maxon motor Australia Pty Ltd
Unit 1, 12-14 Beaumont Rd.
Mount Kuring-Gai NSW 2080

Tel. +61 2 9457 7477
sales.au@maxongroup.com
www.maxongroup.net.au

August 15, 2022

Press Release

The Benefits of Electric Drives in Downhole Equipment

Every oil and gas extraction operation now includes gathering big data and managing the down-hole processes, from surveying and preparing extraction areas to maximising and optimising the production of mature oil and gas wells.

Over the years, the oil and gas extraction sector has maintained the same objectives: maximise output to satisfy the energy needs of the market while doing it effectively, affordably, and sustainably. Efficiency and sustainability are becoming a more prominent role as the sector sets its sights on achieving zero nett carbon emissions. Even though it has significant technological and environmental obstacles, downhole drilling has the greatest potential for technological advancement. To achieve these goals, industry mindsets must change to embrace a more data-driven strategy, which is driving downhole drilling towards electrification.

Electric drive benefits

The concept of electrifying downhole operations is not new, but advancement has lagged over time as a result of a combination of overcoming the extremely challenging climatic conditions, a lack of cutting-edge technology, and resistance to change. Technical advancements in motor, electronics, and battery technologies are providing the tools needed to move towards the electrification of the oil and gas industry, however, since old solutions like hydraulics are no longer cost viable in fulfilling the new targets set by the industry. There are key advantages of an all-electric system as well.

Efficiency gains are made possible by digitisation. Operators can make better and more consistent strategic production control decisions when they have access to a real-time data reservoir and precise control positioning. For the administration of manufacturing activities in the future, both onshore and offshore, digitalisation is becoming more and more crucial. Large volumes of data, including information on reservoir behaviour, production procedures, well integrity and safety, and the health and operation of the equipment, may be gathered in real time using electric production systems. With this digital strategy, a project's overall efficiency and safety are increased, and its carbon impact is decreased.

Electric infrastructure construction is far more affordable and simpler to maintain. In comparison to hydraulics, an electric wire may be extended further, and a single line can be used to control various systems and provide sensor input. This enables creating and maintaining infrastructure with numerous branches and expansions easier. Additionally, the leakage danger associated with hydraulic lines is fully eliminated by an electric connection. Battery technology advancements have also made it possible to use batteries in harsh environments.

Electric motors allow for precise and quick control when used for valve actuation and control. Electric drive inputs and commands are received in real-time and are immediately carried out, allowing operators to quickly adjust and immediately optimise their operation. Electric motors can be controlled using a variety of factors, including torque (by measuring the motor's current), speed and position (using motor halls or resolvers), and possibly other parameters depending on the sensors used. Full motor control is made possible as well as the opportunity to gather data that may be utilised to forecast the state of the motor health condition.

Technical challenges and solutions

Extreme environmental conditions have been a significant barrier to using electric drives more frequently in downhole operations. Components of conventional electric motors cannot survive downhole temperatures, which frequently exceed +200°C, high pressures, and potentially significant shocks and vibrations. Motors must run consistently, increase the lifetime of a downhole tool, and require less maintenance in order to meet specified cost efficiency targets and prevent expensive downtime. In order to achieve the industry's goals of increased productivity and efficiency, it is essential to maximise the output of already-existing wells while simultaneously drilling into harder, unconventional wells and pushing electric motor technology even further.

As conventional motors are not suitable for these industry demands, custom solutions tailored to downhole specifications needed to be developed. To do this, successful motor manufacturers must have the expertise and resources to perform all the development steps, plus ensure reliable production and testing processes. Designing such drive system requires specialized knowledge in material behavior at extreme temperatures as well as extensive testing to make sure all components can survive the HPHT (high pressure, high temperature) environment found in downhole operations.

Conventional permanent magnet DC motors typically use neodymium magnets which start to demagnetize once temperatures of +150°C are exceeded. Similarly, conventional winding insulations are not able to withstand the extreme conditions. It is important to keep in mind that temperature ratings include ambient, and the added temperature caused by the load. That means a certain safety margin needs to be considered as the motor must be able to operate under load without overheating. Other motor parts must be made of high-grade stainless steel and the use of adhesives or plastics should be avoided.

The process of development includes more steps than just selecting the appropriate components. In order to validate that the correct design has been implemented and that the motor can deliver the requisite life-time in these harsh conditions, it is also necessary to specify and carry out acceptable environmental tests. To achieve reliable manufacturing, production processes must be developed and include appropriate test-ing both during production and during final inspection.

The maxon solution

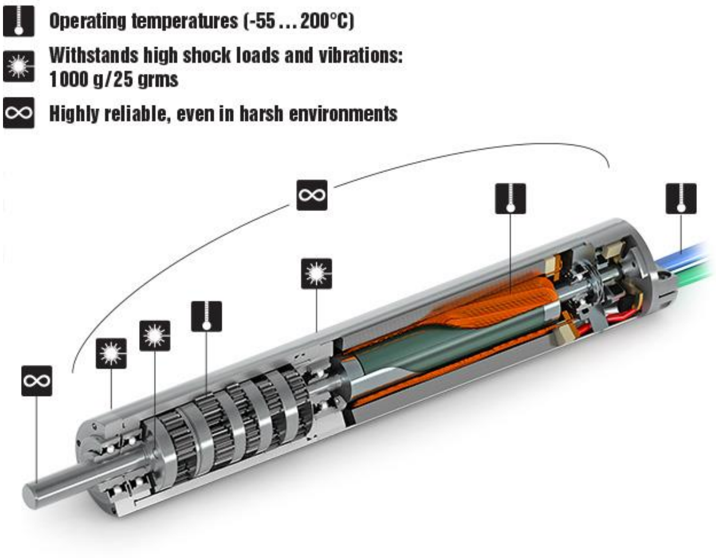
maxon's heavy-duty platform portfolio provides the robust design that is critical for extreme operating conditions. For example, their EC 22 HD brushless DC motor with GP 22 HD planetary gearhead provides:

- An Ultra compact (Ø22 mm), highly efficient (>75 %) and powerful (240 W) drive solution
- A fully welded stainless-steel assembly along with encapsulated samarium-cobalt magnet
- A high temperature ironless core winding, proven to withstand temperatures up to 240° C
- A gearhead designed for high torque (12 Nm overload torque capability)

Along with these technical capabilities, these motors incorporate new materials and process technologies. An ironless core winding and high-performance rotor is the "heart" of maxon heavy duty motors. Together with the powerful gearhead, maxon provides high torque drive solutions. Most parts of heavy-duty drives are made of stainless steel. The assembly minimizes the use of adhesives, concentrating instead on the connection of individual components through mechanical fits and secured with laser welding. This results in a reliable and mechanically robust drive system.

Some key advantages of maxon HD motors include:

- Wide temperature range (-50 to 200°C) components tested up to 240°C
- Robust design laser welded connections
- High performance to volume ratio, compact, high-power density
- Low energy consumption, high efficiency
- Excellent control properties, linear motor characteristics
- Operation in air or in hydraulic oil
- Low magnetic interference
- High quality/reliability production process controls



maxon

Qualification and production testing

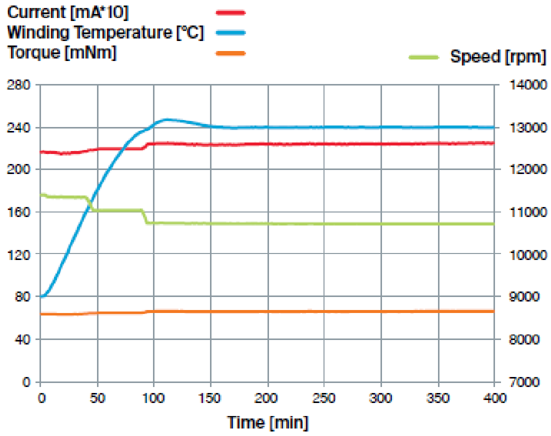
To ensure that motors can withstand harsh downhole conditions, it is important to define and conduct proper tests during the design qualification phase as well as during serial production. Manufacturers must have enough resources and expertise to develop and conduct these tests and implement all the necessary steps on the production line to ensure that each unit produced meets the requirements. There are three specific tests that are required to assure the long life and proper operation of these motors.

To ensure that motors can withstand harsh downhole conditions, it is important to define and conduct proper tests during the design qualification phase as well as during serial production. Manufacturers must have enough resources and expertise to develop and conduct these tests and implement all the necessary steps on the production line to ensure that each unit produced meets the requirements. There are three specific tests that are required to assure the long life and proper operation of these motors.

Internal full load test

Motors are tested in air or in hydraulic oil at extreme temperatures and under full load during continuous operation. During this load test the winding heats up to its maximum rated temperature. Continuous monitoring provides information on the drive's performance characteristics.

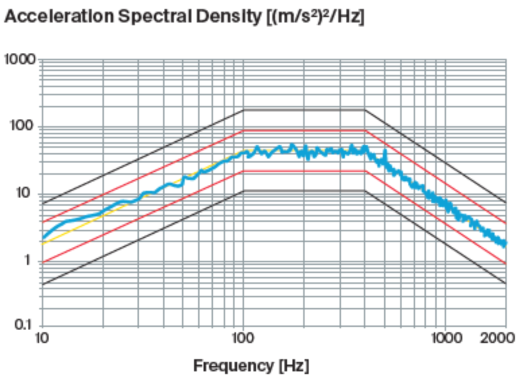
Load test EC 22 HD
(60-70 mNm at 180°C in oil)



Vibration and thermal stress test

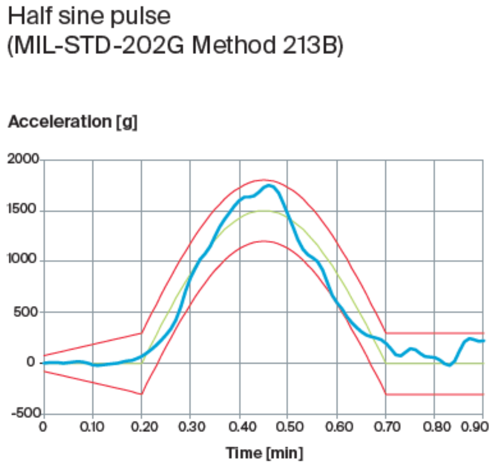
Drives are placed in a climate-controlled enclosure and subjected to high vibration. Testing is carried out with the motors in operation at high temperature. The motors are required to continue functioning within their performance specification while vibrations are applied in all directions.

Random vibration 17.4 grms



Shock test

The laboratory system performs a variety of shock loads of more than 1,000 G. After the shock test, the drives must be fully functional.



Standard test procedures are also performed prior to delivery to the customer. All of maxon's HD drives—the motor plus accessories—must pass these procedures, which include:

- Environmental Stress Screening (ESS)
  - o high temperature test
  - o load test
- General Electrical Test
  - o insulation test
  - o maxon standard test
- Visual and Dimensional Check
  - o visual inspection
  - o dimension checks

Application examples

A typical use for electric motors in downhole operations is in **Measurement While Drilling (MWD)** systems, which use electric actuators in their mud pulser units. This equipment is responsible for using the complex technology that provides a second-by-second feed on the progress of the bore. Because the data transferred to the drilling technicians is critical to the operation—allowing them to respond quickly to make drilling corrections—the motor used in the actuator must provide power efficiency, reliability, and robustness.

Battery technology developments have increased the use of electric motors in downhole operations where they can also be used as **generators** to power the batteries. For this to happen, the motors must be very efficient. Brushless HD motors from maxon are not only suitable for the extreme environments attributed to downhole operations they can be used as DC or AC voltage generators using the drilling fluids pumped downhole. A voltage rectifier is required for DC voltage production, while AC voltage can be acquired using two of the three motor phases. The basic calculations are very simple due to the linear behavior of motors with slotless windings.

Another emerging use for electric actuators is in **intelligent flow control valves**. Instead of switching between fully open or closed positions, electric motors allow for highly precise control of flow valves to achieve optimal flow rate at any time. Software development has provided easy monitoring and control via user friendly interfaces at the surface. For example, it has been shown that smart gas lift systems have the potential to reduce lifting costs significantly, plus increase the well production capabilities with less intervention.

Well inspection is another segment with large potential for using electric actuators to achieve more efficient operation. Whether actuating a wheel assembly to drive a conveyor or controlling fingers of a multi-finger imaging tool to inspect the casing, electric drives are a great choice for increasing operational speed and precision. High precision positioning linear movements can be made by incorporating linear actuators with ball screws integrated into the gearhead and a heavy-duty resolver at the back of the motor. Overall, electric motors can solve challenges in various downhole tools, from drilling operations to completion and well inspection.

Conclusion

The oil and gas sector will undergo a great deal of change and innovation in the coming years and decades in order to satisfy strategic targets like providing affordable, carbon-free energy. These advances and modifications may be fueled by the development of all-electric systems. It is anticipated that an oil and gas extraction project will electrify all of its components, including the downhole portion. Many applications are actually migrating from more conventional technologies like hydraulics to electric actuation right now. With the industry facing difficult targets it is thrilling to see where the road leads and what kinds of innovations emerge in the future.

For information:

maxon motor Australia tel. +61 2 9457 7477.

Length of this update: 1890 words

The press release is available on the internet at: www.maxongroup.net.au

maxon motor Australia Pty Ltd
Unit 1, 12-14 Beaumont Road
Mt Kuring-Gai NSW 2080

Tel: +61 2 9457 7477
sales.au@maxongroup.com
www.maxongroup.net.au
Twitter @maxongroupAus

maxon