青岛创梦仪器有限公司

Qingdao ChuangMeng Instrument Co., Ltd.

旋 转 粘 度 计
Rotational Viscometer
型号 Model: 1104

使用手册
Instruction Manual

版本 1.0

Version 1.0

请你仔细阅读《使用手册》，正确掌握本产品的安装和使用方法。阅读后请将本《使用手册》妥善保管，以备今后进行检修和维护时使用。

Carefully read this User Manual to learn how to install and use the product correctly. After reading, properly keep the User Manual as a reference for future maintenance and repair.

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Ⅰ.概述 Introduction

1104 型数显旋转粘度计是我公司全新设计的一款新型粘度计。该款粘度计采用嵌入式结构设计，内置高精度角度传感器，采用步进电机驱动，转速更加平稳精确；面板按键标示明晰便于操作，高分辨液晶显示屏可实时显示测试液粘度值以及搅拌速度。

本产品可广泛应用于石油、化工、食品、药品、化妆品等行业和科研单位。

工作原理简介：将盛有待测液的浆杯放置于托盘上，待测液进入粘度计外套筒和浮子之间形成的环形空间(剪切间隙)内，当步进电机带动外套筒旋转时，套筒在待测液中受到粘滞阻力产生反作用力，该作用力会通过环形空间中的待测液对套筒中的浮子产生扭矩，而浮子与一套刻度组件相连，当该扭矩与粘滞阻力达到平衡时，刻度盘组件会稳定在某个刻度值上，由于刻度值与套筒所受的粘滞阻力成正比，因此将该刻度值乘以特定的系数就能得到最终的粘度值，同时显示在液晶屏上以便读取。

剪切速率和粘度值呈线性对应关系，即剪切应力与剪切速率的关系图像为直线。在实际应用时，可能许多流体并不遵循牛顿定律，但是其流变学比较接近牛顿定律，因此仍然可以使用粘度计来测量，而且测得的粘度值也比较准确。1104 型数显旋转粘度计的校准方式是牛顿模式的线性校准，不适用于不符合牛顿线性计算方法的待测样品。在这种情况下，粘度测量以及速度计算应当使用非线性计算方法。

当外套筒、浮子、和扭力弹簧以 300 转/分钟的速率运转时，粘度计的测量单位为厘泊(或毫帕斯卡/秒)。在其他转速下测得的数据需进行一系列乘法转换，本文第六部分会给出假塑流体（例如钻井液）的粘度计算方法。

当选择不同的转速或者使用不同的扭簧-浮子组合时，剪切速率的可选范围可能会改变，为了拓宽剪切应力的范围、测量更多的液体，可以通过更换不同的扭力弹簧来解决。

The Model 1104 digital display rotarional viscometer is a new type of viscometer designed by our company. The viscometer uses embedded structure design, built-in high-precision angle sensor, stepper motor drive, speed more stable and accurate; panel keys clearly marked for easy operation, high-resolution liquid crystal display can real-time display the viscosity of the test solution and stirring speed.

This product can be widely used in petroleum, chemical industry, food, medicine, cosmetics and other industries and scientific research units.

Working Principle: Put the slurry cup with mud on the pallet.The mud enters the annular space (shearing clearance) formed between the outer sleeve and the float of the viscometer. When the stepper motor drives the outer sleeve to rotate, the sleeve will react with viscous resistance in the mud. This force produces torque to the float in the sleeve through the mud in the annular space, and the float is connected to a set of calibration components. When the torque is in equilibrium with the viscous

resistance, the dial assembly will stabilize at a certain scale. Because the scale value is proportional to the viscous resistance of the sleeve, the final viscosity value can be obtained by multiplying the scale value by a specific coefficient and displayed on the LCD screen for reading.

There is a linear relationship between shear rate and viscosity. So the relationship between shear stress and shear rate is linear. In practice, many fluids may not follow Newton's law, but their rheology is close to Newton's law, so viscometers can still be used to measure, and the measured viscosity is more accurate. The calibration method of model 1104 Digital Rotating viscometer is linear calibration in Newton mode. It is not suitable for the samples which do not conform to Newton linear calculation method. In this case, the nonlinear calculation method should be used for viscosity measurement and velocity calculation.

When the standard outer sleeve, floater and torsional spring rotate in 300 rounds/minute, the measurement unit of the viscometer is centipoise (or milli pascal/second). At other rotating speeds, the read data must be conducted a series of simple multiplying conversion. The sixth part will present the calculation method of viscosity of plastic fluids (such as drilling fluid).

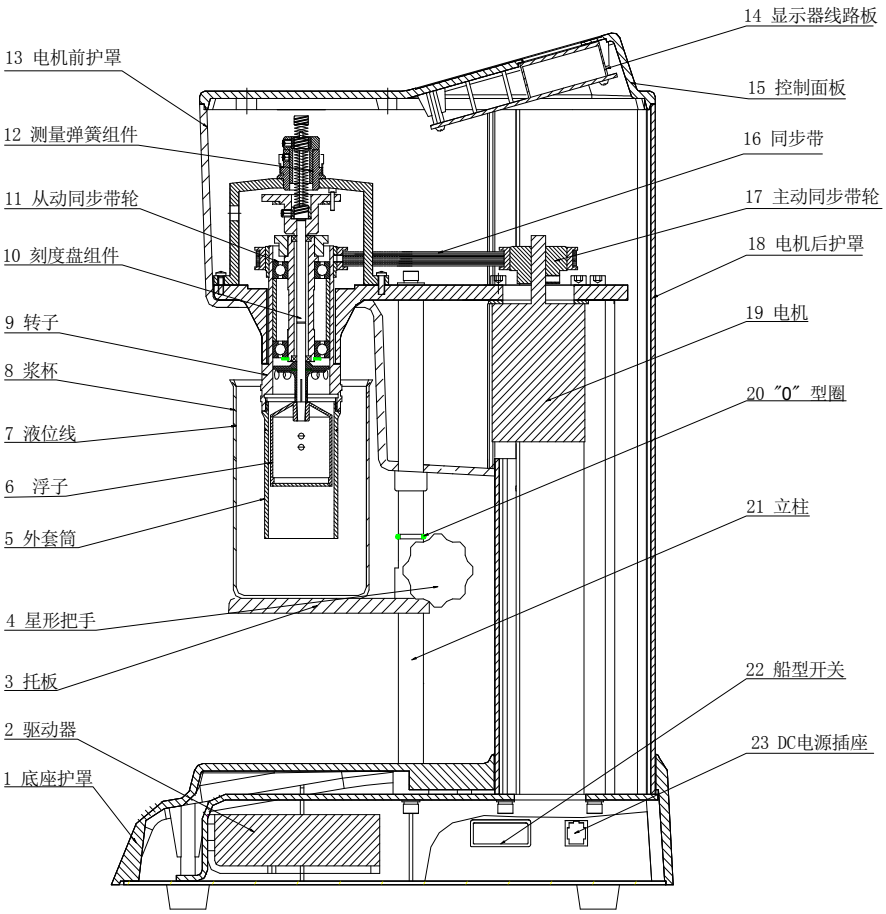
If choosing different rotating speeds or using different combinations of torsional spring-floater, the scope of shearing rate may have some changes. In order to expand the scope of shearing stress and thus measure all sorts of liquids, we have designed different series of torsional springs, which can carry out reciprocal conversion easily.

Ⅱ.型号及规格 Model and specification

1104-6	F1 扭力弹簧测量组件/ F0.2 扭力弹簧测量组件（可选件） F1 Measuring assembly of torsion spring/F0.2 Measuring assembly of torsion spring(option)
1104	F1 扭力弹簧测量组件/ F0.2 扭力弹簧测量组件（可选件） F1 Measuring assembly of torsion spring/F0.2 Measuring assembly of torsion spring(option)

Ⅲ.仪器的主要技术参数 Technical parameter

名称 Name	技术参数 Technical parameter
电源 Power Supply	AC110/220V±5% 50/60Hz
电机功率 Motor power	40W
环境温度 Ambient temperature	≥20±5℃
环境湿度 Ambient humidity	45%RH～60%RH
电机转速 Motor speed	720 r/min
变速范围 Rotary speed range	1、2、3、6、10、20、30、60、100、200、300、600r/min
测量精度 Measurement accuracy	±0.1 mPa.s （牛顿流体 Newtonian fluid）
粘度测量范围 Viscosity measurement range	**牛顿流体 Newtonian fluid：** 0～300mPa.s (F1 测量组件) 0～60mPa.s (F0.2 测量组件) **非牛顿流体 Non Newtonian fluid:** 0～150 mPa.s (F1 测量组件) 0～30 mPa.s (F0.2 测量组件) **剪切应力 Shear stress：** 0～153.3Pa (F1 测量组件) 0～30.7Pa (F0.2 测量组件)



图（Ⅰ）1104 数显旋转粘度计结构图

Structure diagram of digital display rotary viscometer

序号 No	名称 Name	序号 No	名称 Name	序号 No	名称 Name
1	底座护罩 Base cover	9	转筒 Rotor	17	主动同步带轮 Active synchronous pulley
2	驱动器 Driver	10	刻度盘组件 Dial assembly	18	电机后护罩 Rear shield
3	托板 Supporting plate	11	从动同步带轮 Driven synchronous pulle	19	电机 Electric machinery
4	星形把手 Star grip knob	12	测量弹簧组件 Measuring spring assembly	20	"0"型圈 "0"-ring
5	外转筒 Outer sleeve	13	电机前护罩 Front shield	21	立柱 Upright column
6	内转筒 Floater	14	显示器线路板 Display circuit board	22	船型开关 Rocker switch
7	液位线 Liquid level line	15	控制面板 Control panel	23	DC 电源插座 DC power socket
8	浆杯 Slurry cup	16	同步带 Synchronous pulley		

Ⅳ.安全原则 Safety principle

1. 安全操作

***警告：*操作人员必须熟知仪器的操作流程，同时了解可能存在的潜在危险。此仪器可用 100 伏至 240 伏的电源供电。务必保持双手、衣服和其他物品远离仪器的旋转部分。**

本粘度计可选用电加热器对样品进行加热。通电前需确保加热体与待测样品充分接触，并保证已接地。

在进行维护保养时，一定要关闭粘度计并拔掉电源。如果待测液溢出，请用软布擦拭干净。严禁直接用水清洗，严禁将水倒进机座，以免损坏电器元件。

2. 样品温度

本粘度计不可测试温度高于 93℃的样品。

3. 可选加热器的安全操作

当使用加热器加热待测液时，请务必防止待测液受热溅出。严禁用手直接触摸加热器。加热器的加热温度不得超过 93℃。

1. Safe operation

Warning: Operators must be familiar with the operation process of the instrument and understand potential hazards. The instrument can be supplied from 100 V to 240 V. Be sure to keep your hands, clothes and other articles away from the rotating parts of the instrument.

The viscometer can be heated by electric heater. Before heating, ensure that the heating body is fully contacted with the sample to be tested, and ensure that the ground is grounded.

During maintenance, it is necessary to turn off the viscometer and unplug the power supply. If the liquid is overflowing, wipe it with a soft cloth. It is strictly prohibited to clean directly with water. It is strictly prohibited to pour water into the frame so as not to damage

electrical components.

2.Sample temperature

The viscosimeter can not test samples with temperatures above 93 degrees.

3.Safe operation of optional heater

When heating the liquid to be tested with the heater, make sure that the liquid is heated and spilled. It is strictly forbidden to touch the heater directly with your hands. The heating temperature of the heater must not exceed 93 C.

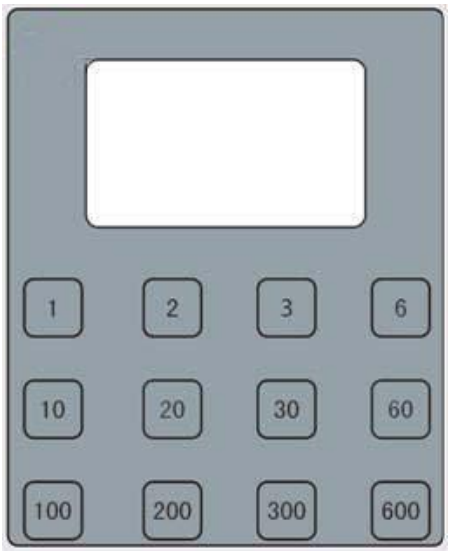
Ⅴ.粘度测试Viscosity test

向浆杯中注入待测液，使液体达到杯体上的刻度线（350ml）处。将浆杯放置于托盘上，待测液进入旋转套筒，此时套筒上的液位线能够指示浸入深度。如果浸入深度超过最大值,可能会对浮子的轴承造成破坏。如果使用其他样品容器，外套筒底部与容器底部的距离应当大于等于1.27㎝。

1104型数显旋转粘度计有12种转速可以调节,调节范围从1转/分钟到600转/分钟。使用时先接通电源，然后通过控制面板（图Ⅱ）上的数字键选择所需的转速，通过液晶显示屏可实时查看转速和粘度值。

The liquid is injected into the slurry cup to make the liquid reach the scale line (350ml) on the cup body. Place the slurry cup on the tray and the liquid to be measured enters the rotary sleeve, where the level line on the sleeve can indicate the immersion depth. If the immersion depth exceeds the maximum value, it may cause damage to the bearing of the float. If other sample containers are used, the distance between the bottom of the outer sleeve and the bottom of the container should be greater than or equal to 1.27cm.

Model 1104 digital rotary viscometer has twelve rotational speeds, ranging from 1 to 600 rpm. When used, the power supply is switched on first, and then the required speed is selected by the digital key on the control panel (Fig. II). The speed and viscosity can be real-time viewed through the LCD screen.



图（Ⅱ）1104 数显旋转粘度计面膜 Digital display rotary viscometer panel

转速（转/分钟）RPM	1104
600	√
300	√
200	√
100	√
60	√
30	√
20	√
10	√
6	√
3	√
2	√
1	√

表（Ⅱ）1104 数显旋转粘度计测试速度
Digital display rotational viscometer test speed

Ⅵ.外套筒、浮子和扭力弹簧 Outer sleeve, float and torsion spring

R1-B1-F1 组合适用于所有类型的粘度计，为了计算待测样品的剪切速率，可能也会使用其它的组合方式。当某些组合方式会使剪切应力的读数出现较大误差，这种组合方式不符合要求不能选用。

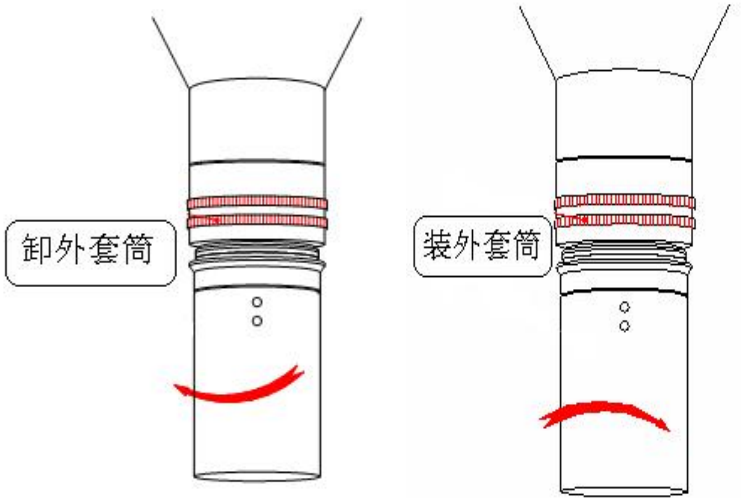
The R1-B1-F1 combination is suitable for all types of viscometers, and

other combinations may be used to calculate the shear rate of the sample to be measured. When some combinations make the reading of shear stress more erroneous, the combinations can not be selected if they do not meet the requirements.

1.外套筒的拆除与安装 Removal and installation of outer sleeve

依照图III所示可以对外套筒进行装卸，安装时注意应使其旋转到最高位置。

According to figure III, the outer sleeve can be loaded and unloaded. Attention should be placed to the highest position when installing.



图（III）外套筒的拆装 Removal and installation of outer sleeve

2.浮子的拆除与安装 Removal and installation of float

拆除浮子时，向下拉浮子，同时逆时针旋转；安装浮子时，向上推浮子，同时逆时针旋转。

When the float is removed, the float is pulled down and rotated counterclockwise; when the float is installed, the float is pushed up and rotated counterclockwise.

3.扭力弹簧的拆装 Removal and installation of torsion spring

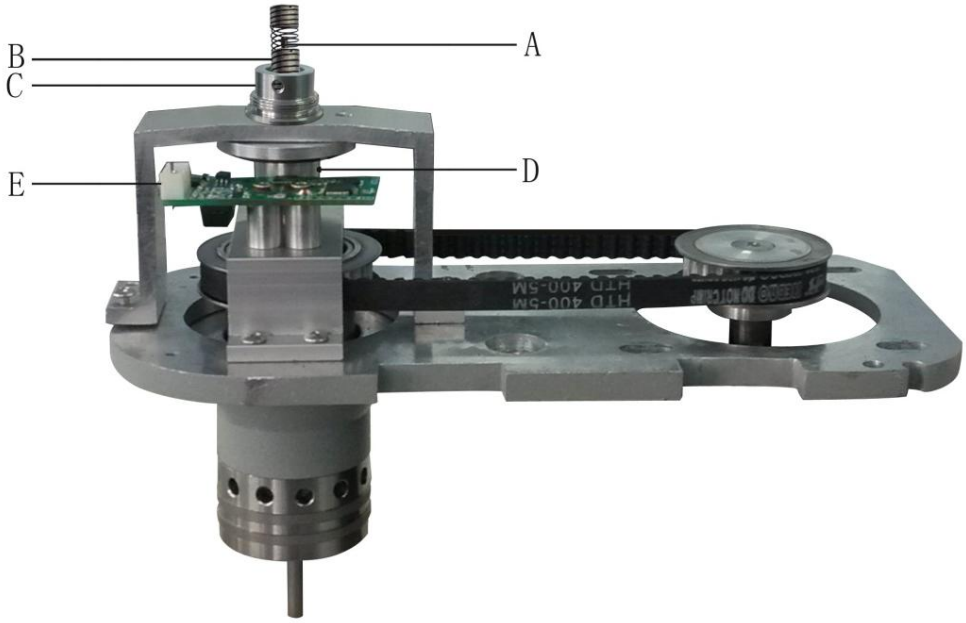
拆卸弹簧时，参照图Ⅳ将螺钉 C 和 D 卸下后可以拆除弹簧；安装弹簧时将弹簧定好位后拧紧螺钉 C 和 D 即可。注意不要用力拉伸弹簧，防止超出弹性极限导致

弹簧损坏。在螺钉 C 和 D 拧紧之前要轻压或轻拉弹簧，以确保调节芯轴 A 的顶部高出弹簧钮结 B 的顶部。螺钉 D 要和弹簧钮结 B 固定在一起。

注意：下图所示 E 为高精度角度传感器电路板，拆装时注意保护。

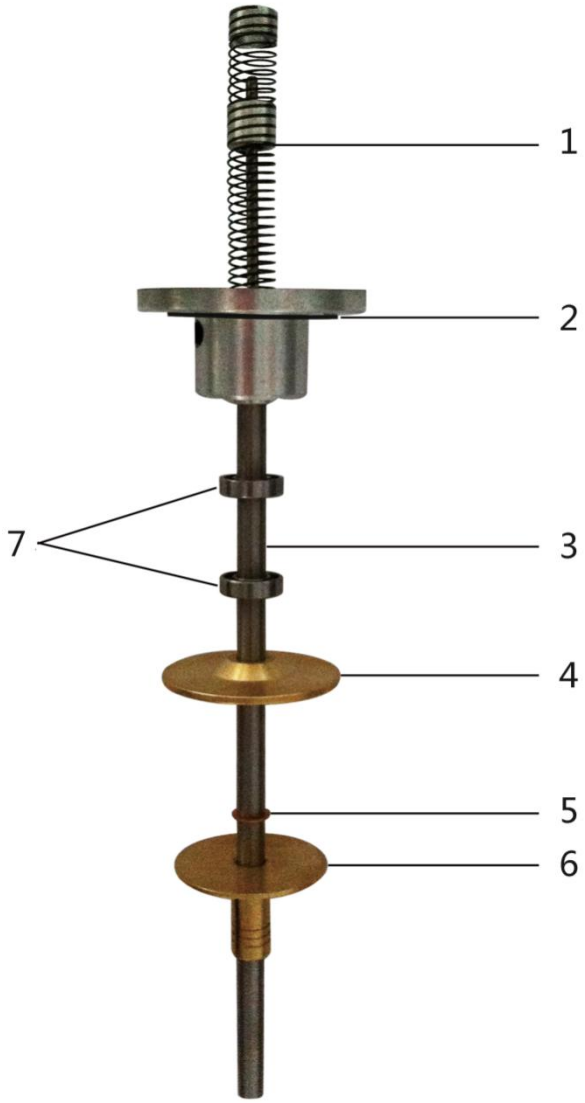
When the spring is removed, the bolts C and D can be removed after removing them with reference to Fig. IV. When the spring is installed, the bolts C and D can be tightened after the spring is positioned. Be careful not to stretch the spring to prevent spring damage from exceeding the elastic limit. Before screws C and D are tightened, press or pull the spring gently to ensure that the top of the adjusting mandrel A is higher than the top of the spring knob B. The screw D should be fixed together with the spring knob B.

Note: the E shown in the following figure is a high-precision angle sensor circuit board. Attention should be paid to protection during assembly and disassembly.



图（Ⅳ）扭力弹簧的拆装Removal and installation of torsion spring

图（Ⅴ）静负载校准装置Static load calibration device



1.测试弹簧组件 Measuring spring assembly	2.磁环 Magnetic ring	3.浮子轴 Float pin
4.轴承盖 Bearing cap	5.轴用挡圈 External retaining ring	6.档泥板 Splash guard
7.轴承 Bearings		

图（VI）扭力测试组件 Torque test assembly

Ⅶ.仪器校准 Instrument calibration

本粘度计应当定期保养和校准，可通过向浮子轴施加扭矩的方法来进行校准。通过定期保养和校准及时发现问题，使仪器保持准确的测量精度。校准方法有两种：

The viscometer shall be regularly maintained and calibrated by applying torque to the float shaft. Through timely maintenance and calibration, problems can be found in time, so that the instrument can maintain accurate measurement accuracy. There are two ways to calibrate:

A.静负载校准 Static load calibration

静负载校准方式操作简便，当对弹簧进行调整时，其调整结果能够方便的得到证实。静负载校准工具为 NLJ-A 型扭簧测力计（图Ⅴ），以下为校准流程说明：

1)卸下外套筒，将浮子逆时针方向旋转并向上推（浮子与浮子轴锥度配合），装上浮子。

2)取一段没有弹性的细丝线，用胶纸将丝线的一端固定在浮子的表面，然后将丝线逆时针绕浮子表面缠绕 2～3 圈，丝线的另一端通过专用测力架或水平的固定轮后，在这一端系上挂钩。

3)参照表Ⅲ选取合适的重量。

4)根据需要，调整扭力弹簧。可参照“Ⅵ.外套筒、浮子和扭力弹簧”章节中的 C“扭力弹簧的拆装”部分。

本仪器配套的 F1 弹簧的公差有两种：50 克的为 127±0.5 mPa·s ，100 克的为 254±0.5 mPa·s。当主轴旋转时允许 0.5mP.s 的误差。通常当测试流体时，这个误差会变小。至少要读取三次数值然后取平均值。如果弹簧没有线性变化，则表明浮子轴弯曲需要维修。

Static load calibration method is easy to operate, when the spring is adjusted, the adjustment results can be easily confirmed. The static load calibration tool is NLJ-A type torsion spring dynamometer (Figure V). The following is the calibration process description:

1)Remove the outer sleeve, the float will rotate counterclockwise(Axis taper coordination of float and float) and push upward.

2)Take a piece of inelastic filament and fix one end of the filament on the surface of the float with adhesive paper. Then wrap the filament counter-clockwise around the surface of the float for 2-3 turns. The other end of the filament is hooked on the end after passing through a special force measuring frame or a horizontal fixing wheel.

3)Select appropriate weight according to table Ⅲ.

4)Adjust torsion springs as required. Reference can be made to the C "Disassembly and Installation of Torsional Springs" section of "VI. Outer sleeves, floats and torsional springs".

There are two kinds of tolerances for F1 spring matched with this instrument: 127±0.5 mPa·s for 50g and 254±0.5 mPa·s for 100g. 0.5mP.s error is allowed when spindle rotates. This error usually decreases when testing fluid. At least read three times and get the average value. If the spring does not change linearly, it indicates that the bending of the float shaft needs to be repaired.

扭力弹簧总成 Torsion spring assembly (R1-B1 组合)	扭力弹簧常数 Torsion spring constant K1 Dynes/cm/def	扭力弹簧系数 Torsion spring coefficient	重量（克）Weight (g)				
			10	20	50	100	200
			粘度值 Viscosity value				
F-0.2	77.2	0.2	127.0	254.0	-	-	-
F-0.5	193.0	0.5	50.8	101.6	254.0	-	-
F-1	386.0	1	25.4	50.8	127.0	254.0	-
F-2	772.0	2	-	25.4	63.5	127.0	254.0
F-3	1158.0	3	-	-	43.0	84.7	169.4
F-4	1544.0	4	-	-	-	63.5	127.0
F-5	1930.0	5	-	-	-	50.8	101.6
F-10	3860.0	6	-	-	-	-	50.8

表（III）扭力弹簧刚度线性测试表(假设半径是 1cm)

Torsion spring stiffness linear test table (assumed radius 1cm)

砝码(克) Weights (g)	允许转动范围(格) Allowable rotation range	砝码(克) Weights (g)	允许转动范围(格) Allowable rotation range
5	21.55～22.21	40	172.45～177.70
10	43.11～44.42	45	194.00～199.90
15	64.66～66.63	50	215.57～222.13
20	86.23～88.85	55	237.12～244.30
25	107.78～111.06	60	258.68～266.56
30	129.34～133.28	65	280.23～288.77
35	150.89～155.49	70	301.80～310.99

表III-1 F1.0 扭力弹簧刚度线性测试表（半径为 1.725cm）

F1.0 torsion spring stiffness linear test table (radius 1.725cm)

砝码(克) Weights (g)	允许转动范围(格) Allowable rotation range	砝码(克) Weights (g)	允许转动范围(格) Allowable rotation range
1	21.55～22.21	8	172.45～177.70
2	43.11～44.42	9	194.00～199.90
3	64.66～66.63	10	215.57～222.13
4	86.23～88.85	11	237.12～244.30
5	107.78～111.06	12	258.68～266.56
6	129.34～133.28	13	280.23～288.77
7	150.89～155.49	14	301.80～310.99

表Ⅲ-2 F0.2 扭力弹簧刚度线性测试表（半径为 1.725cm）
F0.2 torsion spring stiffness linear test table (radius 1.725cm)

B.流体校准 Fluid calibration

用流体校准方式可对整台仪器进行彻底校核，它在检验浮子弯曲、外套筒偏心等方面比静负载校准方式更精确彻底（注：此方式仅适用于符合牛顿认证的流体的校准）。校准液体可以是 20,50,100,200 和 500cP。所有符合 ASTM 标准的每一瓶液体都配有一个粘度温度对照表。以下为流程说明：

1．在把外套筒和浮子浸入标准液之前要保证被检测的仪器是干净的，必要时应拆除外套筒对浮子进行彻底清洗。确保浮子轴和外套筒完好无损。

注意：标准液标签上的批号必须与粘度/温度图上的数字匹配。

2．将校准液加至浆杯的液位线处，把浆杯放在仪器的托盘上。向上提升托盘，直到浸到适当深度。参照图Ⅰ。

3．将温度计放入被测样品中，选择一个安全位置防止破碎。

4．开机设定 300 转运行 3 分钟，平衡浮子、外套筒、样品与环境的温度。

5．记录 300 转、600 转时液晶显示屏上的粘度读数，温度计的读数精确到 0.1℃（0.15℉）。

This procedure is to be used for calibration using only Newtonian certified calibration fluids. Calibration Fluids are available in nominal 20, 50, 100, 200, and 500 cP. All are traceable to ASTM standards and each bottle of fluid is furnished with a viscosity temperature chart certifying that batch of fluid.

1. Before immersing the outer sleeve and float into the standard solution, ensure that the instrument to be tested is clean. If necessary, remove the outer sleeve and wash the float thoroughly. Make sure the float shaft and outer sleeve are intact.

2. Add the calibration fluid to the liquid level line of the slurry cup

and place the slurry cup on the tray of the instrument. Lift the tray upwards until it reaches the proper depth. Reference figure I
3. Place the thermometer in the tested sample and choose a safe position to prevent breakage.
4. Operate the instrument at 300 rpm for three minutes, This will equalize the temperature of the float, rotor and the fluid.
5 .Record the viscosity readings on the LCD display at 300 rpm and 600 rpm. The reading of the thermometer is accurate to 0.1℃ （0.15℉）.

Ⅷ.数据计算

A.牛顿粘度的计算 Newtonian viscosity calculation
在 300rpm 运行时，R1 B1 F1 组合刻度盘上的读数就是牛顿粘度。如果使用其他弹簧需要表盘读数乘以“f”因子(弹簧常数)。
用粘度计确定牛顿粘度 cP，使用下面的公式:
Newtonian Viscosity in centipoise may be read directly from the dial when viscometer is run at 300 rpm with R1-B1-F1 combination. Other springs may be used providing the dial reading is multiplied by the "f" factor (spring constant).
To rapidly determine Newtonian viscosities in cP with FANN viscometer, use the following formula:

$$N = S \times \theta \times f \times C$$

注释:
S = 速度因子 Speed factor (见表Ⅴ, Reference Table Ⅴ)
θ= 刻度盘读数 Dial reading
f = 弹簧系数 spring parameter (见表Ⅲ, Reference Table Ⅲ)
C = 外套筒-浮子因子 Outer sleeve --float factor (见表Ⅳ, Reference Table Ⅳ)
N = 牛顿粘度 Newtonian viscosity - cP
示例:
使用一个 R2 B1 组合 600 rpm 的速度与 f5.0 弹簧,一个表盘读数 189。
N = 0.5 ×189 × 5×0.315 = 149 cP
1 mPa.s 等于 1 cP

Example:
Using an R2-B1 combination at a speed of 600 rpm with an F5.0 spring, and a dial deflects to 189.
N = 0.5 ×189 × 5×0.315 = 149 cP
1 mPa.s = 1 cP

注意:
校准用标准液有粘度的范围,使用标准的 R-B-F 组合用于测试。如果选择不当,会影响到测试数据。
Note:
Combinations with the larger gaps are likely to give results that differ

from these figures. For best accuracy, calibrate with a standard fluid having a viscosity near the range of interest and using the R-B-F combination to be used in the test

外套筒-浮子组合 Outer sleeve --float combination	外套筒-浮子因子 Outer sleeve --float factor
R1-B1	1.000
R1-B2	8.915
R1-B3	25.392
R1-B4	50.787
R2-B1	0.315
R2-B2	8.229
R2-B3	24.707
R2-B4	49.412
R3-B1	4.517
R3-B2	12.431
R3-B3	28.909
R3-B4	57.815

表（Ⅳ）外套筒-浮子因子 Outer sleeve --float factor

转速 Rotary speed	速度因子 Speed factor
1	333.3
2	166.6
3	100
6	50
10	10
20	5
30	3.33
60	3
100	1.667
200	1.5
300	1
600	0.5

表（Ⅴ）速度因子 Speed factor 300 rpm = 1

B.计算弹簧常数(重量法) Spring constant calculation (gravimetric method)

$$K1 = G \times r \times g / \theta$$

注释：

K1 = 弹簧常数 spring constant（Dynes/cm/° def）

G = load 负载（g）

g = 981 = 引力常数 constant of gravitation (cm/ sec²)
半径 Semidiameter r = 1.725cm
θ=粘度值 viscosity mPa.s

例如:所需的设置为 F1 扭簧, 扭力弹簧常数是 386 Dynes/cm/° def 与 R1 B1 组合。使用 50 克砝码,公式是:
K1 = 50 × 1.725 × 981 / 386 = 219.2
Example:
Set F1 torsional spring, spring constant is 386 Dynes/cm/° def and R1 and B1 combination. Use 50 gram weight. The formula is:
K1 = 50 × 1.725 × 981 / 386 = 219.2

C. 数据测试及计算 Data testing and calculation:
将室温调整在 20±5℃，严格按照“测试操作方法”工作。如在井场测量时，应尽可能减少取样所耽搁的时间，取样地点、条件应记录在测量表上。
Adjust the temperature indoors and make it 20±5℃. Operate it according to testing operation methods. If you measure in well site, please reduce the sampling time and record sampling place and conditions on the measurement table.

仪器系数为 Instrument coefficient *C = 5.11*

1.牛顿液体绝对粘度：
将仪器转速调整 300r/min，等到刻度盘上的读数恒定，其读数为绝对粘度值。
η=300r/min（读数） mPa·s
2.塑性流体粘度：
1）仪器转速调整 600r/min，待刻度盘上的读数恒定，其读数的 1/2 为视粘度值。
2）将仪器转速调整为 300r/min，其读数与 600r/min 读数之差为塑性粘度。
3）将钻井液在高速下搅拌 10 秒钟，以 3r/min 转速开始旋转后的最大度数值即为初切力。静置 10 分钟记录静切力。
视粘度： η视 = 1/2 ×600 r/min (读数) mPa·s
塑性粘度：η塑 = 600r/min (读数)－300r/min（读数）mPa·s
动 切 力：τ_0= 5.11（300r/min 读数 －η塑）Pa
静 切 力：τ初 = 5.11×3r/min (读数) Pa (静置 1 分钟)
τ终 = 5.11×3r/min (读数) Pa (静置 10 分钟)
3.假塑流体：

其流动特点是有切应力就开始流动，但粘度随切应力的增大而降低，假塑性流体的流动服从幂函数，其表达式：

$$\tau = k \left(\frac{dv}{dx}\right)^n \qquad \lg\tau = \lg k + n \lg\frac{dv}{dx}$$

n——流行指数　其值在 0～1 之间

k——稠度系数

流性指数 n = 3.32lg 600r/min（读数）/ 300r/min（读数）(无因次)

稠度系数　k = 5.11×300r/min （读数） / 511 "　Pa·s "

1.Newtonian fluid Absolute viscosity:

Adjust rotary speed of the instrument to 300 r/min. When the reading on the dial is constant, the reading is absolute viscosity.

η=300r/min (reading)　mPa·s

2.Plastic viscosity:

1) Adjust rotary speed to 600 r/min. When reading on the dial is constant, half of reading is apparent viscosity.

2) Adjust rotary speed of the instrument to 300 r/min. The difference of 300 r/min and 600r/min is plastic viscosity.

3) Mix the drilling fluid 10 minutes at high speed. Rotate at 3 r/min then maximum reach is initial gel strength.　After 10 minutes standing and then you can record get strength.

apparent viscosity:　η_a = 1/2×600 r/min (reading)　mPa·s

Plastic viscosity: η_p = 600 r/min (reading) —300r/min(reading) mPa·s

yield point: τ_0 = 5.11（300r/min　reading — η_p) Pa

gel strength: τ_{begin} = 5.11×3r/min (reading)　Pa　(1 min)

τ_{end} = 5.11×3r/min (reading)　Pa　(10 mins)

3.Pseudoplastic fluid:

Its flowing characteristics is　that viscosity decreases with shear stress increasing.The flowing of pseudoplastic fluid follows power function.

$$\tau = k \left(\frac{dv}{dx}\right)^n \qquad \lg\tau = \lg k + n \lg\frac{dv}{dx}$$

n——liquidity index　0～1

k——consistency coefficient

liquidity index n = 3.32lg 600r/min (reading)/300r/min(reading)　(zero dimension)

consistency coefficient k = 5.11×300r/min (reading)/511”　Pa·s”

Ⅸ.测量范围 Measurement range

外套筒-浮子 Outer sleeve --float factor	R1 B1	R2 B1	R3 B1	R1 B2	R1 B3	R1 B4
基本数据Basic Data						
外套筒半径, R0,cm Float radius, R0,cm	1.8415	1.7588	2.5866	1.8415	1.8415	1.8415
浮子半径,R1, cm Float radius,R1, cm	1.7245	1.7245	1.7245	1.2276	0.8622	0.8622
浮子高, L, cm Float height , L, cm	3.800	3.800	3.800	3.800	3.800	1.900
剪切间隙, cm Shearing clearance, cm	0.1170	0.0343	0.8621	0.6139	0.9793	0.9793
半径比, R1/R0 Radius ratio, R1/R0	0.936	0.09805	0.667	0.666	0.468	0.468
最高使用温度, ° C (° F) Maximum use temperature,	99 (200)	99 (200)	93 (200)	99 (200)	93 (200)	93 (200)
最低使用温度, ° C (° F) Minimum use temperature	0(32)	0(32)	0(32)	0(32)	0(32)	0(32)
仪器常数,K 标准的F1扭力弹簧 Instrument constant,K Standard F1 torsion ? = Kfq / N	300.0	94.18	1355	2672	7620	15,200
剪切应力范围						
剪切应力常数为有效浮子表面K2,cm(-3)剪切应力范围,dynes / cm2t = K1K2q	0.01323	0.01323	0.01323	0.0261	0.0529	0.106
F0.2 q = 1°	1.02	1.02	1.02	2.01	4.1	8.2
F0.2 q = 300°	307	307	307	605	1225	2450
F0.5 q = 1°	2.56	2.56	2.56	5.04	10.2	20.4
F0.5 q = 300°	766	766	766	1510	3060	6140
F1 q = 1°	5.11	5.11	5.11	10.1	20.4	40.9
F1 q = 300°	1533	1533	1533	3022	6125	12300
F2 q = 1°	10.22	10.22	10.22	20.1	40.8	81.8
F2 q = 300°	3066	3066	3066	6044	12250	24500
F3 q = 1°	15.3	15.3	15.3	30.2	61.3	123
F3 q = 300°	4600	4600	4600	9067	18400	36800
F4 q = 1°	20.4	20.4	20.4	40.3	81.7	164
F4 q = 300°	6132	6132	6132	12090	24500	49100
F5 q = 1°	25.6	25.6	25.6	50.4	102	205
F5 q = 300°	7665	7665	7665	15100	30600	61400

F10 q = 1°	51.1	51.1	51.1	100.7	204	409
F10 q = 300°	15330	15330	15330	30200	61200	123000
剪切速率 shear rate						
剪切速率常数 K3,秒 1 / rpm 剪切速率范围内,秒 1 g = K3	1.7023	5.4225	0.377	0.377	0.268	0.268
N = 0.9 rpm	1.5	4.9	0.4	0.4	0.24	0.24
N = 1.8 rpm	3.1	9.8	0.7	0.7	0.48	0.48
N = 3 rpm	5.1	16.3	1.1	1.1	0.80	0.80
N = 6 rpm	10.2	32.5	2.3	2.3	1.61	1.61
N = 30 rpm	51.1	163	11.3	11.3	8.0	8.0
N = 60 rpm	102	325	22.6	22.6	16.1	16.1
N = 90 rpm	153	488	33.9	33.9	24.1	24.1
N = 100 rpm	170	542	37.7	37.7	26.8	26.8
N = 180 rpm	306	976	67.9	67.9	48.2	48.2
N = 200 rpm	340	1084	75.4	75.4	53.6	53.6
N = 300 rpm	511	1627	113	113	80.4	80.4
N = 600 rpm	1021	3254	226	226	161	161
粘度范围 Viscosity range (1)						
最低粘度(2) Minimum viscosity(2)						
最大转速 600, Maximum rotary speed 600	0.5(3)	0.5(3)	2.3	4.5	12.7	25

注释:

(1)计算出标准扭力弹簧(f = 1)。对于其他扭簧粘度范围乘以 f 因子。

(2)最低粘度计算了最小剪切应力和最大剪切速率。

(3)出于实用目的最低粘度仅限于 0.5 cP 因为泰勒漩涡。

Note:

1.Computed for standard Torsion Spring (f = 1) For other torsion springs multiply viscosity range by f factor.

2.Minimum viscosity is computed for minimum shear stress and maximum shear rate.

3.For practical purposes the minimum viscosity is limited to 0.5 cP because of Taylor Vortices.

表(Ⅵ) 测量范围指示粘度计 Testing range indicator viscometer

X.故障排除与维护 Troubleshooting and maintenance

A. 故障排除 Troubleshooting

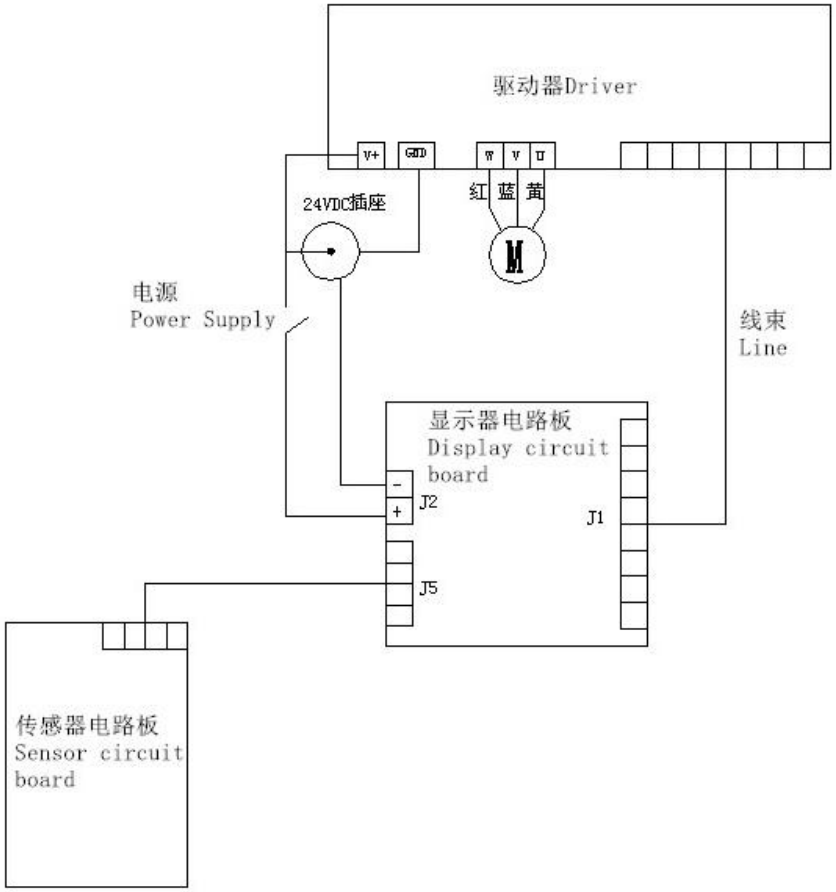
故障 Fault	原因 Reason	排除方法 Elimination method
液晶显示屏读数不稳 LCD readings are not stable.	1.浮子轴轴承生锈 2.浮子轴弯曲 3.外套筒失准 1.The bearing of the float shaft is rusted. 2.Bending of float shaft 3.Outer sleeve misalignment	1.更换浮子轴轴承 2.更换浮子轴 3.更换外套筒 1.Replace float shaft bearings. 2.Replace float shaft. 3.Replace the outer sleeve.
液晶显示屏数据不准 LCD display data not allowed	1.浮子轴轴承生锈 2.浮子轴弯曲 3.外套筒弯曲 4.扭力弹簧损坏或安装不正确 5.电机需要更换 1.The bearing of the float shaft is rusted. 2.Bending of float shaft 3.Bending of outer casing 4.Torsion spring damage or incorrect installation. 5.Motors need to be replaced.	1.更换浮子轴轴承 2.更换浮子轴 3.更换外套筒 4.更换扭力弹簧或重新安装 5.更换电机 1.Replace float shaft bearings. 2.Replace float shaft. 3.Replace the outer sleeve. 4.Replace torsion springs or re install them. 5.Replace the motor
噪音过大 Too loud	1.电机故障 2.同步带轮松动 1. motor failure 2. Synchronous belt pulley loosening	1.更换电机 2.调节同步带轮中心距 1.Replace the motor 2.Adjust the center distance of synchronous pulley.
外套筒径过大 The diameter of the outer sleeve is too large.	1.外套筒损坏 2.传动轮或传动皮带损坏 1.Damage of outer casing 2.Damage of drive wheel or drive belt	1.更换外套筒 2.更换传动轮或传动皮带 1.Replace the outer sleeve. 2.Replace the transmission wheel or drive belt.
按键失灵 Key failure	1.主控制板故障 1.Main control panel failure.	1.更换主控制板 1.Replace main control panel.
电机不运行 Motor not running	1.电机损坏 2.驱动器损坏 3.电源插头未插好 1.Motor damage. 2.Drive damage. 3.The power plug is not inserted.	1.更换电机 2.更换驱动器 3.重新进行接线 1.Replace the motor. 2.Replace drive. 3.Rewiring.

B.维护 Maintenance

1)浮子和外套筒在每次测试后应及时清洗,定期检查压痕、磨损或其他损伤。
2)正常使用的粘度计是不需要加油或润滑的。
3)在运输过程中将浮子外套筒取下避免浮子轴弯曲及外套筒受损,定期测试浮子轴轴承。
4)在没有样品的情况下,操作仪器在 3 rpm 或 6 rpm 观察浮子和外套筒的运转状态,不应该有超过±1 的波动。不灵敏的浮子轴轴承应及时更换。
1)Float and outer casing should be cleaned in time after each test, regularly check indentation, wear or other injuries.
2)The viscometer used normally does not require lubrication or lubrication.
3)Remove the outer sleeve of the float during transportation to avoid bending of the float shaft and damage of the outer sleeve, and periodically test the float shaft bearing.
4)In the absence of a sample, the operating instrument should not fluctuate more than ±1 in observing the operation of the float and the sleeve at 3 rpm or 6 rpm. Insensitive float shaft bearings should be replaced in time.

XI.配件 Parts

扭力弹簧 Torsion spring			
编号 No	F	常数 Constant	剪切应力 Shear stress
110031A	F0.2	77.2	307
110031B	F0.5	193	766
110031	F1	386	1533
110331C	F2	772	3066
110031D	F3	1158	4600
110031E	F4	1544	6132
110031F	F5	1930	7665
110031G	F10	3860	15330
外套筒 Outer sleeve			
11003306	R1, 316 不锈钢 Stainless steel		
11003306A	R2, 316 不锈钢 Stainless steel		
11003306B	R3, 316 不锈钢 Stainless steel		
浮子 Float			
1100326	B1,316 不锈钢 Stainless steel,空心 Hollow		
1100326A	B2, 316 不锈钢 Stainless steel,空心 Hollow		
1100326B	B3, 316 不锈钢 Stainless steel,空心 Hollow		
1100326C	B4, 316 不锈钢 Stainless steel,空心 Hollow		
样品杯 Sample cup			
1106	加热器 Heater, 220V,50Hz,1A		
110015	浆杯 Slurry cup		
校准			
1104	1105 型扭簧测力校准装置 Model 1105 Torsion spring force calibration device		
G0400	标准液 Standard liquid,10 cP,16 盎司(475ml)		
G0401	标准液 Standard liquid,20 cP,16 盎司(475ml)		
G0402	标准液 Standard liquid,50 cP,16 盎司(475ml)		
G0403	标准液 Standard liquid,100 cP,16 盎司(475ml)		
G0404	标准液 Standard liquid,200 cP,16 盎司(475ml)		
G0405	标准液 Standard liquid,500 cP,16 盎司(475ml)		



图（Ⅶ）电路图Circuit diagram

1.转子 rotor	2.挡泥板 Splash guard	3.浮子 Float
4.外套筒 Outer sleeve	5.托板 Plate	

图（Ⅷ）零件示意图 Part diagrammatic sketch

青岛创梦仪器有限公司 装箱单

Qingdao Chuangmeng Instrument Co., Ltd. Packing list

生产企业：青岛创梦仪器有限公司
Manufacturing enterprise: Qingdao Chuangmeng Instrument Co.,Ltd.

生产地址：青岛市城阳区流亭街道兴海路 3 号
Production address: No. 3 Xinghai Road, Liuting Street, Chengyang District, Qingdao

主机型号: 1104
Model of the main motor: 1104
出厂编号：
Manufacturing No:

序号 No	编号	名称及规格 Name and specification	数量 Quantity	备注 Remarks
1		主机 Main engine	1	
2		电源线 Power cord	1	
3		电源适配器 The power adapter	1	
4		钻井液杯 Slurry cup	1	
5		内筒 Float	1	
6		外转筒 Outer sleeve	1	
7		使用手册 Instruction Manual	1	
8		合格证 Certificate	1	