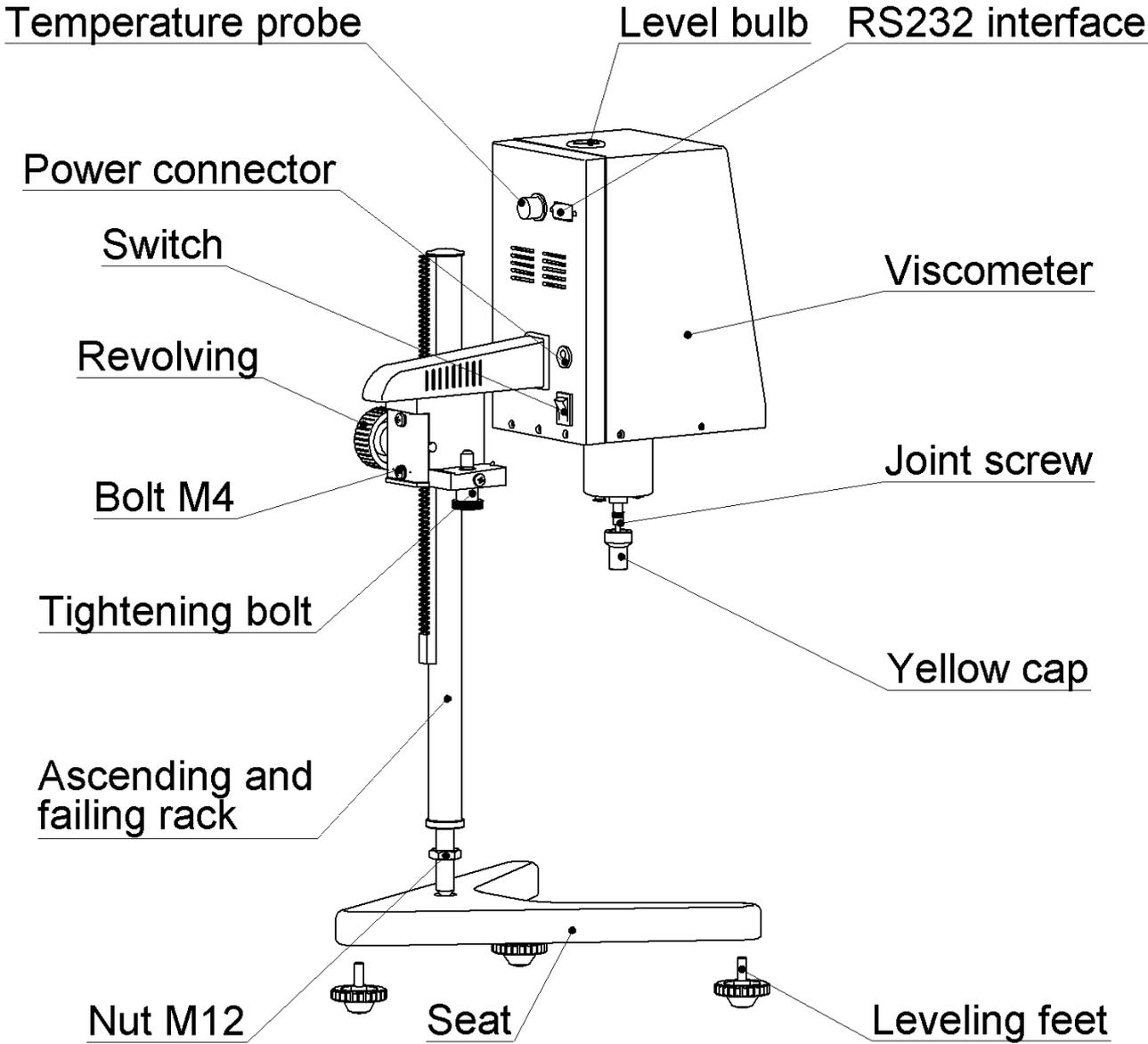
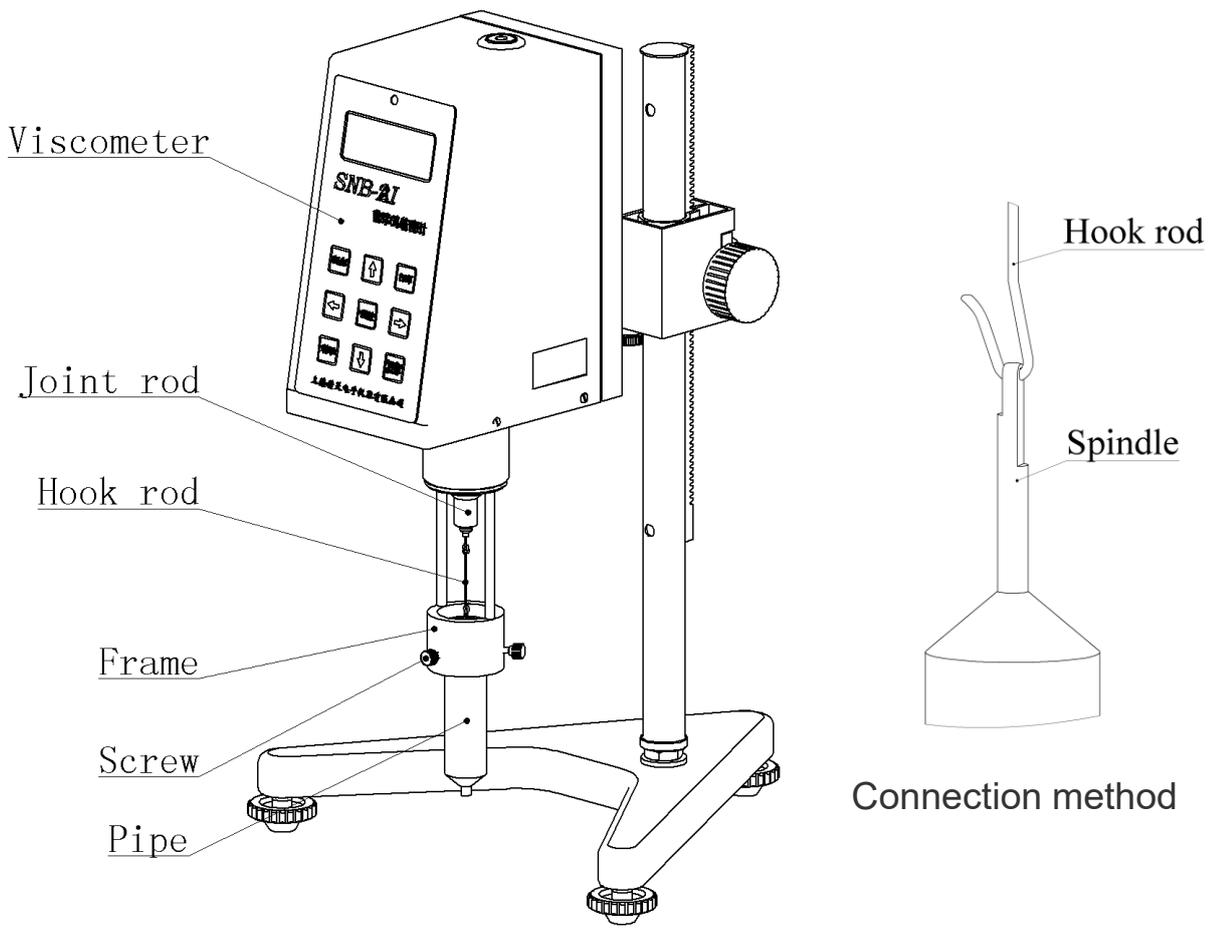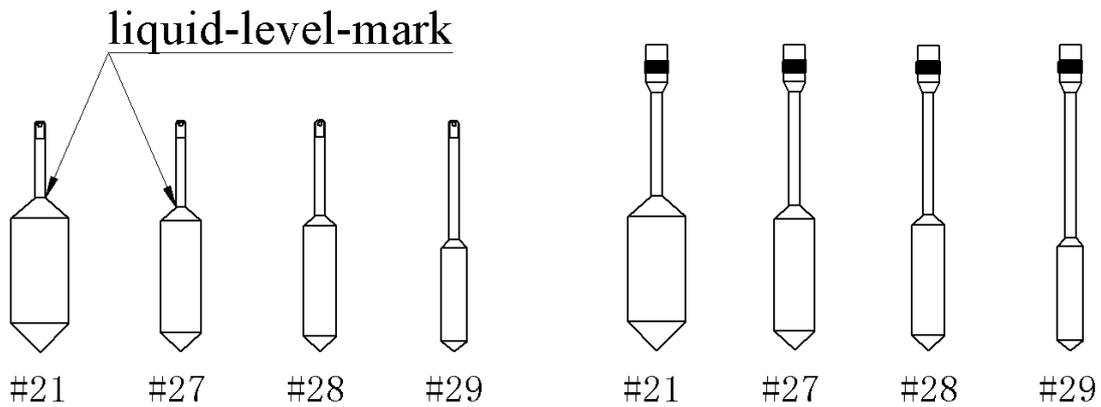Temperature probe

Level bulb   RS232 interface

Power connector

Switch

Viscometer

Revolving

Bolt M4

Joint screw

Tightening bolt

Yellow cap

Ascending and
failing rack

Nut M12   Seat   Leveling feet

Figure 1

Viscometer

Joint rod

Hook rod

Frame

Screw

Pipe

Hook rod

Spindle

Connection method

Figure 2

Spindle set

liquid-level-mark

#21   #27   #28   #29   #21   #27   #28   #29

Applies to LVDV-1H, RVDV-1H,   Applies to HBDV-1H, HBDV-2H
LVDV-2H, RVDV-2H
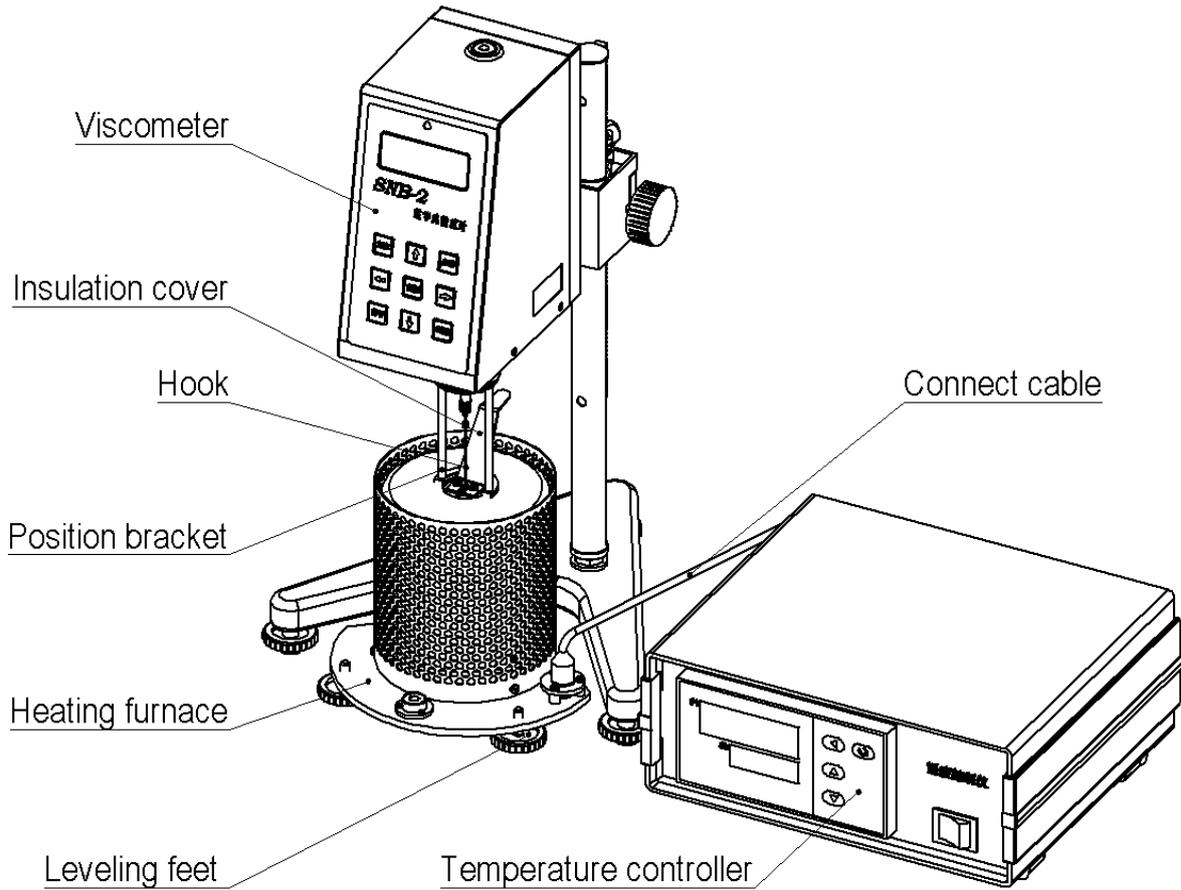
Figure 3

Figure 4

1. Main Technical Parameters

Model	LVDV-1H	RVDV-1H	HBDV-1H	LVDV-2H	RVDV-2H	HBDV-2H
Standard spindle	21、27、28、29					
Measuring Range（mPa・s）	10～1M	100～10M	800～80M	5～1M	50～10M	400～80M
Speed range（r.p.m.）	0.1～99.9 Stepless Gear			0.1～200 Stepless Gear		
Accuracy	±1%(FS) Newton liquid					
Repeatability	±0.5% (FS) Newton liquid					
Sample capacity（m L）	10～20					
Temperature control range(℃)	10℃ above ambient～300℃					
Power	Power adapter(input:220V　50Hz)					

K=1,000　　M=1,000,000

2. Basic Structure and Operation Principle

2.1 As shown in the following diagram, point A, spring, point B, axis and spindle rotate at a constant speed driven by the step motor. If the spindle is not resisted by liquid, Point A is in the same position with the pointer B. On the contrary, if the rotor is resisted by viscous liquid, the spring produces the torque and will repel or balance with the viscous resistance for reaching the balance at large. At this moment, by transmitting the angle difference between point A and Point B measured by the photoelectrical load cell to 16-bit microprocessor for data processing, the viscosity (mPa·s) will be displayed on LCD screen.
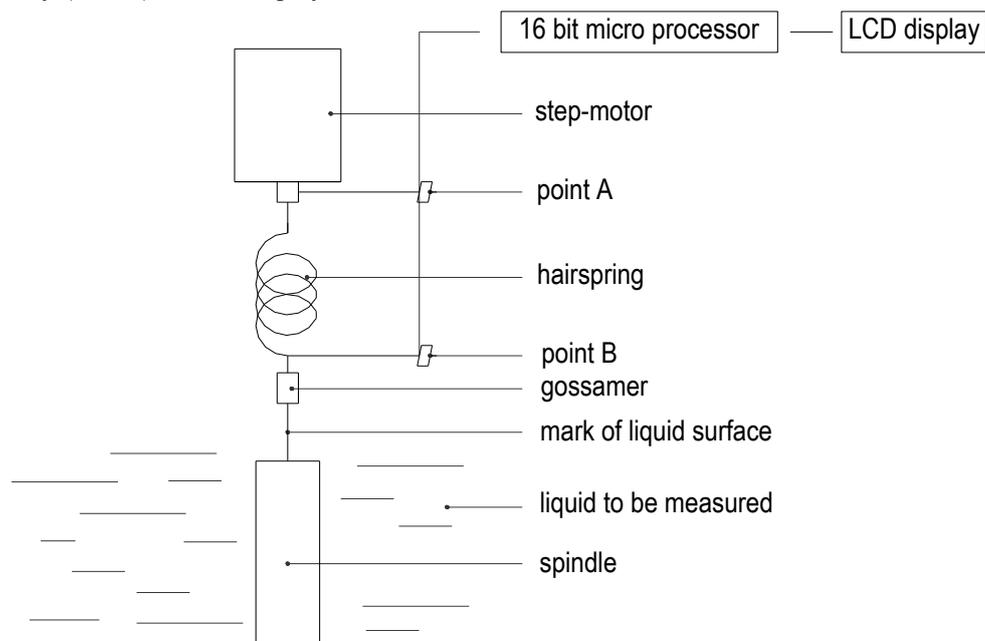
2.2 The test standard for spindle: select any of 21、27、28、29 or accept 29 if it is difficult to choose.

2.3 It is applied to detect the viscosity of wax, hot melts, asphalt and polymers when a special thermostatic heater is employed.

3. Components

3.1	Digital viscosity meter	1 pce	3.2	Ascending and falling	1 set
3.3	Frame and pipe	1 set	3.4	Power adapter	1 pce
3.5	Standard spindle	1 set	3.6	Spanner	1 pce
3.7	Seat and leveling feet	1 set	3.8	RTD temperature probe	1 pce
3.9	Temperature controller	1 pce	3.10	Heating furnace	1 pce
3.11	Insulation cover	1 pce	3.12	Special tweezers	1 pce
3.13	Position bracket	1 pce	3.14	Connect cable	1 pce
3.15	Power cord	1 pce	*3.16	Connection hook	2 set

*：There is no connection hook for HBDV-1H and HBDV-2H.

Optional equipment：

3.17   L0 spindle(ULA)

3.18   Spindle L1、L2、L3、L4、L5 (suitable for LVDV-1H, LVDV-2H models ONLY)

3.19   Spindle R1、R2、R3、R4、R5、R6、R7 (suitable for RVDV-1H, HBDV-1H,RVDV-2H and HBDV-2H models ONLY)

3.20   Viscometer Data Collection,Analysis and Graphing Software

3.21   DV download program control software

4. Installation (Please install as per the installing chart)

4.1 Take out the seat, ascending and failing rack, viscometer, spindle support and so on;

4.2 Screw down the ascending and failing rack into the hole of the socket and tighten the screw with spanner.

4.3 By running the knob of the ascending and failing rack, check the agility and self-locking capacity of the collet of the ascending and failing rack. If loosing and tightening are found, you can adjust the bolt M4 on the back of the ascending and failing rack with the screw driver to make sure that it can be ascended and fallen. It will be better if it is screwed down more less tightened so as to prevent the viscosity meter from its going down after installed.

4.4 Install the viscosity meter on the ascending and failing rack and make it tighten with the bolt. The bolt that is unscrewed under the apparatus and remove and place the cap in yellow properly for next use. The cap in yellow plays a role in preventing the joint screw. It should cover the cap in yellow if it is not used for a longer time or being transported.

4.5 This system has two kinds of sample measurement, a method of assembly as shown in Figure 2, mainly used for measuring the liquid material at room temperature(Convenient with the use of other low constant temperature equipment); Another method as shown in Figure 4, is mainly used for measuring be solid at room temperature, high temperature heated into liquid substances.

4.5.1 According to figure 2 assembly.

4.5.1.1 Take the spindle from the accessory box, hook (short), frame, pipe etc., then frame is arranged on the lower end of the viscometer.

4.5.1.2 The spindle is Installed in the hook (short), in order to minimize the measurement error, assembly hook and the spindle must be shown in Figure 2 (right).

4.5.1.3 The hook (short) connected with the viscometer.The first rotating shaft to lightly lift and squeeze with your left hand, then the right hand pinch the hook (short), (looking down) clockwise connect and lightly tighten.

4.5.1.4 Note, the spindle HBDV-1H, HBDV-2H type viscometer with can be directly installed on the main shaft, so there is no hook (short).

4.5.1.5 10 ~ 20 ml of the measured liquid is injected into the pipe, the pipe bottom loaded stent, when the liquid level to the spindle liquid-level-mark, tighten the three screws fixed to the pipe.

4.5.2 According to figure 4 assembly.

4.5.2.1 Remove the position bracket from the packing box and install in the viscometer (turn right into the mount, to the left than unloaded).

4.5.2.2 Take the spindle from the accessory box, hook (long), pipe etc.

4.5.2.3 The spindle is Installed in the hook (long), in order to minimize the measurement error, assembly hook and the spindle must be shown in Figure 2 (right).

4.5.2.4 The hook (long) connected with the viscometer.The first rotating shaft to lightly lift and squeeze with your left hand, then the right hand pinch the hook (long), (looking down) clockwise connect and lightly tighten.

4.5.2.5 Note, the spindle HBDV-1H, HBDV-2H type viscometer with can be directly installed on the main shaft, so there is no hook (long).

4.5.2.6 Remove the temperature control instrument, the heating furnace from the packing box in Figure 4 shows position.

4.5.2.7 Adjust the leveling feet make the level bulb is located in the center of.

4.5.2.8 Connect cable temperature control instrument (input signal) and heating furnace.

4.5.2.9 Use special forceps will pipe from heating furnace to remove and wash, pour 10 ~ 20mL after the sample, by turning the revolving, the spindle immersed in liquid samples and to the spindle liquid-level-mark, as shown in Figure 3, and then covered with insulation cover.

4.5.2.10 If you want to use the < Data acquisition and drawing software >, using the USB to RS232 cable is connected with the temperature control instrument signal output interface and computer interface.

4.6 Adjust the seat leveling feet, so that the viscometer at the top of the level bulb in the center.

4.7 Connect the RTD temperature probe with the interface.

4.8 Connect the viscometer and the AC power socket with the power adapter(Input:100～240V 50～60Hz) provided. And the temperature control instrument access 220V, 50Hz power supply , the connection is correct to be put through the power switch.

5. Function of keys

5.1 The viscometer

| Reset | Reset the applied program |

| Print / Timing | Printing/Timing function |

| Speed | Selection of the motor rotating speed |

| Spindle | Spindle Selection. The viscous value maximum measured under the current rotating |

| Run | Start to measure t |

| → | Shift rightwards | | ← | Shift leftwards（DV-2H，shear rate、shear force、viscosity number select Display） |

| ↑ | The number goes up | | ↓ | The number goes down |

5. 2 The temperature controller

| < | Shift key | | ∧ | Increase key |

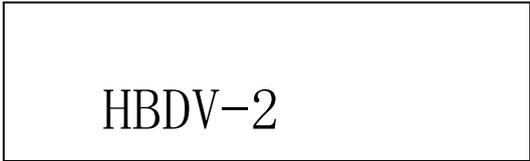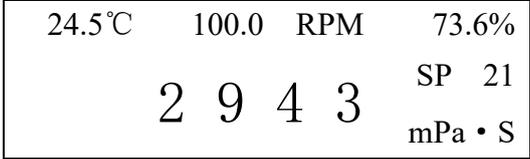| ↻ | Set key | | ∨ | Decrease key |

6. Content Description on screen (Take HBDV-2H viscometer under certain condition as an example)

6.1 The viscometer
     It is displayed when switching on and resetting the apparatus

```
┌─────────────────────────────┐
│                             │
│         HBDV-2              │
│                             │
└─────────────────────────────┘
```

Selection of spindle and speed, input and set by the 'Run' key, LCD screen display as follows

```
┌─────────────────────────────────────┐
│  24.5℃     100.0  RPM      73.6%     │
│                         SP   21      │
│       2  9  4  3                     │
│                         mPa • S      │
└─────────────────────────────────────┘
```
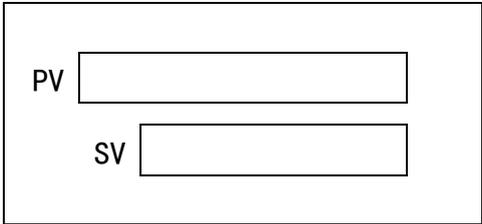
24.5℃	The current room temperature detected by RTD (Only with RTD)
SP 21	Spindle with code 21
100.0RPM	The current rotating speed.
mPa • s	Unit of dynamic viscosity
2943	The actual measurement of viscosity
73.6%	The % torque

By pressing the <Run> key, the screen display 21 spindle at the speed of 100 RPM maximum range is 4000, the unit is mPa • s.

Press the <Run> key, the motor drives the spindle to rotate, then the measured viscosity values of 2943 mPa • s and torque of 73.6% displayed on the LCD screen. The results of torque at 20% ~ 90% between the effective range, otherwise, the buzzer will alarm, suggest that should change the speed or replace the spindle.

6. 2 The temperature controller

```
┌─────────────────────────────────────┐
│                                     │
│   PV ┌───────────────────────┐      │
│      └───────────────────────┘      │
│      ┌───────────────────────┐      │
│   SV └───────────────────────┘      │
│                                     │
└─────────────────────────────────────┘
```

PV: The actual measured value
SV: The set temperature value

7. Operating Procedures

7.1 Make sure that the set-up steps have been finished.

7.2 Open the temperature controller switch, display window in SV data set temperature value is the last operation, display window data in the PV rapid rise and reach the display window SV within the set temperature value.

7.3 If you need to set temperature, press < ∧ > or < ∨> keys can increase or decrease the data, thereby setting required working temperature, then the display window in PV data will quickly reach the display window SV within the set temperature value, if the set temperature than low temperature showed slower window data change export in PV.

7.4 Note: instrument open longer time after the power switch, if the window PV the measured temperature value is still under the changes frequently and vary greatly, can according to the following steps:

7.4.1 Long press< ↻ > Press and hold for 2 seconds, release when window PV shows "At" and window SV shows "OFF";.

7.4.2 Press the< ▲ >key to change the "OFF" appearing in window SV to "on";

7.4.3 Press the< ↻ >key to confirm, and the window SV will start to display a flashing "At". Wait for several tens of seconds before "At" disappears. At this time, the data displayed on the window PV may still fluctuate up and down. Wait for it to stabilize before it can work normally.

7.5 When the work is finished, close the switch, temperature controller automatically save the last set temperature.

7.6 When the sample is heated to dissolve enough long time, turn on the power switch viscometer, the screen bright, viscometer in a wait state, the motor does not work.

7.7 Input the spindle code, the displayed spindle code will be changed once the <spindle> key is pressed and the code is circulated among 21→27→28→29→0→R1→R2→R3→R4→R5→R6→R7(LVDV-1H, LVDV-2H is a cycle between 21→27→28→29→0→L1→L2→L3→L4).The input is over when the selected spindle code is displayed.

7.8 Selecting the rotating speed: Once pressing the key for the speed, 60 or 60.0 will be displayed and"6"flickers if the speed is set at 60 in the previous operation. At this time, you can press the key for number going up or going down to set the tens digit of the rotating speed. And then press the key shifting rightwards to set the single digit and the tenth digit. If the shift is needed in reverse direction, press the key shifting leftwards. In this way, you can set the value of other digit. Press the key for confirmation when the setting is over.

7.9 Adjust the leveling feet make the level bulb is located in the center of, the viscometer to maintain the level of state.

7.10 Press the <Run> key after the motor starts to work, the screen display viscosity.

7.11 In the course of measurement, if you need to change the spindle, you can press the <Reset>key. At this moment, the motor stops and the viscometer is on standby. After the spindle is changed, you can continue to measure with the procedures from 7.7 to 7.10 mentioned above.

7.12 Pressing <Print/Timing> key to perform printing or timing measurement function.

Select the printing and timing measurement function: Switch on the power of the viscometer, and then press <Print/Timing> key when the viscometer is not in measuring state. Once "P:XX:XX" is displayed on the screen, the printing setting is selected. Press <Print/Timing> key again, once "T:XX:XX" is displayed on the screen, the timing setting is selected.

7.12.1 Setting the time interval for printing

Press the <Print /Timing> key until "P:00:05" displayed on the screen. And then press one of the four direction keys to set the time interval according to your need. Using the direction keys < →> and <←> to move the cursor and the numerical increasing key < ↑ > and decreasing key < ↓ > to set the time interval. And press the <Print /Timing> key for final confirmation.

After the printer is connected, press the <Print /Timing> key to start the printing. "on" will be printed out and the printing will be performed at the interval time set. To stop printing, press the <Print /Timing> key again, "off" will printed out and the printing stops.

7.12.2 Setting timing measurement

Since the spindle, rotating speed and measurement time should be selected in measuring the "non Newton liquid". The operator can set different measurement time according to the properties of the samples. The detailed procedure is given as follows:

Press the <Print /Timing> key before it comes into the measurement state. Do not release the "Print /Timing" key until the LCD display has changed from "P:00:00" to "T:00:00", and then a cursor will be found flickering on the screen. Using the direction keys <→> and <←> and the numerical increasing key < ↑ > and decreasing key < ↓ > to select the measurement time. It should be noted that "T:00:00" stands for no timing; "T:00:10" stands for ten-second measurement; "T:05:00" stands for five-minute measurement and so on. When the measurement time is displayed on the screen, press the <Print /Timing> key once to exit the state of "edit". Thus, the setting of timing measurement function has been completed.

Since the timing measurement has been selected and set, when the measurement time reaches a certain value for each measurement, the viscometer meter will stop measuring. And the LCD screen will display the current viscosity and be locked as well. This function provides the operators the convenience to record, compare and analyze the progress and result of the "non

Newton liquid" measurement.

In case that this function has to be cancelled, set the measurement time to "T:00:00" in the same procedures above.

7.13 Selection the display of shear rate and shear stress

This function is only provided in DV-2H series. At the standby state, press <→> key, display is circulated among viscosity measurement range (unit: mPa • s), shear rate (unit: 1/s) and shear stress (mPa). Note that the display of shear rate and shear stress are only applicable to cylindrical spindles.

7.14 Attention should be paid to sample should make constant temperature at the test temperature measurement process, in order to keep showing the value of stable and accurate. The sample should have enough time to reach the equilibrium temperature, sample test required.

7.15 The measurement work is completed, first close the viscometer power, slowly will viscometer rise, moved to the spindle from the heating furnace, remove the spindle wash.

7.16 Close the temperature controller switch.

7.17 Use special forceps will pipe from heating furnace to remove and clean, cleaning spindle, pipe in the process of preventing scald.

7.18 The cleaned pipe back into the heating furnace, clean the spindle if not temporary, into the accessory box standby.

8. Cautions

8.1 Keep the connecting side of the joint bolt with the spindle and the screw thread itself clean. Otherwise, it will effect the shacking degree of the spindle.

8.2 You should hold the ascending and failing rack in your hand when it is on raise and down to prevent it from dropping due to its deadweight.

8.3 After changing the spindle, you should input the new number of the spindle. The spindle that is used and changed should be cleaned first and then put on the rack of the spindle. Do not leave the spindle on the meter and clean it.

8.4 When the liquid is changed, you should clean the spindle and the pipe to avoid the error caused by the interblended liquid for measurement.

8.5 The viscosity meter is matched with the spindle. Do not interblend several viscosity meters with the spindles

8.6 Do not dismantle and adjust the spare parts in the viscosity meter with liberty.

8.7 When the viscosity meter is moved and transported, the yellow cap should be on the joint screw and the bolt should be screwed down and packed in the box.

8.8 After the spindle is installed, you do not circumrotate it for a longer in case of no liquid to prevent it from being damaged.

8.9 The suspended and confused liquid, high polymer and the other more condensed liquid have a lot of " non Newton liquid". Their viscous values are varied with the shear speed and the time. Therefore, their checking results under the different spindles and rotating speed are different. This is the normal case. It is not the error caused by the meter. Normally, you should regulate the spindle ,rotating speed and time to measure the non Newton liquid.

9. The following points you should pay more attention for more accurate data

9.1 Clean the spindles and the pipe before measurement.

9.2 Measurement of the spindle position is adjusted to the center of pipe, and the surface dip to the spindle liquid-level-mark. In order to ensure the flat surface markers by sample surface and the spindle, the first water quantitative estimation experiment sample amount needed:

9.2.1 Use special forceps to pipe is removed from the furnace, into the water after the pipe back into the heating furnace.

9.2.2 The position bracket is mounted on the viscometer (turn right into the mount, to the left than unloaded). The selection of spindle and hook screw joint screw.

9.2.3 Regulation of viscometer slowly decreased gradually, the spindle gradually immersed in the measured liquid, when the liquid level reaches the liquid-level-mark of the spindle, record the location of position bracket position.

9.2.4 Pour water into the graduated beaker, record amount of sample in the experiment.

9.3 Putting the spindle into the liquid to be measured for an enough longer time and keep the same temperature for both.

9.4 When measured, the spindle is placed in the center of the screw. Make the mark on the spindle and liquid surface at the same level. Adjust the viscometer to be horizontal.

9.5 You should turn off the apparatus at time when the measurement at high speed is changed into the measurement at low speed at one or keep a less longer time at the low speed to overcome the error that may be caused by the circumvolved inertia of the liquid.

9.6 When measuring the low viscosity, 21 of the spindle is chosen, and 29 of the spindle for the high viscosity.

9.7 The measure time for the viscosity measured at low speed is relatively longer.

9.8 The viscosity meter can be replaced by revolving the ascending and failing rack when you need to change the spindle and liquid to be measure in process of the measurement. Make sure to adjust the viscometer to be horizontal.

9.9 Test the viscometer frequently with standard viscosity liquid to check the performance.

10. Sampling measurement for unknown viscosity

10.1 The General Principle for Measurement: For the sample with high viscosity, you should choose the little dimensioned spindle 28、29 and slow rotating speed. For the sample with low viscosity, you should choose the large dimensioned spindle 21、27 and fast rotating speed. When measured ,the mark measured by the percentage meter between 20% and 90% is the normal value. The viscous value measured within this range is the correct value.

10.2 Under normal circumstances, can select 29 spindle and low speed 10 RPM, measurement according to the screen display torque values to determine the speed of the spindle and the choice is whether reasonable, torque at20%~90% (with L0 spindle 10%~90%) between the measured effective value, if not in this range, the buzzer will alarm, suggesting that changes in speed and change the spindle, replace the spindle must be selected according to the spindle immediately enter the number of the new spindle, otherwise it will affect the measurement.

10.3 Estimation of the measured liquid (sample) viscosity range, according to the principle of operation, first select the spindle, then select the speed, the same selection of 21 spindle, rotating speed 100RPM, display the maximum range is 4000 mPa•s, when the speed is 10RPM, the maximum range is 40000 mPa•s, range expand ten times.