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螺杆钻具 DOWNHOLE MOTOR

使用说明书
OPERATION MANUAL



天津德华集团
TIANJIN DEHUA GROUP



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1. 前言

本手册主要介绍螺杆钻具的性能和使用要求以及注意事项, 便于用户更好地了解螺杆钻具, 结合钻井的需要, 选好、用好、维护好钻具, 发挥其应有的技术性能, 提高钻井经济效益。

2. 螺杆钻具工作原理

螺杆钻具是以泥浆为动力的一种井下动力钻具。泥浆泵泵出的泥浆液流经旁通阀进入马达, 在马达进出口处形成一定压差推动马达的转子旋转, 并将扭矩和转速通过万向轴和传动轴传递给钻头。螺杆钻具的性能主要取决于螺杆马达的性能参数。

3. 螺杆钻具的组成

螺杆钻具由旁通阀、马达、万向轴和传动轴四大总成组成。(如图1)

1. Introduction

This manual mainly introduces downhole motor property, application and cautions, so as for the customers to know well our downhole motors, and to do better selection, application, repair and maintenance of downhole motor according to drilling demand. As a result, our downhole motor may play its reliable technical function, to enhance drilling economic efficiency.

2. Principle

Downhole motor is a kind of downhole dynamic drilling tool upon the power of drilling mud. Mud stream from the outlet of mud pump flows through a by-pass valve into the motor. This stream produces pressure loss at both inlet and outlet of the pump, to push the rotor into rotating, and to transmit the torque and speed onto the bit. The downhole motor property mainly depends upon its property parameters.

3. Constitution

Downhole motor is composed of four assemblies of by-pass valve, motor, cardan shaft and drive shaft (Fig.1).

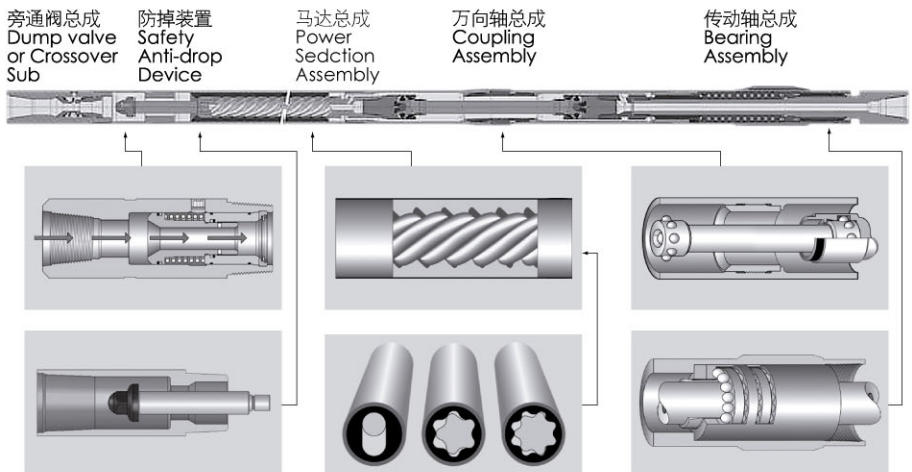


图1 (Fig.1)

3.1 旁通阀总成

它有旁通和关闭两个位置（如图2），在起下钻作业过程中处于旁通位置，使钻柱中泥浆循环绕过不工作马达进入环空，这样起下钻时泥浆不溢于井台上。当泥浆流量和压力达到标准设定值时，阀芯下移，关闭旁通阀孔，此时泥浆流经马达，把压力能转变成机械能。当泥浆流量值过小或停泵时，所产生的压力不足以克服弹簧力和静摩擦力时，弹簧把阀芯顶起，旁通阀孔又处于开启位置。一般情况下，深井、大斜度井、水平井以及使用中空转子时多采用代用接头。（如图2-1）

3.2 马达总成

它由定子和转子组成。定子是在钢管内壁上压注橡胶衬套而成。橡胶内孔是具有一定几何参数的螺旋。转子是一根有镀铬硬层的螺杆。

转子与定子相互啮合，是用两者的导程差而形成的螺旋密封线，同时形成密封腔。随着转子在定子中的转动，密封腔沿着轴向移动，不断的生成与消失，完成其能量转换，这就是螺杆马达的基本工作原理。

马达转子的螺旋线有单头和多头之分（定子的螺旋线头数比转子多1）。转子的头数越少，转速越高，扭矩越小；头数越多，转速越低，扭矩越大。（如图3）是几种典型马达配合的截面轮廓：

3.1 By-pass Valve Assembly

It has two positions of by-pass and close (Fig.2). It is in by-pass position during trip operation, circulates mud fluid in the drill string into the annular space by-passing the idle motor, so that no mud may spray out onto the platform during the trip operation. When mud flow rate and pressure reach the setting value, the valve stem moves down and closes the valve. Meanwhile, mud stream flows through the motor, and converts the pressure energy into mechanical energy. As mud flow rate is too low, or mud pump stops, and as the created pressure is not enough to overcome spring force and static friction force, the spring presses the stem upward, and by-pass is in open position. In general, The cross-over sub are used in deep well and large angle well horizontal well or hollow rotor selected (Fig.2-1).

3.2 Power Section Assembly

It consists of stator and rotor. Stator is made by squeezing rubber sleeve on the wall of steel tube. There forms spiral structure with a certain geometric parameter. Rotor is a chrome-plated screw rod.

Stator and rotor matches with each other, to form spiral line and seal cavity through their guide rail difference. With rotor running in the stator, the seal cavity is moving along its axial direction, continuously forms and disappears to complete its energy conversion. This is the basic principle of downhole motor.

Spiral seal line on rotor is divided into single end and multi-end (stator with one more end than rotor). The less ends the motor has, the higher speed and the lower torque is. The more ends it has, the lower speed and the higher torque is. Figure 3 shows the sectional profile of several typical motors.

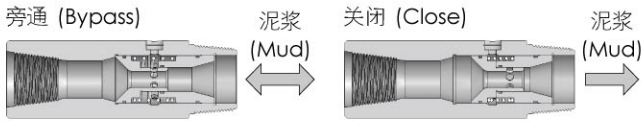


图2 (Fig.2) 旁通阀 (Bypass-Valve)

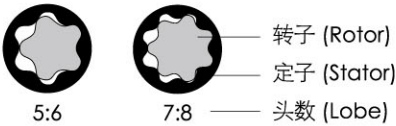


图3 (Fig.3)



马达总成 (Power Section)

马达定子一个导程组成一个密封腔，也称为一级。每级额定工作压降为0.8Mpa，最大压降为额定工作压力的1.3倍，如四级马达，额定压降应为3.2Mpa，最大压降为4.2Mpa。压降超过此值马达就会产生泄漏，转速很快下降，严重时甚至会完全停止转动，甚至造成马达损坏，用户应特别注意。

为了确保马达的密封效果，转子与定子之间的配合尺寸与不同井深的温度有关，因此在选择钻具时应尽可能准确地提供给厂家钻具应用场所的井温情况，以便推荐使用松紧配合状态适合的马达。现场使用的泥浆流量应在推荐的范围之内，否则将影响马达效率，甚至马达磨损加快。

马达的输出扭矩与马达的压降成正比，输出转速与输入泥浆量成正比，随着负



图2-1 (Fig.2-1) 代用接头 (Cross-Over Sub)



防掉装置 (Anti-Drop-Device)

A guide rail forms a seal cavity in motor stator. This is called one stage. When the rated working pressure of each stage lows down to 0.8 Mpa, the maximum pressure loss will be 1.3 times of the rated pressure. For an example, for 4-stage motor, the rated pressure loss shall be 3.2 Mpa, maximum pressure loss shall be 4.2 Mpa. As the pressure loss is over such value, motor may bring about leakage and speed will quickly slow down. More seriously, it may cause operation into complete stop, even cause the motor to be damaged. This is the caution for the customers.

In order to ensure rotor seal in good condition, the matching size between rotor and stator relates closely to depth temperature. Therefore, correct downhole temperature shall be provided to the manufacturer for reliable selection of appropriate motor. The actual mud flow rate is required in the recommended range. Otherwise incorrect flow rate may affect the motor efficiency, even cause speeding up motor wear.

载的增加，钻具的转速有所降低，因此在地面只要根据压力表控制压力，根据流量计控制泵的流量，就可以控制井下钻具的扭矩和转速。

3.2.1 中空转子马达

为了增加钻头的水马力和泥浆的上返速度，将转子加工成为带喷咀的中空转子。此马达的总流量应等于流经马达密封腔流量和流经转子喷咀流量的总和，每种规格的马达都有其推荐的最大和最小流量值。如果流量过大，转子会超速运转，定子和转子会出现提前损坏，如果流量过小，马达将停止转动。因此在选择转子喷咀尺寸时，应确保马达密封腔流量始终保持或高于最小推荐流量值，这样才能使马达正常运转。（如图4）

Motor torque is proportional to its pressure loss, but its outlet speed is inversely proportional to mud flow rate. With load increasing, screw drill speed decreases. Thus, pressure shall be controlled by the pressure gauge and flow rate shall be controlled by the flow rate gauge on surface. This way may control both torque and speed of downhole screw drill.

3.2.1 Hollow Rotor Motor

To increase hydraulic horsepower and upward speed of mud stream, rotor is manufactured into hollow rotor with nozzles. Thus, motor total flow rate is equal to the sum of the flow rate through seal cavity and rotor. Each type of motor has its own recommended maximum and minimum flow rate value. If flow rate is too high, rotor may be running at over speed, earlier damage would occur onto stator and rotor. If it is too low, motor will stop operating. Therefore, the flow rate through seal cavity shall be ensured or even higher than the recommended maintenance value, while selecting nozzle size. Only in this way, can motor be kept in normal operation (Fig. 4).

图4 (Fig.4)



5:6



7:8

中空转子 (Hollow Rotor)

在泥浆密度、喷嘴尺寸和马达流量为定量时，流经转子喷嘴的流量和流经马达密封腔的流量总是随负载变化而变化的。钻头离开井底，马达负载近似为零，此时流经转子喷嘴流量最小，而流经马达密封腔的流量最大。钻头钻进，使马达压差不断增加，使流经转子喷嘴流量增加，而此时流经马达密封腔流量减少。

流经马达密封腔的流量为 Q_m ，通过马达喷嘴的流量 Q_z 。

即：总流量 $Q=Q_m+Q_z$

设定马达转速 n 值计算 Q_m 值

$$Q_m = \frac{nq}{\eta_v \times 60} \quad (L/s)$$

容积效率 η_v 取 0.90

$$\therefore Q_z = Q - Q_m \quad (L/s)$$

喷嘴直径

$$d = \sqrt[4]{\frac{898\rho Q_z^2}{\Delta P}} \quad (mm)$$

Q_m —马达密封腔流量 (L/s)

Q_z —转子喷嘴的流量 (L/s)

Q —中空转子马达的总流量 (L/s)

η_v —容积效率

马达压降 $\Delta P = \Delta P_{st} + \Delta P_{op}$

ΔP_{st} —马达启动压降(Mpa)

ΔP_{op} —马达工作压降(Mpa)

ρ —泥浆比重(kg/L)

计算公式中 q 为中空转子马达的每转排量 (L/r)

其数值参 (如表1)。

When mud density, nozzle size and total flow rate is a constant value, the flow rate through nozzle and seal cavity always changes with the load. When bit leaving hole bottom, the load is approximately zero. Whereas, the flow rate becomes minimum through nozzle on the rotor, but the flow rate becomes maximum through the seal cavity. While the bit dropping down, motor pressure loss will continuously increase, and the flow rate through rotor nozzle will become higher, but the flow rate through the seal cavity will become lower.

Flow rate through seal cavity is Q_m , Flow rate through nozzle is Q_z .

Then, total flow rate $Q = Q_m + Q_z$

Suppose motor speed n , calculate Q_m

$$Q_m = \frac{nq}{\eta_v \times 60} \quad (L/s)$$

Volumetric efficiency η_v is 0.90

So $Q_z = Q - Q_m \quad (L/s)$

Nozzle diameter

$$d = \sqrt[4]{\frac{898\rho Q_z^2}{\Delta P}} \quad (mm)$$

Q_m —Flow rate of motor seal cavity (L/s)

Q_z —Flow rate of rotor nozzle(L/s)

Q —Total flow rate of motor with hollow rotor (L/s)

η_v —Volumetric efficiency

Motor pressure loss $\Delta P = P_{st} + P_{op}$

ΔP_{st} —Motor start pressure loss (Mpa)

ΔP_{op} —Motor operating pressure loss (Mpa)

ρ —Mud density (kg/L)

In the equation, q is flow rate of hollow rotor motor (L/r)

For the parameters, (Table-1)

螺杆钻具说明书

DOWNHOLE MOTOR MANUAL

按以上推荐计算公式，用户可以根据使用需要随时更换不同直径的喷嘴，从而达到理想的效果。

Based on the above recommended equation, the customers can timely change different diameter nozzles according to the actual demand, so as to reach ideal effect.

表1 中空转子马达每转排量估算:

(Table-1) Equation of Flow Rate of Hollow Rotor

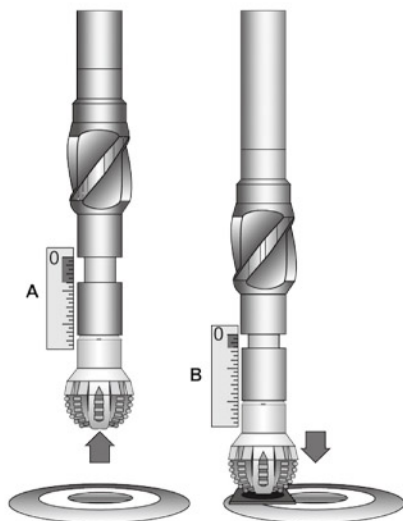
5LZ 244 X 7.0 TT		q = 20.3
5LZ 216 X 7.0 TT		q = 17.1
5LZ 197 X 7.0 TT	5LZ 197 X 14.0 TT	q = 14.0
5LZ 172 X 7.0 TT		q = 10.2
5LZ 165 X 7.0 TT	5LZ 165 X 14.0 TT	q = 8.5
5LZ 120 X 7.0 TT	5LZ 120 X 14.0 TT	q = 5.0
5LZ 95 X 7.0 TT		q = 2.6
9LZ 95 X 7.0 TT		q = 3.3
5LZ 89 X 7.0 TT		q = 2.4
5LZ 73 X 7.0 TT		q = 1.3

最大允许轴向轴承间隙说明: 见图表2

Allowed Maximal Clearance of Axial Bearing:

表2 (Table-2)

钻具型号 Size	间隙 Clearance
Φ43mm	2mm
Φ54mm	3mm
Φ60mm	3mm
Φ73mm	3mm
Φ79mm	3mm
Φ89mm	4mm
Φ95mm	4mm
Φ105mm	4mm
Φ120mm	5mm
Φ140mm	5mm
Φ159mm	6mm
Φ165mm	6mm
Φ172mm	6mm
Φ197mm	7mm
Φ203mm	7mm
Φ216mm	7mm
Φ228mm	7mm
Φ244mm	8mm
Φ286mm	10mm



间隙=A-B
Clearance=A-B

3.3 万向轴总成

万向轴的作用是将马达的行星运动转变为传动轴的定轴转动，将马达产生的扭矩及转速传递给传动轴至钻头。万向轴大多采用瓣形，也有采用挠轴形式的。天津德华钻具的瓣型万向轴采用线切割技术制成，切口平行度高，粗糙度可达 $\sqrt{0.3}$ 且不破坏金属化学成分，因此使用寿命长、机械损失小（如图5）。

钻具使用后，应立即拆卸，检查万向轴，如磨损量超过维修标准，应及时更换有关易损件，否则会因万向轴的使用过度致使钻具无法正常工作。



图5 (Fig.5)
球形万向轴 (Ball Drive Universal Shaft)

3.4 传动轴总成

传动轴的作用是将马达的旋转动力传递给钻头，同时承受钻压所产生的轴向和径向负荷。我公司制造的钻具传动轴总成有两种结构：

(1) 钻头水眼压降为7.0Mpa，采用硬质合金径向轴承和中间有一组推力轴承的传动轴总成（如图6）；

(2) 钻头水眼压降为14.0Mpa，采用硬质合金径向轴承和金刚石复合片（PDC）的平面止推轴承，其寿命更长、承载能力更高。

3.3 Universal Shaft Assembly

The function of cardan shaft is to convert planetary motion into fixed constant rotation of drive shaft, to transmit torque and speed from motor to the drive shaft, and to the bit. Cardan shaft mostly use flat shaft, but some are flexible shafts. Our flat type shaft used on our downhole motor is made by linear cutting technology. So the cut has high parallelism. Its roughness can reach $\sqrt{0.3}$ and it doesn't damage metal chemical composition. Thus, it has longer running life and less mechanical loss (Fig.5).

Downhole motor shall be disassembled as quickly as possible after use to examine cardan shaft. If it is found out that wear degree is over maintenance standard, relevant consumable components shall be changed promptly. If it is not, downhole motor can not be running normally due to over run time of cardan shaft.



图5 (Fig.5)
瓣形万向轴 (Flat Universal Shaft)

3.4 Drive Shaft Assembly

Drive shaft is used to transmit motor rotary dynamic force to the bit, meanwhile to withstand axial and radial load from drilling weight. We have two types of drive shafts, as follows:

- 1) Bit nozzle pressure loss is 7.0 Mpa, using hard alloy radial bearing and drive shaft assembly with thrust bearings (Fig.6);
- 2) Bit nozzle pressure loss is 14.0 Mpa, using hard alloy radial bearing and PDC cutter flat thrust bearing. It has longer lasting life and higher bearing capacity.



图6 (Fig.6)

4. 螺杆钻具型号说明

4. Model of Downhole Motor

□ □ LZ □ X □ - □ - □ □ □ □ □ □ - TT - □

马达级数 (用阿拉伯数字表示, 如2,3,4,5……)
Stages of power section (2,3,4,5 stage……)

企业标志:
Symbol of DEHUA company

D-表示弯钻具弯角形式:
D-bend angle types

D-单弯 (单弯壳体或弯接头):

D-single bend (single bend housing or bend sub)

P-大偏距同向双弯 (弯接头+单弯壳体):

P-large offset distance double bend housing in same direction (bendsub+single bend housing)

T-同向双弯:

T-double bend housing in same direction

S-异向双弯:

S-double bend housing in two directions opposite to each other

无-直钻具:

Omitted-straight motor

K-表示可调弯壳体钻具结构形式:

K-Adjustable bend housing

W-表示稳定器:

W-Assembled with stabilizer

H-表示可换稳定器:

H-Assembled with changeable stabilizer

F-表示转子中空分流 (省略-转子非中空):

F-Hollowed rotor (omitted: solid rotor)

G-表示钻具耐温特性 (G-耐温150℃; 省略-耐温120℃):

G-heat-resistant performance: (G-150℃; omitted-120℃)

防掉形式 (SF-双防结构、省略-为单防)

Anti-drop types: (SF-double anti-drop Omitted-single anti-drop)

钻头最大水眼压降 (Mpa)

Max bit pressure loss (Mpa)

螺杆钻具规格 (外径 mm)

Size of motor in millimeter (OD mm)

螺杆钻具产品代号

Code of motor

转子头数

Lobes of motor

马达形式 (JC-加长马达、C-长导程马达、D-短马达、K-空气或泡沫马达、Y-油基泥浆、省略-常规)

Type of power section (JC-extended power section、C-long guide rail、D-short power section、K-air or foam power section、Y-oil based mud、omitted-conventional)

5. 使用须知

5.1 井场钻井技术人员和司钻必须了解钻具的结构原理和使用参数。按使用手册的要求合理使用钻具。

5.2 根据整个井眼的钻井作业计划，由钻井工程师根据任务结合地层结构、井眼孔径、深度、机械转速选定所用钻头与钻具型号，决定水眼直径和钻具组合。现场施工必须严格按制定的钻井作业计划执行。

5.3 对钻井液的要求：螺杆钻具的马达为容积式，决定钻具性能的因素是马达的输入流量和作用于两端的压力降，而不是钻井液的类型。钻井液的物理化学性能除个别有损钻具寿命外，一般不影响钻具性能，应注意考虑钻井工艺的需要。但钻井液所含的各种硬颗粒必须予以限制，因为它会加速轴承、马达的磨损而降低钻具的使用寿命，建议固相含砂量不超过1%（事实证明：若含砂量达到5%，钻具寿命会降低50%）。同时注意钻井液中不要混有各种气体，因为混有气体的钻井液在钻具中压力的变化下容易产生“气蚀作用”，加速钻具的损坏，尤其是定子橡胶更容易被气蚀坏，必须予以足够的重视。

5.4 使用钻头的选择：与螺杆钻具一起使用的钻头在选择上是十分重要的问题。因此螺杆钻具是否能成功的发挥作用的几个因素中，钻头与钻具的匹配是最重要的，希望能引起现场使用人员的重视。选择钻头与螺杆钻具配套使用的因素应是：

（1）钻井方案及计划；

5. Application Notices

5.1 Site drilling technical persons and drillers shall know well downhole motor structure principle and technical parameters, correctly apply downhole motor in accordance with requirements specified in this manual.

5.2 Drilling engineer shall make operation program upon the whole hole, and select the model of downhole motor and bit to be used, determine nozzle size and downhole motor combination according to formation edge structure, hole size, depth and mechanical speed. The determined drilling program shall be strictly carried out accordingly on the location.

5.3 Drilling Fluid Requirement: Downhole motor shall be volumetric. The key factor to downhole motor property is motor inlet flow rate, and the pressure loss functioning onto both ends. But it is not the kind of drilling fluid. Physical and chemical property of drilling fluid, except the individual damage to downhole motor running life, normally does not affect its property.

This shall be considered for the need of drilling process. However, the content of hard grains in mud stream must be limited since they can speed up wear of bearing and motor, may cause shortening downhole motor running life. It is suggested that solid sand content should not be over 1% (actually when sand content is 5%, running life will be reduced by 50%). Also, take care, not let drilling fluid mixed with any gas, because the fluid with gas may easily cause "Gas Erosion". It may speed up tool damage with change of pressure. In particular, the rubber on stator is more easily damaged by gas erosion. Enough attention shall be paid to this problem.

5.4 Bit Selection: For bit selection, it is important to combine and match downhole motor to be used. It relates to success of downhole motor application. It is advised site operators shall take care of this matter. Application factors to combine bit with downhole motor are as follows:



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- (2) 针对地层需要的刃部结构;
- (3) 钻井液流通通道的结构;
- (4) 预先计划的机械钻速;
- (5) 使用该钻头, 钻具运转的时间估算;
- (6) 钻头水眼压降的设计。

什么样的地层结构、地层软硬、使用哪类钻头、用什么样的刃部设计, 请参考有关钻头的专业资料, 这里仅就使用螺杆钻具完成各种钻井作业, 对钻头的选择作些简要说明。

A: 除了钻头水眼造成的压降外, 要使钻井液流经钻头底部时别再形成其他较大的压力损失, 尤其是钻头水眼压降已达到该型号钻具规定的压降值时更应注意。这对牙轮钻头不必担心, 但是PDC钻头冠部液体通道的设计, 就必须考虑通道过流面积是否可能造成额外过多的压力损失问题, 同时并能保证岩屑及时排出及钻头冷却需要。

B: 牙轮钻头: 这类钻头在螺杆钻具配合使用时, 更实用于钻井周期不长的作业, 如定向造斜、侧钻等。

C: PDC钻头: PDC钻头不仅适用于定向造斜, 更适用于钻井周期较长的作业, 如打直井等。在较长周期的钻井作业中, 最重要的因素就是钻头与钻具作为一个整体, 不要由于其中的哪一部分出了问题, 而造成不必要的起下钻。大家已熟知: 复合片钻头较牙轮钻头寿命长, 而且结构是整体的, 具有很多优点。

D: 提高钻具和钻头的使用寿命, 也是一个重要因素。改善传动轴的稳定性, 例如加稳定器, 对提高钻具寿命发挥钻

- (1) Drilling Plan and Program;
- (2) Formation Edge Structure;
- (3) Structure of Mud Flowing Channels;
- (4) Determined Mechanical Drilling Speed;
- (5) Estimation of Bit and Downhole motor Running Life;
- (6) Design of Bit Nozzle Pressure Loss.

Please refer relevant professional information for details of bit selection on formation structure. Hereby it briefly describes bit selection for performance of drilling operation with downhole motor.

A: Except bit nozzle pressure loss, in order to avoid producing higher pressure loss while drilling fluid flowing through bit bottom, attention shall be specially paid to this matter when the nozzle pressure loss has reached the specified loss value of this kind drilling tool. This does not affect rock bit, but for the crown passage design of PDC bit. The problem shall be considered that passing fluid area may cause much extra loss, meanwhile to ensure prompt discharge of cuttings and bit cooling.

B: Rock Bit: When this kind of bit is used with downhole motor, it is more appropriate to shorter drilling period, such as directional deflection and re-entry etc.

C: PDC Bit: It is not only used for directional deflection, but also more appropriate to longer drilling period, such as vertical well drilling. During longer period of drilling operation, the more important factor is to integrate bit and downhole motor, so as to avoid unnecessary trip operation due to some problems. It is known that PDC bit can last longer time than rock bit, and it is integral in structure, having more advantages.

D: It is also an important factor to prolong running life of bit and tool. It is helpful to extend screw life and to develop bit property by improving stability of drive shaft, e.g. stabilizer. And it shall be considered the close relationship between diamond geometric dimension, allocation, drilling weight load and the required high speed and lower drilling weight of downhole tool. In general, it is hard to obtain satisfactory effect without strictly



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头性能是有帮助的。考虑钻头金刚石的几何尺寸、布置方位、钻压负荷与要求井下钻具转速高、钻压小的甚密关系。总之，使用螺杆钻具不对所匹配的钻头进行认真选择，要想取得满意的效果是困难的，还会造成钻具过早地损失。

5.5 对井底环境温度的要求：温度过高对钻具马达性能十分不利，会使所有不利因素加剧。使用油基泥浆液，井底温度低于95℃，钻具工作状态最佳。当温度超过150℃时，即使使用最佳的油基钻井液，甚至使用水基钻井液，钻具定子寿命也会大幅度缩短。

为使钻具在较高的油基钻井液下正常工作，可以采用分段下钻，间歇循环，使用带分流孔的空心转子，以加速循环或改善钻井液的散热性及其它性能的方法。保证实际定子工作温度低于极限值。

我公司生产两种定子。一种是普通定子，额定温度为95℃，最高温度120℃。一种是耐高温定子，额定温度105℃，最高温度150℃。

5.6 对钻井液流量的要求：螺杆钻具特点之一，输出转速与输入钻井液流量成正比。每种钻具都有一定的有效工作流量范围，建议按推荐参数进行选择，否则会降低钻具的工作效率和使用寿命。

5.7 钻井液压力与钻压的特点：钻具进行空运转时，若保持泥浆流量不变，钻具与钻头的压降为一个常数，该值随钻具型式和规格的不同而有所不同。钻具工作时，随着钻压逐步增加，钻井液循环压力逐渐上升，该压力的增量与钻压或

matching bit and downhole motor, it can also cause earlier damage to the tool.

5.5 Requirement for Hole Bottom Temperature: It is unfavorable to the motor property, and it may intensify all disadvantageous factors if temperature goes too high. When using oil base mud, the hole bottom temperature shall be lower than 90℃, downhole motor shall be working in optimum condition. When temperature is over 150℃, stator life may be greatly shortened, even by using optimum oil base mud or using water base mud.

In order to keep downhole motor working normally at high temperature of oil base mud, the way shall be adapted to conduct trip-in by sections and intermittent recycling, to ensure the actual temperature of stator below the ultimate value by using hollow rotor with splitter hole to speed up recycling or improve heat radiation of the fluid and other property. Our company manufacture two kinds of stators. One is conventional stator, with 95℃ of rated temperature and 120℃ of maximum temperature; another is hi-temperature stator, with 105℃ of rated temperature and 150℃ of maximum temperature.

5.6 Requirement for Flow Rate of Drilling Fluid: One of the downhole motor features is that the output speed is proportional to the input flow rate of drilling fluid. Each downhole motor has a certain effective range of working flow rate. It is advised to choose the range according to the recommended parameters. Otherwise, it may shorten the downhole motor's working efficiency and running life.

5.7 Features of Drilling Fluid and Drilling Weight: When downhole motor is in idle working condition, if keeping fluid flow rate unchanged, the pressure loss caused by both bit and downhole motor shall be a constant value. This value changes with the difference of drill model and specification. As downhole motor is running, fluid recycling pressure will gradually increase with gradual rise of drilling weight. The increment of pressure is proportional to the torque increment needed



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钻进所需扭矩的增量成正比，当达到最大推荐值时，产生最佳扭矩。继续增加钻压，当循环钻井液在马达两端产生的压降超过最大设计值时，钻具将发生泄漏。正常工作时，表压随钻压的增减而升降。如果泵压突然增加了几兆帕，继续增加钻压，泵压不再增加，这说明钻具发生了泄漏，此时钻具定子与转子间密封破坏，钻井液通过破坏的马达密封腔从钻头水眼中流出。当因故障卡钻时，钻井液在钻具制动情况下，仍可以继续循环流过钻具。一旦钻具发生制动，应迅速将钻具提离井底降低钻压，因为钻井液长时间流转过转的马达会使钻具严重损坏。

另外，要使钻具获得最佳工作效率，应将钻具两端的压差控制在推荐参数范围内。

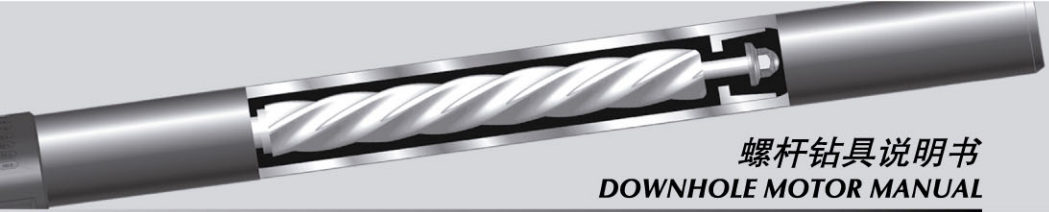
5.8 预先进行必要的水利计算：钻井作业时，由泥浆泵泵出的钻井液依次经立杆、水龙头、方钻杆而进入钻杆、钻铤、无磁钻铤、钻具（马达）、钻头水眼及环空而返回地面。在钻井液不断循环过程中，由于钻井液本身的摩擦和钻井液与管壁、井壁的摩擦及各局部流动造成的损失，皆需消耗一定的能量。这一能量损失以压力损失表现出来。累加各部分的压力损失后可计算出总的压力损失，按预计钻井深度算出总压力损失后，就可以作为确定泵压的一个参数，这种大量的压力损失计算是很繁琐的。对于现场操作者来说可以采用一种简便的做法，只要将钻头稍稍提离井底，在额定排量下，

by drilling weight and stripping in. When it reaches the maximum recommended value, optimum torque shall be produced. If drilling weight goes on rising, when the pressure loss of recycling fluid at both ends of motor is over maximum design value, leakage shall occur from the downhole motor. In normal operation, the gauge pressure rises with the drilling weight up and down. If the gauge shows sudden rise of temperature to several Mpa, when the drilling weight goes on increasing, pump pressure shall no longer increase. This indicates there occurs some leakage from downhole motor. The seal between stator and rotor may be changed, and fluid may be flowing out from bit nozzle while going through the damaged seal cavity. When it is sticking due to this problem, fluid is still recycling through downhole motor since downhole motor braking. Once downhole motor brakes, it shall be quickly lifted away from the hole bottom to reduce drilling weight, since downhole motor may be seriously damaged with fluid flowing through the idle motor for longer time.

Additionally, the pressure loss at the bottom ends of downhole motor shall be controlled within the recommended range, to ensure downhole motor in optimum working efficiency and running life.

5.8 Early Hydraulic Calculation: In drilling operation, the pumped mud flows successively through riser, swivel, kelly into drill pipe, collar, non-magnetic collar, motor ,bit nozzle and annular space, and upwards to the surface. During recycling, the loss caused from the friction of fluid its own and the friction of fluid onto the pipe wall, hole wall and/or partial flow will consume a certain energy.

The energy loss will be shown from the pressure loss. Total pressure loss can be calculated by accumulating pressure loss in each portion. After calculation of total pressure loss according to the determined drilling depth, it can be a parameter to determine the pump pressure. It is complicated to calculate large amount of pressure loss. Therefore, the site



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主管压力表上的读数值就是上述总压力损失值。

6. 使用方法

在选择钻具及其组合方案时，应制定钻井作业计划，充分考虑井眼轨迹、钻头类型、规格、地层结构和水利计算等细节。

6.1 钻具下井前的地面检查；

6.1.1 钻具除提升短节与旁通阀连接外，其他部分的壳体连接均涂以锁紧剂。

6.1.2 用钻头装卸器把钻头装上，只许用链钳转动钻具传动轴头，而且只能逆时针旋转（俯视旋向，下同），以防止内部螺纹松扣。

6.1.3 吊起提升短节，把钻具放入转盘中，把旁通阀置于转盘易于观察的位置。用卡瓦把钻具卡牢，卸去提升短节。

6.1.4 检查旁通阀：用锤柄或木棒向下压旁通阀芯，从上部向旁通阀注满水，此时旁通阀应不漏，水面无明显下降，然后挪走木棒，阀芯应被弹簧弹起复位，所注水应从侧面各孔均匀流出，即可认为正常。

6.1.5 接方钻杆并下放，使旁通阀位于钻杆下方便于观察的地方，开动钻井泵，逐渐提高排量直到旁通阀关闭，上提钻具，看钻头是否转动，此时旁通阀处于“关闭”位置。

不应有钻井液从旁通孔流出，检查的目的仅是看钻头是否旋转，不必持续很长时间，操作过程中应避免钻头与井口防喷器、井口管线接触、碰撞。停泵

operator can adapt a simple method. Only by lifting the bit a little bit from the bottom, the reading on the pressure gauge of main pipe shall be the mentioned total pressure loss at the rated flow rate.

6. Application

When selecting the downhole motor and its combination, you should work out drilling program, fully consider hole size, hole trace, bit type, specification, formation structure and hydraulic calculation.

6.1 Surface Checking Before Tripping in

6.1.1 Except lifting the connections between nipple and by-pass valve, other connections on shell of downhole motor shall be coated with locking agent.

6.1.2 Assembly bit on the handling device, counter clockwise rotate the drive shaft ends only with chain wrench to protect the inside threads from loosening.

6.1.3 Hoist lifting sub and put downhole motor into turntable and by-pass valve into the center in easy watch position. And then clamp tightly downhole motor with slips, and disassembly lifting sub.

6.1.4 Check by-pass valve: Press downward the valve stem with hammer handle or wood stick. Fill water from the top into the valve, there should no leakage from the valve and no great drop of water level. And then loosen the stick, the valve stem is springed up to its original position. The filled water shall flow out evenly from the side holes. This is normal.

6.1.5 Connect and low down the kelly. Put by-pass valve under the kelly in easy watch position. Start pump, and gradually increase flow rate till by-pass valve is closed. Lift the downhole motor to watch bit rotating. Now by-pass valve is in "close" position.

There should be no fluid flowing out of by-pass hole. To do this is only for checking bit rotation. It should not last longer. In the operation, it should prevent the bit from touching wellhead blowout preventer and flow line. After pump stops, check by-pass valve in open position or not, and fluid flowing out of by-pass valve or



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后注意观察旁通阀是否再次打开，使钻井液从旁通孔排出。泵未完全停止之前，不要把旁通阀提到转盘以上，防止污染井台。

6.1.6 卸下方钻杆，按设计的钻具组合，分别把弯接头、无磁钻铤、稳定器等接好。将弯接头拧入旁通阀之前，如果用斜口管鞋座造斜，应检查造斜键，保证斜口管鞋座处于正常的工作位置，并保证与接头的弯头刻线对准。

在所有钻具组合及钻杆连接过程中，注意防止粘扣错扣。为防止操作中移扣，建议装卸过程中应牢记：钻头接头相对于壳体的旋向为俯视反时针方向。违反此项规定，如反向转动转盘或用转盘旋紧马达以上的扣等，就会造成钻具内部零件的松扣或脱扣，请用户注意。

6.2 把钻具及其组合下到井眼里：尽管钻具本身外形简单，且有足够的刚性，司钻下放钻具时，仍需控制下放速度，否则易被井眼中的沙桥、井眼台肩、套管鞋所损坏。遇有这样的井段，往往需开动钻泵，慢慢地扩大井眼再通过。

如果用弯接头或弯壳体，钻头侧面就更容易碰上井壁的硬岩层和套管鞋等，因此要周期性的转动钻具组合，以消除侧钻的影响。

对于深井和高温井，下放钻具时建议周期性地进行中途循环，这样可以防止钻头堵塞，或因高温造成钻具定子损坏。

在井内，钻井液若不能迅速通过旁通阀阀口，进钻柱中，应减慢下井速度，或不时停下来充灌泥浆，下钻时，注意

not. Do not lift the valve over turntable until pump completely stops as to protect the platform from pollution

6.1.6 Disassembly kelly and combine the downhole motor in accordance with the program. Connect bent sub, non-magnetic collar and stabilizer etc. separately. If you make deflection with muleshoe, before twisting bent sub into by-pass valve, you should examine deflecting key to ensure muleshoe sitting in normal working position, and align the scale line of connector and bent sub.

During the period of downhole motor combination and drill pipe connection, pay attention to avoiding thread gluing and alternation.

In order to prevent thread from moving in the operation, it is advised to keep in mind: Rotary direction of bit sub opposite the shell is counter clockwise. If you rotate turntable or clamp motor with turntable in wrong direction, thread loosening and thread off will occur on parts inside the downhole motor. This is caution for the customers.

6.2 Trip in the combined downhole motor into borehole: Even though the outside of downhole motor looks simple and it has enough rigidity, it still needs controlling trip-in speed, when drillers are stripping in downhole motor. Otherwise, the downhole motor may be damaged by sand bridge, hole shoulder or casing shoe in the hole. When this happens, it is usually required to start pump, slowly to extend the hole for its passing.

If it is a bent sub or bent shell, it is easily for bit side to touch the hard rock status and casing shoe etc. on the bore wall. So periodically rotate downhole motor combination to eliminate the influence of lateral drilling.

As to deep and hi-temperature well, it is advised periodically to conduct middle way recycling while stripping in the downhole motor. Thus, this can protect the bit from plugging or protect stator from damaging due to high temperature.

In case the fluid can not rapidly flow through



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不可墩钻或将钻具直接放进井底。

6.3 开动钻具：如果钻具处于井底，必须提起0.3-0.6m，开动钻井泵此时记下立杆压力表读数，与计算的压力值对比一下，如果超过水力计算的数值也是正常的，这是钻头侧钻引起的。

清理井底，尤其是打斜井，井底必须足够“干净”，因为井底堆积或沉淀的岩屑影响转速或造斜。最好用正常的钻井液循环清理，清理时也可慢慢转动钻具或钻具分次转动（每次转动 30° ~ 40° ），依次地把堆在井底的物体清理干净。

清理干净后，再把钻具上提0.3-0.6m，校对压力值，记录下来。

重新下入井底并逐步加井压，马达扭矩增加，立杆压力表压值升高，这个升高的压力值应符合各型号钻具规定的马达压降值，此压力表增大的数值反映了马达的负载是否正常，也反映钻压加的是否合适，因此保持马达转距基本稳定，钻压基本稳定，只要把立杆压力表读数限制在所选钻具推浮范围内就可以了。它能使司钻及时了解钻具工作情况。

钻头不在井底时，如果循环压力低于计算值，可能是旁通阀处与“开位”或钻杆损坏，井漏等造成的。

如果循环压力高于计算值，而且侧钻造成压力升高的因素已排除，循环压力仍高于计算值，则可能是钻头水眼被堵或传动轴被卡死，此时循环压力要比计算压力高得多。

6.4 起钻：钻具起钻过程类似常规操作。起钻时，旁通阀处于开位，允许钻柱中

the holes of by-pass valve in the borehole, the strip-in speed should be slowed down or suspended regularly for mud filling. Again in stripping in, take care, there occurs no percussion or direct strip-in.

6.3 Start Downhole motor : If downhole motor is located at the hole bottom, you must lift it for 0.3-0.6m. Then start the pump and record the readings of riser pressure. As compared with the calculated pressure value, it is also normal if it is over the pressure of hydraulic calculation. This is caused from lateral drilling. Clear the hole bottom. In particular, for slant hole, the hole bottom must be very "clean", since the cuttings packed and deposited in the bottom affect the torque or deflection. It is best to clean it with normal recycling. While cleaning, slowly turn the downhole motor or turn it by times(turning 30° - 40° each time), gradually to clean up the bottom. Then lift downhole motor for 0.3-0.6m, calibrate and record the pressure value.

Gradually enhance drilling weight when tripping into the bottom again. Meanwhile, motor torque increase, riser pressure on gauge increases, too. The pressure value should conform with the motor pressure loss specified for any type of downhole motor. The increased value on the gauge indicates motor load is normal or not, and also shows the added weight is appropriate or not. Therefore, motor torque and drilling weight shall be kept stable only by limiting the riser gauge reading to the recommended range. This makes drillers know downhole motor operation timely.

When the bit is not at the bottom, if recycling pressure is lower than the calculated value, it is possible that by-pass valve locates in "open" position, or it is caused by drill pipe damage or well leakage etc.

If recycling pressure is higher than the calculated value, and the factor of pressure rise caused in re-entry is eliminated, but it is still over the calculated value, possibly the bit nozzle is plugged or drive shaft is stucked. Now recycling pressure is much higher than the

的钻井液泻入环空。但是钻具本身不能排出钻井液，通常在起钻前在钻柱上部注入一段加重钻井液顺利排出。

6.4.1 在钻具提出到旁通阀位置后，卸下旁通阀口上各部件，先用清水从旁通阀顶部进行冲洗，然后使用木棒或锤柄等将阀芯按下、松开使其移动无阻。清洗完毕，拧上提升短节，提出钻具。

6.4.2 装好钻头装卸器，卡牢钻具外壳，反转钻头（俯视反旋）把马达中残存的泥浆从旁通阀排出，卸下钻头。

6.4.3 卸下钻具，从传动轴孔中冲洗钻头，将传动轴水帽及轴承清洗干净，然后平放钻具，正常维护保养待用。若暂停使用或长时间搁置不用，建议向钻具内注入少量矿物油防锈（注：不允许加入柴油）。

6.5 用钻具井的故障分析：

如前所述，钻井液循环压力变化反映在立杆压力表上，它可以帮助现场人员辨别井底发生的情况和问题，事实证明：正确的判断可以节省大量起下钻所耗费的时间和成本。综合考虑钻具使用过程中的各种因素，归纳为（表3）。供用户参考。

calculated value.

6.4 Trip Out: Downhole motor tripping out is similar to the conventional trip-out. By-pass valve is in open position in stripping out. The fluid in string is allowed to be drained into annular space. But downhole motor can not rapidly discharge the fluid by itself. Usually a section of heavy fluid is added into the top of string before stripping out, to press the fluid in the pipe smoothly to drain.

6.4.1 After downhole motor is stripped out to the location of by-pass valve, disassembly the parts on the top of valve holes. Firstly wash it from the valve top with clean water, and then press down the valve stem with hammer handle or wood stick, loosen it for free movement. As soon as cleaning is completed, twist lifting nipple and trip out the downhole motor.

6.4.2 Install the bit assembly and disassembly device to clamp the shell of downhole motor. Turn the bit in counter rotation to drain the residual mud from by-pass valve, and then disassembly bit.

6.4.3 Disassembly downhole motor. Wash it from the holes of drive shaft, to clean the cap of drive shaft and bearing. Then handle the downhole motor onto a flat place. It is stand-by after repair and maintenance. It is advised to inject small quantity of mineral oil (not allow adding diesel) into downhole motor against rusting, if it is not used temporally or if it is stored for a longer time.

6.5 Troubleshooting

As mentioned above, the change of fluid recycling pressure is indicated from the pressure gauge of riser. This may help site operators identify what is happening in the bottom. In fact, correct identification can save tripping time and cut down the costs. Complex trouble shooting is shown in Table-3 for customers reference.

表3: 钻具故障分析表 (Table-3): Troubleshooting

异常现象 Problems	可能原因 Possible Causes	判断及处理方法 Troubleshooting
压力表压力突然升高 Gauge pressure loss sudden rise	马达失速 Motor speed loss	把钻具上升0.3-0.6m, 核对循环压力, 逐步加钻压, 压力表随之逐步升高, 均正常, 可确认是失速。 Lift Downhole motor for 0.3-0.6m, examine recycling pressure, slowly enhance drilling weight. If gauge pressure rises accordingly in normal condition, the problem is speed loss.
	马达传动轴卡死, 钻头水眼被堵 Motor drive shaft stuck tightly and bit nozzle plugged	把钻头提离井底, 压力表读数仍很高, 只能提出钻具检查或更换钻头。 Lift bit away from the bottom. If gauge pressure is still too high, only lift out the drill for checking or to change the bit.
压力表慢慢地增高(不指随钻井深度增加而增大的正常压降) Gauge pressure slowly increasing (not means increase of the normal pressure loss with the increase of drilling depth)	钻头水眼被堵 Bit nozzle plugged	把钻头提离井底, 再检查压力, 如果压力仍然高于正常循环压力, 可以试着改善循环流量或上下移动钻杆, 如无效只得取出修理、更换。 Lift bit away from the bottom, again examine the pressure. If the pressure is still over recycling pressure, try to improve recycling flow rate or to move the drill pipe up and down. If it is not solved, only lift out the drill for repair or change.
	钻头磨损 Bit wear out	继续工作, 细心观察, 如仍无进尺, 只能取出更换。 Go on operating for careful watch. If still no footagerate, lift out the drill for change.
	地层变化 Formation change	把钻头稍稍上提, 如果压力与循环压力相同, 则可继续工作。 Lift the drill a little bit. If the pressure is same with recycling pressure, it may go on working.
压力表压力缓慢降低 Gauge pressure slowly drops	循环压力损失变化 Fluctuation of recycling pressure loss	检查钻井液流量。 Examine fluid flow rate.
	钻杆损坏 Drill pipe damaged	稍提钻具, 压力表读数仍低于循环压力, 提出并眼检查。 Lift the drill a little bit. If the gauge pressure is still lower than recycling pressure, lift it out for examination.

异常现象 Problems	可能原因 Possible Causes	判断及处理方法 Troubleshooting
没进尺 No footage rate	地层变化 Formation change	适当改变钻压和循环流量（注意必须在允许范围内）。 Appropriately change drilling weight and recycling flow rate (Note: it must be within the allowable range).
	马达失速 Motor speed loss	压力表读数偏高，钻具提离井底，检查循环压力，从小钻压开始，逐步增大钻压。 Gauge pressure increases, lift the drill away from the bottom, examine recycling pressure, to increase drilling weight gradually.
	旁通阀处于“开位” By-pass valve in OPEN position	压力表读数偏低，稍提起钻具，起停钻并泵两次仍无效，则需要提出井眼更换检查旁通阀。 Gauge pressure is too low, lift the drill a bit and start and stop the pump twice. If it is not solved, lift it out to check or change by-pass valve.
	万向轴损坏 Cardan shaft damaged	常伴有压力波动，稍提起钻具，压力波动范围小些，只能取钻具，检查更换。 Often with pressure fluctuation, lift the drill a bit, less fluctuation range. Only lift it out for examining and changing.
	钻头磨损 Bit wear out	更换新钻头。 Change new bit.

7. 定向井螺杆钻具的使用

定向钻井就是沿着预先设计的井眼轴线钻到目的层的钻井方法。要实现这个目标除螺杆钻具，还需要组成钻具组合的浮动接头、弯接头、钢钻铤、无磁钻铤、稳定器、钻头以及测量系统等配套工具和设备。我公司生产的螺杆钻具仅是完成这项工作的主要工具之一。

7.1 我公司生产的螺杆钻具可以满足定向钻井的各项需要。

7. Application of Steering Downhole Motor

Directional drilling is a way to drill the target along with the designed axial line. To do this, except for applying downhole motor, it is required to use a complete system, combined with float sub, bent sub, steel collar, non-magnetic collar, stabilizer, bit as well as MWD system. Our downhole motor is one of the drilling tools to perform this operation.

7.1 Our downhole motor meets the demands of directional drilling.

7.2 弯接头是有弯曲角度的接头短节，其公扣拧入钻具上部。弯接头上部再接钻铤，这样在钻铤及钻具间形成一个角度，这个角度对决定定向斜角起主要作用。弯接头的角度为 $0^{\circ} \sim 3^{\circ}$ ，可以由用户自己决定。弯接头角度的选择应考虑井眼尺寸、井斜角变化的要求、所用钻具估计能完成的进尺等因素。弯接头的角度直接影响井眼尺寸、井斜角和井斜角的变化率。（见表4）

7.2 Bent sub is composed of bent nipples, with its male thread onto the top of the drill. The top of bent nipple is connected with collar. Thus, there forms an angle between collar and the drill. This angle plays a key role in determining directional oblique angle. The angle degree of bent sub ranges from 0° to 3° which is decided by the customers. The factors of change of hole size, hole deviation angle and footage rate shall be considered in selection of bent subs. The angle of bent sub may directly affect the hole deviation angle and inclination change (See Table-4).

表4 弯接头角度，井斜角变化率/30m
(Table-4) Bent Sub Angle and Inclination Angle Change/30m

弯接头角度 Bent Sub Angle	120(43/4") Downhole Motor		165(61/2") Downhole Motor		197(73/4") Downhole Motor	
	井眼尺寸 Hole Size	变化率 Change	井眼尺寸 Hole Size	变化率 Change	井眼尺寸 Hole Size	变化率 Change
1°	152.4(6)"	3° 30'	222.3(83/4)"	2° 30'	250.8(97/8)"	2° 30'
1° 30'		4° 45'		3° 30'		3° 45'
2°		5° 30'		4° 30'		5° 00'
1°	171.5(63/4)"	3° 30'	250.8(97/8)"	1° 45'	269.9(105/8)"	2° 00'
1° 30'		4° 00'		3° 30'		2° 30'
2°		5° 00'		4° 45'		4° 15'
2° 30'		5° 45'		5° 00'		5° 30'
1°						
1°	200(77/8)"	2° 30'	269.9(105/8)"	1° 15'	311.2(121/4)"	1° 45'
1° 30'		3° 30'		2° 00'		2° 30'
2°		4° 30'		3° 00'		3° 30'
2° 30'		5° 30'		4° 00'		5° 00'

如果弯接头有斜口管鞋造斜键，应当检查一下这个件要对正弯接头上的刻线，这样可以保证定向方位的正确，并在运转前记录下来。

If the bent nipple has muleshoe key on it, you should examine the alignment between the key and bent sub, to ensure correct directional azimuth. If using magnetic deflection, you should examine the interaction between the alignment line and polarity of the magnet inserted in the collar, and record it before operation.



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7.3 反扭矩对定向钻井的影响: 钻具组合, 通过钻杆下到预定定向造斜深度, 从预定深度到井台在反扭矩的作用下产生变形。施加钻压时, 钻具输出一定的扭矩, 那么大小相同方向相反的反扭矩就作用在整个钻具组合及钻杆上, 造成它们的扭转变形, 因此必然影响定向的方位。在定向钻井工作中, 为了保持正确的方向, 必须考虑扭矩。由反扭矩造成的反扭角的大小取决于:

- 钻压。
- 钻杆的类型与长度。
- 井斜角的大小。
- 钻铤和重钻的类型和长度。
- 装有扶正器时, 扶正器的数量和长度
钻柱的反扭角可以粗略地参照(表5)的数值。

7.3 Influence of Opposite Torque to Directional Drilling: The downhole motor combination will be stripped in with the drill pipe into the scheduled depth of directional deflection, deforming under the reaction of opposite torque from the schedule depth to the platform. When enhancing drilling weight, the drill may output a certain torque. Thus, the opposite torque of same force and reverse direction will react on the combination, causing torsion deformation. This will, of course, affect the directional azimuth.

During the period of directional drilling, the opposite torque shall be considered to ensure correct direction. The degree of opposite torsion angle caused by the opposite torque depends upon:

- Drilling weight
- Type and length of drill pipe
- Size of deviation angle
- Type and length of collar and heavy drill pipe
- The quantity and length of centralizer, when completed with centralizer for the opposite torsion angle of drill string, refer the data in Table-5.

表5 钻柱反扭角估算

(Table-5) Estimation of Opposite Torsion Angle on String

开始造斜深度(m) Initial Deflection Depth (m)	估算反扭角 Estimated Opposite Torsion Angle
0-152	Left Turn 20° 左旋20°
>152-305	Left Turn 25° 左旋25°
>305-475	Left Turn 35° 左旋35°
>475-1524	Left Turn 50° 左旋50°
>1524-full well depth >1524-全井深	Left Turn 10° /305m 左旋10° /305m



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如果在预定方位井斜角下继续造斜而造斜过程中出现偏离预定方位的情况，建议用（表6），它可获得最有效的方位变化，而又很少影响井斜角的变化。

If deviation of scheduled direction occurs, during on-going deflection with the planned deviation angle, it is advised to refer Table-6 to obtain effective azimuth change, which is less affecting the deviation angle.

表6 已有井斜角时（纠偏）反扭角的估算
(Table-6) Estimation of Opposite Torsion Angle with Deviation

井深 Well Depth	井斜角 Hole Deviation Angle	从井眼的高点调整钻具 Adjust the Drill from Top of Hole	
		向左纠偏 Left Correction	向右纠偏 Right Correction
地面-305 Surface-305	2° -5°	Left Turn 40° 左转	Right Turn 140° 右转
	5° -10°	Left Turn 40° 左转	Right Turn 135° 右转
	10° -15°	Left Turn 40° 左转	Right Turn 130° 右转
	15° -20°	Left Turn 40° 左转	Right Turn 125° 右转
	20° -25°	Left Turn 40° 左转	Right Turn 120° 右转
	25° -30°	Left Turn 40° 左转	Right Turn 115° 右转
	30° -35°	Left Turn 40° 左转	Right Turn 110° 右转
305-710	Over 35°	Right Turn 40° 右转	Right Turn 105° 右转
	2° -5°	Left Turn 30° 左转	Right Turn 155° 右转
	5° -10°	Left Turn 20° 左转	Right Turn 140° 右转
	10° -15°	Left Turn 10° 左转	Right Turn 135° 右转
	15° -20°	Left Turn 15° 左转	Right Turn 130° 右转
	20° -25°	Left Turn 0° 左转	Right Turn 125° 右转
	25° -30°	Left Turn 5° 左转	Right Turn 120° 右转
710-全部井深 710-Full depth	30° -35°	Right Turn 5° 右转	Right Turn 115° 右转
	Over 35°	Right Turn 10° 右转	Right Turn 110° 右转
	2° -5°	Left Turn 25° 左转	Right Turn 180° 右转
	5° -10°	Left Turn 15° 左转	Right Turn 170° 右转
	10° -15°	Left Turn 5° 左转	Right Turn 165° 右转
	15° -20°	Left Turn 0° 左转	Right Turn 145° 右转
	20° -25°	Right Turn 5° 右转	Right Turn 125° 右转
25° -30°	Right Turn 10° 右转	Left Turn 115° 左转	
Over 35° 35° 以上	Left Turn 10° 左转	Left Turn 100° 左转	

7.4 注意事项

- 调整弯接头指向时，转盘应按右旋定位，调整完毕，钻柱需慢慢地提升和下放数次（上提高度应超过9m）消除井眼中的钻杆应力，使其处于自由放松状态。
- 所测得的井眼方位和井斜角不是钻头处的数据而是在钻头以上15米左右处，这是测斜装置距钻头的距离。
- 连续造斜时，建议每钻一单根取一测量数据。
为使造斜准确，所加钻压应稳定且不要过大。

7.5 导向钻并螺杆钻具

- 导向螺杆钻具是我公司为水平钻并设计和制造的新型井下动力钻具，通常是指配有弯壳体 and 稳定器的钻具。
- 用途
配合PDC钻头或牙轮钻头组成不同的钻具组合，用于导向钻并系列，完成造斜和在不更换钻具组合而实现稳斜段（配合转盘低速旋转）及水平并段的钻并作业。
- 传动轴外壳带有不同直径和不同形状的稳定器（见图6），用户可根据钻并工艺的需要选择使用。
- 弯万向轴壳体
弯万向轴壳体有单弯和双弯两种形式，并有不同角度的弯角供用户选择，双弯壳体还可选择同向双弯和反向双弯。（表7）为我公司常规钻具的弯角及造斜率供用户参考。

7.4 Cautions

- When adjusting the guide point of bent sub, turntable shall be orientated in right rotation. Then slowly trip in and out the drill string (lifting for over 9m) to eliminate the pipe stress in the hole, keeping it in free position.
- The measured hole azimuth and deviation angle is not the data of the bit location, but it is on about 15m point above the bit location. This is the distance between measuring device and bit.
- When continuously deflecting, it is advised to measure the data while stripping in a drill pipe. The added drilling weight shall be kept stable (not too heavy) to ensure correction of deflection.

7.5 Steering Downhole Motor

- Steering downhole motor is our newly designed and manufactured downhole dynamic tool. It is normally a kind of drilling tool completed with bent shell and stabilizer.
- Application
Completed with PDC bit and rock bit, it composes various drill combination, being used for steering drilling. It may perform deflection without changing the combination to realize drilling operation in directional zone (with lower speed of turntable) and horizontal zone.
- The shell of drive shaft is completed with a stabilizer of different diameter and shapes (See Fig.6). The customers are required to choose them according to the drilling program.
- Bent cardan shaft shell
Bent cardan shaft shell is divided into single and double. Various angle shall be provided for your selection. For double bent shell, you may choose both homo direction and reverse direction.
Table-7 shows bent angle and deflection of our conventional downhole motor for your reference.

- 为了解决水平钻井的携屑上返的困难问题，马达转子设计有中心分流孔入口处装有喷咀，从而增加输入流量，可以进行高压喷射钻井。当需要排量较小时，可以封堵转子中孔。

可根据用户要求，制造转子头数与定子头数比为1:2, 3:4, 6:7, 9:10的各种规格（见图7），和不同规格的扶正器（见图8），且可根据使用要求为用户提供钻头水眼压力降为14Mpa的产品。



图7 (Fig.7)

8. 定货须知

如果您要使钻具取得良好的使用效果，不仅注重钻具本身质量状况，技术性能，还与您使用的目的、环境及介质条件、钻具组合等因素密切相关。因此您定货时正确选择钻具型号和结构形式尤为重要。

如果您在选型时存在疑问，请及时与我公司联系。

为了能正确、及时地向您提供所需产品，请您在定货时认真填写定货信息表，并且同时确定下面几个问题：

- In order to overcome difficulty for carrying solid to flow upward in horizontal drilling, a nozzle is designed at the inlet of center splitter on motor rotor, and it may increase the input flow rate and to perform hi-pressure jet drilling. When you need smaller flow rate, you may plug the splitter hole.

We may manufacture various types of Downhole motor with the ratio of numbers of stator rotor ends: 1:2, 3:4, 6:7 and 9:10 according to the customer's demand, (see Fig.7) and various stabilizer, (see Fig.8) and provide the products of 14Mpa bit nozzle pressure loss based on the customer's application.

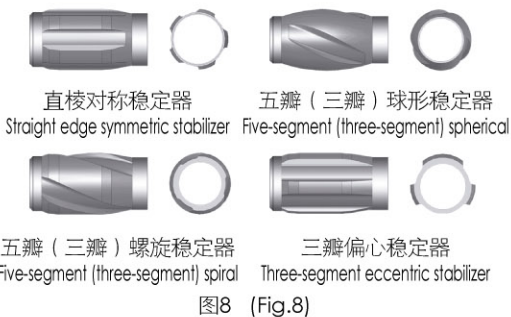


图8 (Fig.8)

8. Purchase Guide

If you want to obtain good effectiveness by using downhole motor, you should take concern not only with its quality, technical property, but also with the application purpose, environmental conditions and its combination as well. So it is very important to make correct selection of the type and composition when purchasing the equipment. Please contact us if you have any questions for selection.

Please fill in the form when you are planning to order the equipment, to ensure correct and rapid provision of our products. So we need to confirm the following information:

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(1) 是否需提供附件或附加结构:

- 提升短节 (井口或随钻)
- 定向接头

(2) 如果有可能, 定货时提供以下信息以便跟踪服务:

- 钻具使用单位
- 钻具使用井位, 使用目的及预计使用时间
- 井身结构, 使用钻具井段、泥浆条件等

(1) Need providing Accessories:

- Lifting nipple (wellhead or with drilling)
- Directional collar

(2) If possible, please provide the following information for feedback:

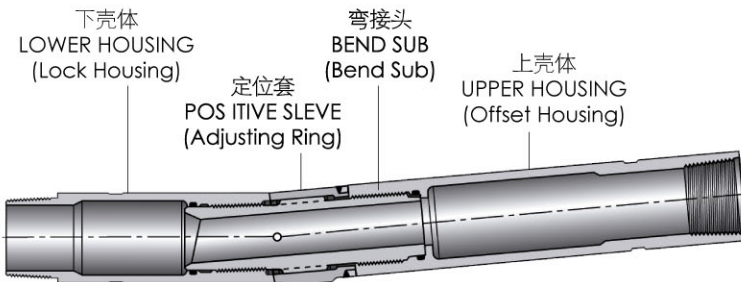
- Name of customers
- Location, purpose and estimated Duration
- Well bore structure, section to use screw drill and mud system

表7 弯外壳螺杆钻具造斜率
(Table-7) Deflection of Bent Shell

参数 Parameter 钻具型号 Model	井眼尺寸 (in) Hole Size	TH。Def 理论造斜率 Angle K° 30m								
		30'	45'	1° 00'	1° 15'	1° 30'	1° 45'	2° 0'	2° 15'	2° 30'
5LZ73 x 7.0TT	31/8	5.9	7.8	20.3	23.6	30	37.6	43.7	48.6	53.8
5LZ89 x 7.0TT	45/8	7.6	11.5	15.4	19.0	23.0	26.7	30.5	34.4	38.2
5LZ95 x 7.0TT	45/8	7.3	10	13.4	16.3	20.0	23.7	27.4	30.0	34.8
5LZ95 x 7.0TT	45/8	7.3	10	13.4	16.3	20.0	23.7	27.4	30.0	34.8
5LZ120 x 7.0TT	6	6.5	7.6	11.3	14.3	17.2	20.7	24		
5LZ165 x 7.0TT	8 1/2	4.4	6.5	8.9	12.0	13.9	15.4	17.5		
5LZ172 x 7.0TT	8 1/2	4.0	6.02	8.1	9.80	11.4	13.3	15.7		
5LZ197 x 7.0TT	12 1/4	4.0	6.0	8.2	10.2	12.3	15.2	16.3		
5LZ244 x 7.0TT	12 1/4	3.6	5.4	7.3	9.1	10.9	12.7	14.5		

I. 可调弯壳体调节操作说明: 图9

(Fig.9) Operate Description of Adjustable Bend Housing:



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德华可调弯壳体可轻松简便的调节角度 $0^{\circ} - 3^{\circ}$ 。

以下为德华可调弯壳体调节设置程序步骤:

参见(图10)来设置第1步和第2步:

1. 将钳牙放在在如图所标的旋扣区域, 松开连结。
2. 当定位套的牙与上壳体的牙啮合时, 顺时针旋开下壳体2-4圈(但不要完全卸开)。

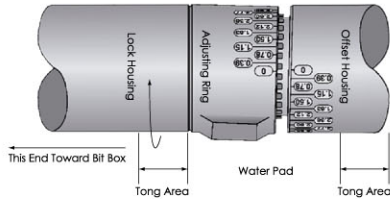
The DEHUA adjustable bend housing allows for quick and easy bend angle adjustment from $0^{\circ} - 3^{\circ}$.

Below is the procedure for setting the DEHUA adjustable bend housing:

Refer to the above (Fig.10) for step 1 and 2:

1. Place the jaws of tongs in the tong areas shown and break the tool joint.
2. While keeping the adjusting ring teeth engaged with the mated slots in the offset housing, unscrew the lock housing two to four complete turns in the clockwise direction (unthread).

图10
(Fig.10)



参见(图11)来设置第3步和第4步:

3. 下滑动定位套至牙齿之间脱离。
4. 调节弯壳体角度, 顺时针旋转定位套, 直到所需角度在上壳体上出现。

Refer to the above (Fig.11) for step 3 and 4:

3. Slide the adjusting ring down to disengage the teeth in the ring and the offset housing.
4. To adjust the bend angle of the bent housing, rotate the adjusting ring clockwise until the desired bend-angle marking on the offset housing.

图11
(Fig.11)

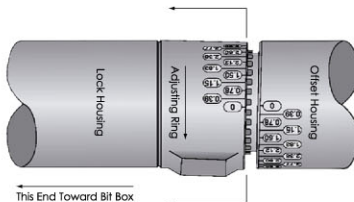
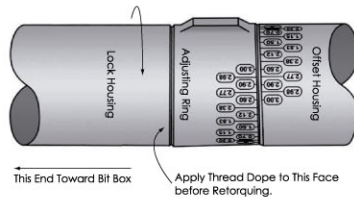


表8 钻具上下端螺纹安装扭矩
(Table-8) Top and Bottom Thread Torque

钻具规格 Size	上端螺纹 Top Thread	紧扣扭矩KNM Twist Torque	下端螺纹 Bottom Thread	紧扣扭矩KNM Twist Torque
43	1 REG	1.6~1.9	1REG	1.6~1.9
54	1 1/2 REG	2.8~3.5	1 1/2 REG	2.8~3.5
60	1 1/2 REG	2.8~3.5	1 1/2 REG	2.8~3.5
73	2 3/8 REG	3.4~4.8	2 3/8 REG	4.8~6.3
79	2 3/8 REG	3.4~4.8	2 3/8 REG	4.8~6.3
89	2 3/8 REG	3.4~4.8	2 3/8 REG	4.8~6.3
95	2 7/8 REG	6.8~11.6	2 7/8 REG	6.8~11.6
120	3 1/2 REG	14.3~17.2	3 1/2 REG	9.4~12.2
140	4 1/2 REG	27.9~31.6	4 1/2 REG	16.3~21.8
159	4 1/2 REG	31.6~33.6	4 1/2 REG	16.3~21.8
165	4 1/2 REG	32.4~35.6	4 1/2 REG	16.3~21.8
172	4 1/2 REG	32.4~35.6	4 1/2 REG	16.3~21.8
197	5 1/2 REG	54.4~68	6 5/8 REG	68.0~79.3
203	5 1/2 REG	54.4~68	6 5/8 REG	68.0~79.3
216	6 5/8 REG	68~79.6	6 5/8 REG	38.1~43.5
244	6 5/8 REG	74.8~88.4	7 5/8 REG	46.2~54.4
286	6 5/8 REG	74.8~88.4	7 5/8 REG	46.2~54.4

图12
(Fig.12)



参见 (图12) 来设置第5步和第7部:

5. 调节弯壳体角度, 顺时针旋转定位套, 调到所需角度。
6. 应用丝扣液来涂下壳体和定位套之间的对接面。
7. 一起调节下壳体和定位套, 并且参考扭矩值表 (表9)。匹配的上壳体外径和定位套显示数值。

Refer to the above (Fig.12) for step 5 and 7:

5. Engage the teeth of the adjusting ring and the offset housing at the desired bend angle.
6. Apply thread dopping to the mated faces between the lock housing and the adjusting ring.
7. Screw the lock housing and the adjusting ring together and apply the torque value listed in (Table-9). The matching markings on the OD of the offset housing and the adjusting ring indicated as well as the high side marks to identify the high side of the tool.

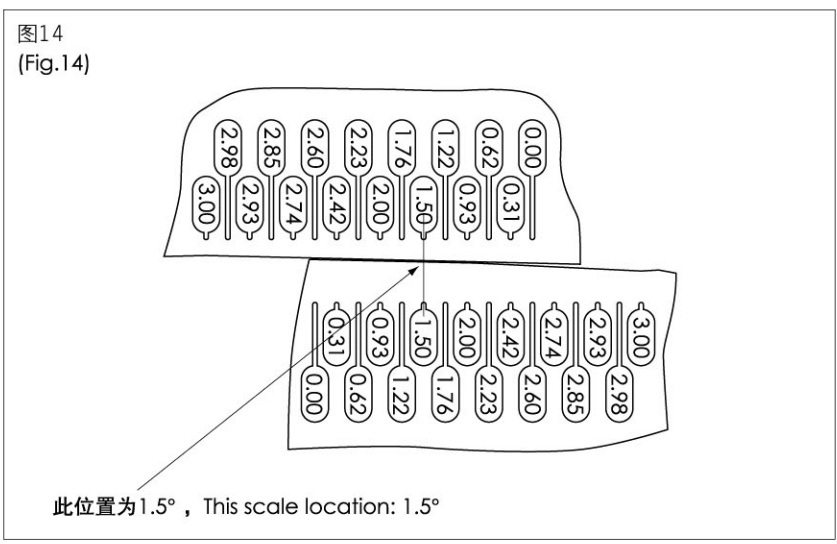
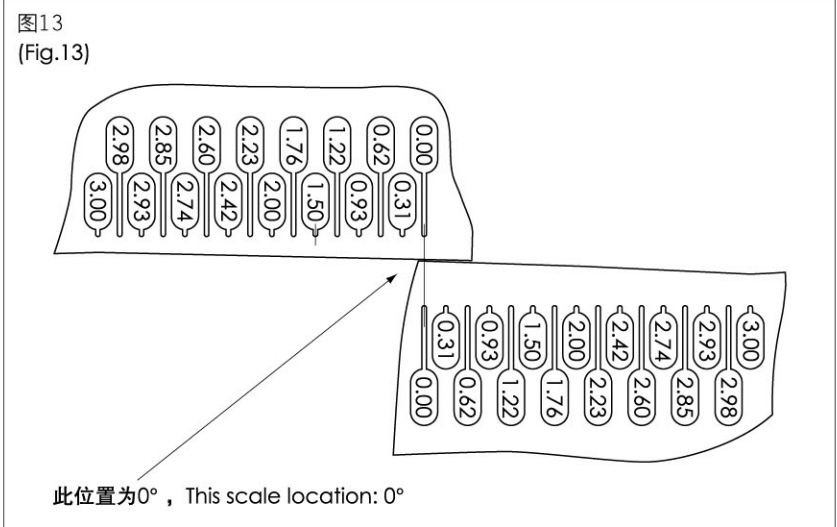


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表9 可调部分下壳体上紧扭矩
(Table-9) Lock Housing Make-up Torque

可调部分下壳体上紧扭矩 LOCK HOUSING MAKE-UP TORQUE		
规格 Motor Size	英制 English	公制 Metric
2-7/8	2,300 ft-lbs	3,200 N-m
3-1/8	2,700 ft-lbs	3,600 N-m
3-1/2	3,800 ft-lbs	5,100 N-m
3-3/4	4,600 ft-lbs	6,300 N-m
4-1/8	7,000 ft-lbs	9,500 N-m
4-3/4	9,500 ft-lbs	12,700 N-m
5-1/2	16,000 ft-lbs	21,500 N-m
6-1/4	20,000 ft-lbs	26,700 N-m
6-1/2	23,000 ft-lbs	31,000 N-m
6-3/4	27,000 ft-lbs	37,000 N-m
7-3/4	29,000 ft-lbs	39,000 N-m
8	30,000 ft-lbs	40,300 N-m
8-1/2	38,000 ft-lbs	51,000 N-m
9	40,000 ft-lbs	53,700 N-m
9-5/8	61,000 ft-lbs	83,000 N-m
11-1/4	100,000 ft-lbs	136,000 N-m

II. 可调弯壳体调节角度说明:
Description of Adjustable Bend Housing:



III. 螺杆钻具弯壳体角度标示规定: 图15

(Fig.15)Description of Angle of Bend Housing:



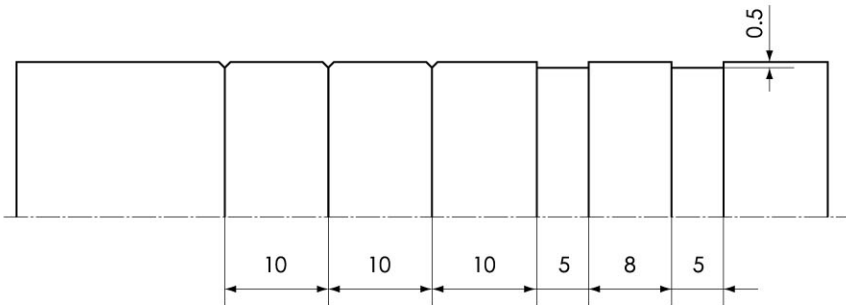
为使用户在使用钻具时能清楚了解到该钻具弯壳体角度，特将标示规定如下：

1. 以环形槽、尖槽标示所弯角度，每一空环槽表示 1° ，每一尖槽表示 $15'$ ；
2. 空环槽、尖槽位置及尺寸如图16：
3. 扎槽位置距内螺纹边缘200-250为宜。

For user clearly know the angle of bend housing when operate this downhole motor, description as follows:

1. Angle meant by annular groove, acuminate groove, per empty annular groove is 1° per acuminate groove is $15'$;
2. Location and dimension of empty annular groove, acuminate groove (see fig.16):
3. It is propriety that Location of fluting near internal edge of thread 200-250.

图16
(Fig.16)



Example Note: Above Angle is $2^\circ 45'$



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IV. 德华螺杆钻具在钻井中对应转盘速度:

Corresponding Speed of Turnplate When Drilling Well:

转盘以高于80rpm 的速度使马达旋转会损伤定子的合成橡胶。高转盘速度可以使转子和传动机构产生的离心力增大，引起定子、传动机构、径向轴承和内连接螺纹磨损增大。

Turnplate speed more than 80rpm lead to destroy of stator rubber. Turnplate high speed lead to centrifugal force increasing at rotor and driving section, lead to abrasion increasing at stator, driving section, radial bearing and internal thread.

V. 转盘速度与弯外壳角度的关系: (见表10)

(Table-10) The Relation Between Speed of Turnplate and Bend Housing:

弯外壳角度 (0° - 3°) Angle of Bend Housing	转盘速度 (rpm) Speed of Turnplate
0.00°	80
0.25°	70
0.50°	70
0.75°	60
1.00°	50
1.25°	40
1.50°	40
1.75°	NR
2.00°	NR
2.25°	NR
2.50°	NR
3.00°	NR

NR: 为不推荐。

NR: Means not recommended.

注: 弯外壳角度超过1.50°, 禁止开动转盘导向钻进。

Note: If angle of bend housing exceed 1.50°, forbid turning turntable to steering drilling.

VI. 德华螺杆钻具允许承受最大拉力: (见表11)
(Table-11) Allowable Max Pull Downhole Motor :

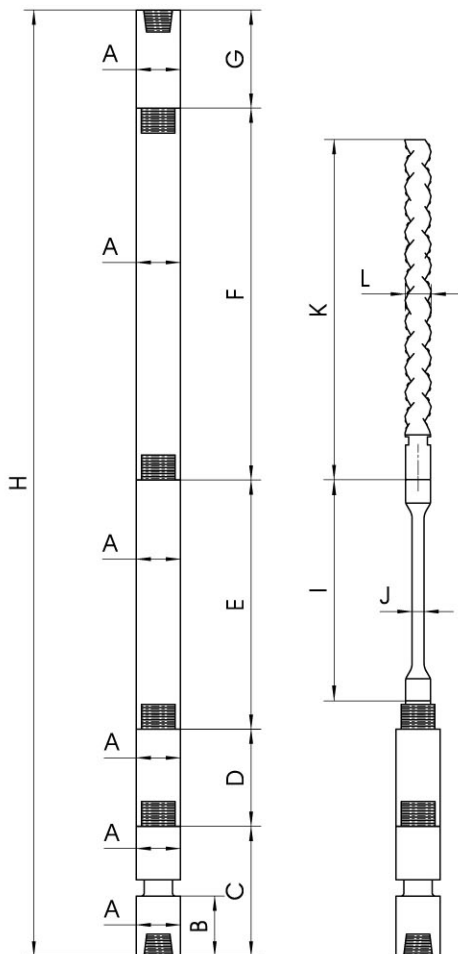
钻具规格 size	作用在钻头上 working on drilling bit		作用在壳体上 working on housing	
	KN	LBS	KN	LBS
43	57	12800	145	32580
54	125	28090	230	51685
60	130	29200	285	64045
73	290	65170	420	94380
79	290	65170	595	133700
89	295	66300	640	143820
95	380	84900	870	195505
120	520	116850	1150	258425
140	723	162480	1592	357770
159	1115	250560	1865	419100
165	1250	280900	1900	426965
172	1370	307860	1935	434830
197	1540	346070	2600	584270
203	1585	356180	3220	723595
216	2395	538200	3700	831460
228	2395	538200	4360	979775
244	2590	582020	4530	1017980
286	3565	801120	4930	1107865

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德华小规格螺杆钻具打捞尺寸图
The Fishing Size Drawing of Dehua Small Size Downhole Motor



德华小规格螺杆钻具打捞尺寸表
The Fishing Size Table of Dehua Small Size Downhole Motor

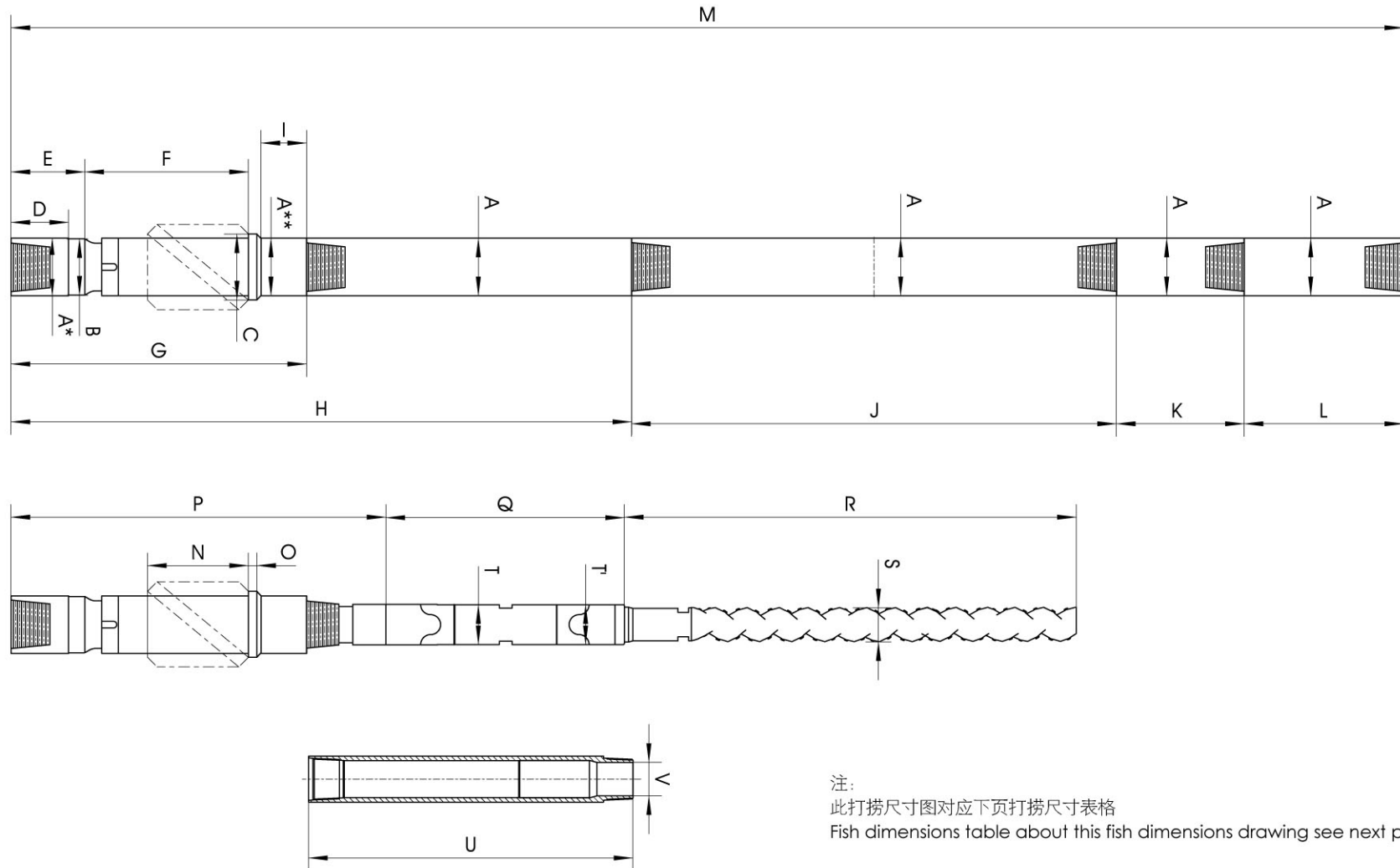
钻具 型号 尺寸 代号	5LZ43A X 3.5	5LZ54A X 3.5	5LZ60A X 3.5
A	Φ43	Φ54	Φ61
B	76	100	110
C	141	210	230
D	136	212	260
E	737	855	990
F	1245	1385	1400
G	121	165	130
H	2380	2827	3010
I	735	970	965
J	Φ15	Φ18	Φ20
K	1120	1120	1340
L	Φ24.3	Φ33.1	Φ33.1

注：
表中提供的尺寸仅供参考，如需要具体尺寸请与公司联系。
Above dimension is referenced, if you need detail dimension, please contact us.



德华常规螺杆钻具打捞尺寸图

The Fishing Size Drawing of Dehua Downhole Motor (stright or bend housing)



注：
此打捞尺寸图对应下页打捞尺寸表格
Fish dimensions table about this fish dimensions drawing see next page



德华常规螺杆钻具打捞尺寸表

The Fishing Size Table of Dehua Downhole Motor (straight or bend housing)

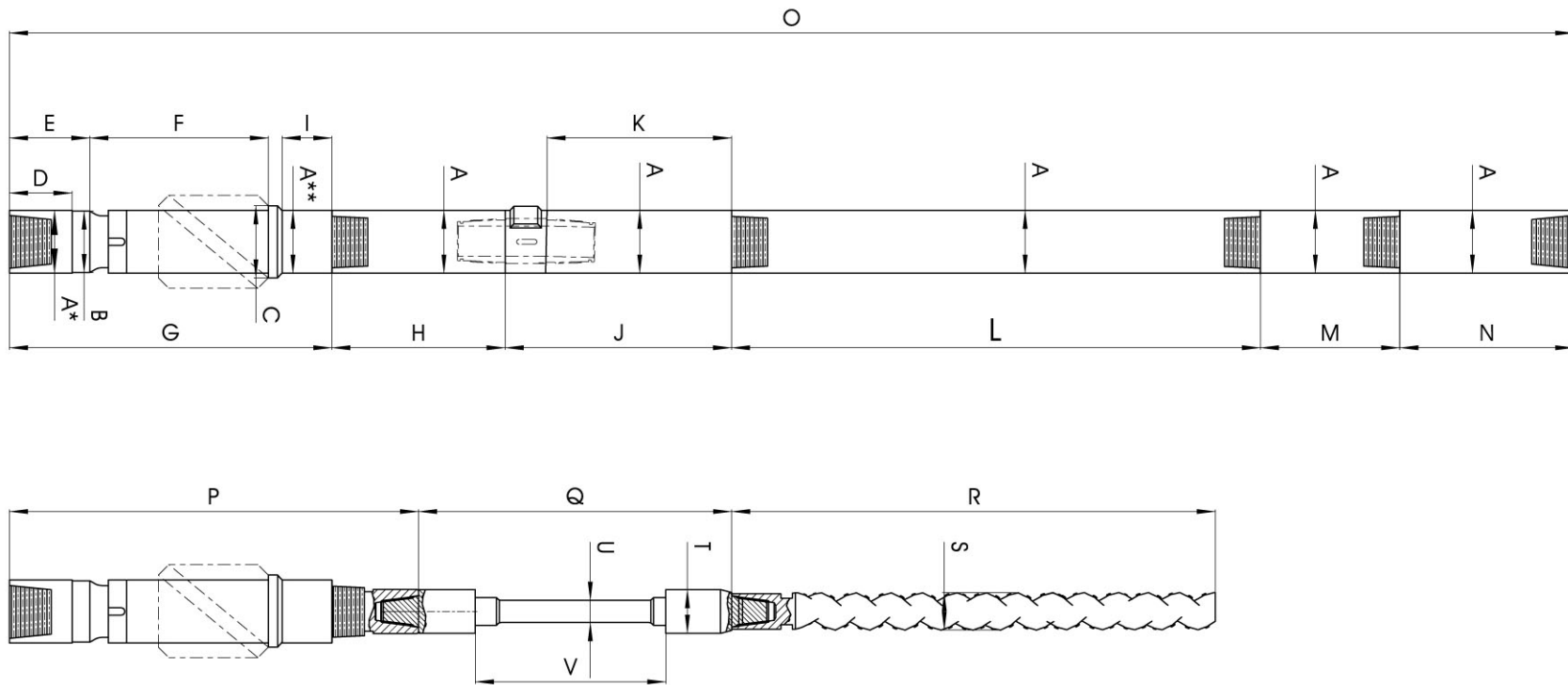
尺寸代号	钻具型号																														
	5LZ73 X7.0-3	5LZ79 X7.0-3	5LZ89 X7.0-3	5LZ95 X7.0-3	9LZ95 X7.0-4	5LZ120 X7.0-3	5LZ120 X7.0-4	5LZ120 X7.0-5	5LZ120 X7.0-6	5LZ140 X7.0-4	5LZ159 X7.0-5	5LZ165 X7.0-4	5LZ165 X7.0-5	5LZ165 X7.0-6	5LZ172 X7.0-4	5LZ172 X7.0-5	5LZ172 X7.0-6	9LZ172 X7.0-2	5LZ197 X7.0-4	5LZ197 X7.0-5	5LZ197 X7.0-6	5LZ203 X7.0-4	5LZ203 X7.0-5	5LZ203 X7.0-6	5LZ216 X7.0-4	5LZ216 X7.0-5	5LZ228 X7.0-5	5LZ244 X7.0-4	5LZ244 X7.0-5	3LZ244 X7.0-6	3LZ286 X7.0-4
A	Φ73	Φ79	Φ89	Φ96	Φ96	Φ120	Φ120	Φ120	Φ120	Φ140	Φ159	Φ165	Φ165	Φ165	Φ172	Φ172	Φ172	Φ172	Φ197	Φ197	Φ197	Φ203	Φ203	Φ203	Φ216	Φ216	Φ228	Φ245	Φ245	Φ245	Φ286
B	NA	NA	NA	94	94	Φ116	Φ116	Φ116	Φ116	Φ137	Φ155	Φ162	Φ162	Φ162	Φ168	Φ168	Φ168	Φ168	Φ194	Φ194	Φ194	Φ194	Φ194	Φ194	Φ214	Φ214	Φ224	Φ238	Φ238	Φ238	Φ280
C	NA	NA	NA	NA	NA	Φ136	Φ136	Φ136	Φ136	NA	Φ176	Φ184	Φ184	Φ184	Φ188	Φ188	Φ188	Φ188	215	215	215	215	215	215	Φ245	Φ245	Φ245	Φ280	Φ280	Φ280	NA
D	NA	NA	NA	155	155	180	180	180	180	180	210	210	210	210	210	210	210	210	210	210	210	210	210	210	225	225	225	234	234	234	270
E	125	125	160	201	201	228	228	228	228	240	269.5	268.5	268.5	268.5	268.5	268.5	268.5	268.5	290	290	290	290	290	290	306	306	301	314.5	314.5	314.5	360.5
F	NA	NA	NA	NA	NA	343	343	343	343	NA	523	564.5	564.5	564.5	532	532	532	532	632.5	632.5	632.5	632.5	632.5	632.5	620	620	NA	666	666	666	NA
G	553	597	604	682	682	763	763	763	763	905	1109	1042	1042	1042	1115	1115	1115	1115	1202	1202	1202	1202	1202	1202	1243	1243	1243	1321	1321	1321	1461
H	1114	1167	1314	1382	1382	1756	1756	1756	1756	2065	2549	2276	2276	2276	2634	2635	2635	2635	2602	2602	2602	2602	2602	2602	2632	2632	2632	2876	2876	2876	3201
I	NA	NA	NA	NA	NA	155	155	155	155	NA	271	NA	NA	NA	264	264	264	264	245	245	245	249	249	249	246	246	NA	244	244	244	NA
J	2080	2080	2120	2100	2700	3020	3920	4690	5484	3600	4640	3865	4600	5440	3780	4610	5350	2290	3760	4600	5440	3760	4600	5440	3760	4600	4600	4562	5570	6688	5770
K	190	190	250	270	270	311	311	311	311	280	390	398	398	398	390	390	390	390	350	350	350	380	380	380	365	365	373	464	464	464	470
L	190	190	230	245	245	288	288	288	288	360	370	387	387	387	363	363	363	363	410	410	410	410	410	410	430	430	430	626	626	626	550
M	3574	3627	3914	3997	4597	5375	6275	7045	7839	6305	7949	6926	7661	8501	7168	7998	8738	5678	7122	7962	8802	7152	7992	8832	7187	8027	8035	8528	9536	10654	9991
N	NA	NA	NA	NA	NA	200	200	200	200	NA	310	305	305	305	310	310	310	310	360	360	360	360	360	360	380	380	NA	440	440	440	NA
O	NA	NA	NA	NA	NA	15	15	15	15	NA	30	NA	NA	NA	36	36	36	36	20	20	20	20	20	20	50	50	NA	65	65	65	NA
P	540	587	876	811	811	815	815	815	815	1285	1553	1480	1480	1480	1558	1558	1558	1558	1735	1735	1735	1735	1735	1735	1767	1767	1767	1869	1869	1869	2091
Q	536	536	400	515	515	880.5	880.5	880.5	880.5	680	934	733	733	733	1014	1014	1014	1014	794	794	794	794	794	794	794	794	794	930	930	930	1006
R	2020	2020	2040	2020	2615	2940	3840	4610	5404	3550	4510	3720	4460	5300	3630	4460	5200	2140	3650	4490	5330	3650	4490	5330	3640	4480	4480	4412	5420	6525	5572
S	Φ45	Φ45	Φ59.8	Φ62.8	Φ65.7	Φ70.8	Φ70.8	Φ70.8	Φ70.8	Φ83.8	Φ94.5	Φ96.6	Φ96.6	Φ96.6	Φ106	Φ106	Φ106	Φ106	Φ123.6	Φ124.5	Φ124.5	Φ124.5	Φ124.5	Φ124.5	Φ137.5	Φ137.5	Φ137.5	Φ152.3	Φ152.3	Φ148.4	Φ169.5
T	Φ45	Φ45	Φ60	Φ66	Φ66	Φ82.5	Φ82.5	Φ82.5	Φ82.5	Φ95	Φ108	Φ108	Φ108	Φ108	Φ116	Φ116	Φ116	Φ116	Φ140	Φ140	Φ140	Φ140	Φ140	Φ140	Φ150	Φ150	Φ150	Φ160	Φ160	Φ160	Φ180
T'	Φ45	Φ45	Φ60	Φ66	Φ66	Φ82.5	Φ82.5	Φ82.5	Φ82.5	Φ95	Φ108	Φ108	Φ108	Φ108	Φ120	Φ120	Φ120	Φ120	Φ140	Φ140	Φ140	Φ140	Φ140	Φ140	Φ150	Φ150	Φ150	Φ160	Φ160	Φ160	Φ180
U	621	516	784	780	780	1082	1082	1082	1082	1250	1550	1336	1336	1336	1630	1630	1630	1630	1520	1520	1520	1520	1520	1520	1515	1515	1515	1691	1691	1691	1890
V	Φ49	Φ49	Φ64	Φ72	Φ72	Φ81	Φ81	Φ81	Φ81	Φ100	Φ112	Φ114	Φ114	Φ114	Φ125	Φ125	Φ125	Φ125	Φ152	Φ152	Φ152	Φ152	Φ152	Φ152	Φ160	Φ160	Φ150	Φ175	Φ175	Φ175	Φ200

- 注:
- 1、图中所示钻具为新型（VIII型）结构，扶正筋为可换式；万向轴为齿瓣型。表中NA表示该型号钻具无此结构。
 - 2、图中A*表示当钻具型号为203时；其值为Φ197。（只有扶正筋为可换式结构时A*值Φ197；其余结构A*值为Φ203）。A**表示当钻具型号为165时，A**值为Φ184，长度为208mm。
 - 3、表中提供的尺寸仅供参考，如需要具体尺寸请与公司联系。
 - 4、扶正筋套筒的外径尺寸根据用户需求而定，表中不提供。
 - 1.Above downhole motor is new structure(VIII), Changeable stabilizer, Flat shaft,NA means there is not this kind of structure downhole motor.
 - 2.Above A* means: when size of downhole motor is 203mm, the value is Φ197mm, (unless the housing of stabilizer is changeable, the value is Φ197mm, the value of others structure is Φ203mm). A**means: when size of downhole motor is 165mm, A**value is Φ184mm, length is 208mm.
 - 3.Above dimension is referenced, if you need detail dimension, please contact us.
 - 4.OD dimension of Sleeve of stabilizer determined by user, no data in above chart.



德华可调弯度螺杆钻具打捞尺寸图

The Fishing Size Drawing of Dehua Downhole Motor With Adjustable Bend Housing (ABH)



注:

此打捞尺寸图对应下页打捞尺寸表格

Fish dimensions table about this fish dimensions drawing see next page

TTGM 德华可调弯度螺杆钻具打捞尺寸表
The Fishing Size Table of Dehua Downhole Motor With Adjustable Bend Housing (ABH)

尺寸代号	钻具型号																									
	5LZ73 X7.0-3	7LZ79 X7.0-3	5LZ95 X7.0-3	9LZ95 X7.0-4	5LZ120 X7.0-3	5LZ120 X7.0-4	5LZ120 X7.0-5	5LZ120 X7.0-6	5LZ140 X7.0-4	5LZ159 X7.0-5	5LZ165 X7.0-4	5LZ165 X7.0-5	5LZ165 X7.0-6	5LZ172 X7.0-4	5LZ172 X7.0-5	5LZ172 X7.0-6	5LZ197 X7.0-4	5LZ197 X7.0-5	5LZ197 X7.0-6	5LZ203K 7.0-4	5LZ203 X7.0-5	5LZ203 X7.0-6	5LZ244 X7.0-4	5LZ244 X7.0-5	5LZ244 X7.0-6	3LZ286 X7.0-4
A	Φ73	Φ79	Φ96	Φ96	Φ120	Φ120	Φ120	Φ120	Φ140	Φ159	Φ165	Φ165	Φ165	Φ172	Φ172	Φ172	Φ197	Φ197	Φ197	Φ203	Φ203	Φ203	Φ245	Φ245	Φ245	Φ286
B	NA	NA	94	94	Φ116	Φ116	Φ116	Φ116	Φ137	Φ155	Φ162	Φ162	Φ162	Φ168	Φ168	Φ168	Φ194	Φ194	Φ194	Φ194	Φ194	Φ194	Φ238	Φ238	Φ238	Φ280
C	NA	NA	NA	NA	Φ136	Φ136	Φ136	Φ136	NA	Φ176	Φ184	Φ184	Φ184	Φ188	Φ188	Φ188	215	215	215	215	215	215	Φ280	Φ280	Φ280	Φ335
D	NA	NA	155	155	180	180	180	180	180	210	210	210	210	210	210	210	210	210	210	210	210	210	234	234	234	270
E	125	125	201	201	228	228	228	228	240	269.5	268.5	268.5	268.5	268.5	268.5	268.5	290	290	290	290	290	290	314.5	314.5	314.5	360
F	NA	NA	NA	NA	343	343	343	343	NA	523	564.5	564.5	564.5	532	532	532	632.5	632.5	632.5	632.5	632.5	632.5	666	666	666	753
G	553	479	682	682	763	763	763	763	905	1109	1042	1042	1042	1115	1115	1115	1202	1202	1202	1202	1202	1202	1321	1321	1321	1470
H	260	300	380	380	460	460	460	460	590	830	830	830	830	752	752	752	982	982	982	990	990	990	1050	1050	1050	1176
I	NA	NA	NA	NA	155	155	155	155	NA	271	NA	NA	NA	264	264	264	245	245	245	249	249	249	244	244	244	220
J	404	426	490	490	533	533	533	533	720	610	618	618	618	666	666	666	715	715	715	715	715	715	884	884	884	900
K	329	351	410	410	445	445	445	445	622	516	524	524	524	563	563	563	597	597	597	602	602	602	710	710	710	723
L	2080	1850	2100	2700	3020	3920	4690	5484	3600	4640	3865	4600	5440	3780	4610	5350	3760	4600	5440	3760	4600	5440	4562	5570	6688	5770
M	190	190	270	270	311	311	311	311	280	390	398	398	398	390	390	390	350	350	350	380	380	380	464	464	464	512
N	190	190	245	245	288	288	288	288	360	370	387	387	387	363	363	363	410	410	410	410	410	410	626	626	626	750
O	3677	3405	4167	4767	5375	6275	7045	7839	6455	7949	7140	7875	8715	7066	7893	8636	7419	8259	9099	7457	8297	9767	8907	9915	11033	10580
P	538	469	811	811	815	815	815	815	1055	1553	1480	1480	1480	1296	1296	1296	1735	1735	1735	1735	1735	1735	1868.5	1868.5	1868.5	2091
Q	496	527	515	515	880.5	880.5	880.5	880.5	1060	934	934	934	934	1174	1174	1174	1102	1102	1102	1102	1102	1102	1294	1294	1294	1318
R	2020	1795	2020	2615	2940	3840	4610	5404	3550	4510	3720	4460	5300	3630	4460	5200	3650	4490	5330	3650	4490	5330	4412	5420	6525	5572
S	Φ45	Φ45	Φ62.8	Φ65.7	Φ70.8	Φ70.8	Φ70.8	Φ70.8	Φ83.8	Φ94.5	Φ96.6	Φ96.6	Φ96.6	Φ106	Φ106	Φ106	Φ124.5	Φ124.5	Φ124.5	Φ124.5	Φ124.5	Φ124.5	Φ152.3	Φ152.3	Φ148.4	Φ169.5
T	Φ45	Φ45	Φ67	Φ67	Φ84	Φ84	Φ84	Φ84	Φ95	Φ112	Φ112	Φ112	Φ112	Φ119	Φ119	Φ119	Φ140	Φ140	Φ140	Φ140	Φ140	Φ140	Φ165	Φ165	Φ165	Φ190
U	Φ21	Φ24	Φ32	Φ32	Φ44	Φ44	Φ44	Φ44	Φ48	Φ62	Φ62	Φ62	Φ62	Φ166	Φ166	Φ166	Φ78	Φ78	Φ78	Φ78	Φ78	Φ78	Φ88	Φ88	Φ88	Φ95
V	378	401	425	425	493	493	493	493	656	610	610	610	610	684	684	684	736	736	736	736	736	736	856	856	856	793

- 注:
- 1、图中所示钻具为新型(VIII)结构,扶正器为可换式;万向轴壳体为可调式,万向轴为球型,表中NA表示该型号钻具无此结构。
 - 2、图中A*表示当钻具型号为203时;其值为Φ197。(只有扶正器壳体为可换式结构时为Φ197;其余结构A*值均为Φ203)。A**表示当钻具型号为165时,A**值为Φ184,长度为208mm。
 - 3、表中提供的尺寸仅供参考,如需要具体尺寸请与公司联系。
 - 4、扶正器套筒的外径尺寸根据用户需求而定,表中不提供。
- 1.Above downhole motor is new structure(VIII), Changeable stabilizer, adjustable Ball drive universal shaft, NA means there is not this kind of structure downhole motor.
- 2.Above A* means: when size of downhole motor is 203mm, the value is Φ197mm, (unless the housing of stabilizer is changeable, the value is Φ197mm, the value of others structure is Φ203mm). A**means: when size of downhole motor is 165mm, A**value is Φ184mm, length is 208mm.
- 3.Above dimension is referenced, if you need detail dimension, please contact us.
- 4.OD dimension of Sleeve of stabilizer determined by user, no data in above chart.

TTGM 技术参数表
Technology Parameters

钻具型号 Model	外径尺寸 Tool OD		钻头尺寸 Bit Size		两端连接螺纹 Connected Thread		头数 Lobe	级数 Stage	排量 Flow Rate		转速 Rotary Speed	工作压力降 Working Pressure Loss		输出扭矩 Output Torque		最大压力降 Max Pressure Loss		最大扭矩 Max Torque		工作钻压 Working Pressure		最大钻压 Max Pressure		输出功率 Output Power		
	mm	in	mm	in	上端 up	下端 down			lpm	gpm		rpm	MPa	psi	N.m	lb-ft	MPa	psi	N.m	lb-ft	KN	lb	KN	lb	KW	hp
5LZ43x7.0 TT-4	43	1 11/16	48-76	1 7/8-3	NC12	NC12	5:6	4	48-96	13-26	435-870	4	585	56	42	5.65	824	79	58	3	660	6	1320	6.5	9	
5LZ45x7.0 TT-3	44	1 11/16	48-76	1 7/8-3	NC12	NC12	5:6	3	57-170	15-45	228-680	2.4	350	85	62	3.39	495	125	90	3	660	6	1320	8	11	
5LZ54x7.0 TT-3	54	2 1/8	60-89	2 3/8-3 1/2	1 1/2REG	1 1/2REG	5:6	3	106-240	28-64	282-638	2.4	350	130	96	3.39	495	182	135	4	880	8	1760	11	15	
5LZ60x7.0 TT-3	60	2 7/8	79-111	3 1/8-4 3/8	1 1/2REG	1 1/2REG	5:6	3	140-280	38-75	298-595	2.4	350	156	115	3.39	495	218	160	5	1100	10	2200	12	16	
5LZ73x7.0 TT-3	73	2 3/8	73-90	2 7/8-3 1/2	2 3/8REG	2 3/8REG	5:6	3	162-578	76-153	121-432	2.4	350	460	339	3.39	495	650	479	12	2640	25	5500	27	36	
7LZ79x7.0 TT-4	79	3 1/8	95-121	3 3/4-4 3/4	2 3/8REG	2 3/8REG	7:8	4	140-419	37-111	138-413	3.2	466	465	342	4.25	659	617	455	12	2640	25	5500	24	32	
5LZ89x7.0 TT-3	89	3 1/2	114-149	4 1/2-5 7/8	2 3/8REG	2 3/8REG	5:6	3	255-766	67-202	108-325	2.4	350	810	598	3.39	495	1145	845	22	4400	35	7700	35	47	
LZ95x7.0 TT-4	95	3 3/4	118-149	4 5/8-5 7/8	2 7/8REG	2 7/8REG	1:2	4	150-450	40-119	160-478	3.2	466	432	319	4.25	659	574	423	30	6600	55	12100	26	35	
5LZ95x7.0 TT-3	95	3 3/4	118-149	4 5/8-5 7/8	2 7/8REG	2 7/8REG	5:6	3	320-800	85-211	124-300	2.4	350	833	615	3.39	495	1177	868	30	6600	55	12100	32	43	
9LZ95x7.0 TT-4	95	3 3/4	118-149	4 5/8-5 7/8	2 7/8REG	2 7/8REG	9:10	4	460-928	120-245	139-280	3.2	466	1426	1052	4.25	659	1895	1320	30	6600	55	12100	48	64	
9LZ105x7.0 TT-4	105	4 1/8	121-152	4 3/4-6	2 7/8REG	2 7/8REG	9:10	4	498-997	131-263	132-265	3.2	466	1630	1200	4.25	659	2165	1597	30	6600	55	12100	51	68	
1LZ120x7.0 TT-4	120	4 3/4	149-200	5 7/8-7 7/8	3 1/2REG	3 1/2REG	2:3	4	454-909	120-240	180-360	3.2	466	1030	760	4.25	659	1367	1008	49	10803	100	22000	46	62	
4LZ120x7.0 TT-6	120	4 3/4	149-200	5 7/8-7 7/8	3 1/2REG	3 1/2REG	4:5	6	495-990	131-262	150-300	4.8	700	2137	1576	6.78	988	3019	2226	49	10803	100	22000	81	108	
4LZ120x7.0 TT-5	120	4 3/4	149-200	5 7/8-7 7/8	3 1/2REG	3 1/2REG	4:5	5	495-990	131-262	150-300	4	585	1780	1313	5.65	824	2515	1855	49	10803	100	22000	71	95	
5LZ120x7.0 TT-3	120	4 3/4	149-200	5 7/8-7 7/8	3 1/2REG	3 1/2REG	5:6	3	694-1388	184-367	140-278	2.4	350	1620	1195	3.39	495	2288	1688	49	10803	100	22000	57	76	
5LZ120x7.0 TT-4	120	4 3/4	149-200	5 7/8-7 7/8	3 1/2REG	3 1/2REG	5:6	4	694-1388	184-367	140-278	3.2	466	2160	1593	4.25	659	2869	2116	49	10803	100	22000	71	95	
7LZ120x7.0 TT-4	120	4 3/4	149-200	5 7/8-7 7/8	3 1/2REG	3 1/2REG	7:8	4	745-1489	196-393	130-261	3.2	466	2468	1819	4.25	659	3277	2417	49	10803	100	22000	75	102	
5LZ140x7.0 TT-4	140	5 1/4	171-222	6 3/4-8 3/4	4 1/2REG	4 1/2REG	5:6	4	718-1436	190-379	118-236	3.2	466	2613	1927	4.25	659	3471	2560	49	10803	100	22000	73	98	
5LZ159x7.0 TT-5	159	6 1/4	171-222	6 3/4-8 3/4	4 1/2REG	4 1/2REG	5:6	5	828-1656	219-438	106-212	4	585	4221	3113	5.65	824	5962	4397	80	17600	160	35200	111	148	
LZ165x7.0 TT-4	165	6 1/2	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	1:2	4	450-899	119-237	191-382	3.2	466	1018	751	4.25	659	1352	997	49	10803	100	22000	46	62	
5LZ165x7.0 TT-3.5	165	6 1/2	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	5:6	3.5	686-1371	181-362	102-205	2.8	408	2555	1885	3.955	577	3609	2662	80	17600	160	35200	66	88	
5LZ165x7.0 TT-4	165	6 1/2	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	5:6	4	862-1724	228-456	101-202	3.2	466	3673	2709	4.25	659	4878	3597	80	17600	160	35200	88	119	
5LZ165x7.0 TT-5	165	6 1/2	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	5:6	5	862-1724	228-456	101-202	4	585	4590	3386	5.65	824	6484	4783	80	17600	160	35200	100	135	
5LZ165x7.0 TT-6	165	6 1/2	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	5:6	6	862-1724	228-456	101-202	4.8	700	5509	4063	6.78	988	7781	5739	80	17600	160	35200	121	162	
9LZ165x7.0 TT-4	165	6 1/2	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	9:10	4	990-1979	262-523	93-187	3.2	466	4579	3377	4.25	659	6082	4485	80	17600	160	35200	98	132	
LZ172x7.0 TT-4	172	6 3/4	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	1:2	4	450-899	119-237	191-382	3.2	466	1018	751	4.25	659	1352	997	80	17600	160	35200	46	62	
3LZ172x7.0 TT-6	172	6 3/4	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	3:4	6	770-1539	204-407	107-214	4.8	700	4660	4854	6.78	988	6580	4854	100	22000	170	37400	126	206	
4LZ172x7.0 TT-7	172	6 3/4	213-251	8 3/8-9 7/8	4 1/2REG	4 1/2REG	4:5	7	833-1665	220-440	109-217	5.6	817	6158	4541	7.91	1154	8698	6415	100	22000	170	37400	154	206	

