1. Specifications

- Reference Standard	**ISO 6502, ASTM D5289**
- Pressure system	Air cylinder system
- Die configuration	Biconical Die, close die system, sealed
- Temperature System	PID Microprocessor Controlled Probe RTD Pt 100 Ω(Class A)
- Temperature range	Room Temp. (+25 °C) to 250 °C Resolution 0.1 °C Units °C/ °F
- Oscillation frequency	100 cpm. (1.667 Hz)
- Oscillation angle	0.5°±0.03°, 1°±0.03°
- Drive Motor	Servo Motor
- Torque Measurement	Torque Transducer (Direct Torque Measurement)
- Torque Calibration	Standard Torque Reference value
- Operation Panel	Capacitive Touch Screen, 5 Inches (Standalone)
- Measured Time	1/60 sec, 1/100 sec Unit (min-min/ min-sec/ sec)
- Communication Data	RS-232
- Associated program (Option)	Data Process Software
- Power Supply	220 VAC ±10 VAC, 50/60 Hz, 6 A
- Air Pressure	4.0 bar to 5.0 bar
- Dimension	Width 50.0 cm., Depth 54.5 cm., Height 105 cm.
- Weight	140 kg.

2. Components

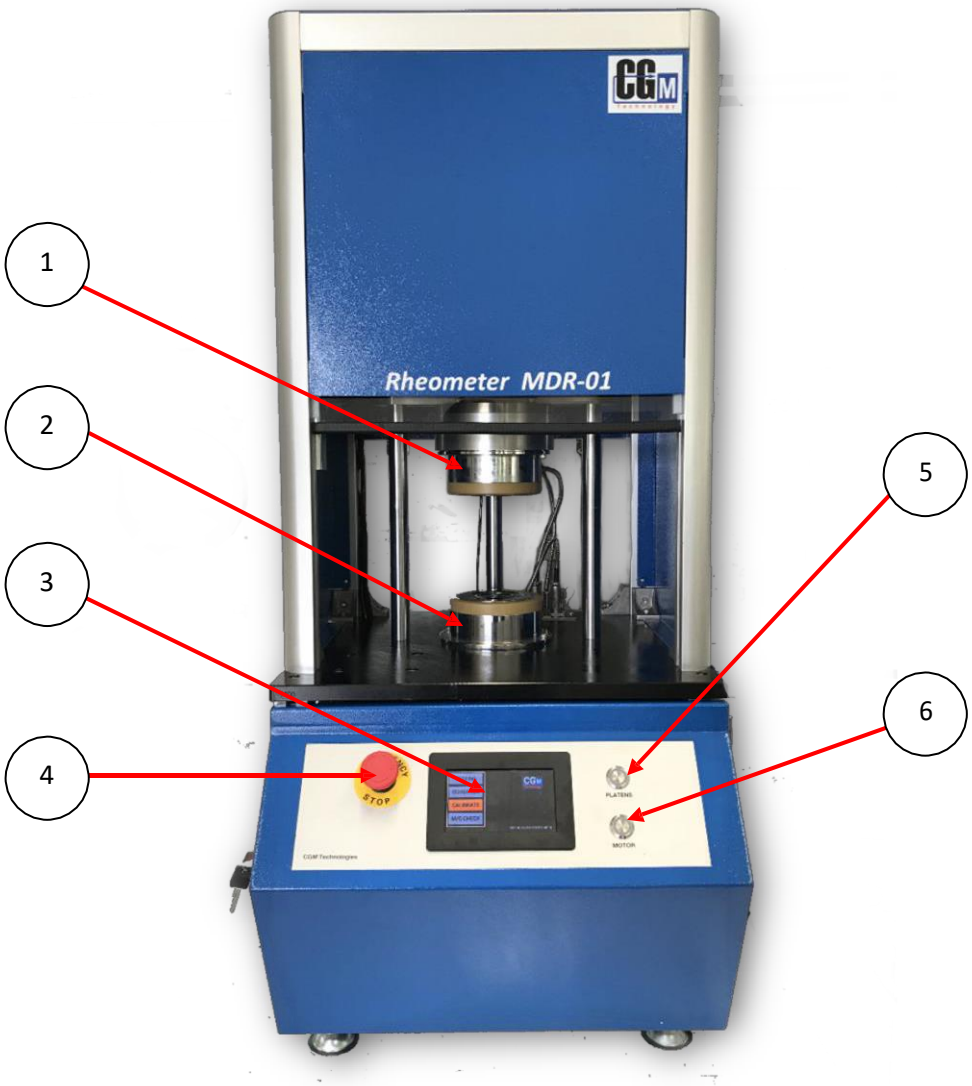


Figure 1 Front image of the MDR-01

Figure 1, illustrates the components of the front perspective of the MDR -01, as follows;

No. 1: The Upper Plate, which consists of the Upper die, Heater, and Probe Sensor

No. 2: The Lower Plate, which consists of the Lower die, Heater, and Probe Sensor

No. 3: Display panel

No. 4: Emergency Stop button

No. 5: On/Off plate switch

No. 6: On/Off motor switch

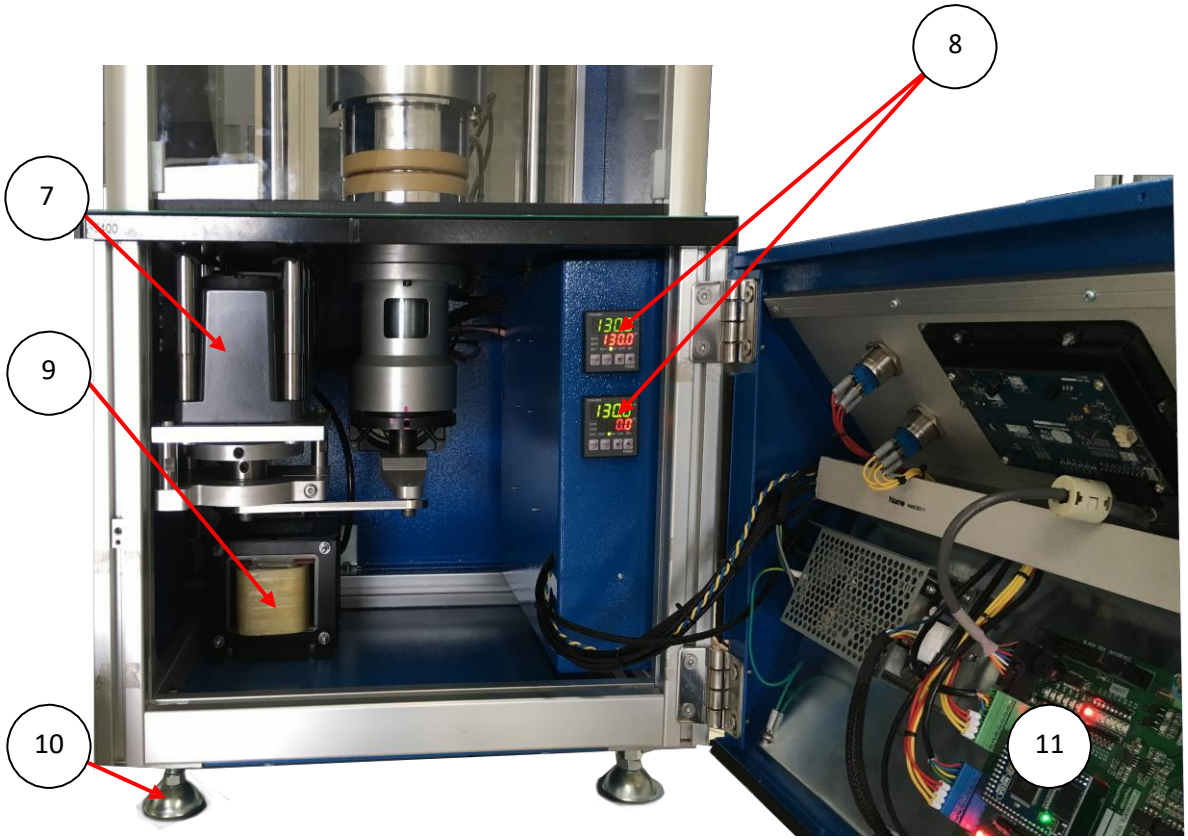


Figure 2 Internal Components of the MDR-01

Figure 2, illustrates the internal components of the MDR -01, as follows;

No. 7: Servo Motor

No. 9: Transformer

No. 8: Thermostat

No. 10: Adjustable leg stand

No. 11: Main control panel

Figure 3 Side image of the MDR-01

Figure 3, illustrates the side perspective of the MDR -01, as follows;

No. 12: RS323 outlet for connection to a computer or printer

No. 13: Power outlet (220 VAC)

No. 14: On/Off breaker switch

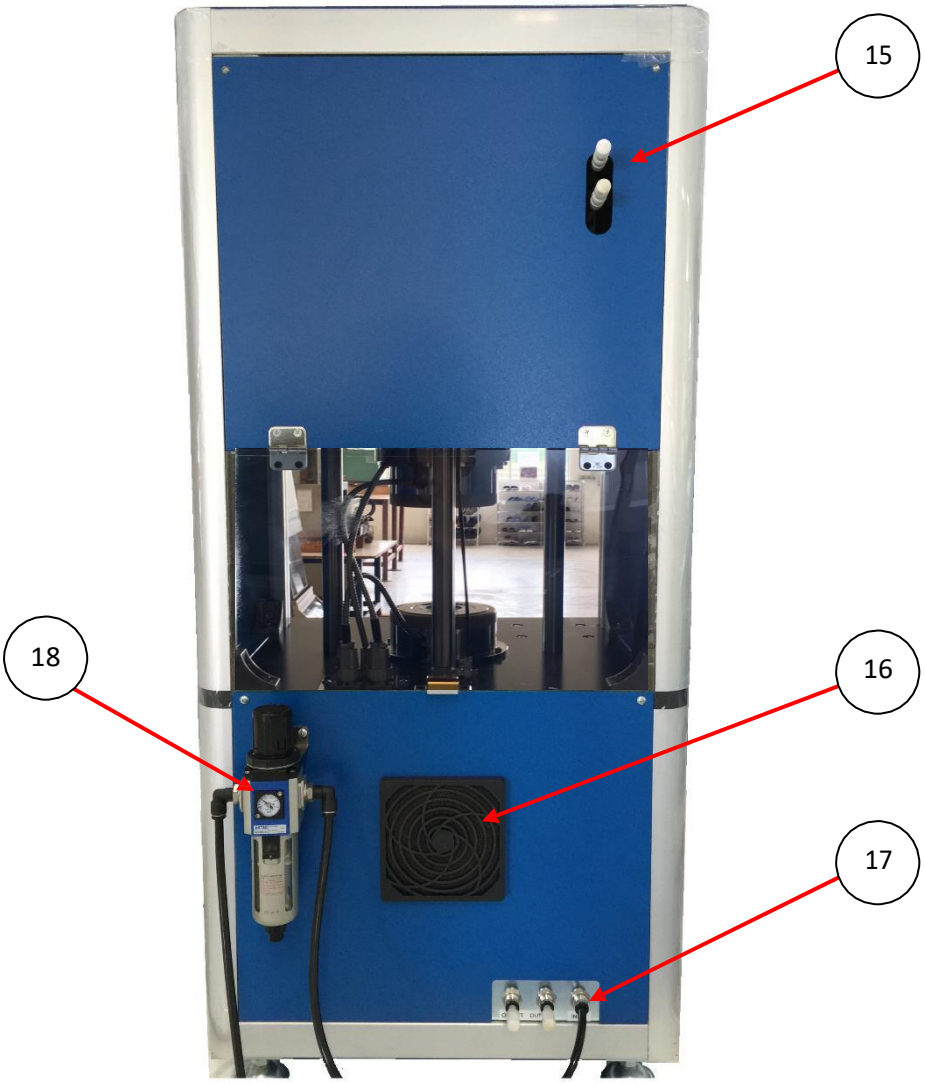


Figure 4 Rear image of the MDR-01

Figure 4, illustrates the rear components of the MDR -01, as follows;

No. 15: Air Muffler

No. 16: Air ventilator

No. 17: Air intake, which is connected to the Air Regulator

No. 18: Air Regulator

3. Installation

3.1) For the installing technician

1. Set the device to a level position

3.2) For users

1. Site preparation for the installation of MDR-01

- Grounded power outlet with a 220 VAC 50Hz/60Hz capacity, that can discharge at no less than 6 Amp
- Compressed air supply of at least 4-5 bars
- Support structure to place the MV-01, which can withstand a weight of 200 kg. or more.

2. Installation instructions for the Rheometer MDR-01

- Recommended to be used in conjunction with a UPS with a minimum capacity of 1.5KVA or more.
- Recommended to be installed in rooms with temperature and humidity control.

4. How to use the touch screen panel of the Rheometer MDR-01

After powering up the MDR-01, the main screen display will be as indicated in Figure 5, which is used for monitoring and tracking of the test results. The main functions will consist of Testing, Condition, Calibrate, and Configuration.

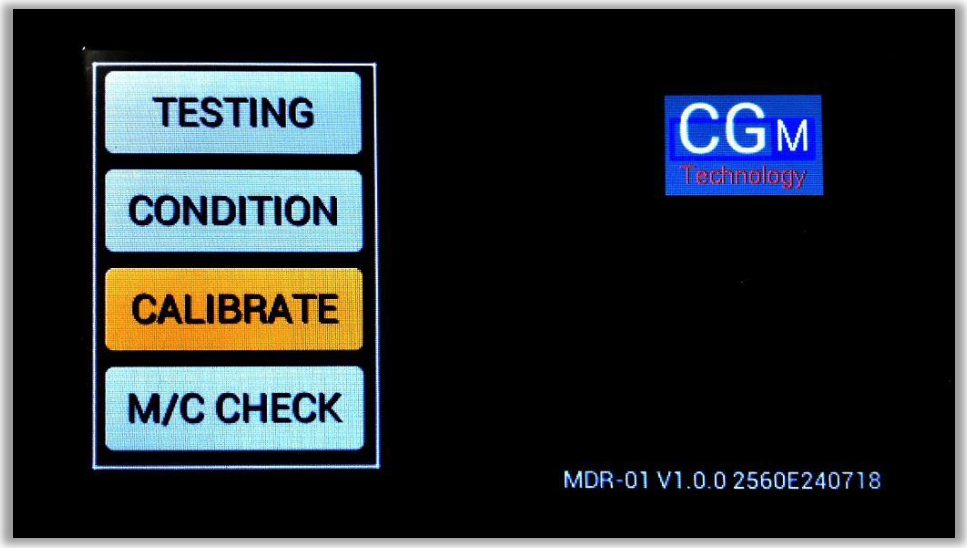


Figure 5 Image of the Main Screen display

1. Testing — Displays the results of the test in a graphical format.
2. Condition — Sets the conditions or state of the sample to be tested.
3. Calibrate — Sets the testing and calibration of the TORQUE STANDARD
4. Configuration — Monitors the status and parameter settings, and stores them in the device's memory.

4.1) Testing

By pressing the "Testing" button, will enter into the testing mode, in which the function consists of 4 sections; STANBY, RESULT, GRAPH, and CLOSE. See Figure 6.

Figure 6 shows the main display of the Testing mode

Figure 7 shows the resulting display when A is selected

Note: Pressing A area on touch screen for switching the display between Figure 6 and Figure 7.

4.1.1) STANBY is the ready function, waiting for the samples to be tested. See example below.

Figure 8 shows the display screen in the STANBY mode

4.1.2) RESULT, will show the test results, as can be seen in Figure 9.

Figure 9 shows the display of the RESULT function

Components of the Test results

1. MH : Value of highest torque
2. ML : Value of lowest torque

3. ts1 : Scorch time 1, time from the start where torque equal ML to the time where torque equal ML+1
4. ts2 : Scorch time 2, time from the start where torque equal ML to the time where torque equal ML+2
5. tc10 : Cure time at 10%
6. tc50 : Cure time at 50%
7. tc90 : Cure time at 90%

Note: Cure time 100% is time from the start of the test where lowest torque value (ML) is reached highest torque value (MH)

4.1.3) GRAPH, displays the sample test results in a graphical format and its associated numerical values, as shown in Figure 10

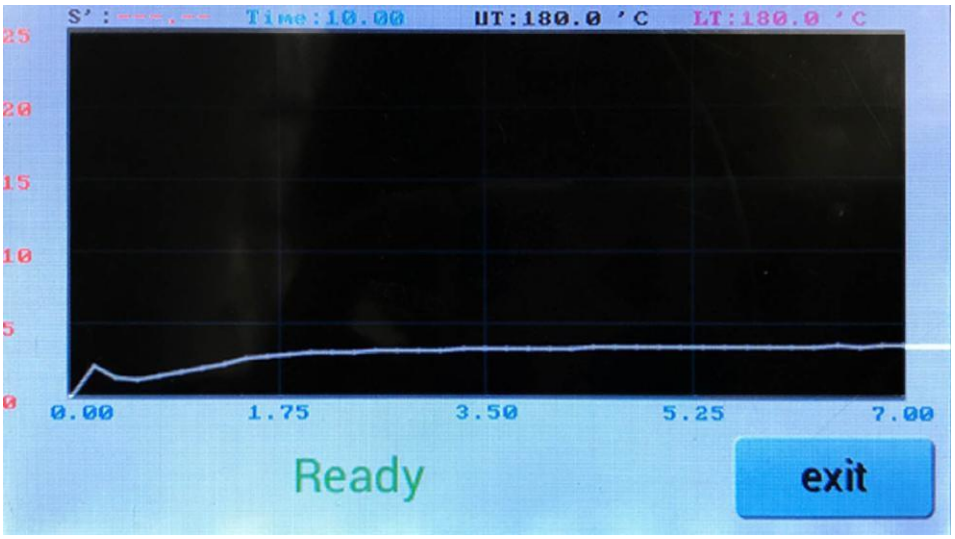
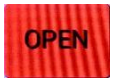


Figure 10 displays the GRAPH function

4.1.4) CLOSE, controls the On/Off function of the Plate and Die

Status

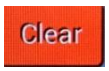


RED, Plate has been closed, and sample testing is in progress.

GREEN, Plate is open, and sample testing is waiting to be tested

4.2) Condition

When "Condition" is selected, you will enter into the Condition page, which will display the conditions of the sample test. The parameters can be adjusted to suit the test sample, as shown in Figure 11



Clears the parameters

Returns to the previous menu

Confirms the value entry

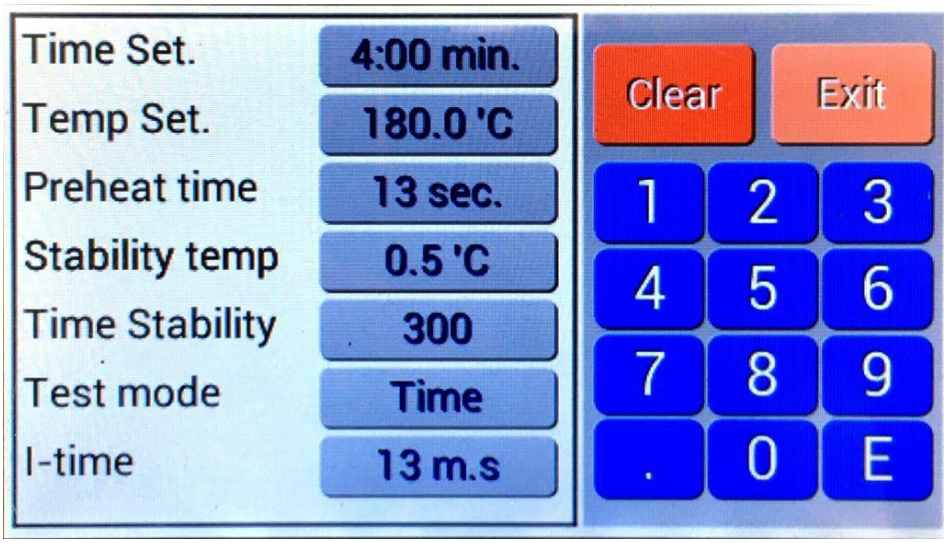


Figure 11 shows the main Condition display

4.2.1) How to Use

To enter or modify the values to any functions, proceed according to the following steps;

1. Entering the parameters, and how to correct it.

Select the required parameter >> enter the value >> Select "**E**" to confirm.

2. To clear the parameters.

Select the required parameter >> Select "Clear" (the value will be reset to 0).

4.2.2) Functions

1. Time Set : is the function that determines the time required to test the sample (with a range of 0–99 minutes) .

For example; to set the time for 1 minute, just press "1" and then "**E**" to confirm.

2. Temp Set : is the function that determines the temperature to test the sample (with a range of 0–250 ºC).

For example; to set the temperature for 150ºC, just press "150" or "150.0" and then "**E**" to confirm.

3. Preheat time : is setting preheat time function before testing. Starts from plate is closed. (ranges 0-99 seconds).

Note: The use of this function must be used under the calibration by an experienced engineer.

4. Stability temp : is the function that configures the operating functioning temperature while the device is operating. It will provide alerts on the status of the temperature (ranges from 0–9 ºC).
   For example; to set the temperature for 1ºC, just press "1" and then "**E**" to confirm.
5. Time Stability: is setting duration function. When the temperature is reached the set point on Testing screen, 'Ready' will be shown for notice the user, machine is ready. (ranges 0-999 seconds x 0.1).
   For example; to set the time for 1 second, just press "1" or 1.0 and then "**E**" to confirm.
6. Test mode : is testing method function. 2 modes as follows;
   1) Time : Testing time depend on Time Set values.
   2) Peak time : Testing time will be stopped when MH values indicated.

7. I-Time : is starting time function before finding ML values.
   Starts from plate is closed. (ranges 0-99 seconds)
   For example; to set the time 13 seconds, just press "13"and then "**E**" to confirm. The machine will be started after plate was closed 13 seconds.

4.3 Calibration

Selecting "Condition" will enter into the Calibrate screen, which consists of 6 components; Utility, Calibration, Motor, Platens, and Clamp, as shown in Figure 12.

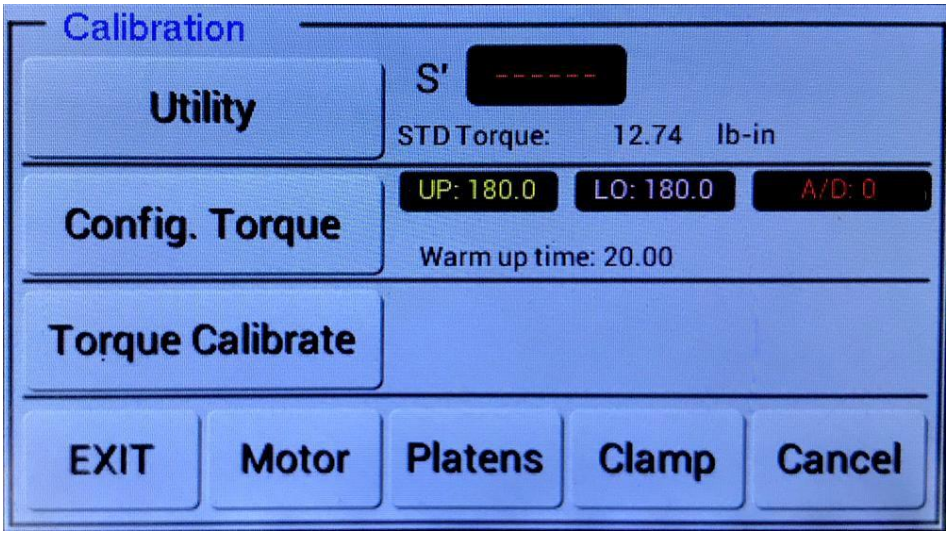


Figure 12 shows the main Calibrate screen

4.3.1) Utility adjusts the Rheo Linearity function

Note: The use of this function must be used under the calibration by an experienced engineer.

4.3.2) Config. Torque adjusts the Torque Reference function. When selected, the screen will be shown as Figure 13.

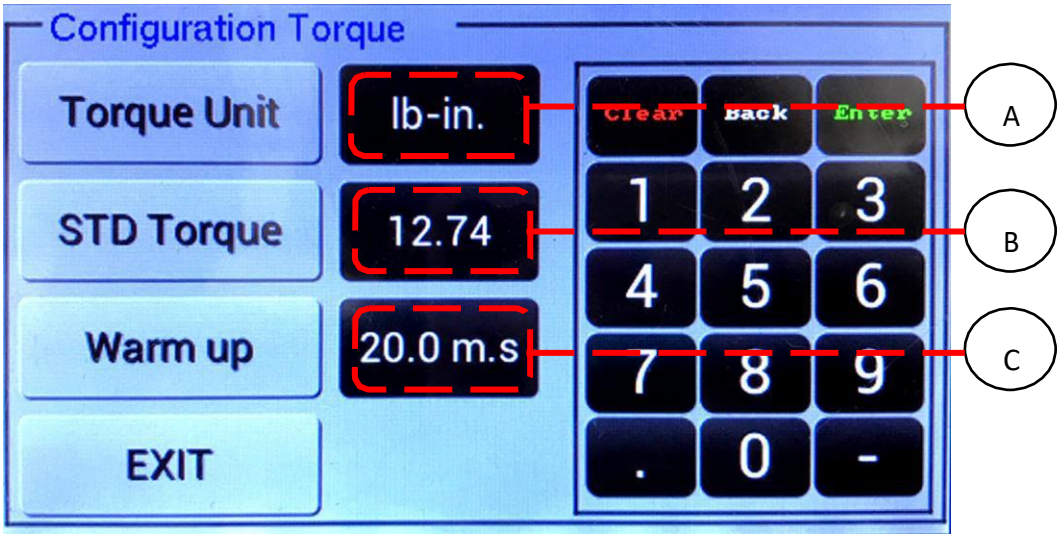


Figure 13 shows the main display of the Configuration Torque

- Select A area to set Torque Standard unit for Calibrate (dNm, lbin, and kg-f).
- Select B area to set STD Torque value according to Correction Torque Standard value for Calibrate.
- Select C area to set Warm up time (Torque Standard warming).

To enter or modify the values to any functions, proceed according to the following steps;

1. Entering the parameters, and how to correct it

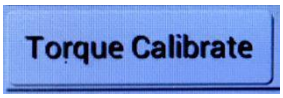
   Select the required parameter >> enter the value >> Select "Enter" to confirm.

2. Using the "Clear" button to clear the parameters

   Select the required parameter >> Select "Clear" (the value will be reset to 0).

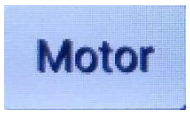
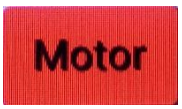
3. Using the "Back" button

   To edit a numeric value, such as 100.0 to 125.0, select the required parameter field >> select "Back" to the required location >> enter the value >> select "Enter" to confirm.

4.3.3) 

is torque calibration sensor function of MDR-01 with Standard torque. To enable the operators to correctly calibrate the device.

4.3.4) Checking the operating status of the device.

Function Status		Response
OFF	ON	
		When "Motor" is selected, the color of the button will change to red, and the motor will start to rotate.
		When "Platens" is selected, the color of the button will change to red, and the front panel of the device will be opened.

4.4 Configuration

When "Configuration" is selected, the Configuration section will appear, which consists of 7 functions; Temp. Parameter, Temp. Auto tune, Temp. Offset, I/O Check, Machine Check, Communication Check, and Instrument setting, as shown in Figure 14.

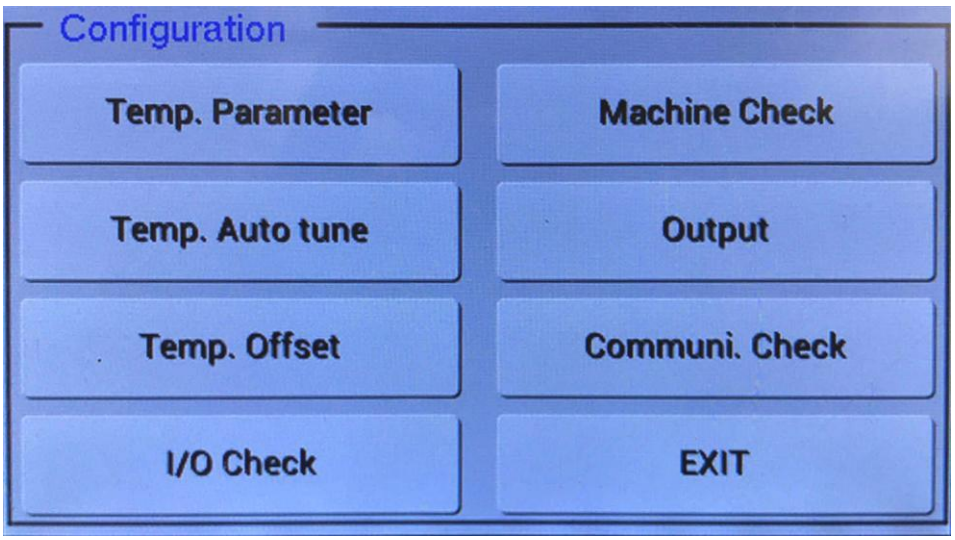


Figure 14 shows the main Configuration screen

4.4.1) Temp. Parameter

Temp. Parameter, will display the functions for monitoring the operating temperature range, as shown in Figure 15.

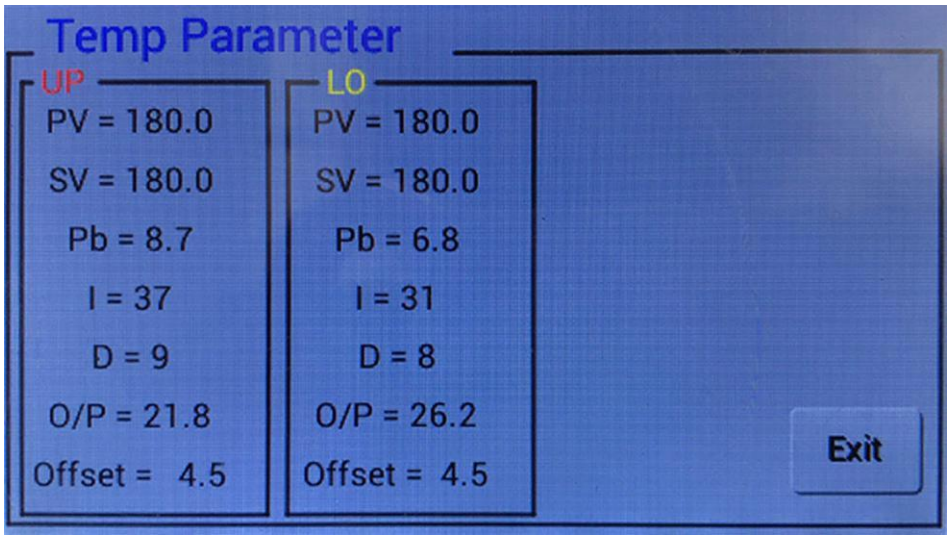


Figure 15 shows the Temp. Parameter screen

4.4.2) Temp. Auto tune

Temp. Auto tune, is used to adjust the temperature controls, as shown in Figure 16

Note: The use of this function must be used under the calibration by an experienced engineer.

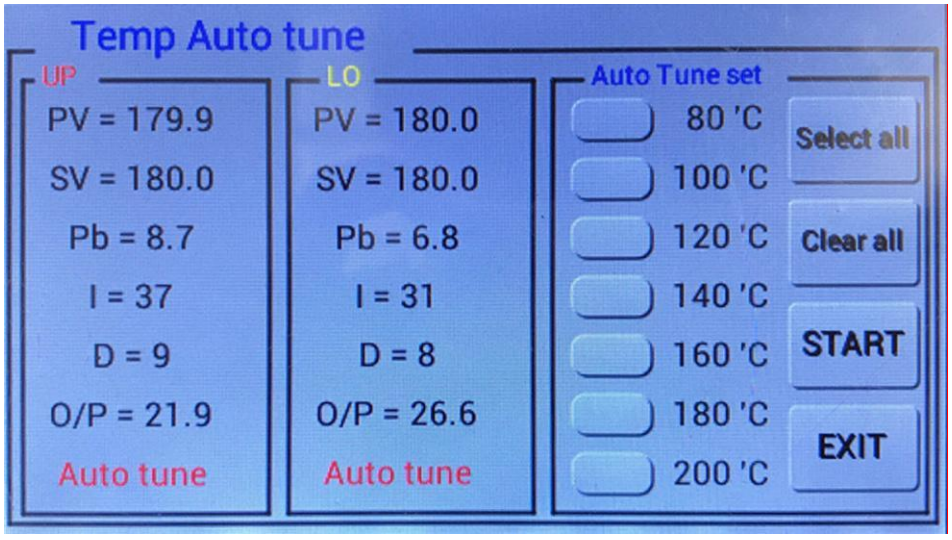


Figure 16 shows the Temp. Auto tune screen

4.4.3) Temp. Offset

Temp. Offset, is used to the parameters of the temperature, as shown in Figure 17.

Note: The use of this function must be used under the calibration by an experienced engineer.

Figure 17 shows the Temp. Offset screen

4.4.4) I/O Check

I/O Check, is used to verify the status of the various buttons, as shown in Figure 18.

Note: The use of this function must be used under the calibration by an experienced engineer.

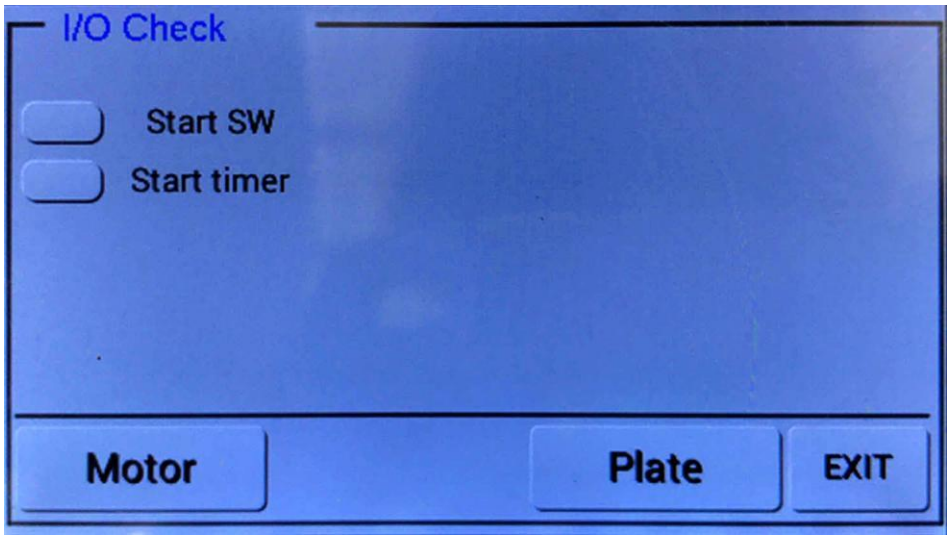


Figure 18 shows the I/O Check screen

4.4.5) Machine Check

Machine Check, is used to verify the status of the test device, as shown in Figure 19.

Note: The use of this function must be used under the calibration by an experienced engineer.

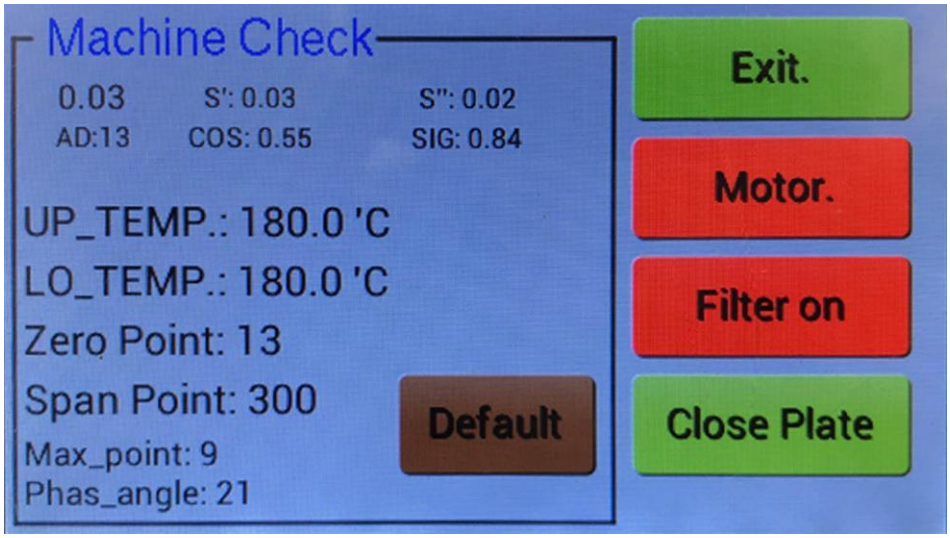


Figure 19 shows the Machine Check screen

4.4.6) Output

Output, is used to setting the connected external device, as shown in Figure 20.

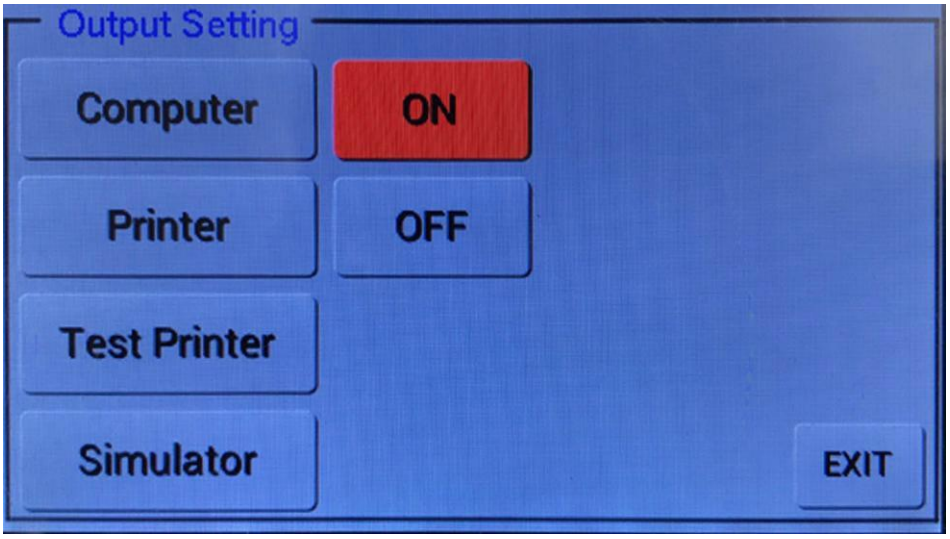


Figure 20 shows the Output screen

4.4.7) Communication Check

Communication Check, is used to check on the communication status of the connected internal and external test device, as shown in Figure 21

Note: The use of this function must be used under the calibration by an experienced engineer.

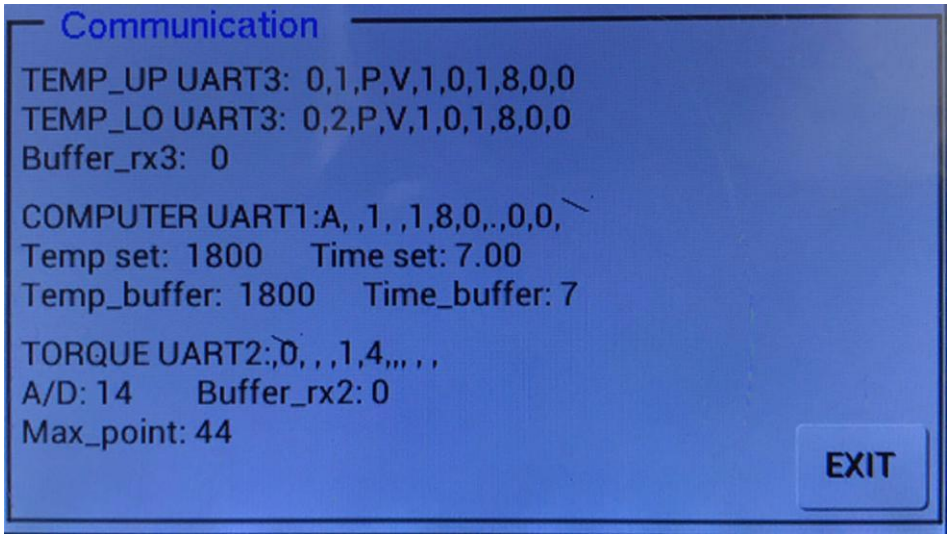
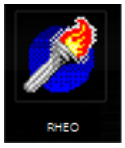


Figure 21 shows the Communication Check screen

5. How to use the Computer System Operations

Double-click on the "RHEO" icon 

to activate the system, which will display the main operating screen, as shown in Figure 22.

5.1) Main Menu descriptions

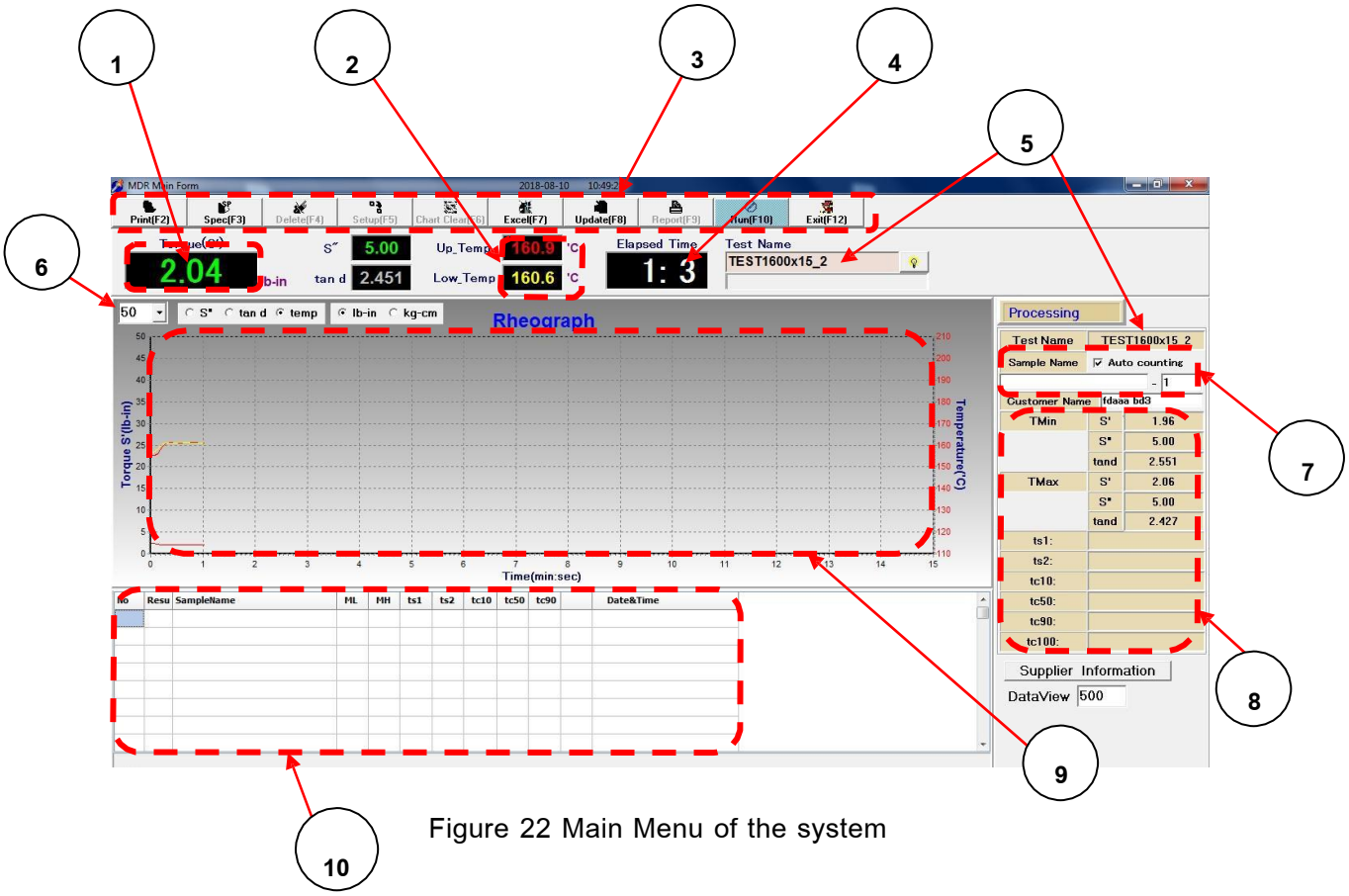


Figure 22 Main Menu of the system

From Figure 22, the main components of the Main Menu can be explained, as follows;

No. 1	Displays the Torque value
No. 2	Displays the temperature of the Upper Die and lower Die
No. 3	Menu Bar
No. 4	Test elapsed time (Mins:Secs)
No. 5	Name of the test sample
No. 6	Set the highest value of the graph in the Y axis. (Torque)

No. 7 Space to input the test sample name

No. 8 Latest test results

No. 9 Graph displaying the Torque and temperature test results

No. 10 Test results table, the latest result is displayed on 1st row.

5.2) Using the Menu bar

5 . 2 . 1 [Spec (F3)] 

Click on this button to set the test specifications. The system will display if the test sample is within the "OK" range, or is outside the "NG" range. Figure 23 shows the Spec setting screen and Figure 24 shows the Spec results screen.

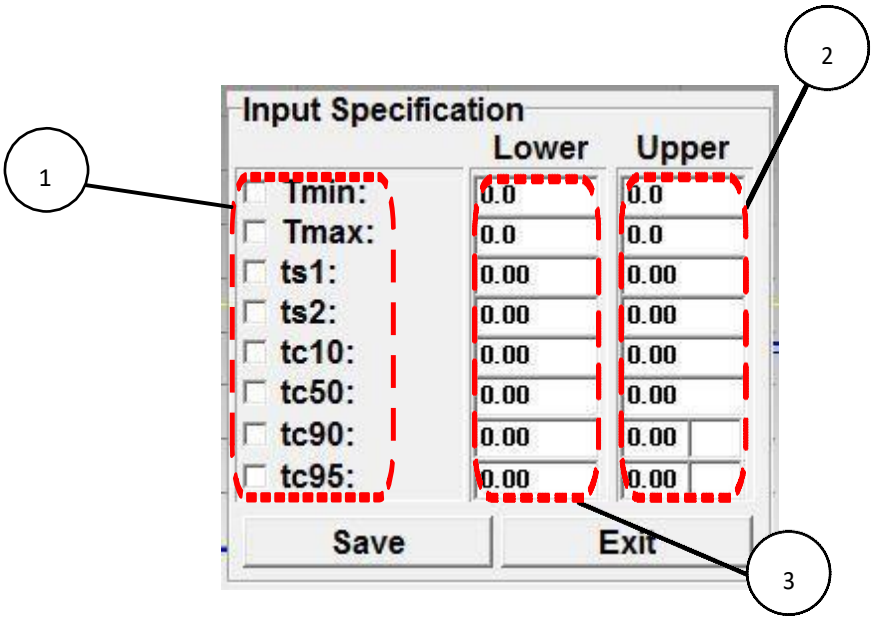


Figure 23 shows the Spec setting screen

From Figure 23, the main components of the Spec screen can be explained, as follows;

No. 1 Select type of required Spec, number and type depend on sample value setting as Menu [Setup (F5)] refer to 5.2.3

No. 2 Highest value of the Spec

No. 3 Lowest value of the Spec

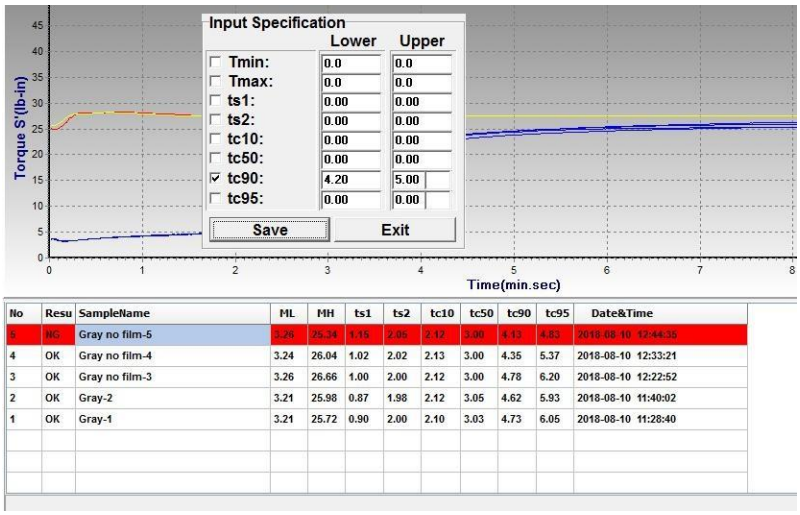


Figure 24 shows the Spec results screen

5.2.2) [Delete (F4)] 

is used to delete the data. Choose the data to be deleted, and press F4.

5.2.3) [Setup (F5)] 

By pressing the Setup (F5) or F5 on the keyboard, will display the windows, as shown in Figure 29.

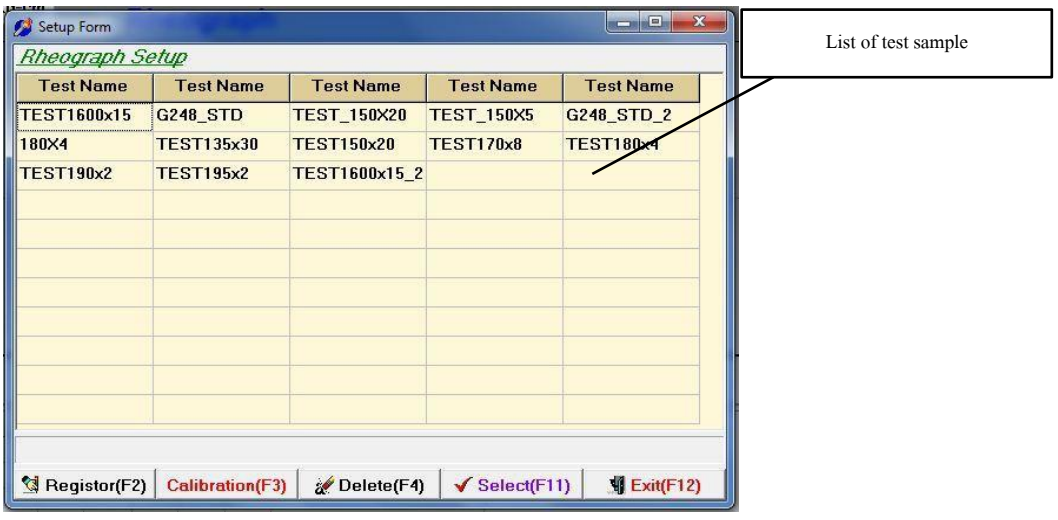


Figure 25 shows the Setup window

1. How to create a test set

Test set creation is create a data set that collects various condition settings for next testing. Proceed according to the following steps;

1.1) Click on the blank space in the table.

1.2) Click on "Registor (F2)" or F2 on the keyboard. This will display the "Rheograph Input form" window, as shown in Figure 26, in order to create a new test sample name and the test conditions.

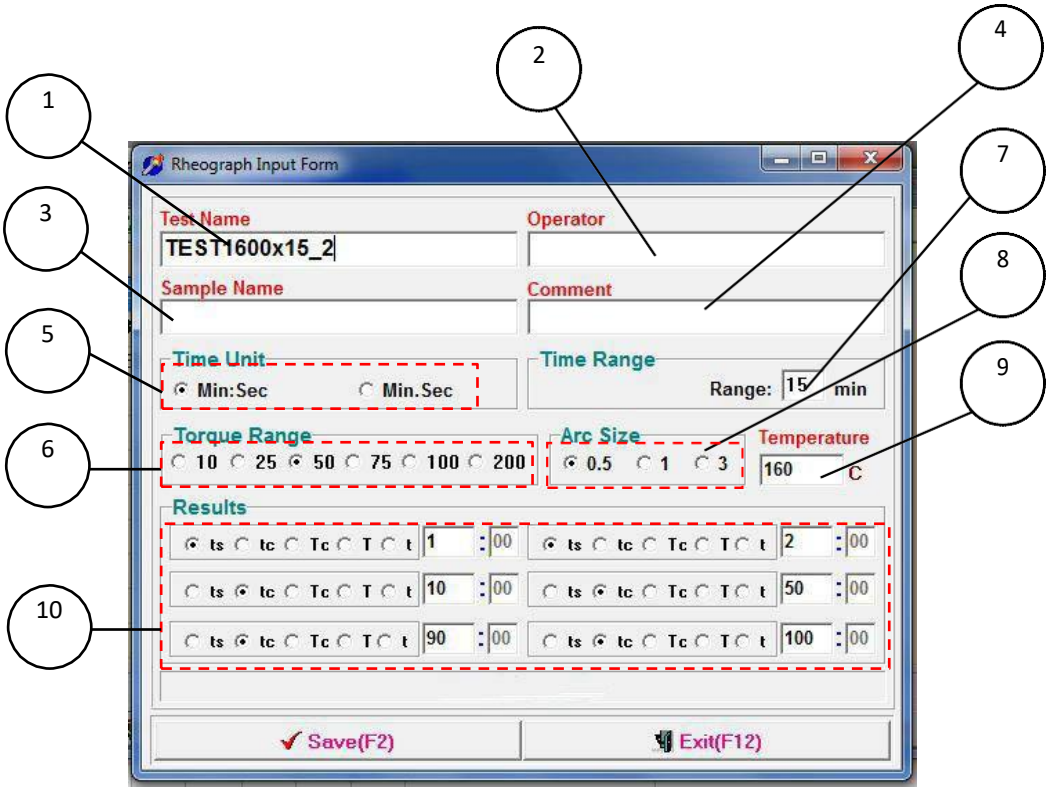


Figure 26 shows the Condition window

From Figure 26, the main components of the Condition window can be explained, as follows;

No. 1	Name of the test set (this cannot be edited later)
No. 2	Name of the person conducting the test
No. 3	Name of the test sample (can be edited later)
No. 4	Notes
No. 5	The time unit to be used
No. 6	The highest value of the graph in the Y axis. (Torque)
No. 7	Duration of the test
No. 8	Torque angle of the test machine
No. 9	Temperature to be used in the test (°C)

No. 10 Type of required test

- **ts** is Scotch time.

  For example; **ts1** is period of time where torque equal lowest torque value +1 (ML+1). Start counting from point of lowest torque value.

- **tc** is Cure time.

  For example; **tc10** is the period of time where rubber set the cure time 10%. Start counting from point of lowest torque value. Cure time 100% is time from the start of the test where lowest torque value (ML) is reached highest torque value (MH).

- **Tc** is Cure torque.
- **T** is Torque at time.
- **t** is Time at torque.

2. How to delete the test sample data.

   2.1) Click on the required name of the test set in the setup form.

   2.2) Press "Delete (F4)" or F4 on the keyboard in order to delete the data.

Note: The data that was tested under the conditions of the selected test set will be deleted.

3. Selecting the test set.

   3.1) Click on the required name of the test set in the setup form.

   3.2) Press "Select (F11)" or F11 on the keyboard.

Note: Changing the test set, can only be done through this method.

5.2.4) [Update (F8)] 

Can be used for recording the test result from programme to Excel file format. Proceed according to the following steps;

1. Press the Update (F8) button or press F8 button on keyboard, ExcelForm screen will be shown as figure 27.

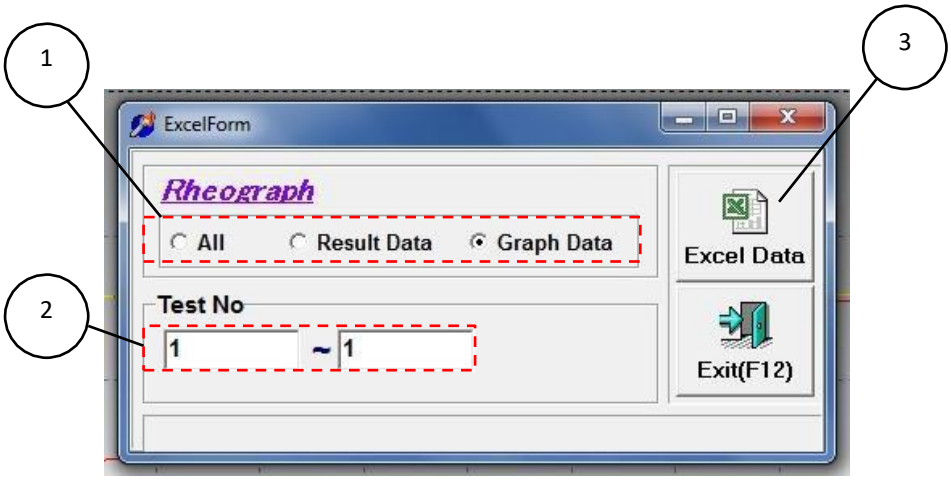


Figure 27 shows ExcelForm screen

From Figure 27, the various options of the ExcelForm can be explained, as follows;

No. 1 Format of the required result.

No. 2 Range of the required result.

No. 3 Excel Data save button.

2. After selecting the required result then press Excel Data button for save data. The result will be saved to "DataBase"folder (Computer/Local Disk(C:)/myungji/DataBase) as figure 28.

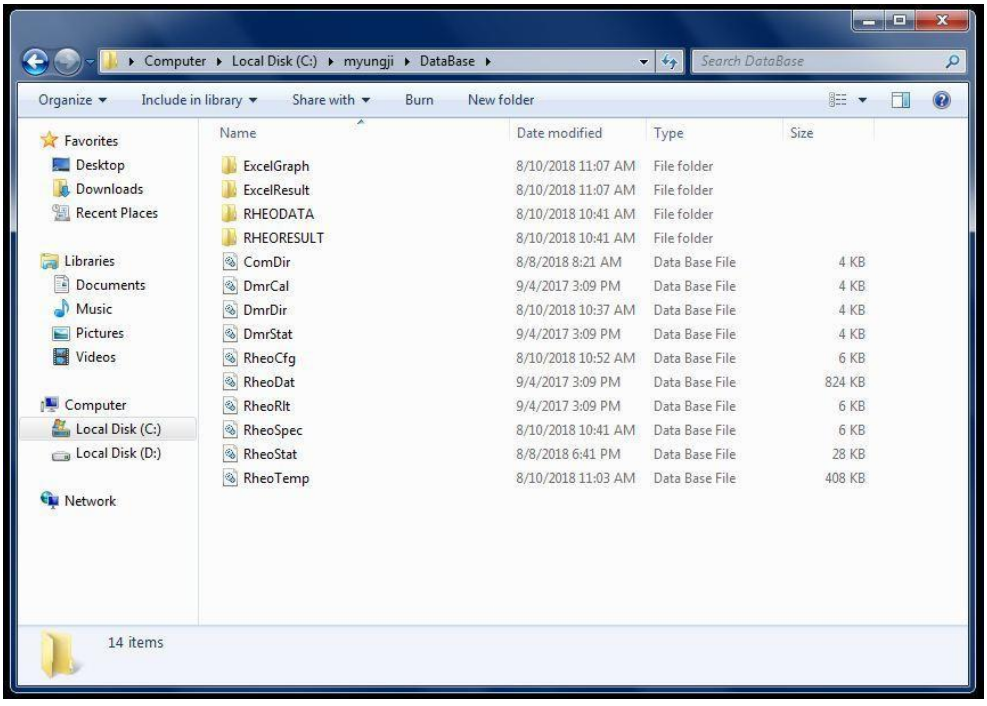


Figure 28 shows saved Excel file in DataBase folder

5.2.5) [Update (F8)] 

Can be used for renaming the test samples. It can be done by clicking on the test sample name which needs to be renamed (from the test results table), and edit in the Sample Name field (No. 7, from Figure 22). Finally, press "Update (F8)" to change the test sample name.

5.2.6) [Report (F9)] 

Clicking on "Report (F9)" or F9 on the keyboard will display the "Print form" screen, as shown in Figure 29.

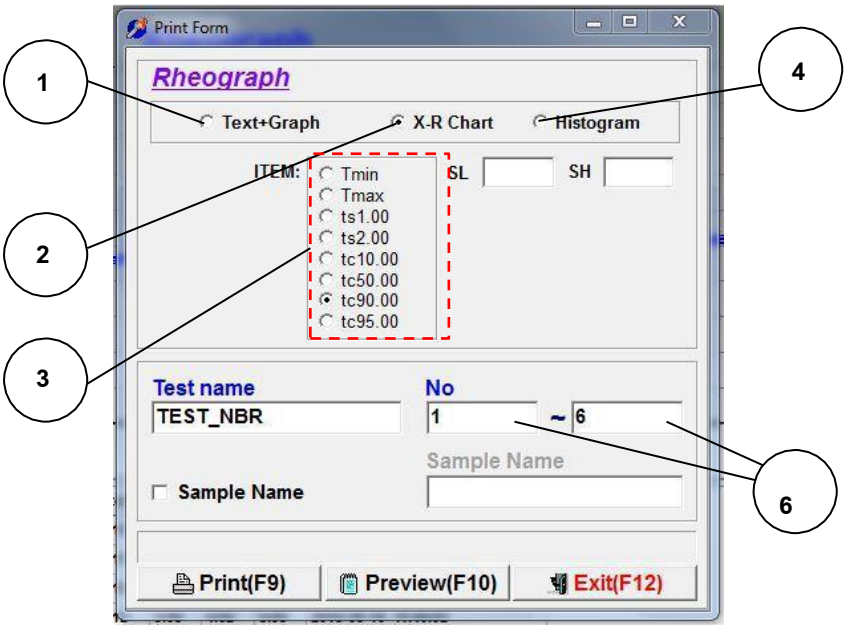


Figure 29 shows the various options in the Print Form screen

From Figure 29, the various options of the Print Form can be explained, as follows;

No. 1 will print the test results and graph

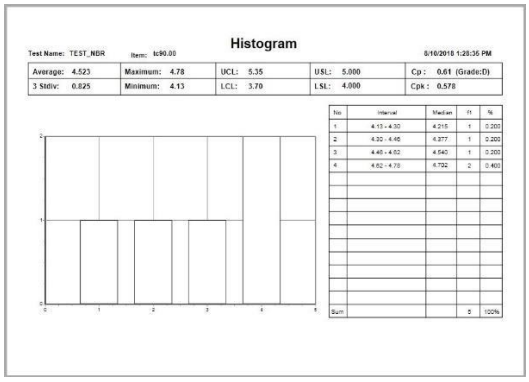
No. 2 will print the test results in the X-R graphical format

No. 3 are the types of variables that can be included in the X-R graph (available only when the X-R graph option is selected)

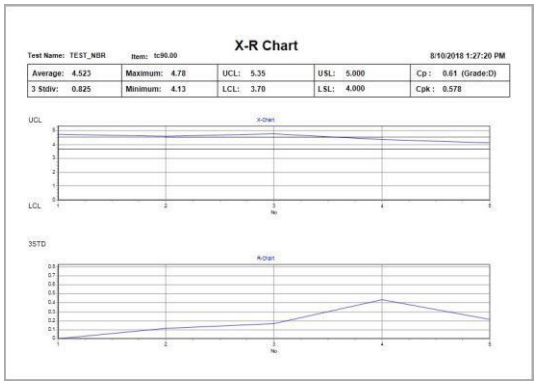
No. 4 will print the test results in a Histogram format

No. 5 is the data range of the test result report

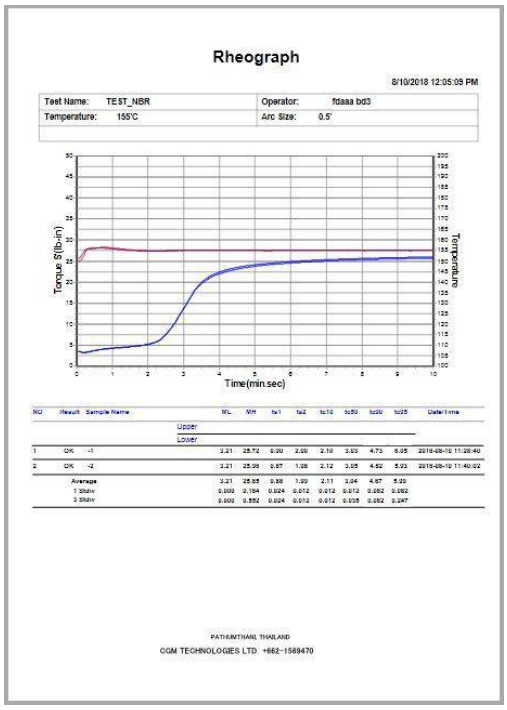
Examples of the test result graphs



Histogram



X-R graph



Test results and accompanying graph

6. How to use Rheometer MDR-01

The MDR-01 device can be used by 2 modes of operations; by the touch screen in the Standalone mode, and by using in conjunction with the "RHEO" (computer mode).

6.1 How to use in the "Standalone" mode.

6.1.1) Switch on the power on the MDR-01, and wait until the following screen appears.

6.1.2) Set the conditions for the test with touch-screen, according to topic no. 4.2

6.1.3) Select the "Testing" function on the screen, in order to enter into the test sample touch-screen. Wait until the screen displays the green "Ready" message.

6.1.4) Prepare the test rubber with approximately weight 5-6 grams (g.) as figure 30. Place on top of The Lower die as figure 31 (film can be used or not)

Figure 30 shows preparing the test rubber for testing

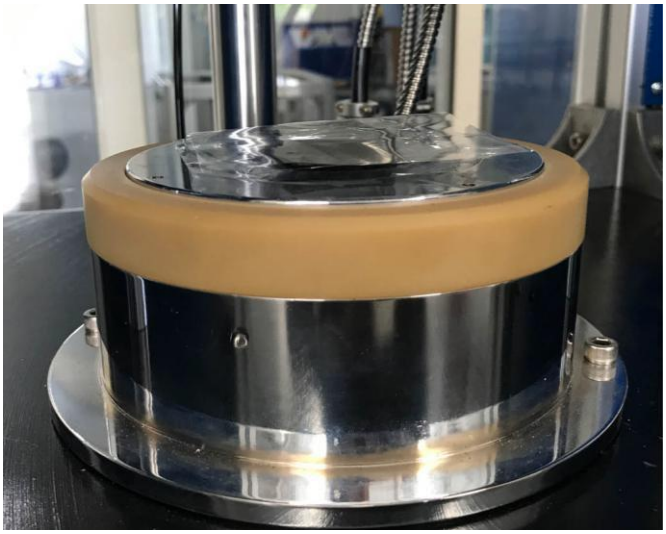


Figure 31 shows placing rubber for testing

6.1.5) Press the CLOSE button, in order to activate the testing process of the MDR-01. During the testing process, real-time monitoring can be observed by selecting "RESULT" or "GRAPH" on the touch screen.

6.1.6) When the test is completed, the plate and the front panel will open automatically.

6.1.7) Clean the die, to prepare for the next test.

6.2 How to use in the computer mode

6.2.1) Switch on the power on the MDR-01, and wait until the main screen appears.

6.2.2) Open the program, which will display the main screen, as shown in Figure 27.

6.2.3) Set the test conditions for the test, according to topic no. 5.2.3. Verify the "Condition" of the MV-01 to match with the values of the program.

6.2.4) Select the testing function on touch-screen of the MDR-01 to enter testing screen Wait until the screen displays "Ready" (green light).

6.2.5) Prepare the test rubber with approximately weight 5-6 grams (g.) as figure 30. Place on top of The Lower die as figure 31 (film can be used or not).

6.2.6) Press the CLOSE button, in order to activate the testing process of the MDR-01. During the testing process, real-time monitoring can be observed by selecting "RESULT" or "GRAPH" on the touch screen.

6.2.7) When the test is completed, the plate and the front panel will open automatically.

6.2.8) Clean the die, to prepare for the next test.

7. Calibration

7.1. Calibrate : Sensor for reading Torque value, MDR-01

Calibrate Sensor for reading Torque value, MDR-01 can be preceded by Torque Standard. For this example, Torque Standard is used for explanation as Figure 32.

Figure 32 Sample of Torque Standard

Calibrate Sensor for reading Torque value, MDR-01. Proceed according to the following steps;

7.1.1) Close Software (In case using MDR-01 with "Rheometer" program)

7.1.2) Select Condition function on the touch-screen of MDR-01. Set temperature to 177 °C as Figure 33.

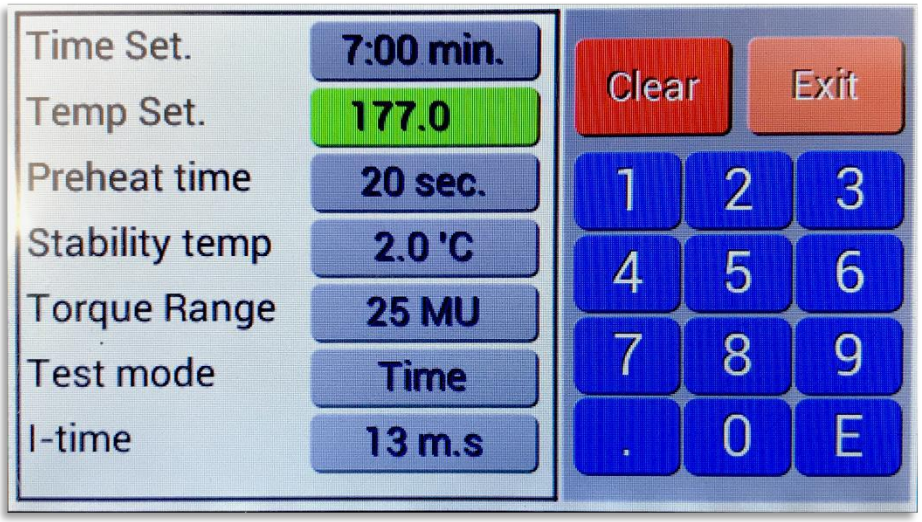


Figure 33 shows Temperature setting screen for Calibrate

7.1.3) Press 

for returns to main screen then select Calibrate function.

7.1.4) Press 

7.1.5) Set parameter values for Calibrate as Figure 34. (sample)

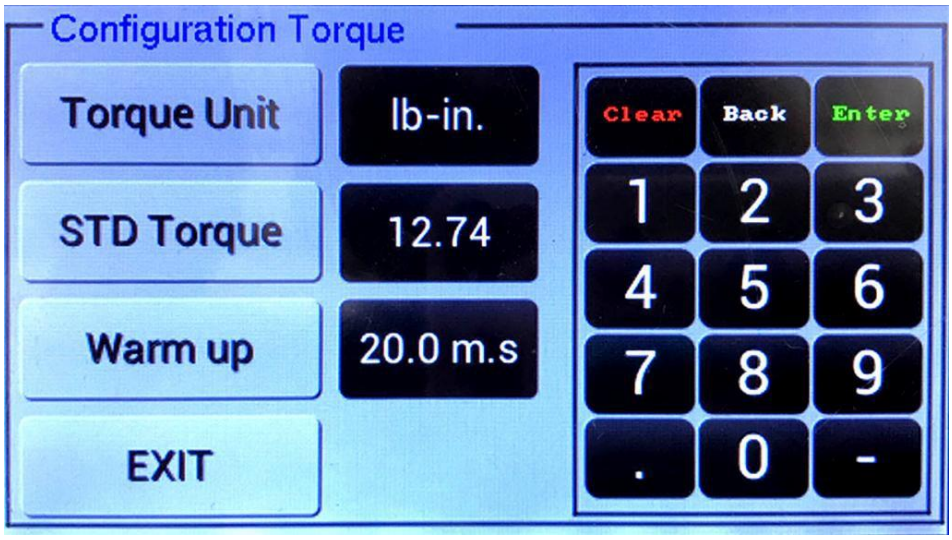
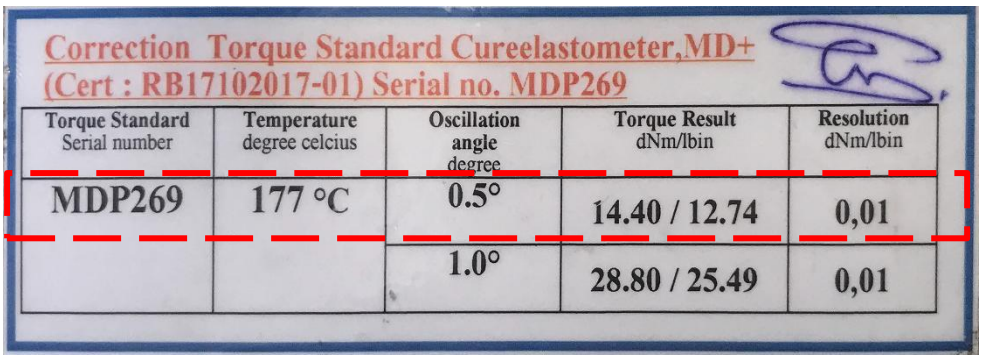


Figure 34 shows sample of parameter values setting

Note: Torque unit and STD Torque depend on torque angle of Rheometer (Oscilla-tion angle) and temperature for Calibrate specified in Torque Standard from manufacturer. For example as Figure 35, Rheometer MDR-01 set angle at 0.5 degree.

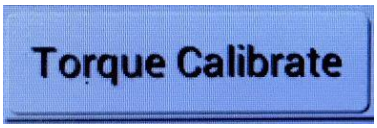

Correction Torque Standard Cureelastometer,MD+
(Cert : RB17102017-01) Serial no. MDP269

Torque Standard Serial number	Temperature degree celcius	Oscillation angle degree	Torque Result dNm/lbin	Resolution dNm/lbin
MDP269	177 °C	0.5°	14.40 / 12.74	0,01
		1.0°	28.80 / 25.49	0,01

Figure 35 shows parameter values of Torque Standard

7.1.6) After set parameter values for Calibrate completely, press 

for returns to Calibration screen.

7.1.7) Press 

7.1.8) Torque Standard input screen will be displayed as Figure 36.

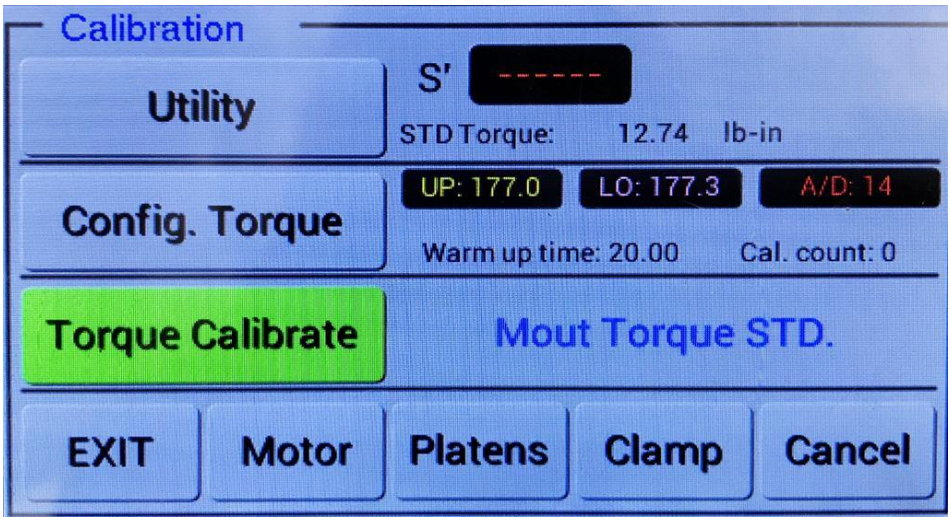


Figure 36 shows the screen after press Torque Calibrate button

7.1.9) Place Torque Standard at the center between Upper die and Lower die as Figure 37.

Note: In case placing Torque Standard in the wrong position will cause of damage and incorrect Calibrate.

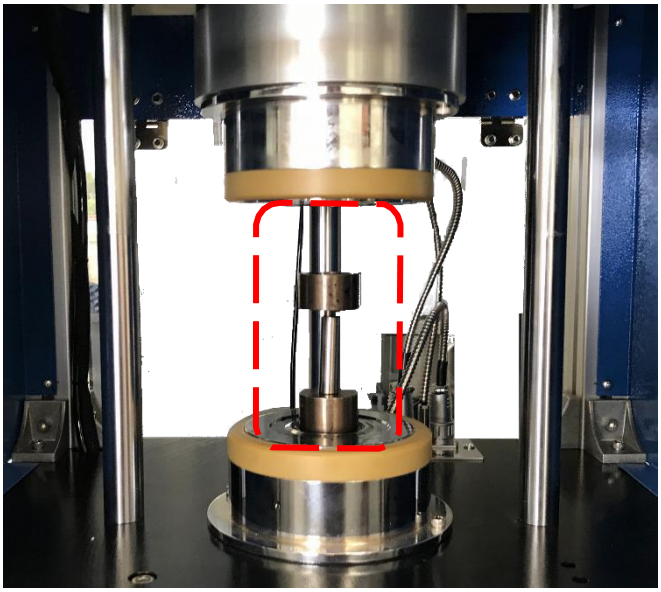


Figure 37 shows the correct position of Torque Standard for Calibrate

7.1.10) Press 

button for close the front panel and move the upper plate press the Torque Standard as Figure 38.

Figure 38 shows the position of upper plate when press down

7.1.11) Then the machine will start to warm up Torque Standard. The screen as Figure 39 will be displayed.

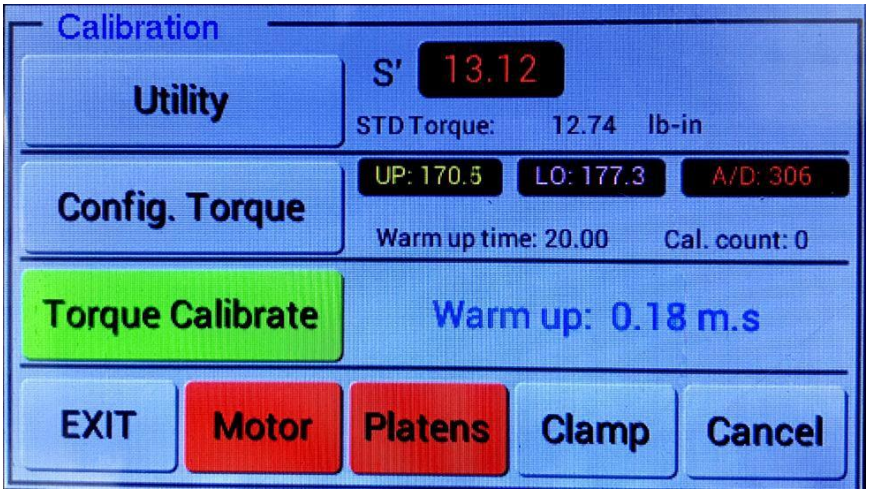


Figure 39 shows the screen while warming up

7.1.12) When Torque Standard warm up is completed then the machine will start Calibrate. After Calibration is finished, the screen as Figure 40 will be displayed.

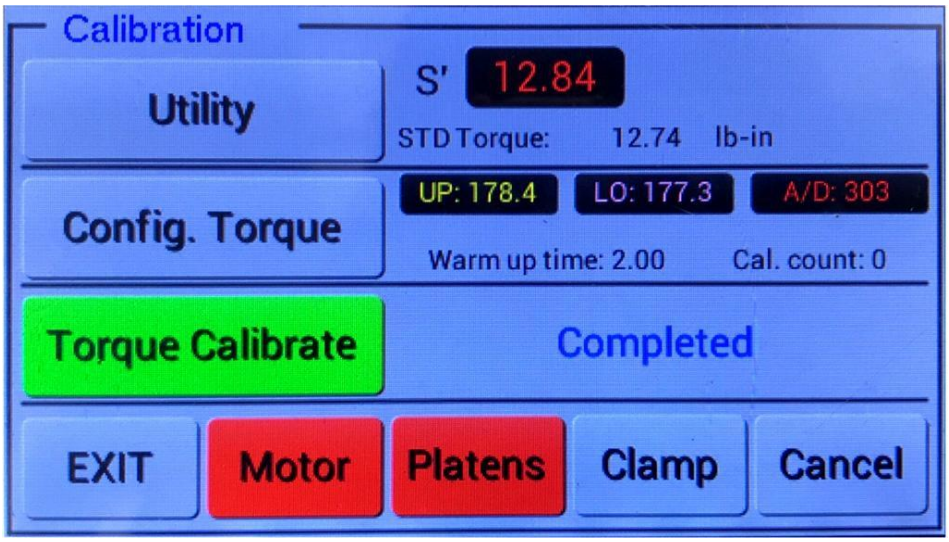


Figure 40 shows the screen when calibrated the sensor completely.

7.1.13) Press 

for stop the motor.

7.1.14) Press 

for open the front panel and lift the plate up.

7.1.15) Move the Torque Standard carefully as figure 41 **Due to remaining high temperature.**

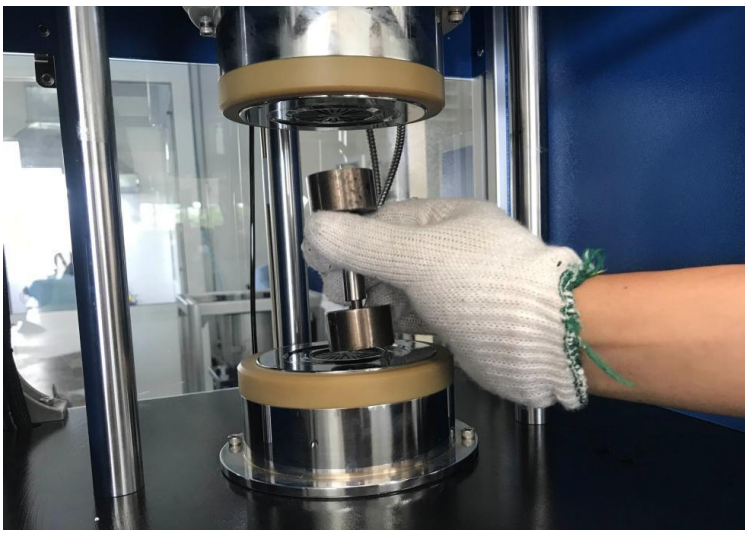


Figure 41 shows how to move Torque Standard out of MDR-01

7.1.16) Press 

for returns to main screen.

7.2 Calibrate Temperature of MDR-01

Calibrate Temperature of MDR-01 must be used by an experienced engineer.

8. Basic Maintenance of the MDR-01

MDR-01 using, required maintenance from user. In order to test effectively and provide test results accurately. The basic maintenance steps as follows;

8.1 Loosen 2 screws as shown in Figure 42

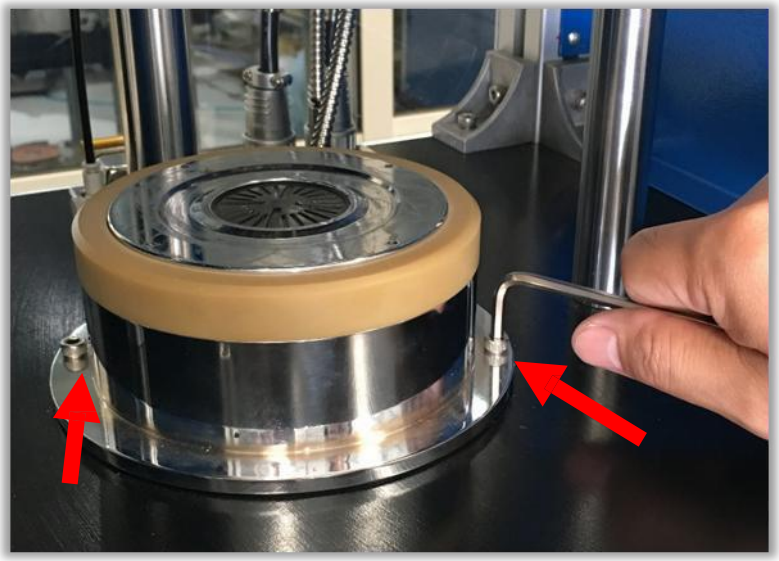


Figure 42 shows removal Cover from the Lower Die by remove 2 screws

8.2 Remove Cover from the Lower Die for cleaning, as Figure 43.

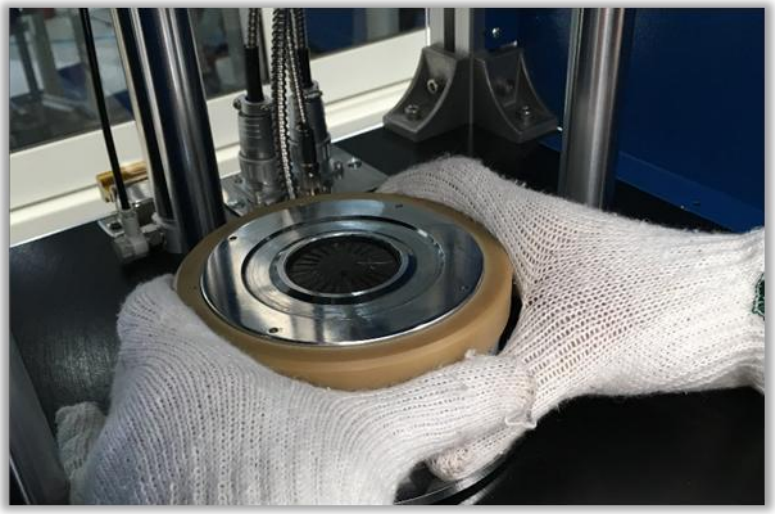


Figure 43 shows the removal Cover from the Lower Die

8.3 Use a brass wire brush to clean the lower die, as shown in Figure 44.

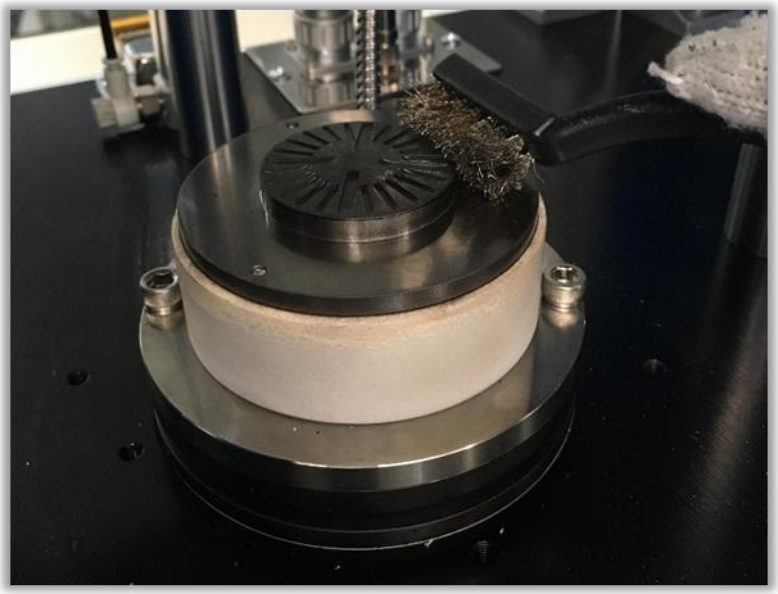


Figure 44 shows the cleaning of the lover die

8.4 Use a sharp steel rod to replace the old O-ring from Cover of the lower die, as shown in Figure 45.

Figure 45 shows replacement the old O-ring from Cover of the lower die

8.5 Cleaning the O-ring groove in Cover Lower Die.

8.6 Replace the original O-ring with a new one, as shown in Figure 46.

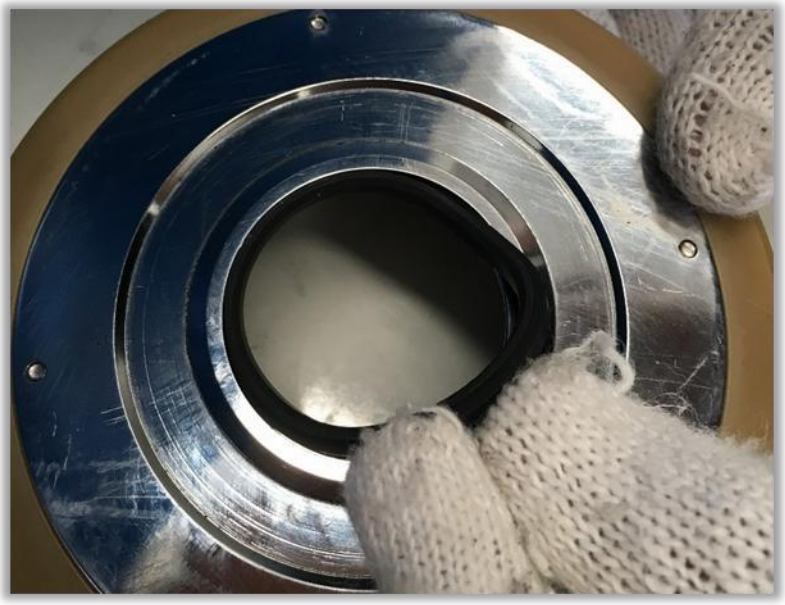


Figure 46 shows replacement the original O-ring with a new one

8.7 Use Jig for supporting O-ring replacement as Figure 47.

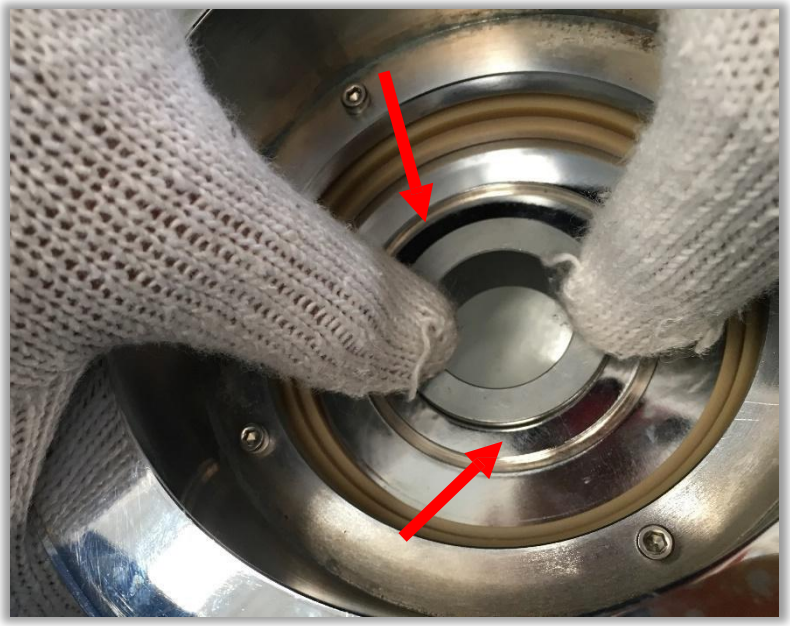


Figure 47 shows using Jig for supporting O-ring replacement

8.8 Place Cover into the Lower Die by pressing Cover until it set in position. Jig is pushed up as figure 48.

Figure 48 shows the assembly Cover after replacement O-ring

8.9 After remove Jig, Tighten the screws to secure Cover, as Figure 49.

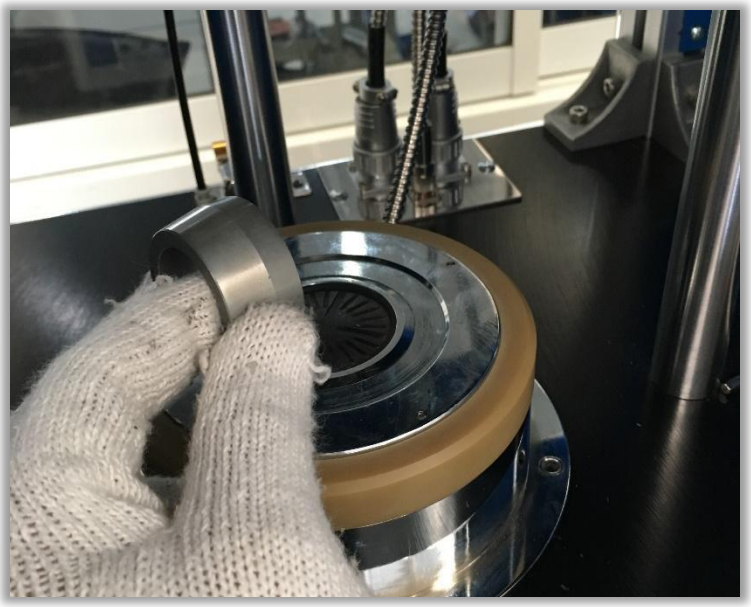


Figure 49 shows removal Jig from O-ring

8.10 Replacement Cover from O-ring of Upper Die with the same method as the Lower Die (No. 8.1-8.9) as Figure 50.

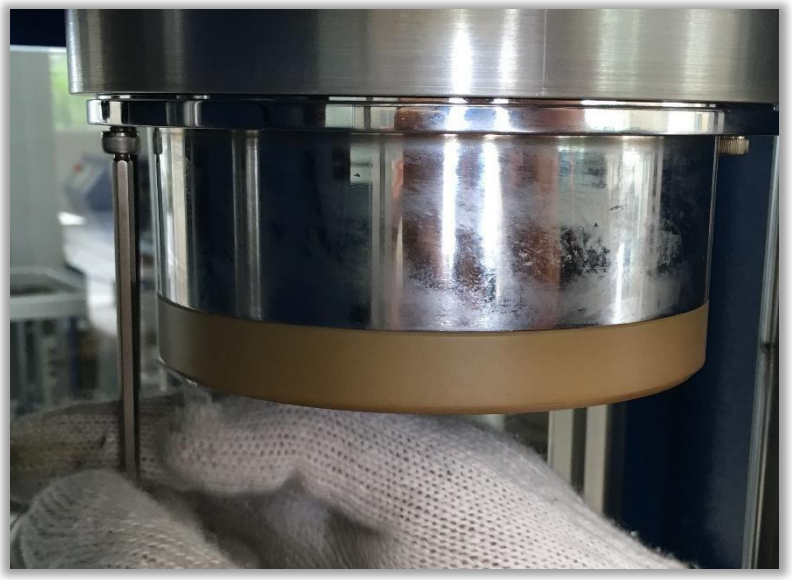


Figure 50 shows removal Cover from the Upper Die by remove screws.

Notes:

1. Clean the upper and lower with a brass wire brush, at least once per day.
2. By using 8 hours / day, the O-ring should be replaced once per 3 months.
   (Frequency of change depends on the number of hours of use per day.)