NDJ-1C

# Rotational Viscometer

## Operation Manual

# Content

## I. Purpose and Scope

The instrument is designed and made as per T0625 “Asphalt Brookfield Rotational Viscosity Test (Brookfield Viscometer Method)” in the Industry Standard of People’s Republic of China JTJ052 *Specifications and Test Methods of Bitumen and Bituminous Mixtures for Highway Engineering*. It is the upgrade one of NDJ-1B and NDJ-1C Rotational Viscometers. It is suitable to determine the absolute viscosity of Newton liquids and the apparent viscosity of Non-Newton liquids.

It adopts advanced mechanical design and manufacturing techniques, and uses a microprocessor for temperature control, data collection and data process. The LCD is a white backlight, ultra-bright LCD. It is also equipped with a micro-printer. Test dada can be shown on the LCD and/or printed out from a printer. The instrument has a RS232 communication port to connect with a computer.

It is sensitive, reliable, generous and easy to be operated. It is widely used for determining viscosities of asphalt, hot melt adhesive, paraffin, high polymer, and other liquids.

## II. Main technical specification and parameters

1. Power supply: AC（220V±10%）V, 50Hz；

2. Total power consumption: 200W;

3. Measurement range: 100 mPa·s～$2\times10^5$mPa·s (the measurement range can be expanded to 4 × 105mPa·s if use No.30 spindles);

4. Spindle: No.21. 27. 28 and 29 spindles (The No.30 spindle is optional);

5. Speed: (5,10,20,50) r/min, stepless speed regulation can be implemented after startup to meet various measurement requirements;

6. Measurement error: ±1% (F·S), for No. 30 spindle, error is ±3% (F·S).

7 Temperature controlling range:20℃～200℃;

8 Temperature controlling accuracy: ±0.1℃;

9 Cubage of sample cylinder: 20 ml;

10. Working environment: Ambient temperature: 15℃～35℃, ≤ 85%.

## III. Main structure and functions

(I) Work principle

The instrument is a rotational viscometer. Driven by a motor, the spindle rotates at a constant speed. When the spindle rotates in a liquid, the liquid will exert a viscosity force moment on the spindle. The greater of the viscosity of liquid is, the greater of the force moment is. Otherwise, the less of the viscosity of liquid is, the less of the force moment is. The viscosity force moment can be measured by a sensor. You can get the viscosity of measured liquids after data process.

Adopts the microprocessor technique, the instrument can preset parameters (spindle No. and speed) conveniently, process test dada measured by the sensor, and show spindle No., speed, viscosity of measured liquid, and percentage of full scale, etc on the LCD clearly.

The instrument has four types of spindles (N0.21, 27, 28, and 29) and 4 grades of speed (5~ 50 ) r/min, See the Fig.1. So it can determine various types of liquids in the measurement range.

No.21 No.27 No.28 No.29

Spindle number

Fig.1

(II) Main structure

The structure of the instrument is shown ad Fig.2.

(1) (2) (3) (4) (5) (6) (7) (8)


Fig.2

(1) Pedestal of main unit (2) Heater (3) Head of the viscometer (4) LCD

(5) Buttons (6) Protective sleeve (7) Auxiliary controlling case (8) Micro-printer

(9) Level adjustment bolt (10) Pedestal of heater

(11) Water level bubble on the pedestal of heater (12) Toothed rod

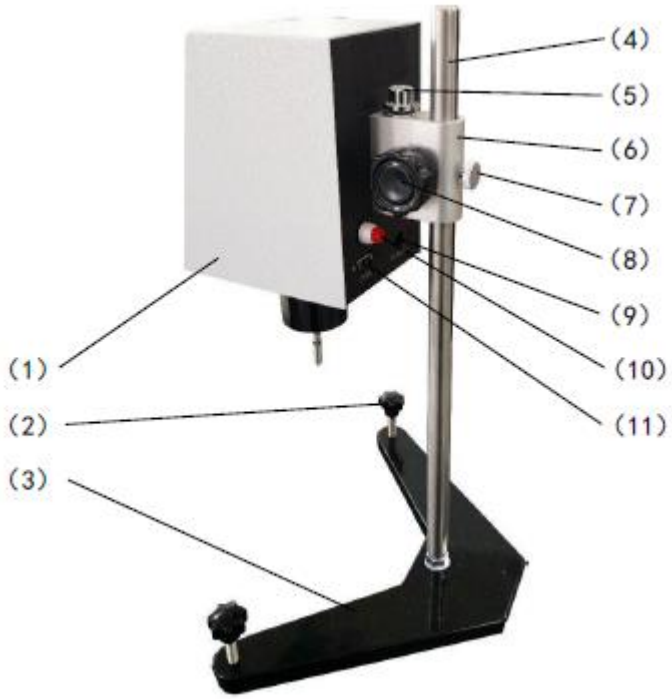
(13) Temperature controller (14) Power switch (15) Heater switch

(III) Installation

1. Check the power supply to make sure it meets test requirements of the instrument. The instrument should have fine grounding end.

2. The instrument should be installed on a stable workbench and there is neither corrosive gas nor electromagnetic device near the instrument.

3. Screw the toothed rod on the pedestal of the main unit. The toothed surface should face to the front of the pedestal. Fasten the nut on the standing rod to avoid rotation of the toothed rod (See Fig.3).




(1) Head of viscometer (2) Level adjustment bolt (3) Pedestal

(4) Toothed rod (5) Water level device (6) Clamp (7) Locknut

(8) Up and down knob (9) Power interface (10) Power switch (11) COM interface

Fig.3

4. Mount the up and down clamp of the head of viscometer on the toothed rod (See Fig.3). Rotate the up and down knob to move the head of viscometer. If you feel it is too tight or too loose when you rotate the knob, you can adjust the adjusting bolt at the lower section of the up and down clamp. Rotate the locknut at the back of the up and down clamp to fix the head of the viscometer when the head of viscometer is at a proper position.

5. Pull down the Yellow protective cover under the viscometer head.

6. Place the heater under the viscometer head and adjust the horizontal adjusting screw of the heater pedestal so that the bubble in the horizontal bubble of the heater pedestal is in the center.

7. Adjust the two horizontal adjusting bolts on the pedestal of the main machine to make the horizontal bubble on the viscometer head in the middle position.

8. Connect the heater to the heating socket on the auxiliary temperature controlling case (three cores), the temperature sensor to the auxiliary controlling case (Four cores), the communication

wire of printer between the head of viscometer and the auxiliary temperature controlling case. Then connect the instrument to the power supply (the sockets at the back of the head of viscometer is shown as Fig.3).If you would like to connect it to a computer, please connect the communication wire between the head of viscometer and serial port of the computer.

## IV. Operation method and procedures

(I) Preparation before test

1. Before measurement, pls estimate the viscosity range of the measured liquid, and then select the appropriate rotor number and speed according to the range table shown in Table 1.

Table 1

| Spindle / Full scale / Speed | 21 | 27 | 28 | 29 | 30 (optional) |
|---|---|---|---|---|---|
| 50 | 1 000 | 5 000 | 10 000 | 20 000 | 40 000 |
| 20 | 2 500 | 12 500 | 25 000 | 50 000 | 100 000 |
| 10 | 5 000 | 25 000 | 50 000 | 100 000 | 200 000 |
| 5 | 10 000 | 50 000 | 100 000 | 200 000 | 400 000 |

2. When the approximate viscosity of the measured liquid cannot be estimated, it shall be regarded as higher viscosity. Select the spindle from small to large (spindle number from high to low) and the speed from slow 5 to fast 50. In principle, the liquid with high viscosity adopts small spindle (spindle No. 29) with slow speed; The liquid with low viscosity adopts large spindle (spindle No. 21) with fast speed.

3. Prepare asphalt sample as per the stipulation in the T0625 “Asphalt Brookfield Rotational Viscosity Test (Brookfield Viscometer Methods)” and put it into a sample container. Heat the sample in an oven to about 100 ℃ over its softening point. Keep the sample at that temperature for about 30 to 60 minutes. Please to eliminate the air bubbles in the modified asphalt.

(II) Operation method

1 Please level the instrument when you install the instrument. Please check the water level bubble to make sure it is in the center. **Note**: The No.30 spindle is optional.

2. There are two switches on the auxiliary temperature controlling case. The upper one is the main power switch and the lower one is the Heat switch. Turn on the two switches and set the controlling temperature as per the test temperature.

3. Select a proper spindle and speed as per the expected viscosity of asphalt (See Table2).

4. Take out of the asphalt container from the oven and properly stir the sample. Fill suitable volume of asphalt (See Table2) into the sample cylinder as per the type of spindle to avoid insufficient or overflow of asphalt.

Table 2

| Spindle No. | Sample quantity (For reference) |
|---|---|
| 21 | 11ml (depending on the density of the sample) |
| 27 | 15.5 ml (depending on the density of the sample) |
| 28 | 17 ml (depending on the density of the sample) |
| 29 | 18 ml (depending on the density of the sample) |

5. Adjust the control temperature of the cylinder to the temperature required by the sample test for 1.5 hours.If the test temperature is too low, please cool the sample cylinder to a temperature lower than the test temperature at first, and then keep its temperature constant in an oven.

6. Take out of the spindle and sample cylinder and install them on the viscometer: Please place the sample cylinder into the hole in the heater using a special forceps. Then connect the spindle, connection hook, and transition bolt in series. Place the spindle into the sample cylinder and screw the upper section of the transition bolt on the connection bolt under the protection sleeve (See Fig.5).

**Note**: (1) Please hold up the connection bolt when you assemble or disassemble the spindle. Rotate the connection bolt anticlockwise to assemble it and rotate it clockwise to disassemble it.

(2) Please take out of the sample container from the hole in the heater using a special forceps.

7. Rotate the up and down knob to lower down the instrument until the surface sign on the spindle is level with the cover of sample cylinder. Move the heater to let the spindle in the center of the sample container, so that to ensure it does not contact the wall of sample container.

8. Carefully level the instrument again.

9. Make determination only when the temperature keeps stable at the preset value.

10. Keyboard operation and introduction for display interface.

(1) The keyboard is shown as Fig.4.

(2) Turn on the Power switch at the back of the instrument and enter into the parameter selection state. The display is shown as Fig.4. The cursor is at the 21#. Press the ◀ to select a suitable spindle No.

(3) Press ▼ to switch to the speed position, and the cursor stops at the 50 rpm position in Figure 5. Press ◀ to select the desired speed.


Fig.4

(4) After selecting the spindle and speed gear, press the OK, the spindle starts to rotate, and the instrument starts to measure the sample. The display is shown in Figure 5.

In Fig.5, the unit of speed is RPM; The unit of viscosity is mPa • s; The rightmost vertical bar shows the sampling process; Percentage refers to the measured viscosity as a percentage of the full scale of the gear.


Fig.5

(5) In Fig.5, in the measurement state, press ◄ to switch between communication on and off. When the communication is on, the real-time test data is transmitted to the external computer through RS232 port.

(6) In Figure 4, in the measurement state, press ◄ can switch the display of percentage, shear rate and shear stress.

(7) In the measurement process, after the data is stable, if you press OK, the current measurement data can be printed through the micro printer. Press RESET and the instrument will stop measuring.

11. Operation procedures

(1) In order to ensure the measurement accuracy, the reading of range percentage during measurement shall be between 10% ~ 100%. If the measurement display value flashes, it indicates overflow or insufficient, and the measuring range shall be changed.

(2) In any state, press RESET, the program will run from the initial state, and the operation interface will return to the working state selected by the user.

(3) After the data is stable during the measurement, press OK to print the test results.

(4) During the measurement, after the data is stable, press ◄ to output the measurement results to the computer or printer for real-time measurement.

(III) Operation methods for software

If equipped with the software for our Rotational Viscometer, it can communicate with a computer, plot viscosity-temperature curve. This highly improves the working efficiency and it is convenient for the customer.

1. Summary

The software is used for data collection and data management for NDJ Series Rotational Viscometer. It includes the function of data collection, curve plotting, and test data printing.

2. Installation

Open **setup.exe** program under the **debug** folder, install the software step by step according to the installation wizard, remember the location of your software, and complete the installation.

Note: the upper computer software needs to be installed outside the C disk.

3. Operation procedures

**A. Run the program**

Double click the icon of the rotational viscometer on the desktop to enter the main interface, as shown in Fig. 6. (Connect the serial port cable to the computer and instrument, and then open the software).

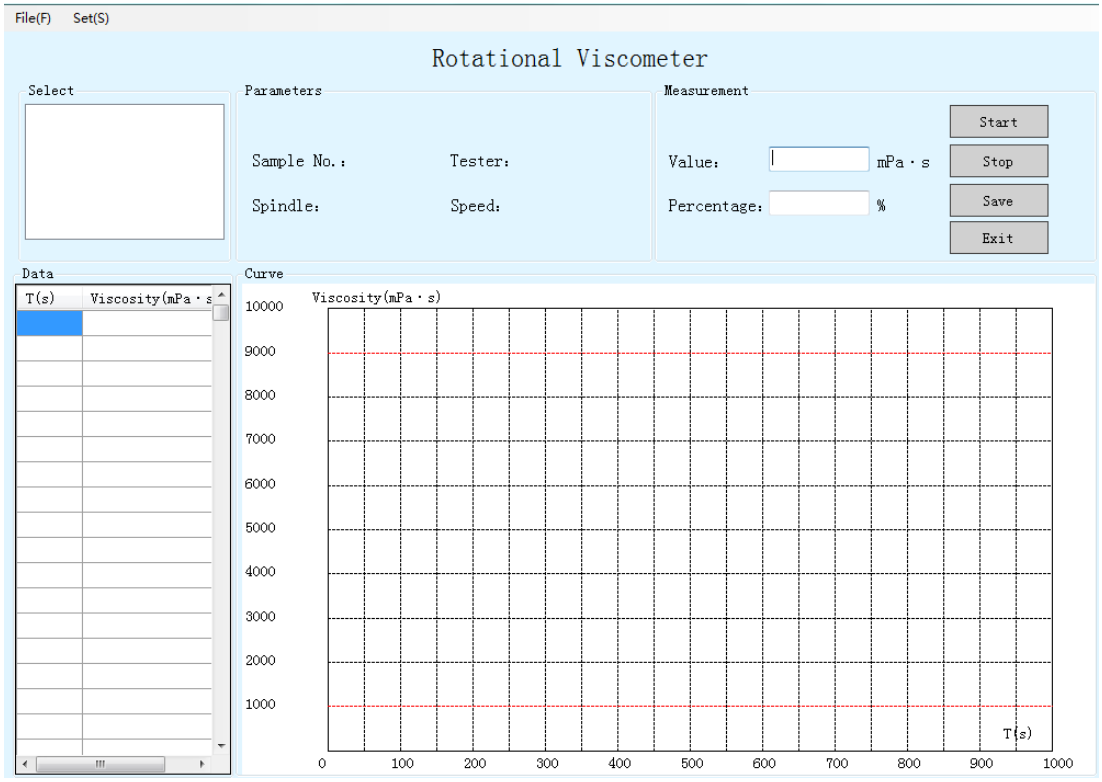



Fig.6

**B. Set parameter**

(1) Communication set

Click "Set" pull-down menu at the upper left of the interface, and then click the

"Communication Set" button to enter the "Communication Set" interface, as shown in Fig. 7. Select the Communication Port number connected to the computer, click “Enter” , change the computer communication port to the selected port, and return to the main interface (do not modify the communication rate, otherwise the test data will not be accepted). Click "Cancel" to keep the original set value unchanged and return to the main interface. Click the "Default" to restore the factory settings.

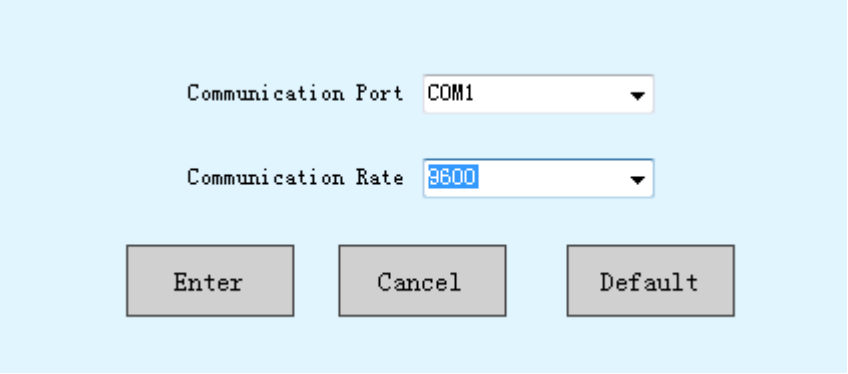



Fig.7

**(2) Test information**

Click "Set" pull-down menu at the upper left of the interface, and then click the "Test Information" to enter the "Test parameters" interface, as shown in Fig. 8. Click the "Company" button to enter the "Company" interface, as shown in Fig.9. After input the company name in the text box, click "Enter" to return to the "Test Parameters" interface.

Fill in the "Sample No.", "Tester", "Temp.(℃)", "Spindle", "Speed" and "Sampling Interval" in turn. It is necessary to select the appropriate spindle and speed to ensure the accuracy of the test. The speed can be selected from the pull-down list or filled in by yourself. After filling in all data, click "ENTER" to return to the main interface, and the parameters of the main interface will change according to the filled data.

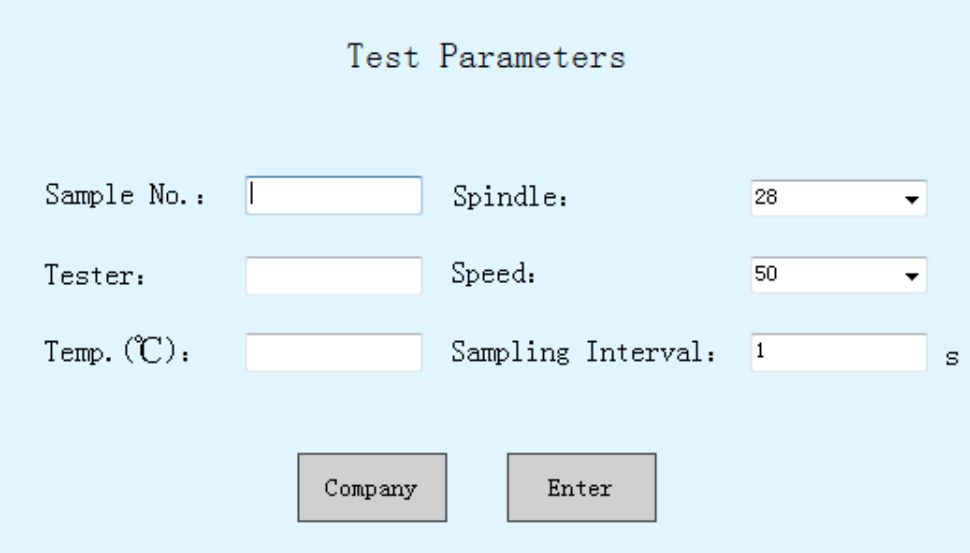



Fig.8

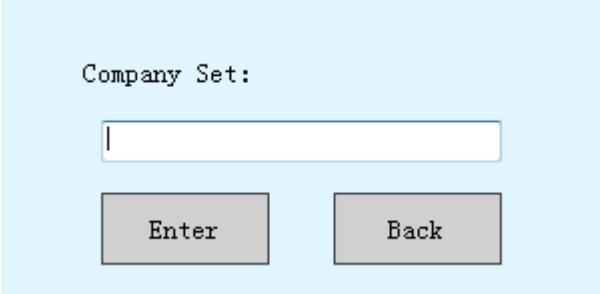



Fig.9

**C. Start to test**

Select the same spindle and speed on the instrument and press to switch on or off the serial port to send data.

Click "Start", the software will read the viscosity value transmitted by the instrument in real time, and the value and curve of viscosity change will be displayed in the table and frame of the main interface little by little.

If the curve exceeds or is lower than the red dotted line, it indicates that the spindle or speed of parameter setting is inappropriate, please reselect.

When you get the viscosity value needed, click "Stop" and press "Save" to save the test data in Excel format. After the file is saved, it will be displayed in the "File" selection box in the upper left corner.

When the data reaches 1000 groups, the main interface will automatically empty the data of the table and frame, automatically store it into excel file and save it, and then continue the test.

**D. Test completes**

After closing the instrument, you can click the file name to be viewed through the "File" selection box in the upper left corner of the main interface. The data and curve will be displayed on the interface again.

You can also directly find the location where the software is installed. There is a "Measurement" folder in it. All the test data are stored here in Excel format. Open it to view the data, or delete the unnecessary test data (Note: please delete carefully).

**E. Viscometer-Temperature curve (V-T Curve)**

Click the "File" pull-down menu at the upper left of the interface, and then click "V- T Curve" button to enter the "V-T Curve" interface, as shown in Fig.10.

Select the appropriate viscosity range, then input the temperature value in the "Tem.(℃)" text box and press enter; then input the viscosity in the “Viscosity” text box and press enter. The temperature and viscosity values will be displayed in the table in the lower left corner. Click the "Clear" button to repeat the operation just now. If the input is wrong, click "Clear All" button to re-enter. After input, click "Plot" to draw the "V-T Curve". Enter values in the "Min. viscosity" and " Max. viscosity" dialog boxes in "Compacting Temp. Range" and "Blending Temp. Range" respectively and press enter to confirm. The software will automatically draw the compacting temperature range and blending temperature range.

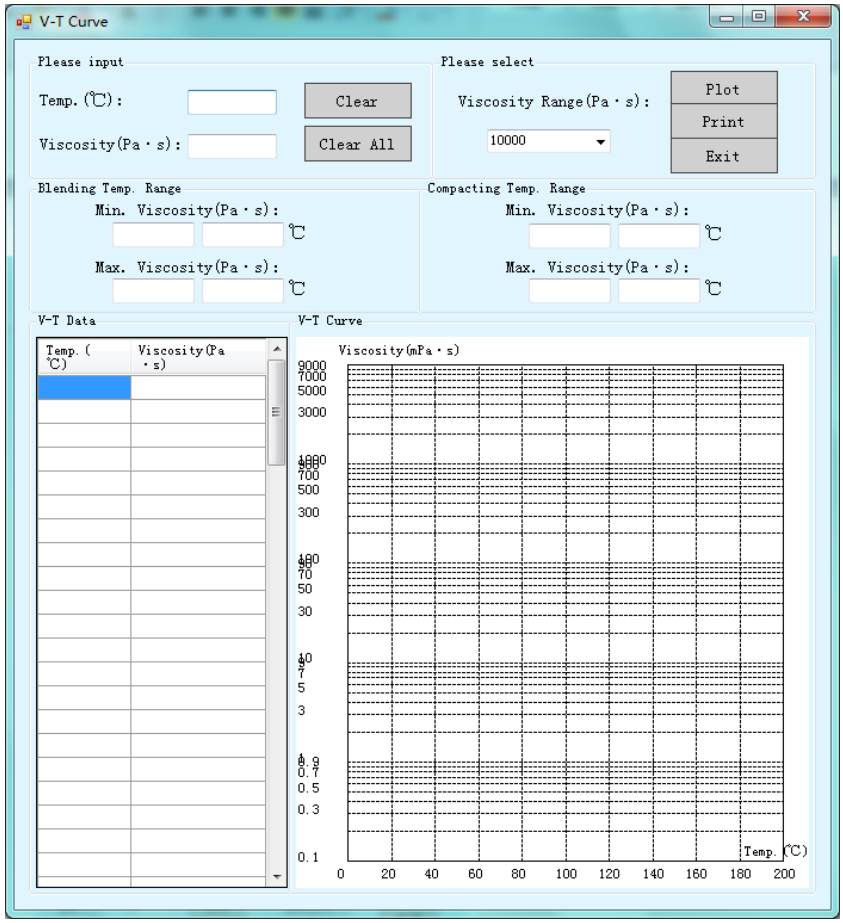



Fig. 10

Click "Print" to enter the print preview interface.

After use, click "Exit" to return to the main interface. Then click "Exit" on the main interface to exit the software.

4. Uninstall software

In the start menu of the computer, find the "Uninstall" folder and click the "Uninst" file to uninstall the software.

## V. Attentions and daily maintenance

1. Please carefully read the Operation Manual before test to acquaint with the operation methods and performance of the instrument.

2. Please refer to the Operation Manual for Temperature Controller for the operation methods of temperature controller.

3. Keep the temperature of measured liquid stable for a long enough time so that the measured liquid is balance at the test temperature.

4. Please be careful when you assemble or disassemble a spindle. Please hold up the connection bolt gently during this procedure. Do not exert a transverse force on the spindle to avoid any damage to the spindle.

5. Do not let the spindle rotate when there is no liquid in the instrument to avoid any damage to the instrument.

6. Please keep the connection surface and screw thread between the connection bolt and transition bolt clean. Otherwise, it will affect the connection of spindle and the rotation stability of spindle. Do not overturn, or tilt the instrument after installing on a spindle to avoid any damage to the instrument.

7. Please hold the head of viscometer when you adjust its height, so that to avoid any damage to it during this procedure.

8. Do not disassemble or adjust the instrument unnecessarily, and do not add lubricating oil to the instrument by yourself.

9. Please clean the spindle and sample cylinder after test. Please disassemble them from the instrument before cleaning. It is forbidden to clean them when they are on the instrument. Please place them in the storage box after cleaning.

10. Please screw on the yellow protection cap on the instrument during instrument movement or transportation.

11. The suspension, emulsion, high polymer, and other high viscosity liquids are most Non-Newton liquids. The apparent viscosities of them will change along with the change of shear speed and time, so the test data are different when you use different spindles, speed and time for determination. In general, you should determine the viscosities of Non-Newton liquids using a stipulated spindle, speed and time.

12. Please make determination as the description as follows to ensure the measurement precision.

(1) Please ensure the uniform of ambient temperature.

(2) Please precisely control the temperature of measured liquids.

(3) Please ensure the measured liquids are uniform (There is no bubbles in the liquid).

(4) Please keep the spindle in the measured liquid for a long enough time to ensure its temperature is the same as the measured liquid.

(5) Please keep the spindle clean and make sure the spindle is in the center of the cylinder.

(6) Please make sure there is no bubble under the spindle.

(7) The test data should be close to the full scale.

(8) Please make determination as per T0605 “Asphalt Brookfield Rotational Viscosity Test (Brookfield Viscometer Method)”.

## VI. Full set and technical documents

1. Full set

| No. | Name | Unit | Quantity |
|---|---|---|---|
| 1 | Head of viscometer | Set | 1 |
| 2 | Pedestal of instrument (having three level adjustment bolts) | Set | 1 |
| 3 | Toothed rod | Piece | 1 |
| 4 | Auxiliary controlling case (containing a temperature controller and a micro-printer) | Set | 1 |
| 5 | Heater | Piece | 1 |
| 6 | Spindle (No.21, 27, 28 and 29) | Piece | 1 for each |
| 7 | Connection hook and transition bolt | Piece | 1 for each |
| 8 | Power supply wire (250 V 6 A) | Piece | 1 |
| 9 | Serial port wire | Piece | 1 |
| 10 | Heater connection wire | Piece | 1 |
| 11 | Sensor wire | Piece | 1 |
| 12 | Power line of main unit | Piece | 1 |
| 13 | Sample cylinder, sample cylinder holder, special forceps | Piece | 1 for each |

| | | | |
|---|---|---|---|
| 14 | Fuse (Φ5×20) 5 A | Piece | 2 |
| 15 | disk | Piece | 1 |

2. Technical documents

(1) Operation Manual 1 piece

(2) Quality Certificate 1 piece

(3) Repair Guarantee 1 piece

3. Optional

(1) Software for communication between viscometer and PC 1 piece

(2) High temperature heating furnace 1 set

(2) No.30 spindle 1 piece

## Appendix: How to place spindle in the sample cylinder

In order to make sure that the viscosity measurement proceed smoothly and the result being reliable, the location of sample and spindle in the cylinder shall be accurate. The explanation is as below:

1. The top of spindle shall be the same height as mouth of cylinder.

2. After placing the spindle, the sample liquid level shall be a little lower than bottom of overflow launder.

3. Please pay attention about the two points above when changing the spindle.

The sketch of the explanation is as below: