

# CHAMPION

## Directional Drilling Motor



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# TORQUATO

## DRILLING MOTORS

### SPECIFICATIONS AND OPERATIONAL GUIDELINES

## INTRODUCTION

The Torquato Down Hole Drilling Motor is a positive displacement hydraulic motor powered by drilling mud or water. When the fluid is pumped through the tool the bit is turned at a speed proportional to the flow and remains relatively constant regardless of the load or developed horsepower. As weight is added to the motor and the bit start drilling the standpipe pressure will increase in direct proportion to the torque generated. This serves as a built-in means of telemetry to indicate exactly how the motor is performing, even if wall drag prevents an accurate response of the rig weight indicator.

*The Torquato motor offers the following advantages:*

### A. Slow Speed/High Speed

The motor operates at a speed compatible with roller bits. This significantly lengthens bit life with increased on bottom time and fewer round trips. At higher flow rates the motor operates at significantly higher speeds to accommodate RPM requirements of fixed cutter PDC drilling bits.

### B. High Torque

More set down weight can be put on bit for faster penetratio with reserve power for the hard spots.

### C. Oil Filled Bearing Section

Pre-pressured and pressure compensated bearing section provides long seal life and extended bearing operation.

## DESIGN

All housings of the Torquato Down Hole Drilling Motor are pre-tightened with controlled torque and are locked to assure that there are no accidental backoffs. Prior to shipment to the field each tools is thoroughly inspected and tested to guarantee long, trouble-free service.

### Power Section

The power section is the heart of the Torquato Down Hole Drilling Motor, being that

portion that converts hydraulic power in the form of flow and pressure into mechanical power as torque and speed. It is a positive displacement motor in the moyno type. It should be noted that in spite of the ability to generate high torque the motor does not always operate automatically at these high levels. The actual torque will be a function of the formation being drilled, mud, bit, weight on the bit and other operating parameters.

The rotor is double plated to protect it from well bore fluids and abrasion. The stator is molded with an elastomer that likewise resists the drilling environment. The power-producing characteristic of the motor is tested each time prior to returning the tool to the field to assure continued high performance.

### **Universal Section**

As the rotor rotates within the stator its center orbits about the centerline of the stator. A double-ended universal joint is used to translate this motion into the pure rotation of the drive shaft.

### **Bearing Section**

The bearing section supports the weight on the bit and provides rigid lateral stability to the drive shaft. Four heavy duty roller bearings operating in synthetic oil permit high bit load and long bearing life. After assembly of the bearing section the unit is completely evacuated to test for leaks and then filled with oil. This assures that there is no air in the system and allows the oil to flow freely through and around all of the components of the section. The system is filled under pressure to charge the oil reservoir and, after a topping operation is bled back a calculated amount to allow for equalization of the oil pressure with the surrounding well bore hydrostatic pressure. This pre-pressure and pressure compensated oil system assures proper oil lubrication for the seals and bearing operation.

## **OPERATION**

The Torquato Down Hole Drilling Motor is an easy tool to operate provided it is operated within its design specifications. It should be noted that the specific use of any tool may vary from operator to operator and experience will show the most efficient and safe procedure to follow. It is recommended that a check valve be run above the tool to keep the bit or other parts of the tool from plugging. Though the tool is built to withstand normal wear and tear, care should be taken while running to depth since damage can occur from hitting bridges, casing shoes, junk or other obstructions in a hole. To run past these tight spots the motor should be operated at its normal speed. If a bent sub is used the drill pipe (and motor) should be slowly rotated to prevent accidental side tracking of the main hole. As a guide, however the following steps are recommended for routine drilling operations:

**A.** Since the speed of the motor is proportional to the fluid volume it is important that the flow rate be accurately set and maintained throughout the drilling operation. When the tool has reached the correct depth and is off bottom, the flow should be set. This will establish the off bottom or no-load pressure the driller sees at the standpipe.

**B.** After proper cleaning of the hole, tool orientation, if applicable, should be performed before drilling ahead. As with all down hole drilling motors Torquato motors impart a left-hand torque (tending to tighten the tool joints) into the string above/before the tool. This torque is equal and opposite to the torque generated at the bit while drilling.

As weight is slowly added to the motor and the bit starts drilling the pressure will increase in direct proportion to the torque generated.

Assuming everything but the weight on the bit remains constant in any specific drilling situation, the rig pressure gage will be an indicator of the weight on the bit and especially useful piece of telemetry where wall drag prevents an accurate response of the rig weight indicator. If the rig pressure gage does not respond as indicated and the tool does not drill off as predicted see the section title "Trouble Shooting". As initial drilling commences a little difficulty may be encountered in getting the tool to drill smoothly. This is due to the bit "seating in" on the previously drilled formation and will disappear in a short time.

## SPECIFICATIONS

To obtain the best performance from the Torquato Down Hole Drilling Motor it is necessary to use the tool within the specifications and limitations for which it is designed. Care should be used in selecting the right size tool for the right job. Due to the high torque capability of the motor there may be a tendency to use a tool that is really too small for the job resulting in unsatisfactory performance due to the flow and strength limitations. Tabled below are the general specifications of the motors that are now or soon will become available. These specifications will change from time to time as improvements are incorporated.

Sometimes due to rig or hole conditions it may be necessary to operate with flow rates other than that recommended in the table. Since the listed operating speed of the motor is directly proportional to the flow its change should also be considered. The output torque of the motor is, however, generally independent of the flow and therefore little change of the allowable weight on the bit should be realized. Changing the flow will, of course, change the bit hydraulic horsepower and this coupled with the change in bit speed will in many instances affect the drilling rate of penetration.

**The tool should never be operated more than 15% above the designed operating flow due to the high pressure drop and flow velocities through the tool. Also operating more than 30% below the recommended flow will result in a lower speed and therefore a decreased rate of penetration and performance. If it is desired to operate below the designed flow, it is recommended that the motor first be started with the designed flow and then adjusted back as required.**

## TROUBLE SHOOTING

When drilling is first started it may take 10-15 minutes for the bit to "seat" in the previously drilled formation before drilling will proceed smoothly. However, if the motor does not take pressure and drill off as predicted, the following outline may help in correcting the situation. It

should be noted though, that most operators have acquired years of experience with drilling motors and have possibly seen every type of malfunction. In each case the operator may use his own particular “trick” to remedy the problem:

**A. Is the pump flow rate setting correct?**

See “Hydraulics” section. Are the mud pit flow line valves operating and correctly set?

**B. Is weight getting to the bit?**

Work the pipe up and down, especially if the pipe is not being rotated.

**C. Is the bit balling?**

Again work the pipe and tag bottom lightly to clean.

**D. Is the tool and bit wedged tightly against the wall of the hole?**

The use of a high angle bent sub, coupled with a small diameter bit could cause wedging. Work and rotate pipe to free.

**E. Is the motor sanded-up?**

An especially dirty hole or faulty check valve could have allowed solids to settle within the motor causing the drilling fluid to channel rather than turn the motor. Continuous pumping (15 minutes maximum) will sometimes correct such a condition. Also during this time slow rotation of the pipe (to the right) while gently tagging bottom will some times free the motor.

If none of the above (or other) corrective actions prove successful it will be necessary to trip the tool from the hole. While tripping check for drill pipe and drill collar for washouts to be sure calculated flow was actually getting to the tool.

Surface check the tool by pumping through at normal flow rates and watch for normal rotation. If the tool does not rotate pump through for 15 minutes to see if it clears itself. If the motor turns at about half its normal speed check the bypass valve again to be sure that it is actuating freely. Check for anything unusual, as for example, pieces of metal or rubber trapped in the bit, a bent bit sub, etc.

If the tool still does not perform satisfactorily file a report on the form provided in the lifting sub and return in the sub when wending the tool back for redressing. If you desire the results of the factory tool inspection contact your local representative or indicate on the form enclosed in the lifting sub. Torquato will make every effort to determine exactly the cause of malfunction and provide you with a full report if desired.

## **FIELD SERVICING**

The bearing section of the Torquato Down Hole Drilling Motor has been completely filled with oil at the factory and should not normally require any additional service at location.

However, for unusually long runs the oil level should be checked in the field to be sure the bearings are operating with the proper amount of lubrication. More information on checking the oil level may be obtained from your local representative.

## HYDRAULICS

In operating the Torquato Down Hole Drilling Motor the most important items to watch to assure a successful run are the motor and system hydraulics. It cannot be overemphasized that reliable, high performance will be obtained by close attention to the proper hydraulic requirements.

## PDC Bit Drilling

Torquato motors can be run with Silver Bullet PDC bits with one important note. The pressure drop across a PDC bit is caused by friction as the drilling fluid flows between the bit surface and the formation. This pressure drop will vary as the bit is put on bottom and increase as the fluid must pass through the small area between the fluid-courses on the bit and hole itself.

**In PDC drilling it should, therefore, be noted that the difference in standpipe pressure between drilling and rotating off bottom is due to the pressure increase across the bit and the normal pressure required to produce power by the motor. By subtracting the “designed” bit pressure drop, the actual motor pressure increase associated with its torque generation can be determined.**

## Pump Setting

The Torquato motor, being a positive displacement motor, will run at a specific speed (RPM) for a specific volume (gal/min.) thruput. The required circulation rate as discussed under “Specifications” should be established prior to drilling and maintained throughout the drilling program for optimum tool performance. For duplex and triplex piston pumps the flow rate depends on the length of the pump stroke, liner size, number of strokes per minute, and efficiency. For easy reference the circulation rate for various sizes of pumps is shown in Appendixes f and g. For duplex pumps these tables were prepared using 95% efficiency for under 40 strokes per minute and 90% efficiency for over 40 strokes per minute. The triplex pump information is shown at 100% efficiency.

## Mud Properties

The Torquato motor is designed to effectively handle most drilling fluids including lost circulation material. However, since the long term performance of the motor depends so heavily on the mud as its source of power more attention will be given to it here.

Regular and complete testing of the mud is important not only to the prevention of damage to the motor but also to the success of drilling and maintaining the hole condition as well. Particular attention should be given to the following items:

## Lost Circulation Material

As a general rule anything the rig pump can handle can also be handled by the drilling motor. Care should be exercised however in adding these materials to the mud system so that the system is not “slugged” with large quantities at one time. These could become lodged within the motor or bit passageways. Also it is advisable to run the rig pumps with screens to avoid extra large debris from entering the system. Rags and tools accidentally dropped down the circulating system will severely plug and damage drilling motor.

## Sand and Solids Content

Just like sand and abrasive solids will damage the rig surface equipment the drilling motor will likewise be adversely affected. If possible, desanders should always be used and kept working correctly. Maximum sand content should be no more than 2% by volume with a preferred content of less than 1%. It should be noted that the standard API measurement for sand considers particles only greater than 200 mesh in size. However, smaller particles, depending on their hardness and shape will remove approximately as much material as the coarser sand. These finer particles will be found in the “solids” content of the mud and will have to be removed if present.

## WARRANTY

Torquato warrants that its product will be free from defects in workmanship and materials and in good working order on the day delivered.

## TORQUATO DRILLING MOTOR SPECIFICATIONS

Model	Tool Size	Bit Size Range	Flow Rate (GPM)	Speed Range (RPM)	Bottom Connection	Length (FT)	Torque (FT LBS)	Weight (LBS)
375	3-3/4"	5-1/4" - 6-1/4"	90 - 160	200 -300	2-7/8" API REG BOX	12.5	957	450
375	3-3/4"	5-1/4" - 6-1/4"	100 - 170	80 - 120	2-7/8" or 3-1/2" API	16.8	900	350
375	3-3/4"	5-1/4" - 6-1/4"	60 - 150	125 - 325	2-7/8" API REG BOX	9.5	450	360
375	3-3/4"	5-1/4" - 6-1/4"	60 - 150	70 - 175	2-7/8" or 3-1/2" API	14	1300	425
475	4-3/4"	6" - 7-7/8"	100 - 250	180 - 575	3-1/2" API REG BOX	18	1300	1000
475	4-3/4"	6" - 7-7/8"	90 - 160	200 - 300	3-1/2" API REG BOX	13	950	450
475	4-3/4"	6" - 7-7/8"	150 - 300	135 - 295	3-1/2" API REG BOX	O.R.	2550	O.R.
500	5"	6-1/4" - 7-7/8"	100 - 200	105 - 250	3-1/2" API REG BOX	14.5	1250	1200
500	5"	6-1/4" - 7-7/8"	140 - 250	105 - 235	3-1/2" API REG BOX	14.5	2500	1200
550	5-1/2"	6-3/4" - 7-7/8"	150 - 300	75 - 170	4-1/2" API REG BOX	15.5	2800	1200
550	5-1/2"	6-3/4" - 7-7/8"	150 - 300	75 - 170	4-1/2" API REG BOX	15.5	2500	1400
625	6-1/4"	7-7/8" - 8-3/4"	150 - 400	50 - 175	4-1/2" API REG BOX	19.5	3800	1700
625	6-1/4"	7-7/8" - 8-3/4"	200 - 400	O.R.	4-1/2" API REG BOX	26.5	7500	2050
650	6-1/2"	7-7/8" - 8-3/4"	150 - 450	27 - 80	4-1/2" API REG BOX	29	7000	3400
650	6-1/2"	7-7/8" - 8-3/4"	150 - 400	50 - 137	4-1/2" API REG BOX	19.5	5500	1700
675	6-3/4"	7-7/8" - 8-3/4"	300 - 600	85 - 175	4-1/2" API REG BOX	O.R.	7000	O.R.
675	6-3/4"	7-7/8" - 9-7/8"	150 - 500	70 - 180	4-1/2" API REG BOX	16	5000	1600
800	8"	9-7/8" - 12-1/4"	300 - 900	35 - 150	6-5/8" API REG BOX	O.R.	9800	O.R.
850	8-1/2"	9-7/8" - 12-1/4"	200 - 500	70 - 150	6-5/8" API REG BOX	14	5000	3000