www.ttgm.com.cn

TTGM

DOWNHOLE MOTOR

TIANJIN DEHUA GROUP

TTGM

Production Bases:

TTGM (DeHua) Petroleum Equipment Manufacturing CO., LTD.
Add: 42 JuYing Road, Jinnan Economy Development Area, 300350, Tianjin, China
Tel.: +86-22-88716069 +86-22-88716001 +86-22-88716087
Fax: +86-22-88716086

Tianjin Tubular Goods Machining Co., LTD.
Add: Crossing of Sanwei Road and Wujing Road, Dongli Economy Development Area, 300300 Tianjin, China
Tel.: +86-22-24998852 +86-22-24996676
Fax: +86-22-24998853

USA Branch:

TTGM International (USA) Inc
Add: 11211 Katy Freeway, Suite240, Houston,77079, Texas, USA
Tel.: +1-713-776-2425
Fax: +1-713-776-3424
Web: www.tarste.com
Email: company@tarste.com

Dubai Branch:

TTGM International (Middle-East) FZE
Add: P.O.Box 263123 Jebel Ali Freezone, Dubai, UAE
Tel.: +971-4-4306251 +971-50-7196228 +971-55-5381658
Fax: +971-4-4306251
Email: ttgmdubai@ttgm.com.cn

Beijing Sales Center

Add: 8 LongTan East Road, Suite B23, Chong Wen District, Beijing, China
Tel.: +86-10-67183378 +86-10-67112163 +86-10-67110597 +86-10-67188437 +86-10-67195839
Fax: +86-10-67183378
Web: www.ttgm.com.cn
Email: ttgm@ttgm.com.cn


GOING BEYOND SELF
STRIVING FOR EXCELLENCE
德華企業以德治業


德华装备
立足全球

TTGM

Content

CONTENT

TTGM DEHUA GROUP

Business Goal

To be a global professional petroleum equipment manufacturer

Operation Philosophy

Going beyond self, striving for excellence

Quality Policy

Taking customers' satisfaction as the standard
Taking market share as the objective
Continuously improving product quality
Continuously satisfying customers' demands

Company Profile

Tianjin TTGM Group is a new and modern petroleum equipment manufacturing company created by Tianjin Petroleum Equipment Manufacturing Co., Ltd. (founded in 1994, and located in Dongli Economic Development Area) through more than ten years of development and growth, located in Jinnan Economic Development area, mainly engaged in the research & development, production and sales of special oil pipe and drilling tools, and it's a comprehensive company setting scientific research, production and trade in one. Its main products include: screw drilling tools, oil casings, drill pipes, mud pump accessories and the appropriate oil drilling equipment.

TTGM Group covers an area of 300 mu, possessing the largest and best-equipped screw drilling tool production line, a 400,000 tons oil casing production line, a friction welding drill pipe production line with production capacity of 20,000 tons and a 100,000 tons steel tube full-length heat treatment production line. The products cover the oil casings and drill pipes within the range of API Standard. In addition, the company also independently researched and developed non-API standard TD-based class oil casing and drill pipe products, with matching capacity of other related petroleum equipment products.

TTGM Group has a laboratory with complete detection means and first-class online testing equipment, Tuboscope non-destructive testing device imported from the United States and precise thread gauges purchased from Gagemaker, Allen and other manufacturers, which provide a strong guarantee for the product quality of TTGM Group.

TTGM Group has passed the certifications of ISO9001 Quality System and American Petroleum Institute (API), obtained the approved network access licenses to major oil fields at home and abroad. Its products have been not only used and recognized by major domestic oil fields, but also exported to more than 30 countries and regions such as the United States, Canada, Russia and the Middle East. TTGM Group has won a good reputation both at home and abroad and established a wide range of long-term cooperation relationship with many domestic and foreign natural gas and oil companies. With the operation philosophy of "Going beyond self, striving for excellence", TTGM Group will create itself to be an industry star with features of "globalized sales, internationalised management and localised service" relying on the strong product advantages. TTGM Group will become the most powerful backing support and best partner of all the oil and gas companies, drilling companies and trading companies.

Qualification Certificates

TTGM Group has passed the certification of IS09001:2000 Quality System, emblem certifications of API 5DP, API 5CT, and quality accreditation certificates from many customers like PetroChina, Sinopec, and Iran's national oil company as well as the certificates of honor issued by all sectors of society.

Screw Drilling Tools

- TTGM Group is one of the largest manufacturers of screw drilling tools. We can provide screw drilling tools with various types of sizes and configurations as well as specially-designed products according to customers' personalized needs in terms of torque, displacement, well temperature and other parameters.
- The non-magnetic screw drilling tool of TTGM Group made of non-magnetic material is a special small-sized screw drilling tool applied in the extraction of the coal-bed gas in underground tunnel.
- TTGM Group has one of the largest stator production lines in the country.




Configuration Options for Screw Drilling Tools

Uniform Thickness

The screw drilling tool with uniform thickness is achieved by reasonably changing the shape of the stator housing and designing the stator with the rubber layer into the motor stator with thin and uniform wall thickness. Such screw drilling tool has features as small length, large power, high pressure drop, low speed, high thermal efficiency, uniform thermal expansion, and wider application range, more optimized structure and lighter overall weight. Especially in ultra-deep wells, horizontal wells and high temperature wells, it can extend the service life of the screw drilling tool and increase the drilling efficiency.

High Temperature and Oil-based Resistant Mud

This type of screw drilling tool is suitable for high-temperature and high oil-cut mud systems. The specially-formulated stator rubber can achieve high retention rate in properties of high strength, tear strength under the oil-cut conditions at 180 ℃ or below. The reasonable interference fit can make the high-temperature and high oil-based mud resistance rubber achieve good effects under the conditions of high temperature and high oil-based mud.

Corrosion Resistance

The rotor has a special coating formed after corrosion spray, so it is more resistant to corrosion, erosion and grinding, which enables the screw drilling tool to work for long time in the corrosive mud.

Production Strength

TTGM Group is a supplier specialized in the production of oil equipment and down-hole drilling tools, especially in the production and sales of high-performance screw drilling tools. The company has a group of experienced and skilled technical research & development and production team, along with the domestically and internationally advanced production and testing equipment as well as the scientific management, which guarantee the good performance of products and make it reach the leading position of similar products. The products are mainly applied in the drilling works of the industries like oil, natural gas, coal, etc. We can also design and machine special tools according to customers' needs.

Testing Equipment

TTGM Group has established modern physical and chemical laboratories, and introduced internationally-advanced testing equipment including the MTS tensile testing machine, impact testing machine and hardness tester of the USA, as well as the ZEISS metallographic microscope of Germany.

The tensile, impact (at normal temperature and low temperature), hardness, scoliosis, metallographic and spectral analysis detections and tests on the incoming raw material and finish parts in term of screw drilling tools, oil tubing, casings, drill pipes, couplings and other products relying on professional and technical personnel have enhanced TTGM Group's quality control capability.

Metallurgical Microscope

Rockwell Hardness Tester

Brinell Hardness Tester

Polishing and Burnishing Machine

Tensile Testing Machine

Impact Testing Machine

Pitch Gauge

Precise Measuring Tools

In order to guarantee the precision of product threads, TTGM Group introduced the gauges made by GAGEMAKER and Allen Companies of the USA, and by Kuroda Company of Japan, providing a strong guarantee for production and new product development.

Inner Taper

Teeth Height Gauge

Outer Taper Gauge

Ⅰ. Introduction

The screw drilling tool is an indispensable drill tool for down-hole operations in each oilfield today. In order to meet customers' needs and make them better understand screw drilling tools, choose, use and maintain the same properly according to their drilling needs so that the products can function their due mechanical properties, and increase drilling economic benefits as well as achieve mutual benefit and win-win objectives, we will take the comments and suggestions from the drilling site as the direction of technology research & development and improvement, and continue to keep forging ahead. To adapt to the drilling needs and meet customers' requirements are the sustainable development objectives of TTGM Group.

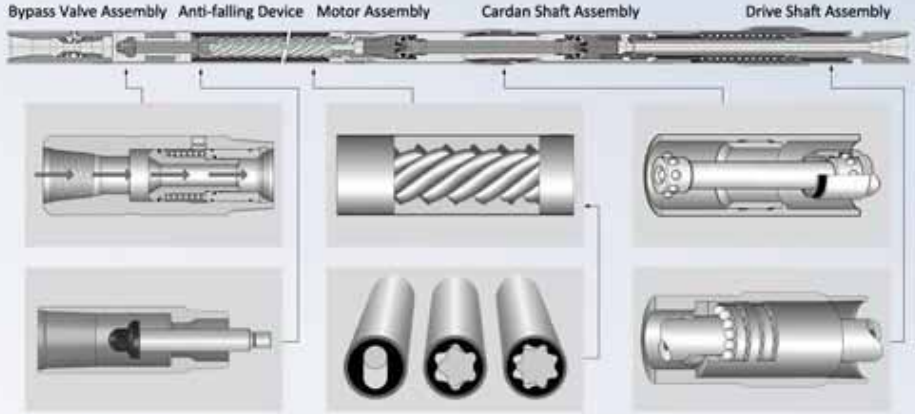
Ⅱ. Working Principles of the Screw Drilling Tools

The screw drilling tool is a positive-displacement down-hole drill tool which converts the liquid pressure energy into mechanical energy using the drilling fluid as power. When the mud pumped by the mud pump enters the motor via the bypass valve, a certain pressure difference at the inlet and outlet of the motor will be formed, which drives the rotor to rotate around the axis of the stator, and transfers the rotational speed and torque to the drill bit through the cardan shaft and the drive shaft, achieving the drilling operations.

As the down-hole power plant, the screw drilling tool has such advantages as low speed, high torque and large displacement. The increase of the drill bit torque and power can improve the footage rate; reduce the wear and damage to drill pipes and casings; achieve direction, kickoff and deviation correction accurately. Therefore the product is widely used in vertical wells, horizontal wells, cluster wells and well-servicing operations.

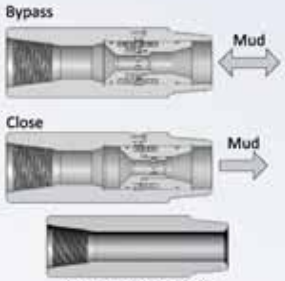
Composition of the Screw Drilling Tool

The screw drilling tool consists of the bypass valve assembly, anti-falling device, motor assembly, cardan shaft assembly and drive shaft assembly (as shown below).



1. Bypass Valve Assembly

It has a bypass position and a close position. During trip operations, it is at the bypass position, making the mud circulation in the drill string bypass the non-operating motor to enter into the annulus so that the mud will not overflow onto the well where. When the flow and pressure of the mud reach the standard set values, the spool will moves down to close the hole of the bypass valve, at this time, the mud flows through the motor, converting the pressure energy into mechanical energy. When the flow rate value of the mud is too small or when the pump stops, the generated pressure is insufficient to overcome the spring force and static friction, the spring will jack up the spool and the hole of the bypass valve will be at the open position again. Under normal circumstances, an alternative connector is mostly used for deep wells, large-deviation wells, highly-deviated wells, horizontal wells and when a hollow rotor is applied (see the figure on the right).



Alternative Connector

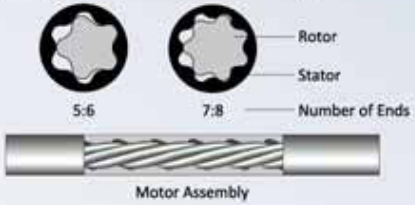
2. Anti-falling Device

Functions: playing a role in anti-skidding for the casing rupture or tripping due to abnormal reasons, and making the pump pressure increase so that the personnel on the ground can find problems timely, and prohibiting the opening of the rotary table (top drive) to prevent the back-off of the anti-falling nut, avoiding accidents (as shown the figure below).

Anti-falling Device

3. Motor Assembly

1. It is composed of a stator and a rotor. The stator is made by die-casting the rubber bushing on the inner wall of the steel pipe. The rubber inner bore is of a spiral structure with certain geometric parameters. The rotor is a screw stem with a hard chromium-plated layer.
2. The rotor and the stator mutually mesh with each other, and a spiral sealed line is formed through the lead difference between the two, and simultaneously a sealed chamber is formed as well. With the rotation of the rotor in the stator, the sealed chamber moves along the axial direction, achieving continuously generation and disappearing, and completing of the energy conversion, which is the basic working principle of the screw motor.
3. The spiral lines of motor rotor include single-end ones and multi-end ones (the stator has one more line end than the rotor). The fewer the number of the ends of the rotor, the higher the speed will be and the smaller the torque will be; the more the number of the ends of the rotor, the lower the speed will be and the larger the torque will be.
4. One lead of the motor stator forms a sealed chamber, also referred to as a stage. The rated working pressure drop of each stage is 0.8Mpa, and the maximum pressure drop is 1.3 times of the rated working pressure. If the pressure drop exceeds this value, leakage will occur in the motor, the speed will drop quickly, and even the motor will be damaged. Therefore, the user should pay special attention to this.
5. In order to ensure the sealing effect of the motor, the mating size between the rotor and the stator is related to the temperatures at different depths. Therefore the user should provide the manufacturer with the well temperature of the application site where the drilling tool will be used as accurate as possible, so that suitable motors can be configured.



Motor Assembly

3.1 Hollow Rotor Motor

In order to increase the water horsepower of the bit and the back-up speed of the mud, the rotor is machined into a hollow one with a nozzle. The total flow of the motor should be equal to the flow sum of the mud flowing through the motor sealed chamber as well as the mud flowing through the rotor nozzle. Each size of motor has its recommended minimum and maximum flow rate value. If the flow is too excessive, the rotor will overdrive, the stator and the rotor will be prematurely damaged. If the flow is too small, the motor will stop rotating. Therefore, it should be ensured that the flow through the motor sealed chamber is always maintained at or above the minimum recommended flow value when you select the size of the rotor nozzle, so as to enable the motor to operate normally.

Hollow Rotor

When the mud density, nozzle size, and flow through the motor are quantitative, the flow of the mud flowing through the rotor nozzle and that of the mud flowing through the motor sealed chamber are always changing with the variation of loads. When the drill bit leaves the bottom of the well, the motor load will be approximately zero. At this time, the flow of the mud flowing through the rotor nozzle is at the minimum value, while that of the mud flowing through the motor sealed chamber is at the maximum. With the drilling going on, the motor differential pressure will continuously increase so that the flow of the mud flowing through the rotor nozzle is increased, while the flow of the mud flowing through the motor sealed chamber flow is reduced.

The flow of the mud flowing through the motor sealed chamber is Qm and the flow of the motor nozzle is Qz.

Namely, the total flow Q=Qm+Qz

Set the motor speed n and calculate the value of Qm

$$Qm=\frac{nq}{\eta v \times 60}\ (L/S)$$

Take the volume efficiency ηv as 0.90

∴ Qz=Q-Qm (L/S)

Nozzle diameter

$$d=\sqrt{\frac{898pQ_z^2}{\triangle P}}\ (mm)$$

Qm—flow through the motor sealed chamber (L/S)

Qz—flow through the rotor nozzle (L/S)

Q—flow through the hollow motor (L/S)

ηv—volume efficiency

Motor pressure drop $\triangle P=\triangle Pst+\triangle Pop$

$\triangle Pst$—startup pressure drop of the motor (Mpa)

$\triangle Pop$—working pressure drop of the motor (Mpa)

p—mud weight (kg/L)

The q in the formula is the displacement per rotation (L/r)

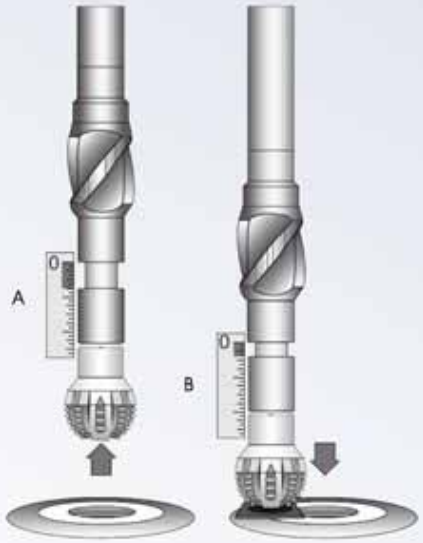
Its parameters are given in Table 1.

The user can replace the nozzles with different diameters according to use needs based on the above recommended formula so as to achieve desired effects.

Estimated values of displacement per revolution of the hollow rotor motor:

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

Description of maximum allowable axial bearing clearance: see the table below



Clearance=A-B

Type of Drilling Tool	Clearance
Φ 43mm	2mm
Φ 54mm	3mm
Φ 60mm	3mm
Φ 73mm	3mm
Φ 79mm	3mm
Φ 89mm	4mm
Φ 95mm	4mm
Φ 105mm	4mm
Φ 120mm	5mm
Φ 140mm	5mm
Φ 159mm	6mm
Φ 165mm	6mm
Φ 172mm	6mm
Φ 197mm	7mm
Φ 203mm	7mm
Φ 216mm	7mm
Φ 228mm	7mm
Φ 244mm	8mm
Φ 286mm	10mm

4. Cardan Shaft Assembly

The function of cardan shaft is to convert the planetary motion of the motor into the fixed-axis rotation of the drive shaft, transfer the torque and speed generated by the motor to the drive shaft till to the bit. Most of cardan shafts are of flat type, and some are of ball type. The drilling tool manufactured by our company uses the ball-type cardan shaft. The product are of long-service life cardan shaft of the screw drilling tool, made of high quality metal materials in the country with advanced machining and heat treatment equipment as well as the superb heat treatment process. Its service life is 2-3 times of that of common cardan shafts. Therefore, it has a long service life, small mechanical loss and can guarantee the safety factor of underground drilling

Ball-type Cardan Shaft

Flat-type Cardan Shaft

5. Drive Shaft Assembly

The function of drive shaft is to transfer the rotation torque to the bit and withstand the axial and radial loads generated by the drilling pressure.

The pressure drop of the bit nozzle is 7.0Mpa, and it uses the cemented carbide radial bearing and the drive shaft assembly with a set of thrust bearings in the medium.

Drive Shaft Assembly

Ⅲ. Installation Torque for the Upper and Lower Threads of the Drilling Tool

Drilling Tool Specification	Upper Thread	Tightening Torque KNM	Lower Thread	Make-up Torque KNM
43	1REG	1.6~1.9	1REG	1.6~1.9
54	11/2 REG	2.8~3.5	11/2 REG	2.8~3.5
60	11/2 REG	2.8~3.5	11/2 REG	2.8~3.5
73	23/8 REG	3.4~4.8	23/8 REG	4.8~6.3
79	23/8 REG	3.4~4.8	23/8 REG	4.8~6.3
89	23/8 REG	3.4~4.8	23/8 REG	4.8~6.3
95	27/8 REG	6.8~11.6	27/8 REG	6.8~11.6
120	31/2 REG	14.3~17.2	31/2 REG	9.4~12.2
140	41/2 REG	27.9~31.6	41/2 REG	16.3~21.8
159	41/2 REG	31.6~33.6	41/2 REG	16.3~21.8
165	41/2 REG	32.4~35.6	41/2 REG	16.3~21.8
172	41/2 REG	32.4~35.6	41/2 REG	16.3~21.8
197	51/2 REG	54.4~68	65/8 REG	68.0~79.3
203	51/2 REG	54.4~68	65/8 REG	68.0~79.3
216	65/8 REG	68~79.6	65/8 REG	38.1~43.5
244	65/8 REG	74.8~88.4	75/8 REG	46.2~54.4
286	65/8 REG	74.8~88.4	75/8 REG	46.2~54.4

IV. Description for Models of Screw Drilling Tools

□□LZ□x□-□-□□□□□□-TT-□

Number of motor stages (indicated by Arabic numerals, such as 2, 3, 4, 5.....)

Corporate logo

D—Indicating the bend angle type of the bend drilling tool
D—Single bend (single bend housing or bending sub)
P—Double bend with large offset distance in the same direction (bending sub + single bend housing)
T—Double bend in the same direction
S—Double bend in different directions
N/A—Straight drilling tool
K—Indicates the structure type of the drilling tool with a bend-adjustable housing
W—Indicates the stabilizer
H—Indicates the replaceable stabilizer
F—Indicates the hollow slit-flow of the rotor (omitted—non-hollow rotor)
G—Indicates the high-temperature resistant characteristic of the drilling tool (G—resistant against 150℃; omitted—resistant against120℃)

Anti—falling type (F—double-resistance structure, omitted- single resistance)

Maximum pressure drop of the bit nozzle (Mpa)

Size of the screw drilling tool (outer diameter: mm)

Product code of the screw drilling tool

Number of rotor ends

Motor type (JC—extended motor, C—long-lead motor, D—short motor,K—air motor or foam motor, Y—oil-based mud, omitted—conventional type)

V. Notes for Operations

1. The well-site drilling technicians and drillers must understand the structure principle and operation parameters of the drilling tool, and use it properly according to the requirements of the User's Manual.

2. The drilling engineer shall select the types of the drill bit and drilling tool and determine the borehole diameter and the drilling tool assembly based on the drilling program of the entire borehole, along with the stratigraphic structure, borehole diameter, depth and mechanical rotation speed. The site construction must be carried out strictly according to the developed drilling program.

3. Requirements for the drilling fluid: the motor of the screw drilling tool is of the displacement type. The factors to determine the performance of the drilling tool are the input flow and the pressure drop applied on the two ends rather than the type of the drilling fluid. Generally speaking, the physical and chemical properties of the drilling fluid will not affect the performance of the drilling tool except that individual property may reduce the service life of the same. However, the user should pay attention to the drilling process demands. A variety of hard particles contained in the drilling fluid must be under control, because they will add the abrasion on bearings and motor, and reduce the service life of the drilling tool. It is recommended that the content of solid should not exceed 1% (Facts show that: if the content of solids reaches 5%, the service life of the drilling tool will be reduced by 50%). Also note that the drilling fluid should not be mixed with any gas, because the drilling fluid mixed with gas may produce "cavitation" due to the pressure change in it, which will accelerate the damage to the drilling tool, especially to the stator rubber. Therefore, sufficient attention must be paid.

4. Selection of the drill bit: The selection of the drill bit used together with the screw drilling tool is very important. Among the several factors determining whether the screw drilling tool functions successfully, the match level of the drill bit and the drilling tool is the most important. We suggest the site operation personnel to pay enough attention. Following factors should be considered for the combination use of the drill bit and the screw drill tool:

(1) The drilling program and plan;
(2) The structure of the edge portion meeting the formation needs;
(3) The structure of the drilling fluid flow channels;
(4) The pre-planned rate of penetration (ROP);
(5) The estimated operation time of the drill bit and the drilling tool;
(6) The design of the pressure drop for the bit nozzle.

Here only provides a brief description about the bit selection in terms of various kinds of drilling works with a screw drilling tool. Refer to the professional data regarding drill bits for the information about the formation structure, formation hardness, type of drill bits to be used, edge design, etc.

A: In addition to the pressure drop caused by the bit nozzle, it should be noticed that no other large pressure loss will occur when the drilling fluid runs through the bottom of the drill bit, especially for the condition that the pressure drop caused by the bit nozzle has reached the specified pressure drop for such type of drilling tool. However, this is not necessary to worry about for roller bits. But, for the design of the crown fluid channel of PDC bits, it must be considered to avoid the channel flow area resulting in additional excessive pressure loss, and ensure the timely discharge of cuttings and meet bit cooling needs.

B: Roller bit: When used together with the screw drilling tool, this type of drill bit is more applicable to the works with short drilling period, such as kickoff, sidetracking, etc.

C: PDC bit: PDC bit is applicable to the works with a long drilling period (such as vertical wells) besides kickoff. In the drilling works with a long period, the most important factor is the integrity of the bit and the drilling tool. It should be avoided to make an unnecessary trip due to the fault of any individual part. As known to us: the PDC bit has a longer service life than the roller bit, and it also has an integrated structure with many advantages.

D: Improvement of the service life for drilling tools and bits is another important factor. Increasing the stability of the drive shaft, e.g. adding a stabilizer, is helpful to improve the service life and performance of a bit. The close relation between the geometry, layout position and drilling load of the drill diamond and the requirements of high down-hole rotation speed and low drilling pressure should be considered. In short, when using a screw drill, you must select the matching bit carefully so that the satisfactory results will be achieved. Otherwise, the drilling tool may be damaged prematurely.

5. Requirements for the down-hole ambient temperature: High temperature is very bad for the motor of the drilling tool, and it will increase the negative impacts. In the oil-based mud, the down-hole temperature should be less than 95℃, at which, the drilling work will be in the best condition. When the temperature exceeds 150℃, the service life of the stator in the drilling tool will be greatly shortened even if the best oil-based drilling fluid or water-based drilling fluid is used.

In order to ensure the drilling tool can work properly in the high oil-based drilling fluid, the methods such as RIH in stages, intermittent cycle or use of the hollow rotor with a slit-flow hole may be applied to accelerate the circulation or improve heat dispersion or other properties of the drilling fluid, so that the actual working temperature is lower than the limit.

Two types of stators are produced in our company. One is a type of common stator, with rated temperature of 95℃and a maximum temperature of 120℃. The other is a type of high-temperature resistant stator, with the rated temperature of 105℃ and the maximum temperature of 150℃.

6. Requirements for the flow of drilling fluid: One of the characteristics of the screw drill is that the output speed is proportional to the flow of the input drilling fluid. Each type of drilling tool has a certain range of effective working flow. The user is suggested to make a selection based on the recommended parameters. Otherwise the working efficiency and service life of the drilling tool will be reduced.

7. Features of the drilling fluid pressure and the drilling pressure: when the drilling tool operates without load, if the mud flow is maintained constantly, the pressure drop of the bit and the drilling tool will be a constant. This value varies with the type and size of different drilling tools. When the drilling tool works, the cycling pressure of the drilling fluid will gradually increase with the growth of the drilling pressure. The pressure increment is proportional to the drilling pressure or the increment of the torque required for drilling. When the maximum recommended value is reached, the best torque will be generated. If the drilling pressure is continuously increased and when the pressure drop on the two ends of the motor generated by the motor exceeds the maximum design value, leakage will occur in the drilling tool. When the drilling tool works normally, the gauge pressure will increase or decrease with the growth or reduction of the drilling pressure. If the pressure of the pump pressure gauge is suddenly increased by several MPa, the pump pressure will be further increased even if the drilling pressure is continuously increased, which indicates that leakage occurs in the drilling tool. In this case, the seal between the rotor and the stator of the drilling tool is damaged, and the drilling fluid flows out of the bit nozzle via the sealed chamber of the motor. Once the drilling tool is jammed due to any fault, the drilling fluid will still be able to run through the drilling tool circularly in the condition that the drilling tool is under brake. In case the drilling tool has been under brake, it should be immediately lifted away from the down-hole to reduce the drilling pressure because the drilling tool will be seriously damaged if the drilling fluid run through the non-operating motor for a long term.

Meanwhile, in order to achieve the best efficiency of the drilling tool, the pressure difference between the two ends of the drilling tool should be controlled within the range of the recommended parameters.

8. Necessary hydraulic pre-calculations: During drilling, the drilling fluid pumped by the mud pump will flow through the vertical pipe, faucet and kelly and enters into the drill pipe, drill collar, non-magnetic drill collar, drilling tool (motor), bit nozzle and annulus, and finally return to the ground. In the continuous cycle process of the drilling fluid, a certain amount of energy will be consumed due the friction of the drilling fluid itself as well as its friction with the pipe wall and well wall, plus the losses caused by partial flowing. This energy loss is reflected in the form of pressure loss. The total pressure loss may be worked out

via the accumulation of the pressure loss of each part. Then the total pressure loss calculated based on the expected drilling depth may be used as a parameter to determine the pump pressure. Such a large amount of the pressure loss calculation is very cumbersome. There is a simple approach for on-site operators, namely: as long as the bit is slightly lifted away from the well bottom, the reading shown on the main pipe pressure gauge under the rated displacement is namely the value of the total pressure loss.

VI. Instructions for Operation of the Drilling Tool

When the user selects the drilling tool and bit combination program, a drilling plan should be prepared based on full consideration of the details like the borehole track, type and specification of the bit, formation structure and hydraulic calculation.

1. Inspection of the ground before running the drilling tool down in the well:

1.1 Connect the lift sub and the bypass valve and coat the other parts of the housing connection with locking agent.

1.2 Mount the bit with a bit breaker. The operator is only allowed to rotate the drive shaft head with a chain wrench in the counter-clockwise direction (in the top view, the same for below) in order to prevent the internal thread being loosened.

1.3 Lift the lifting sub and put the drilling tool into the rotary table. At the same time, put the bypass valve at a position in the rotary table where it is easily observed. Clamp the drilling tool securely with a clip and remove the lifting sub.

1.4 Check the bypass valve: Press the bypass spool with a hammer handle or a wooden stick. Fill water into the bypass valve from the upper side until the bypass valve is full. At this time, the bypass valve should not leak and there should be no obvious level lowering in the water, and then take away the stick, the spool should be bounced by spring to reset, and the filled water should flow out of the holes on each side uniformly. Such condition is considered as normal.

1.5 Connect the kelly and run it down, and locate the bypass valve on a place below the kelly where it is easy to observe. Start the drilling pump, and gradually increase the displacement until the bypass valve is closed. Lift the drilling tool and observe if the bit rotates. At this time, the bypass valve is at the "off" position. There should be no drilling fluid outflowing from the bypass hole. The purpose of the inspection is to observe whether the drill bit is rotates. The inspection doesn't need to last long. During the operation, avoid the bit contacting with the wellhead blowout preventer and wellhead pipeline. Observe whether the bypass valve is opened again to make the drilling fluid outflow from the bypass hole after stopping the pump. Before the pump stops completely, do not rotate the bypass valve above the rotary table, to prevent pollution of the well where.

1.6 Remove the kelly and connect the bending sub, non-magnetic drill collar and stabilizer properly according to the designed drill assembly. Before screwing the bending sub into the bypass valve, if the mule shoe seat is used for kick-off, you should check the kick-off key to ensure the mule shoe is located at the normal working position, and aligned with the bending sub line.

During the assembly and connection of all drilling tools and drill pipes, it should be avoided that the thread is galled, or the connections are crossed. In order to prevent that the connections are moved, it is recommended to keep the following in mind: the direction of the bit adapter is anti-clockwise in the top view relative to the housing. Any violation of this rule, such as reversely rotating of the rotary table or tightening the threads above the motor with the rotary table, the internal parts of the drilling tool will be loosened or tripped. The user should pay attention to this.

2. Run the drilling tool and assembly into the bore hole: Although the drilling tool itself is simple in profile, it has sufficient rigidity. Driller need to control the speed when running the drilling tool down. Otherwise, it may be damaged by sand bridges, borehole shoulders or casing shoes. For such sections like this, it is often necessary to start the drilling pump for slowly expanding borehole before making it going through.

If a bending sub or bent housing is used, the side of the bit is easier to contact with the hard rock of the borehole and the casing shoe. Therefore, the drilling tool assembly should be rotated periodically, to eliminate the impacts of side tracking.

For deep wells and high temperature wells, periodical halfway cycle is recommended upon running the drilling tool down, so as to prevent the bit being clogged or the stator damage being damaged due to high temperature.

In the well, if the drilling fluid is not rapidly running through the bypass valve hole to enter the drill string, you should slow down the running speed, or stop to fill mud from time to time. When running the drilling tool down, pier drilling or directly running the drilling tool to the well bottom is not allowed.

3. Starting the drilling tool- If the drilling tool is located in the bottom of the well, it must be lifted by 0.3-0.6m. Record the pressure gauge readings of the vertical pipe when starting the drilling pump, and make a comparison to the calculated pressure value. If the pressure value exceeding the hydraulic calculation value is normal, it is caused by the side tracking of the bit.

Clean up the bottom of the well, especially for drilling an inclined well, the bottom of the well must be sufficiently "clean", because the deposits on the bottom hole or the settled cuttings will affect the rotation speed or kick-off. It's better to perform the cleaning circularly using the normal drilling fluid. During cleaning, you may also rotate the drilling tool by several times (30°~40° for each time) and clean up the substances deposited on the well bottom.

After cleaning is completed, lift the drilling tool by 0.3-0.6m, check the pressure value and record it.

Re-run the drilling tool down to the well bottom and gradually increase the well pressure, at the same time, the motor torque and the pressure value shown on the pressure gauge are increased. The increased pressure values should be consistent with the pressure drop values of various types of motors. The increased values reflect whether the motor load is normal, and whether the drilling pressure is increased properly. Therefore, if the motor torque is maintained to be basically stable and the drilling pressure will be basically stable. It will be ok as long as the readings of the pressure gauge for the vertical pipe are limited within the range of push floating for the selected drilling tool. It enables the driller to keep abreast of the working condition of the drilling tool.

When the bit is not on the well bottom, if the circulating pressure is less than the calculated value, it may be caused by the damage at the bypass valve, "open position" or the drill pipe or lost circulation.

If the circulating pressure is larger than the calculated value, and after the cause of pressure rise due to the sidetracking has been ruled out, the cyclic pressure is still larger than the calculated value, it might because the bit nozzle is blocked or the drive shaft is stuck. At this time, the circulating pressure is much larger than the calculated pressure.

4. Pulling out of hole - The process of the pulling-out-of-hole for the drilling tool is similar to conventional operations. During pulling, the bypass valve is at the open position, allowing the drilling fluid in the drill string to flow into the annulus. However, the drilling tool itself can't drain out the drilling fluid. Usually you should fill heavy drilling fluid into a section of the upper part of the drilling string before pulling-out-of-the-hole to prompt that the drilling fluid is drained out smoothly.

4.1 After the drilling tool is lifted to be the location of the bypass valve, remove the parts at the bypass valve port. Flush the bypass valve from its top first, and then press down the spool using a wooden stick or hammer handle, next release it to make it move freely. When the cleaning is completed, screw down the lift sub and lift the drilling tool out.

4.2 Install the bit breaker properly, and clip the drilling tool housing securely. Reversely rotate the bit (in the top view) to drain out the remained mud in the motor through the bypass valve, and then remove the bit.

4.3 Remove the drilling tool, and flush the bit from the drive shaft hole to make the drive shaft water cap and bearing clean. Then, lay down the drilling tool, provide normal maintenance and keep it ready for use. If it is not used temporarily or for long term, it is recommended to fill a small amount of mineral oil for rust resistance (Note: diesel is not allowed).

5. Failure analysis of the screw drilling tool: As mentioned above, the circulation pressure changes of the drilling fluid are reflected by the vertical pipe pressure gauge, it can help the on-site personnel to identify the situations and problems occurring at the well bottom. Facts proved that a correct judgment can save a lot of time and costs consumed for tripping. Table 1 is summarized based on the comprehensive consideration of a variety of factors in the use process of the drilling tool, and the values (Table 1) are provided as a reference for users.

Failure Analysis Table of the Drilling Tool (Table 1)

Failure	Possible cause	Judgment and correction measures
The pressure shown on the pressure gauge suddenly increases	Motor stal	List the drilling tool by 0.3-0.6m. Check the circulating pressure, and gradually increase the drilling pressure, if the pressure shown on the pressure gauge will increase as well. Everything is normal, then, stalling can be confirmed.
	The motor drive shaft is stuck and the bit nozzle is blocked	Lift the bit away from the well bottom, and the readings of the pressure gauge are still high. You have to lift out the drilling tool for checking or replace the bit.
The pressure shown on the pressure gauge gradually increases (excluding the normal pressure drop rising with the increase of the depth)	The bit nozzle is blocked	Lift the bit away from the well bottom and re-check the pressure. If the pressure is still higher than the normal circulating pressure, you may try to improve the circulating flow or move the drill pipe up and down. If such measures can't work, repair and replacement will be required.
	Abrasion of the bit	Continue make it work and observe the operation condition carefully, if there is still no footage, you have to take out and replace the bit.
	Variation of formations	Lift the bit slightly. If the pressure is the same as the circulating pressure, it can continue working.
The pressure shown on the pressure gauge gradually decreases	Changes in circulating pressure loss	Check the drilling fluid flow.
	The drilling pipe is damaged.	Lift the drilling tool. If the readings shown on the pressure gauge are still lower than the circulating pressure, lift it out of the borehole for checking.

Failure	Possible cause	Judgment and correction measures
No footage	Variation of formations	Change the drilling pressure and circulating flow appropriately (note: do it within the allowable range).
	Motor stall	If the readings of the pressure gauge are high, lift the drilling tool away from the well bottom and check the circulating pressure from a low drilling pressure, then increase it gradually.
	The bypass valve is in the "Open" position	If the readings of the pressure gauge are low, lift the drilling tool slightly. Once twice pulling-out-of-hole and stops don't work, you have to lift it out of the borehole for replacing or checking the bypass valve.
	Damage of the cardan shaft	It is often accompanied with pressure fluctuations, if the drilling tool is slightly lifted, the pressure fluctuation range will become a little smaller, in this case, you have to check and replace the cardan shaft.
	Abrasion of the bit	Replace a new bit.

Ⅶ. Application of the Drilling Tool

With the constantly increasing difficulty of exploration and development of oil and gas wells, the screw drilling tool has been an indispensable down-hole power tool for oil and gas drilling works. The screw drilling tool plays a particularly important role in vertical wells, especially in such special process wells as directional wells, horizontal wells, extended reach wells, multi-lateral wells and cluster wells.

The straight screw drill tool is often used to drill vertical oil and gas wells. The upper part with a bending sub is usually used for the control of the borehole, such as deviation, deviation correction and correction run. The bending sub is normally a short section with a bending angle, on the upper part of which, a drill collar will be connected, so that an angle is formed between the drill collar and the drilling tool. Such angle plays a major role in determining the well material angle. The angle is 0° -3°, and it can be decided by the user. The requirements for the size of the bore hole and changes in the well deviation angle as well as the estimated drill footage of the drilling tool being used should be considered upon selection of the angle of the bending sub. The perpendicularity of the bending sub directly affects the changing rate of the borehole size, well deviation angle and its rate of change (Table 2). If there is a single point inclinometer key in the bending sub, you should check if this bending sub is aligned with the tool face scribing line on the bending sub to ensure the accuracy of the directional orientation.

Angles of the Bending Sub and the Rate of Change for the Well Deviation Angle/30m (Table 2)

Angle of Bending Sub	120 (4¾")		165 (6½") Drilling Tool		197 (7¾") Drilling Tool	
	Size of Borehole	Rate of Change	Size of Borehole	Rate of Change	Size of Borehole	Rate of Change
1°	6"	3°30′	8½"	2°30′	9⅞"	2°30′
1°30′		4°45′		3°30′		3°45′
2°		5°30′		4°30′		5°00′
1°	6¾"	3°30′	9⅞"	1°45′	10⅝"	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°	7⅞"	2°30′	10⅝"	1°15′	12¼"	1°45′
1°30′		3°30′		2°00′		2°30′
1°		4°30′		3°00′		3°30′
2°30′						

Ⅷ. Influence of Reverse torque on the directional drilling

The kickoff point and the rotary table are connected by several drill pipes. When applied the drilling pressure, the screw drilling tool will output a certain torque, then, the reverse torque with the same size and different directions will be applied on the entire drilling tool assembly. A certain torque deformation will be generated under the action of the reverse torque, therefore, which will surely affect the directional orientation. In the directional drilling work, in order to maintain the correct direction, you must consider the anti-torque. The anti-torsion angle caused by the anti-torque depends on:

1. Drilling pressure.
2. Type and length of the drill pipe.
3. Hole deviation angle.
4. Types of the drill collar and the heavy weight drill pipe as well as the depth of the well.
5. The number and length of centralizers (if any). As for the reverse-torsion angle of the drill string, you may roughly refer to the values listed in Table 3.

Note: The bit is of right-handed rotation so the reverse torque of the parts above the bit is of left-hand rotation.

■If further kick-off is made based on a certain well deviation and in case the deviation from the predetermined orientation occurs in the kickoff process, it is recommended to use Table 4. It can achieve the most effective orientation variation and rarely affect the changes in the hole deviation angle.

Notes:

■When adjusting the directing of the bending sub, the rotary table should be positioned based on the right-handed rotation. After completing the adjustment, lift and lower the drill string slowly for several times (the lift height should be more than 9m) to eliminate the drill pipe stress in the borehole and make it in the freely-released state.

The measured borehole direction and well deviation angle are the data at the deviation-measuring device instead at the down-hole drill bit. The distance between the deviation-measuring device and the drill bit should be considered.

■As for continuous kickoff, it is recommended to get the measurement data once after each single drill pipe is completely drilled. In order to ensure the kickoff is accurate, the increased drilling pressure should be stable and not too large.

Estimated values of the drill string reverse-torsion angle upon directing in vertical wells (Table 3)

Depth of Kickoff Start	Estimated Torsion Angle
0-152	Left rotation by 20°
>152-305	Left rotation by 25°
>305-475	Left rotation by 35°
>475-1524	Left rotation by 50°
>1524-total depth of the well	Left rotation by 10°/305m

Estimated values of the reverse-torsion angle when the well deviation angle has been available (Table 4)

Well Depth	Angle of Deviation	Adjusting the drilling tool from the high point of the borehole	
		Deviation correction towards left	Deviation correction towards right
Ground-305	2°-5°	Left rotation by 40°	Right rotation by 140°
	5°-10°	Left rotation by 30°	Right rotation by 135°
	10°-15°	Left rotation by 15°	Right rotation by 130°
	15°-20°	Left rotation by 10°	Right rotation by 125°
	20°-25°	Left rotation by 5°	Right rotation by 120°
	25°-30°	Left rotation by 0°	Right rotation by 115°
	30°-35°	Right rotation by 5°	Right rotation by 110°
	Above 35°	Right rotation by 5°	Right rotation by 105°
305-710	2°-5°	Left rotation by 30°	Right rotation by 155°
	5°-10°	Left rotation by 20°	Right rotation by 140°
	10°-15°	Left rotation by 10°	Right rotation by 135°
	15°-20°	Left rotation by 5°	Right rotation by 130°
	20°-25°	Left rotation by 0°	Right rotation by 125°
	25°-30°	Right rotation by 5°	Right rotation by 120°
	30°-35°	Right rotation by 5°	Right rotation by 115°
	Above 35°	Right rotation by 10°	Right rotation by 110°
710-well bottom	2°-5°	Left rotation by 25°	Right rotation by 180°
	5°-10°	Left rotation by 15°	Right rotation by 170°
	10°-15°	Left rotation by 10°	Right rotation by 165°
	15°-20°	Left rotation by 5°	Right rotation by 145°
	20°-25°	Right rotation by 5°	Right rotation by 125°
	25°-30°	Right rotation by 10°	Right rotation by 115°
	Above 35°	Right rotation by 10°	Right rotation by 100°

IX. Steerable Screw Drilling Tool

With the increasing improvement of the drilling level, the screw drilling tools only used for the control of the borehole, such as kickoff, deviation correction and direction run can no longer meet the needs of today's drilling. Especially because such wells with big difficulties as horizontal wells, have gradually increased, which put a higher demand on the screw drilling tool, namely: one-time running-down-in-borehole of the same screw drilling tool can complete the drilling work including the vertical section of well, directional kickoff, direction run, deviation building up, and deviation holding and achieve to control the well tracks at any time. To meet this demand, our company designed and manufactured a new type of down-hole power tool-steerable drilling screw tool. The steerable screw drilling tool usually refers the drilling tool with a bent housing and a stabilizer.

The steerable screw drilling tool may form different drilling tool assemblies with PDC bit or roller bit, used in directional well series to complete kickoff, and they can achieve the drilling work in deviation holding sections (with the low speed rotation of the rotary table) and horizontal sections.

■The drive shaft housing may be equipped with the stabilizers with different diameters and shapes, so the user can choose to use in accordance with the needs of the drilling process (for directional drilling, it is not recommended to use the eccentric centralizer).

■The bent housing of the cardan shaft includes the single bend type and double-bend type and there are various angles for users to choose. The angle of the single-bend cardan shaft housing is generally 0°-3°, and; The double-bend housing includes the double bends in the same direction and double bends in the opposite directions. In addition, the ground adjustable cardan shaft bent housing is available, and you can adjust the angle according to the needs of the on-site drilling process.

■The requirements of the screw for the rotary table speed upon composite drilling (screw + low speed drilling dish): If the rotary table rotates at the speed above 80rpm, the synthetic rubber of the stator will be damaged. The bent housing with a large bend angle plus the high speed of the rotary table can make the rotor and transmission mechanism generate large centrifugal force, thus causing the prematurely damage of the screw, and even down-hole accidents. To this end, we provide the requirements for the bend angles and the corresponding speeds of the rotary table for TTGM's drilling tools as follows:

Structure angle of bent housing (°)	Speed of rotary speed (rpm)
0.00°	≤70
0.25°	≤70
0.5°	≤70
0.75°	≤60
1.00°	≤50
1.25°	≤40
1.5°	≤40
Above1.5°	The composite drilling by starting the rotary table is prohibited.

■The calculation results for the model configured to the typical "Borehole Drilling Tool Assembly" are summarized in the table. The slope is affected by many factors such as: formation structure, drill bit size, size and position of the stabilizer, positions of the stabilizer and the bending point, as well as the rigidity changes of the drilling tool, etc.. All of them eventually cause the difference between the actual kickoff slope and the theoretical kickoff slope. Therefore, the user can modify the slope according to the actual on-site conditions. The values provided in the table is only for reference (Table 5)

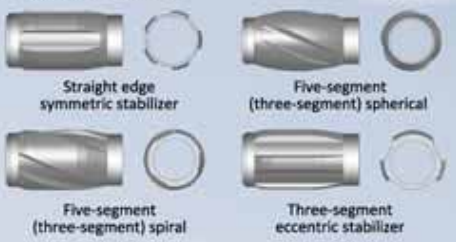
■In order to solve the problem that the back-up of the carried cuttings is difficult for horizontal wells, we install a nozzle at the inlet of the center slit-flow hole as the design of the motor rotor, thereby increasing the input flow, based on which, the high-pressure injection drilling may be achieved. When the smaller displacement is required, the center hole of the rotor maybe blocked.

Estimated Build-up rate of TTGM Drilling Tools (Table 5)

Type of Motor	Borehole Size (in)	Drilling Tool Assembly for Upper and Lower Stabilizers							Drilling Tool Assembly for Lower Stabilizers							Non-stabilizer Drilling Tool Assembly						
		0.5°	0.75°	1°	1.25°	1.5°	1.75°	2°	0.5°	0.75°	1°	1.25°	1.5°	1.75°	2°	0.5°	0.75°	1°	1.25°	1.5°	1.75°	2°
Φ73	Φ3 3/8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.31	12.52	17.63	24.19	27.63	30.14	36.43
Φ89	4 1/4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.72	11.54	16.12	19.03	23.41	27.08	31.13
Φ96	4 5/8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7.61	11.3	15.03	18.91	22.72	26.23	30.04
Φ120	6	5.1	7.4	9.8	11.4	14.7	16.9	19.8	6.5	9.7	13.0	16.2	19.6	22.8	26.3	NA	NA	NA	NA	NA	NA	NA
Φ165	8 1/2	3.4	4.8	6.5	8.3	9.7	11.9	13.2	4.7	6.0	9.0	11.3	13.5	15.7	17.7	NA	NA	NA	NA	NA	NA	NA
Φ172	8 1/2	3.1	4.7	6.3	8.0	9.4	11.0	12.8	4.5	6.5	8.7	10.8	12.9	15.3	17.2	NA	NA	NA	NA	NA	NA	NA
Φ197	12 1/4	2.7	4.1	5.4	6.8	8.0	9.7	11.3	4.2	6.3	8.5	10.7	12.8	14.6	17.0	NA	NA	NA	NA	NA	NA	NA
Φ203	12 1/4	2.6	3.9	5.2	6.6	8.3	9.5	11.0	4.0	6.1	8.1	10.1	11.8	13.7	15.9	NA	NA	NA	NA	NA	NA	NA
Φ216	12 1/4	2.4	3.7	5.5	6.6	8.3	9.5	10.8	3.5	5.3	7.1	8.9	10.7	12.6	14.3	NA	NA	NA	NA	NA	NA	NA
Φ244	12 1/4	2.6	3.8	5.3	6.3	7.8	8.8	10.4	3.6	5.4	7.4	9.6	11.3	13.0	14.8	NA	NA	NA	NA	NA	NA	NA

Other accessories of the steerable screw drilling tool:

1. Upper centralizer: our company can also provide a variety of centralizers with different sizes and shapes to users. See Fig. They may be installed above the bypass valve, to increase the effect of the angle holding.



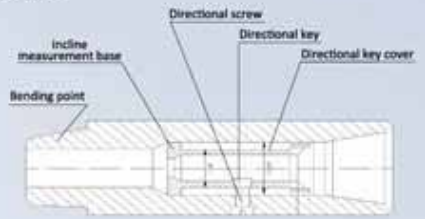
Straight edge symmetric stabilizer

Five-segment (three-segment) spherical

Five-segment (three-segment) spiral

Three-segment eccentric stabilizer

2. Direction sub: In order to help users to measure the downhole date timely and accurately in the drilling process, TTGM Group has installed a deviation-measuring device in screw drilling tools before shipment, used to align the directional key with the working plane, ensuring more accurate directions.



Speeds of TTGM drilling tools corresponding to the rotary table: If the rotary table rotates at the speed above 80rpm, the synthetic rubber of the stator will be damaged. High speed of the rotary table can increase the centrifugal force generated by the rotor and the transmission mechanism, thus causing the increase of wear in the stator, transmission mechanism, radial bearings and inner connecting threads.

Relationship between the rotary table and the bent housing angle:

Bent housing angle (0°-3°)	Speed of rotary table (rpm)
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: not recommended

Note: Do not start the steerable drilling of the rotary table when the bent housing angle exceeds 1.50°.

Maximum allowable tension for TTGM screw drilling tools

Specifications of Drilling Tool	Applied on the bit		Applied on the 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

X. Technology Parameters Table

Model	Tool OD		Bit Size		Connected Thread		Lobe	Stage	Flow Rate		Rotory Speed		Working Pressure Loss		Output Torque		Max Pressure Loss		Max Torque		Working Pressure		Max Pressure		Output Power	
	mm	in	mm	in	up	down			lpm	gpm	rpm		Mpa	psi	N.m	lb-ft	Mpa	psi	N.m	lb-ft	KN	lb	KN	lb	KW	hp
5LZ43×7.0TT-4	43	111/16	48-76	17/8-3	NC12	NC12	5:6	4	435-870		4 585		56	42	5.65	824	5.65	824	79	58	3	660	6	1320	6.5	9
5LZ45×7.0 TT-3	44	111/16	48-76	17/8-3	NC12	NC12	5:6	3	228-680		2.4 350		85	62	3.39	495	3.39	495	125	90	3	660	6	1320	8	11
5LZ54×7.0 TT-3	54	21/8	60-89	23/8-31/2	11/2REG	11/2REG	5:6	3	282-638		2.4 350		130	96	3.39	495	3.39	495	182	135	4	880	8	1760	11	15
5LZ60×7.0 TT-3	60	27/8	79-111	31/8-43/8	11/2REG	11/2REG	5:6	3	298-595		2.4 350		156	115	3.39	495	3.39	495	218	160	5	1100	10	2200	12	16
5LZ73×7.0 TT-3	73	23/8	73-90	27/8-31/2	23/8REG	23/8REG	5:6	3	121-432		2.4 350		460	339	3.39	495	3.39	495	650	479	12	2640	25	5500	27	36
7LZ79×7.0 TT-4	79	31/8	95-121	33/4-43/4	23/8REG	23/8REG	7:8	4	138-413		3.2 466		465	342	4.25	659	4.25	659	617	455	12	2640	25	5500	24	32
5LZ89×7.0 TT-3	89	31/2	114-149	41/2-57/8	23/8REG	23/8REG	5:6	3	108-325		2.4 350		810	598	3.39	495	3.39	495	1145	845	22	4400	35	7700	35	47
LZ95×7.0 TT-4	95	33/4	118-149	45/8-57/8	27/8REG	27/8REG	1:2	4	160-478		3.2 466		432	319	4.25	659	4.25	659	574	423	30	6600	55	12100	26	35
5LZ95×7.0 TT-3	95	33/4	118-149	45/8-57/8	27/8REG	27/8REG	5:6	3	124-300		2.4 350		833	615	3.39	495	3.39	495	1177	868	30	6600	55	12100	32	43
9LZ95×7.0 TT-4	95	33/4	118-149	45/8-57/8	27/8REG	27/8REG	9:10	4	139-280		3.2 466		1426	1052	4.25	659	4.25	659	1895	1320	30	6600	55	12100	48	64
9LZ105×7.0 TT-4	105	41/4	121-152	43/4-6	27/8RE	27/8REG	9:10	4	132-265		3.2 466		1630	1200	4.25	659	4.25	659	2165	1597	30	6600	55	12100	51	68
2LZ120×7.0 TT-4	120	43/4	149-200	57/8-77/8	31/2REG	31/2REG	2:3	4	180-360		3.2 466		1030	760	4.25	659	4.25	659	1367	1008	49	10803	100	22000	46	62
4LZ120×7.0 TT-6	120	43/4	149-200	57/8-77/8	31/2REG	31/2REG	4:5	6	150-300		4.8 700		2137	1576	6.78	988	6.78	988	3019	2226	49	10803	100	22000	81	108
4LZ120×7.0 TT-5	120	43/4	149-200	57/8-77/8	31/2REG	31/2REG	4:5	5	150-300		4 585		1780	1313	5.65	824	5.65	824	2515	1855	49	10803	100	22000	71	95
5LZ120×7.0 TT-3	120	43/4	149-200	57/8-77/8	31/2REG	31/2REG	5:6	3	140-278		2.4 350		1620	1195	3.39	495	3.39	495	2288	1688	49	10803	100	22000	57	76
5LZ120×7.0 TT-4	120	43/4	149-200	57/8-77/8	31/2REG	31/2REG	5:6	4	140-278		3.2 466		2160	1593	4.25	659	4.25	659	2869	2116	49	10803	100	22000	71	95
7LZ120×7.0 TT-4	120	43/4	149-200	57/8-77/8	31/2REG	31/2REG	7:8	4	130-261		3.2 466		2468	1819	4.25	659	4.25	659	3277	2417	49	10803	100	22000	75	102
5LZ140×7.0 TT-4	140	51/4	171-222	63/4-83/4	41/2REG	41/2REG	5:6	4	118-236		3.2 466		2613	1927	4.25	659	4.25	659	3471	2560	49	10803	100	22000	73	98
5LZ159×7.0 TT-5	159	61/4	171-222	63/4-83/4	41/2REG	41/2REG	5:6	5	106-212		4 585		4221	3113	5.65	824	5.65	824	5962	4397	80	17600	160	35200	111	148
LZ165×7.0 TT-4	165	61/2	213-251	83/8-97/8	41/2REG	41/2REG	1:2	4	191-382		3.2 466		1018	751	4.25	659	4.25	659	1352	997	49	10803	100	22000	46	62
5LZ165×7.0TT-3.5	165	61/2	213-251	83/8-97/8	41/2REG	41/2REG	5:6	3.5	102-205		2.8 408		2555	1885	3.955	577	3.955	577	3609	2662	80	17600	160	35200	66	88
5LZ165×7.0 TT-4	165	61/2	213-251	83/8-97/8	41/2REG	41/2REG	5:6	4	101-202		3.2 466		3673	2709	4.25	659	4.25	659	4878	3597	80	17600	160	35200	88	119
5LZ165×7.0 TT-5	165	61/2	213-251	83/8-97/8	41/2REG	41/2REG	5:6	5	101-202		4 585		4590	3386	5.65	824	5.65	824	6484	4783	80	17600	160	35200	100	135
5LZ165×7.0 TT-6	165	61/2	213-251	83/8-97/8	41/2REG	41/2REG	5:6	6	101-202		4.8 700		5509	4063	6.78	988	6.78	988	7781	5739	80	17600	160	35200	121	162
9LZ165×7.0 TT-4	165	61/2	213-251	83/8-97/8	41/2REG	41/2REG	9:10	4	93-187		3.2 466		4579	3377	4.25	659	4.25	659	6082	4485	80	17600	160	35200	98	132
LZ172×7.0 TT-4	172	63/4	213-251	83/8-97/8	41/2RE	41/2REG	1:2	4	191-382		3.2 466		101	751	4.25	659	4.25	659	1352	997	80	17600	160	35200	46	62
3LZ172×7.0 TT-6	172	63/4	213-251	83/8-97/8	41/2REG	41/2REG	3:4	6	107-214		4.8 700		4660	4854	6.78	988	6.78	988	6580	4854	100	22000	170	37400	126	206
4LZ172×7.0 TT-7	172	63/4	213-251	83/8-97/8	41/2REG	41/2REG	4:5	7	109-217		5.6 817		6158	4541	7.91	1154	7.91	1154	8698	6415	100	22000	170	37400	154	206

Model	Tool OD		Bit Size		Connected Thread	Lobe	Stage	Flow Rate		Rotory Speed	Working Pressure Loss		Output Torque		Max Pressure Loss		Max Torque		Working Pressure		Max Pressure		Output Power	
	mm	in	mm	in	up down			lpm	gpm	rpm	Mpa	psi	N.m	lb-ft	Mpa	psi	N.m	lb-ft	KN	lb	KN	lb	KW	hp
5LZ172×7.0 TT-4	172	63/4	213-251	83/8-97/8	41/2REG 41/2REG	5:6	4	48-96	13-26	92-185	3.2	466	4160	3068	4.25	659	5525	4075	100	22000	170	37400	126	170
5LZ172×7.0 TT-5	172	63/4	213-251	83/8-97/8	41/2REG 41/2REG	5:6	5	57-170	15-45	92-185	4	585	5200	3835	5.65	824	7345	5417	100	22000	170	37400	118	159
5LZ172×7.0TT-6	172	63/4	213-251	83/8-97/8	41/2REG 41/2REG	5:6	6	106-240	28-64	92-185	4.8	700	6240	4600	6.78	988	8814	6500	100	22000	170	37400	142	190
7LZ172×7.0 TT-5	172	63/4	213-251	83/8-97/8	41/2REG 41/2REG	5:6	5	140-280	38-75	84-168	4	585	7176	5293	5.65	824	10137	7476	100	22000	170	37400	150	200
9LZ172×7.0 TT-2	172	63/4	213-251	83/8-97/8	41/2REG 41/2REG	5:6	2	162-578	76-153	78-156	1.6	233	3148	2320	2.26	330	4446	3279	100	22000	170	37400	61	82
9LZ172×7.0 TT-4	172	63/4	213-251	83/8-97/8	41/2REG 41/2REG	7:8	4	140-419	-111	84-169	3.2	466	5355	3949	4.25	659	7112	5245	100	22000	170	37400	78	105
5LZ185×7.0 TT-5	185	71/8	222-251	83/4-97/8	41/2REG 65/8REG	5:6	5	255-766	67-202	91-182	4	585	5548	4090	5.65	824	7836	5779	100	22000	170	37400	134	180
LZ197×7.0 TT -4	197	73/4	251-311	97/8-121/4-	51/2REG 65/8REG	1:2	4	150-450	40-119	139-277	3.2	466	1366	1007	4.25	659	1814	1338	100	22000	170	37400	47	62
5LZ197×7.0 TT-4	197	73/4	251-311	97/8-121/4-	51/2REG 65/8REG	5:6	4	320-800	85-211	79-158	3.2	466	5022	3704	4.25	659	6700	4920	150	33000	200	44000	99	133
5LZ197×7.0 TT-5	197	73/4	251-311	97/8-121/4-	51/2REG 65/8REG	9:10	5	460-928	120-245	79-158	4	585	6277	4629	5.65	824	8866	6540	150	33000	200	44000	130	176
5LZ197×7.0 TT-6	197	73/4	251-311	97/8-121/4-	51/2REG 65/8REG	9:10	6	498-997	131-263	79-158	4.8	700	7533	5555	6.78	988	10640	7847	150	33000	200	44000	157	210
7LZ172×7.0 TT-5	197	73/4	251-311	97/8-121/4-	51/2REG 65/8REG	2:3	5	454-909	120-240	75-150	4	585	7220	5324	5.65	824	10197	7520	155	34100	250	55000	130	176
9LZ197×7.0 TT-4	197	73/4	251-311	97/8-121/4-	51/2REG 65/8REG	4:5	4	495-990	131-262	72-145	3.2	466	6260	4617	4.25	659	8315	6132	150	33000	200	44000	113	152
LZ203×7.0 TT-4	203	8	251-311	97/8-121/4-	51/2REG 65/8REG	4:5	4	495-990	131-262	139-277	3.2	466	1366	1007	4.25	659	1814	1338	100	22000	170	37400	47	62
5LZ203×7.0 TT-4	203	8	251-311	97/8-121/4-	51/2REG 65/8REG	5:6	4	694-1388	184-367	79-158	3.2	466	5022	3704	4.25	659	6700	4920	155	34100	250	55000	99	133
5LZ203×7.0 TT-5	203	8	251-311	97/8-121/4-	51/2REG 65/8REG	5:6	5	694-1388	184-367	79-158	4	585	6277	4629	5.65	824	8866	6540	155	34100	250	55000	130	176
7LZ203×7.0 TT-5	203	8	251-311	97/8-121/4-	51/2REG 65/8REG	7:8	5	745-1489	196-393	75-150	4	585	7220	5324	5.65	824	10197	7520	155	34100	250	55000	143	194
9LZ203×7.0 TT-4	203	8	251-311	97/8-121/4-	51/2REG 65/8REG	9:10	4	718-1436	190-379	72-145	3.2	466	6260	4617	4.25	659	8315	6132	150	33000	200	44000	113	152
5LZ210×7.0 TT-5	216	81/8	251-375	97/8-143/4	65/8REG 65/8REG	5:6	5	828-1656	219-438	75-150	4	585	7481	5517	5.65	824	10567	7793	180	39600	300	66000	149	200
5LZ216×7.0 TT-4	216	81/8	311-394	121/4-151/2	65/8REG 65/8REG	5:6	4	450-899	119-237	72-145	3.2	466	6105	4502	4.25	659	8108	5980	180	39600	300	66000	112	150
5LZ216×7.0 TT-5	216	81/8	311-394	121/4-151/2	65/8REG 65/8REG	5:6	5	686-1371	181-362	72-145	4	585	7631	5628	5.65	824	10607	7823	180	39600	300	66000	147	197
5LZ228×7.0 TT-4	228	9	311-394	121/4-151/2	65/8REG 65/8REG	5:6	4	862-1724	228-456	72-145	3.2	466	6105	4502	4.25	659	8108	5980	180	39600	300	66000	112	150
5LZ228×7.0 TT-5	228	9	311-394	121/4-151/2	65/8REG 65/8REG	5:6	5	1228-2455	325-650	72-145	4	585	7631	5628	5.65	824	10607	7823	180	39600	300	66000	147	197
3LZ244×7.0 TT-6	244	95/8	311-445	121/4-171/2	65/8REG 65/8 (75/8) REG	3:4	6	1345-2690	355-710	75-150	4.8	700	9570	7060	6.78	988	11087	8177	220	484000	330	79200	158	212
5LZ244×7.0 TT-4	244	95/8	311-445	121/4-171/2	65/8REG 65/8 (75/8) REG	5:6	4	1650-3300	450-880	64-129	3.2	466	9114	6722	4.25	659	12105	8927	220	484000	330	79200	147	197
5LZ244×7.0 TT-5	244	95/8	311-445	121/4-171/2	65/8REG 65/8 (75/8) REG	5:6	5	1650-3300	450-880	64-129	4	585	11393	8402	5.65	824	16092	11868	220	484000	330	79200	195	262
C5LZ244×7.0 TT-4	244	95/8	311-445	121/4-171/2	65/8REG 65/8 (75/8) REG	5:6	4	2100-4200	600-1110	65-131	3.2	466	13020	9602	4.25	659	17290	12753	220	484000	330	79200	215	288
3LZ286×7.0 TT-4	286	111/4	375-660	143/4-26	(65/8) 75/8REG (65/8) 75/8REG	3:4	4	2850-5700 1000-1500		97-196	3.2	466	11840	8731	4.25	659	15724	11597	300	67500	550	123750	195	262

Domestic sales network

The products of TTGM Group cover various major domestic oilfields like Daqing, Changqing, Shengli, Liaohe, Xinjiang, Yanchang etc. At present, we have achieved the strategy of three "Ones".
And they are "One service center" in each region, "One service technician" for each customer and "Replying to each item of customer's comments within one day".
TTGM Group has set up a sales department in Beijing to provide back-up support for the domestic and international sales and service.

Major Customers

PETROCHINA	SINOPEC	YANCHANG OILFIELD	CNOOC