

Positive Displacement Motor (PDM)

Mud motor (or Drilling Motor) refers to a Progressive Cavity Positive Displacement Pump placed in the Drill string to provide additional power to the bit while drilling. The PCPD Pump uses Drilling Fluid (commonly referred to as Drilling Mud, or just Mud) to create eccentric motion in the power section of the motor which is transferred as concentric power to the drill bit. The Mud Motor uses different rotor and stator configurations to provide optimum performance for the desired drilling operation, typically increasing the number of lobes and length of power assembly for greater horsepower. In certain applications, compressed air, or other gas, can be used for Mud Motor input power. Normal rotation of the bit while using a Mud Motor can be from 60 rpm, to over 100 rpm.

Normal construction/Usage

Normal mud motor construction consists of a top sub, which connects the mud motor to the drill string; the power section, which consists of the rotor and stator; the transmission section, where the eccentric power from the rotor is transmitted as concentric power to the bit using a CV joint; the bearing assembly which protects the tool from off bottom and on bottom pressures; and the bottom sub which connects the mud motor to the bit.

When the bit is on bottom and the motor is effectively working, there is a notable increase in the pressure in the fluid system. This is caused by a restriction within the motor and is termed the "differential pressure". If this differential pressure is too high then the motor can stall which means the bit has stopped turning and this can cause severe damage to the internal surface of the stator.

A mud motor is described in terms of its stages, lobe ratio and external diameter. Stages are the number of full twists that the rotor makes from one end to the other and the lobe ratio is the number of lobes on the stator, to the number of lobes on the rotor (the stator always has one more lobe than the rotor). A higher number of stages or the number of lobes indicates a more powerful motor, capable of producing more torque. A lower number of lobes indicates a reduction in the torque produced but a faster bit rotation speed.

Basic relationships are that the torque is proportional to the differential pressure and the bit rotation speed is proportional to the fluid flow rate through the motor.

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The use of mud motors is greatly dependent on financial efficiency. In straight vertical holes, the mud motor may be used solely for increased rate of penetration (ROP), or to minimize erosion and wear on the drill string, since the drill string does not need to be turned as fast.

The majority of mud motor use is in the drilling of directional holes. Although other methods may be used to steer the bit to the desired target zone, they are more time consuming which adds to the cost of the well. Mud motors can be configured to have a bend in them using different settings on the motor itself. Typical mud motors can be modified from 0 degrees to 3 degrees with approximately six increments in deviation per degree of bend. The amount of bend is determined by rate of climb needed to reach the target zone. By using a Measurement While Drilling (MWD) Tool, a directional driller can steer the bit to the desired target zone.

Advantages of the Mud Motor

1. Extremely hard rock formations can be drilled with motors using diamond or PDC bits.
2. High penetration rates can be achieved since rotation speeds are high.
3. Will allow circulation of the borehole regardless of the horsepower or torque produced by the motor.

Major disadvantage in oilfield applications

The PDM stator, which is a major component of the pump, is usually lined with an elastomer. Most of the PDM pump failures are due to the elastomer part. Elastomers are affected by abrasive fluids, high temperatures; oil based drilling fluids and solids. Over time the oil degrades the elastomers and the seals in the motor.