



RM100P

Operating instructions



LAMYRHEOLOGY

_ viscosimètres

_ rhéomètres



CE CERTIFICATE OF CONFORMITY

Directive CEM 2004/108/CEE

Conformity of viscometers and rheometers :

BLACK ONE – FIRST RM – RM100 – RM200 – RM300

Verified according to the EN 55011 standard.

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1- Including parts in RM100P Viscometer

- 1- Electronic Measuring Head
 - Control box with display and keyboard
 -
- 2- Power supply with cable
- 3- Plastic case with foam-rubber setting
- 4- All parts listed in the customers order (joined to this package)

2-Introduction

Viscosity

Viscosity is the capacity of a product to resist to the flow – by the way of a **Shear stress** (force by surface unit) – to a given **Shear rate** (speed which the sample is submitted).

Influence of Temperature

Viscosity depends for a great influence of the temperature, then it must be essential that all viscosity values are associated to a reading of the sample temperature, in order to compare viscosity for different samples.

Viscosity measurement

We impose to the fluid a certain **shear rate**, and we measure **The resistant Torque**. Those two values enables to calculate the viscosity value, with standard curves or coefficients related to the measuring systems used.

Different substances

There are some products for which the viscosity, to a constant temperature, stay unchanged, even if we change the shear rate. Those samples are named **Newtonian fluids**, i.e. : Oils, Water, Glycerol, etc...However, many substances have a variation of viscosity in function of speed of shearing, and the Flow Behaviour of those samples could be determined only with the help with measuring instruments with many speeds of rotation.

PRINCIPLE of MEASUREMENT

The **RM100P** viscometer is constituted with a continuous current motor with an optical encoder, in order to warranty a great accuracy of the speed of rotation of bob, on all torque range.

The viscometer has a very easy back-lighted display reading , on which you could read **Temperature** from the Pt100 sensor, the **Speed, Measuring spindle** reference, the measured torque and the dynamic **viscosity** in **mPa.s (=cPoises) (or Pa.s)**

3- Installation and Measure

- For the first using ,Connect the power supply box to the instrument and let it connected for loading the battery during 4 hours.

3.1- Zero Adjustment

- **In the air and without measuring spindle,**
- To press **simultaneously (AT THE SAME TIME)** on the **ON** and « **0** » keys,
- The RM100 turns to a predined speed of rotation for this zero adjustment.

On the display, you read :

**Zero adjustment
on the air,
Please, wait.**



This zero adjustment enables to avoid the motor frictions, which could appears in the time.

IMPORTANT :

Do not disturb the RM100p during this adjustment.
This adjustment does NEVER be made IN A SAMPLE .

This adjustment could be made :

- After a transport,
- Before a verification of the instrument ;

This adjustment doesn't be made before each measurement

3.2- Start of measurement

Press **ON**.

- choose the measure type :

display shows :

Temp= 23.1°C

Direct measure
Manual

E = enter

3.2.1- direct measure:

- if you want to the same measure than the last one, press « **E** »,
- you can change the sample number if you want.

3.2.2- Manual :

a- choose the measuring system with arrows and enter it

Temp= 23.1°C

MS : 12

↑↓ Choice

E enter

b- Choose the shear rate with arrows and enter it:

D = 100 s⁻¹
 ↑↓ Speed choice
 E enter

c- choose the measuring time in seconds :

at the end of this time the display will be fixed on the last value .

Measuring time : 60 s
 ↑↓ Time choice
 E enter

d- Print interval : (Optional)

TO SELECT IT PRESS SIMULTANEOUSLY “E” and “ON”, ENTER THE CODE “↑” “E” “↓” “←---”
 AND SELECT “menu impression”, THEN “YES”:

If you want to print values , connect a printer with a centronics parallel interface and select a print interval in seconds

Interval : 5 s
 ↑↓ Interval choice
 E enter

In this case there will be a printing every 5 seconds.

e-date :

To enter eventually a date , on following format: Day (JJ), Month (MM) and Year (AA).

The above date stay in memory, if you want to change, just modify the value that have changed and valid with “E”.

f-Sample reference:

If you want to add a sample reference, to be printed or transferred, you could adjust with the alphanumeric keyboard and the arrows ↑ ↓ to choose the characters, and select with “0” and valid finally with “E”.

4- Calibration and Adjustment

The adjustment and calibration of this viscometer is usually carried out by the manufacturer (LAMY RHEOLOGY) before the first sending to the customer, and with a frequency to define by the user. The measuring principle of the first RM, **without spring**, has no drift in the time, then the **frequent adjustment is not really necessary**. The **calibration, made on Newtonian, and stable oil by the user is sufficient to verify the measuring chain**: viscometer + bob + Pt100 sensor and if the result of this calibration isn't OK, then an adjustment could be decided.

5 – Choice of rotational speed and spindle

Choose the rotational speed-spindle combination taking into account the value of viscosity to be measured, the desired precision and the velocity gradient. It is necessary to make this choice in such a way that no measurement corresponds to less than 0.05 mNm or more than 29.5 mNm of full-scale deflection. However, for the best accuracy it is advisable to choose the speed-spindle couple that it gives the highest torque. But you could decide to work with a lower accuracy to respect the same measuring conditions like another sample, above all you measure some non-Newtonian fluids, and start the reading from 0.01 mNm.

6- Procedure of measurement

Mount the viscometer on its stand. Fill the beaker with the right volume (function of used cup, see tables hereafter) of sample to be tested, taking care not to introduce air bubbles, hang the cup to the head, then place it in the bath or the CT (if you have one) for a sufficient time to reach the desired temperature. If the product contains volatile matter or is hygroscopic, take care to close the beaker tightly during this operation.

Wait until the temperature of the sample is between the prescribed limits. Start the motor and run at the desired rotational speed.

Start the rotation, until the displayed value become stable, or impose a measuring time if the sample has a viscosity which decrease during time: thixotropic samples.

7- ASTM / ISO 2555 Standard

- Scope and field application:

This international Standard specifies a method of determining an apparent viscosity of sample, using a rotational viscometer.

The viscometer used must measure from 0.02 Pa.s (20 cP) to 470 000 Pa.s (470×10^6 cP).

- Principle:

A spindle of cylindrical or related form (disc), is driven by a motor at a constant rotational frequency in the product being studied.

The resistance exerted by the fluid on the spindle, which depend on the viscosity of the product, **causes resisting torque on the motor, measured by a current (mA)**, directly related to the dynamic viscosity of sample.

The apparent viscosity is obtained by multiplying this value by a coefficient which depends on the rotational frequency and characteristics of the spindle.

This coefficient is inside the memory of the RM100p and it is selected when you choose the spindle reference before the test.

The products to which this international Standard is applicable are generally non-Newtonian and the measured viscosity depends on the velocity gradient to which the products are subjected during the measurement.

With these types of spindles, the velocity gradient is not the same for every point of the spindle. Thus, for a non-Newtonian fluid, the result is not strictly the true "viscosity at a known velocity gradient" and therefore is conventionally called the apparent viscosity.

Apparatus:

The rotative viscometer RM100P, cover the complete necessary torque range, from 0 to 30 mNm.

It turns at 34 rotational speeds:

0.3 \ 0.5 \ 0.6 \ 1 \ 1.5 \ 2 \ 2.5 \ 3 \ 4 \ 5 \ 6 \ 10 \ 12 \ 20 \ 30 \ 40 \ 50 \ 60 \ 100 \ 200 \ 250 \ 300
\ 400 \ 500 \ 600 \ 700

\ 800 \ 900 \ 1000 \ 1100 \ 1200 \ 1300 \ 1400 \ 1500 rpm

MS ASTM-ISO2555 n°1 -7



- Procedure of measurement in ASTM Standard:

Mount the viscometer on its stand. Fill the beaker with 500 ml of sample to be tested, taking care not to introduce air bubbles, then place it in the bath (if you have one) for a sufficient time to reach the desired temperature. If the product contains volatile matter or is hygroscopic, take care to close the beaker tightly during this operation.

With the beaker still in the bath (or in room temperature), hold the spindle at the head of instrument, and immerse it in the product. Take care to bubbles appears under the disc !

Adjust the position of viscometer in the sample, in order the sample immerse the rod of bob until the level mark on the shaft, and the Pt100 sensor is immersed too. Be careful that the end of the bob is more than 10 mm from the bottom of the beaker.

Wait until the temperature of the sample is between the prescribed limits. Start the motor and run at the desired rotational speed.

You must choose the spindle in function of the viscosity you would to measure:

- **For a low viscosity measurement, choose the ASTM 2, and turn at a high speed 100 rpm for example.**
- **For a High viscosity measurement, choose the ASTM 7, and turn at a low speed 1 rpm for example.**

Maximum Viscosity (Pa.s) value according to speed and ASTM /ISO 2555 spindle

Speed rpm	Spindle number						
	Astm1	Astm2	Astm3	Astm4	Astm5	Astm6	Astm7
1500	0.278	1.113	2.782	5.564	11.13	27.82	111.3
1400	0.298	1.192	2.980	5.961	11.92	29.80	119.2
1300	0.321	1.284	3.210	6.420	12.84	32.10	128.4
1200	0.347	1.391	3.477	6.955	13.91	34.77	139.1
1100	0.379	1.517	3.793	7.587	15.17	37.93	151.7
1000	0.417	1.669	4.173	8.346	16.69	41.73	166.9
900	0.463	1.855	4.636	9.273	18.55	46.36	185.5
800	0.521	2.086	5.216	10.43	20.86	52.16	208.6
700	0.596	2.385	5.961	11.92	23.85	59.61	238.5
600	0.695	2.782	6.955	13.91	27.82	69.55	278.2
500	0.834	3.339	8.346	16.69	33.39	83.46	333.9
400	1.043	4.173	10.43	20.86	41.73	104.3	417.3
300	1.391	5.565	13.91	27.82	55.65	139.1	556.5
250	1.669	6.678	16.69	33.38	66.78	166.9	667.8
200	2.086	8.347	20.86	41.73	83.47	208.6	834.7
100	4.173	16.69	41.73	83.46	166.9	417.3	1669
60	6.955	27.82	69.55	139.1	278.2	695.5	2782
50	8.346	33.39	83.46	166.9	333.9	834.6	3339
40	10.43	41.73	104.3	208.6	417.3	1043	4173
30	13.91	55.65	139.1	278.2	556.5	1391	5565
20	20.86	83.47	208.6	417.3	834.7	2086	8347
12	34.77	139.1	347.7	695.5	1391	3477	13912
10	41.73	166.9	417.3	834.6	1669	4173	16695
6	69.55	278.2	695.5	1391	2782	6955	27825
5	83.46	333.9	834.6	1669.2	3339	8346	33390
4	104.3	417.3	1043	2086	4173	10432	41737
3	139.1	556.5	1391	2782	5565	13910	55650
2.5	166.9	667.8	1669	3338	6678	16692	66780
2	208.6	834.7	2086	4173	8347	20865	83475
1.5	278.2	1113	2782	5564	11130	27820	111300
1	417.3	1669	4173	8346	16695	41730	166950
0.6	695.5	2782	6955	13910	27825	69550	278250
0.5	834.6	3339	8346	16692	33390	83640	333900
0.3	1391	5565	13910	27820	55650	139100	556500

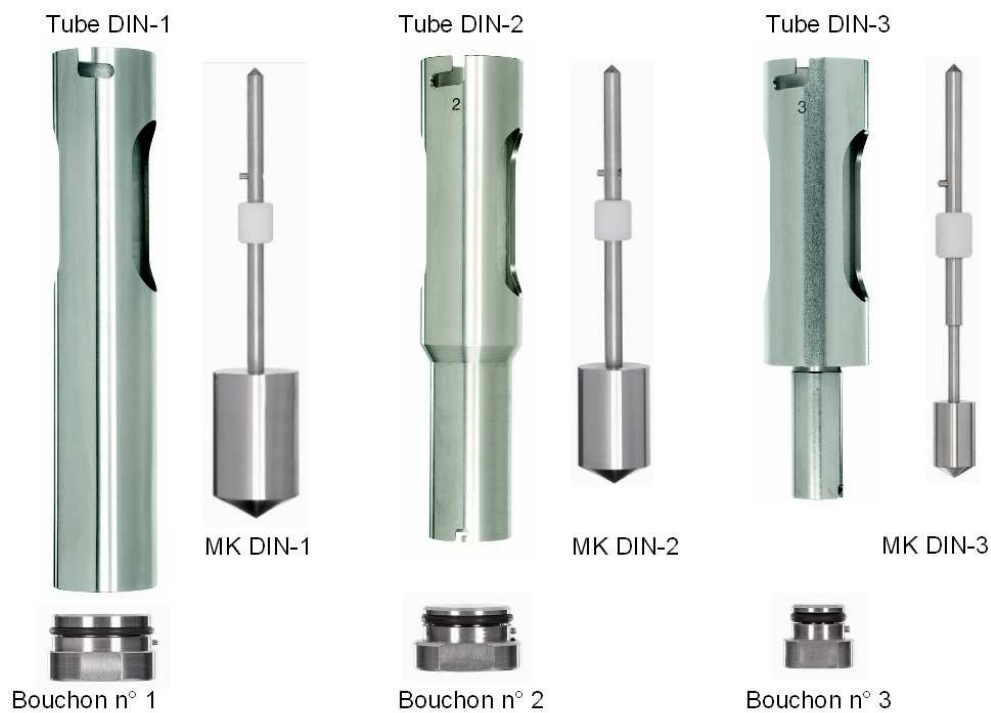
With this system , the speed N is expressed in rpm and not in s-1 because a shear rate can't be calculated.

Additional accessories :

Beaker, 90 to 92 mm diameter and 115 to 160 mm height is recommended to correspond to this Standard. **The normal volume of a such vessel is 600 ml .**

8. DIN / ISO 3219 systems

MS – DIN 11, 22, 33



Maximum Viscosity (Pa.s) value according to speed and Systems DIN / ISO 53 019

Speed rpm	Spindle number											
	DIN11		DIN22		DIN33		DIN19		DIN12		DIN13	
	D s-1	Eta max Pa.s	D s-1	Eta max Pa.s	D s-1	Eta max Pa.s	D s-1	Eta max Pa.s	D s-1	Eta max Pa.s	D s-1	Eta max Pa.s
1500	1936	0.2	1936	0.4	1936	2	4834	0.075	531	1.09	228	8.47
1400	1807	0.215	1807	0.43	1807	2.15	4512	0.08	496	1.17	213	9.08
1300	1678	0.23	1678	0.46	1678	2.3	4190	0.09	460	1.26	198	9.78
1200	1549	0.25	1549	0.5	1549	2.5	3868	0.097	425	1.37	182	10.59
1100	1420	0.275	1420	0.55	1420	2.75	3545	0.106	389	1.5	167	11.56
1000	1291	0.3	1291	0.6	1291	3	3223	0.117	354	1.64	152	12.71
900	1162	0.33	1162	0.67	1162	3.35	2901	0.13	319	1.83	137	14.12
800	1033	0.375	1033	0.75	1033	3.75	2578	0.146	283	2.05	122	15.89
700	904	0.42	904	0.85	904	4.25	2256	0.167	248	2.35	106	18.16
600	775	0.5	775	1	775	5	1934	0.195	212	2.74	91.2	21.18
500	645.5	0.6	645.5	1.2	645.5	6	1611	0.234	177	3.29	76	25.42
400	516.4	0.75	516.4	1.5	516.4	7.5	1289	0.29	142	4.11	60.8	31.78
300	387.3	1.0	387.3	2	387.3	10	967	0.39	106	5.48	45.6	42.37
250	322.8	1.2	322.8	2.4	322.8	12	806	0.47	88.5	6.57	38	50.84
200	258.2	1.5	258.2	3	258.2	15	645	0.58	70.8	8.22	30.4	63.55
100	129	3	129	6	129	30	322	1.17	35.4	16.44	15.2	127.1
60	77.5	5	77.5	10	77.5	50	193	1.95	21.2	27.4	9.12	211.8
50	64.5	6	64.5	12	64.5	60	161	2.34	17.7	32.9	7.6	254.2
40	51.6	7.5	51.6	15	51.6	75	129	2.92	14.2	41.1	6.08	317.8
30	38.7	10	38.7	20	38.7	100	96.7	3.9	10.6	54.8	4.56	423.7
20	25.8	15	25.8	30	25.8	150	64.5	5.85	7.08	82.2	3.04	635.5
12	15.5	25	15.5	50	15.5	250	38.7	9.74	4.25	137	1.82	1059.2
10	12.9	30	12.9	60	12.9	300	32.2	11.7	3.54	164.4	1.52	1271
6	7.75	50	7.75	100	7.75	500	19.3	19.48	2.12	274	0.91	2118
5	6.45	60	6.45	120	6.45	600	16.1	23.4	1.77	329	0.76	2542
4	5.16	75	5.16	150	5.16	750	12.9	29.22	1.42	411	0.61	3177
3	3.87	100	3.87	200	3.87	1000	9.67	38.97	1.06	548	0.46	4236
2.5	3.23	120	3.23	240	3.23	1200	8.06	46.76	0.88	657	0.38	5084
2	2.58	150	2.58	300	2.58	1500	6.45	58.45	0.71	822	0.30	6355
1.5	1.94	200	1.94	400	1.94	2000	4.83	78	0.53	1096	0.23	8473
1	1.29	300	1.29	600	1.29	3000	3.22	117	0.35	1644	0.15	12710
0.6	0.77	500	0.77	1000	0.77	5000	1.94	195	0.21	2740	0.09	21184
0.5	0.65	600	0.65	1200	0.65	6000	1.61	234	0.18	3288	0.076	25421
0.3	0.39	1000	0.39	2000	0.39	10000	0.97	390	0.11	5480	0.045	42368

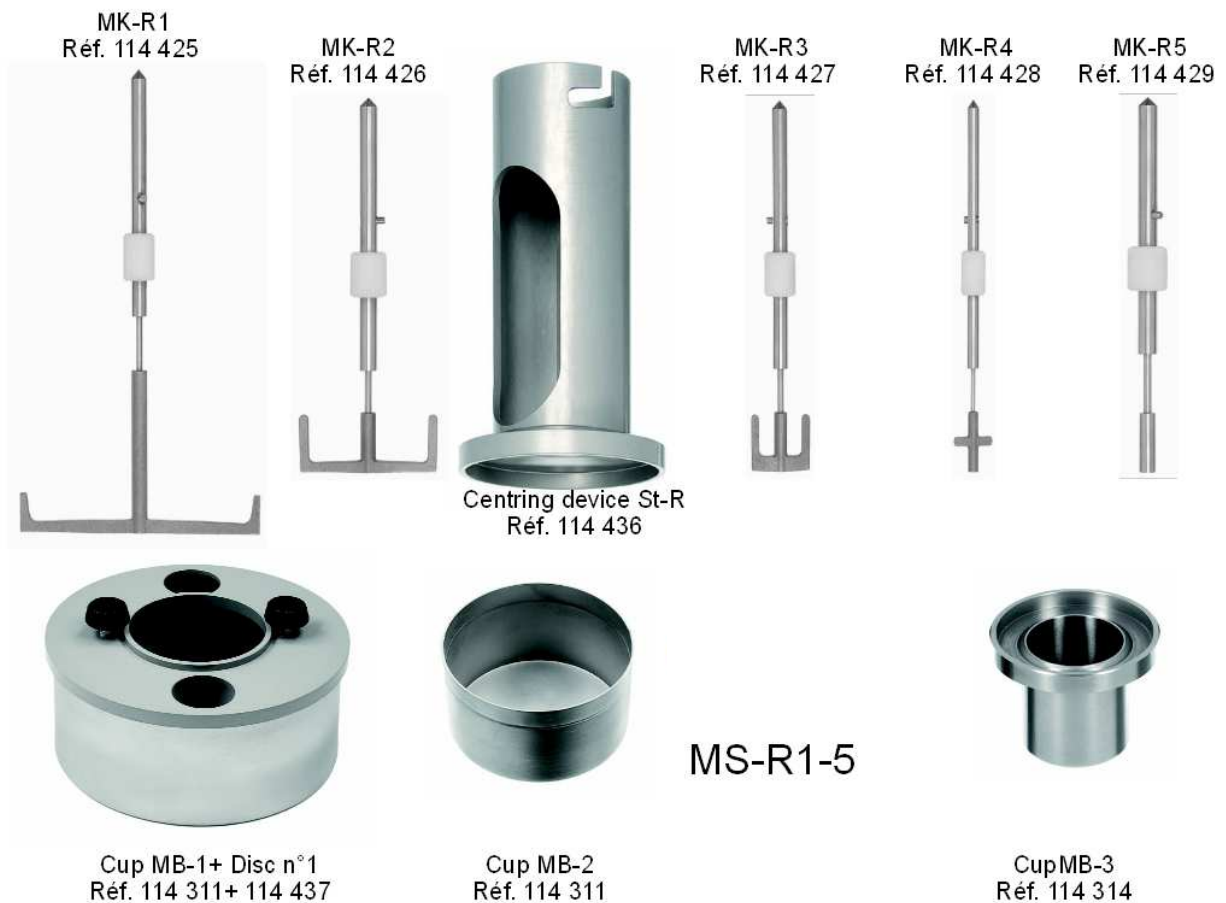
9- Measuring system MSR-1 to 5

- Choose measuring system :75.

-Choose only the speed 200 rpm

- the display value is 0 to 100 UD or %

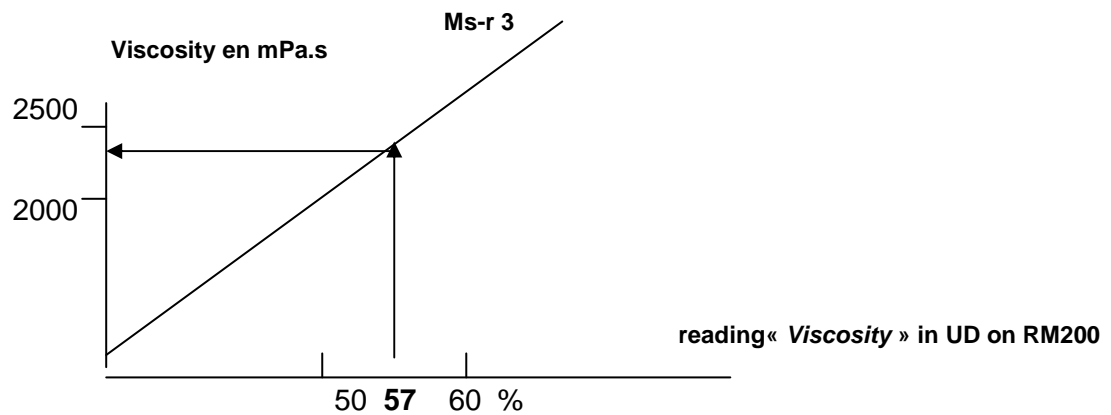
if you want to know the viscosity in mPas you must read the calibration curves.



Measuring system	Shear rate range at 200 rpm	Viscosity range	Filling volume
MS – R1	100 s ⁻¹	1 - 200 mPa.s	320 ml
MS – R2	70 s ⁻¹	40 - 4 000 000 mPa.s	60 ml
MS – R3	60 s ⁻¹	200 - 20 000 000 mPa.s	25 ml
MS – R4	50 s ⁻¹	1000 - 100 000 000 mPa.s	25 ml
MS – R5	20 s ⁻¹	5000 - 510 000 000 mPa.s	25 ml

Example with MS-r3

Every system have a curve for determination of the **Viscosity** :



for example if the reading is 57 (with MS-r3).the viscosity will be 2400 mPas.

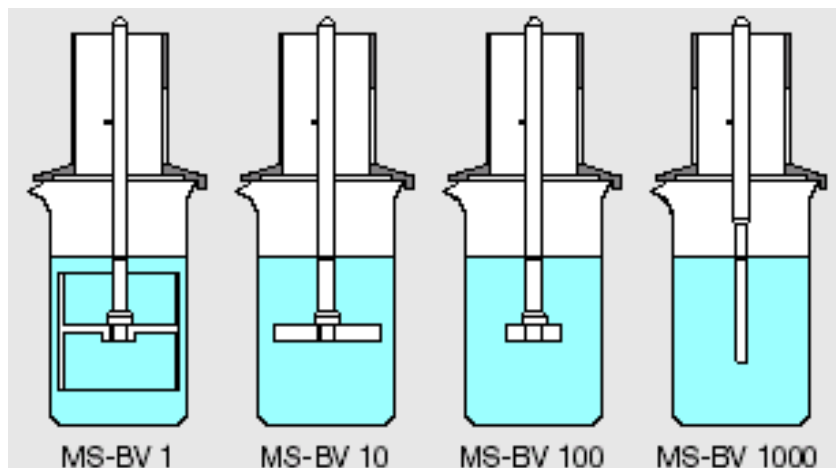
For measuring systems MS-r 3, 4 and 5, you can enter coefficients in the memory in the RM200, for a direct determination of the viscosity in mPa.s. in this case don't choose MS 75, but MS R3, MS R4, or MS R5.

CONTROL of RM100 with water

Measurement of Water at 20° C with MS-R1 system

- 1- Fill the cup MB-1 with 320 ml of water at 20° C.
- 2-Choose the **Measuring system named MS 75**, on **“Manual”** mode on the RM100,
- 3-Select the **speed 200 rpm**;
- 4-The **“VISCOSITY”** reading must be between **29 and 30 UD +/- 1UD**.

10-measuring system MSBV



Shear rate and Viscosity for 5 mN.m according speed

Speed rpm	Measuring system Reference							
	BV1		BV10		BV100		BV1000	
	D s-1	Eta mPa.s	D s-1	Eta mPa.s	D s-1	Eta mPa.s	D s-1	Eta mPa.s
1000	1000	25	500	250	150	2500	100	25000
900	900	27.5	450	275	135	2750	90	27500
800	800	31	400	310	120	3100	80	31000
700	700	35	350	350	105	3500	70	35000
600	600	41	300	410	90	4100	60	41000
500	500	50	250	500	75	5000	50	50000
400	400	62.5	200	625	60	6250	40	62500
300	300	83	150	830	45	8300	30	83000
250	250	100	125	1000	37.5	10000	25	100000
200	200	125	100	1250	30	12500	20	125000
100	100	250	50	2500	15	25000	10	250000
60	60	410	30	4100	9	41000	6	410000
50	50	500	25	5000	7.5	50000	5	500000
40	40	625	20	6250	6	62500	4	625000
30	30	830	15	8300	4.5	83000	3	830000
20	20	1250	10	12500	3	125000	2	1250000
12	12	2000	6	20000	1.8	200000	1.2	2000000
10	10	2500	5	25000	1.5	250000	1	2500000
6	6	4100	3	41000	0.9	410000	0.6	4100000
5	5	5000	2.5	50000	0.75	500000	0.1	5000000

11- Technical features of RM100 P

Measurement Principle : Rotational viscometer

34 rotations speeds : 0.3, 0.5, 0.6, 1,1.5, 2, 2.5, 3, 4, 5, 6, 10, 12, 20, 30, 40, 50, 60, 100, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500 rpm
(accuracy $\pm 0,5$ %)

Torque range : 0 to 30 mN.m (accuracy ± 1 %)

Accuracy : +/- 1% of full scale

Reproducibility : +/- 0.2%

Digital display: Temperature ($^{\circ}$ C), speed (rpm/min) or shear rate (s-1), Torque (mN.m), Dynamic viscosity (mPa.s or Pa.s) or UD .

Temperature by PT100 :

Range from -20° C to $+ 120^{\circ}$ C (display $0,1^{\circ}$ C, precision $\pm 0,2^{\circ}$ C)

Admissible surrounding temperature : $+ 10^{\circ}$ C to $+ 40^{\circ}$ C

Viscosity range of different measuring systems :

MS ASTM ISO 2555	3 mPa.s to 470 000 Pa.s
MS-R 1 à 5	1 mPa.s to 510 000 Pa.s
MS-DIN 11,22,33,19	1 mPa.s to 42 000 Pa.s
MS-C,C2,C4	20 mPa.s to 14 000 Pa.s
MS-Cone-plate CP100	5 mPa.s to 150 000 Pa.s
MS-RT300 Oven	5 mPa.s to 70 000 Pa.s

Power supply : 90-240 Vac 50/60 Hz

Made by :

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