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DEAL WITH IT

A RADIAL SEALING SYSTEM TO COPE WITH HIGH OVERPRESSURE AND STRONG FRICTION IN SINGLE-DIRECTION HYDRAULIC MOTORS PROVIDES AN EFFECTIVE BARRIER AGAINST LEAKAGE. TALK ABOUT ENGINEERING UNDER PRESSURE...

In recent years Marzocchi Pompe has revitalised its product range with two new lines. The first, ALP and ALM, includes, respectively, pumps and motors with aluminium flanges and covers, and is the natural evolution of the previous range. The second, GHP and GHM, is a new line of products with cast-iron flanges and covers, dedicated to high-pressure applications and the mobile market.

With 40 years' experience in this sector, the project design department has completely revised the design of the products and their production process, revolutionising the industrialisation of all the components. R&D has applied the latest FEM and CFD simulation techniques that, together with new tools for the experimental mechanics, have produced specific product optimisation aimed at maximum efficiency, reliability and reduced noise levels. To this end the company's R&D department has co-operated with the DIEM department of Mechanical Engineering of Bologna University for the last 20 years.

Very strong efforts have been made in the area of research into internal mechanical and hydraulic conditions; for this purpose the R&D department has been equipped with new experimental test benches for mechanical, hydraulic, acoustic and vibration performance analysis, and durability test benches able to simulate the toughest working conditions. This has led to the optimisation of the compensation geometry (used to balance the dynamic thrust caused by pressure in gear vanes), gear profiles and the undercut drain on the bushings in order to increase product reliability and reduce noise levels.

The current Marzocchi production range varies between 0.19 and 200.3cm^3/rev and it is divided into eight groups according to gear size: 0.25, 0.5, 1P, 1, 2, 3, 3.5, and 4. Within each group, the different displacements are obtained by changing the width of the gears.

Ace FMC-750F-HYD high-performance hydraulic motor-driven centrifugal pump

A wide range of flange, shaft and coupling configurations is available; these components can also be manufactured according to customer specifications. The cast-iron versions exist in groups 1, 2 and 3. Maximum operating pressure depends on pump displacement and type: it varies on an average between 230 bar (3,300psi) on aluminium models and 280 bar (4,100psi) for cast-iron versions. All products can also be supplied with Viton seals, and special versions are available for temperatures between -40°C and +120°C.

Mono-directional and bi-directional motors are divided into three families (1, 2, 3) covering a range of displacements between 2.8 and 87cm^3/rev. The maximum working pressures for the motors are similar to those established for the pumps; they can deliver torque up to 250Nm and power up to 60kW.

A special radial sealing system

Driven by customer demand, Marzocchi Pompe has produced a system of radial sealing at the shaft that can bear enormous internal overpressures without resulting in damage. This radial sealing is particularly useful in single-direction hydraulic motors when, in certain conditions of use, high overpressures will be generated at the motor output. With bi-directional motors, the area adjacent to the seal ring of the driveshaft is maintained at atmospheric pressure by the drainage circuit. In single-direction motors, this area is directly connected to the output so any overpressure impacts directly on the seal ring, causing the lip to turn over or the ring to be expelled from its seat with a consequent leakage of fluid.

These products can also be supplied complete with anticavitation valves (valves for maximum pressure with internal or external drainage).

The motors can be supplied with an internal drainage circuit. In this case the hydraulic motor always drains inside with a lower pressure; the combination of this product with a high-performance sealing ring substantially increases its reliability.

Marzocchi Pompe's solution is made up of a single-lip radial seal ring in a P450 composite material and reinforcement ring, both of which are

Air sprayer using Ace FMC-750F-HYD centrifugal pump

the result of a special design and construction process. The external reinforcement ring fully follows the form of the seal ring, and has been sized to bear the axial force generated by internal overpressures. Before performing laboratory tests, it was necessary to strengthen the entire system that fastens the ring onto the flange, so that it could bear all the stresses submitted to the ring.

The best characteristics with respect to the components were determined with FEA software. The new radial seal ring has a much stiffer structure than normal rings, making it necessary to employ special assembly procedures.

During the first few seconds of operation, the P450 material adapts evenly to the texture of the machining on the shaft to guarantee a perfect seal. Because of the internal pressure, the lip of the seal ring is constantly compressed against the shaft. The increase in pressure is accompanied by an increase in friction, with heat being generated in the sliding zone as a result.

The properties of the P450 material make it possible to bear high-pressure loads, strong friction and temperatures between -30 and +200ºC. To guarantee a long operating life, it was necessary to perform in-depth research on the methods for grinding the area where the sliding of the seal ring's lip takes place.

Defining the limits

Validation tests have revealed that the system is able to work on a continuous basis at a constant pressure of 30 bar (430psi) without the spilling of fluid and without the ring and the shaft exhibiting wear. Tests performed at higher pressures also demonstrated the possibility of the system functioning for short periods of time (several minutes) with overpressures of up to 140 bar (2,030psi).

If the operating conditions must be maintained with extremely high overpressure values (80-100 bar/1,160-1,450psi) for prolonged periods of time (over 30 minutes), the heat generated by the friction between the ring and the shaft can result in temperatures of over 300°C. This inevitably plays a part in deteriorating the structure of the P450 material used in the seal ring, as well as compromising the ground profile on the shaft, and thereby reduces its sealing function.

In the presence of pressure peaks, for example caused by errors of manoeuvre or an incorrect timing of the valves of the hydraulic circuit, or in static conditions, with the shaft immobile, this sealing system can bear overpressures of over 210 bar (3,050psi) without leading to any loss of fluid or deformation of the components.

The robust and reliable characteristics of this product make it particularly suitable for applications that function as appendages of other machines without knowledge of the exact circuit characteristics.

Ace applications

Marzocchi Pompe is a long-time partner of US-based Ace Pump Corporation, a specialist in centrifugal pumps for mobile equipment. Ace continues to develop a comprehensive range of reference materials and hydraulic accessories that enable the pumps to be effectively applied on the full range of hydraulic systems.

Centrifugal pump design provides good resistance to abrasive solutions and extra flow for agitation. All hydraulically driven pumps are equipped with a stainless-steel shaft and wear ring for excellent corrosion resistance. The advantages of the hydraulic motor-driven pump are:

- **Mounting versatility:** The location of the pump is not tied to the PTO or engine driveshaft; the pump can be mounted in a variety of locations to suit application requirements.
- **Customised performance:** The performance is dependent on the supply of hydraulic oil to the motor and not necessarily tied to engine speed. A hydraulically driven pump can produce higher pressures than PTO or belt-driven pumps can manage. They can also hold constant pressure at a variety of engine speeds on closed-centre hydraulic systems.
- **Easy maintenance:** On a hydraulically driven pump there are no belts to align or break. Separate pump and hydraulic motor shafts simplify repair and replacement. Two main pump bearings support shaft loads.

The Ace gear-type hydraulic motor is more efficient than gerotor-type motors, and is less subject to damage by contamination than the gerotor design. A built-in needle valve enables the bypass of up to 34 l/min excess hydraulic fluid on open-centre systems.

Hydraulic motor, with rear ports, anticavitation valve and high-pressure seal

Ace pumps offer the convenience of a close-coupled design and efficient operation. A variety of options – including pump materials, seal options, motor sizes, mounting configurations, etc – is available to customise the pumps for virtually any application. All Ace hydraulic motors include a high-pressure shaft seal, reverse check valve, integrated anticavitation check, and needle valve bypass for open-centre systems.

The largest market for Ace pumps is the application of agricultural chemicals. Trailed sprayers can present the greatest challenge for the hydraulic motor, which must have integrated features to enable it to be used on any of the three hydraulic systems: open centre, pressure compensated and load sensing. The motor shaft seal must be capable of withstanding continuous hydraulic back pressures up to 17.2 bar (250psi), which result from restrictive plumbing in the tractor's hydraulic circuit. The shaft seal must also withstand pressure spikes up to 138 bar (2,000psi), which result from improper valve synchronisation.

Marzocchi is partnering with Ace to supply a high-pressure seal for this application. Marzocchi's seal solution is comprised of a spring-loaded Teflon lip seal paired with a sustaining ring for lip support. The sustaining ring also has a large cross-section to withstand pressure spikes without deformation. The Marzocchi motor with this high-pressure seal technology is standard on Ace's new Max Series product line for maximum reliability.

Compact in size, the Max Series gear pumps and motors have a simple construction and are reliable, offering an excellent ratio between cost and performance. Many applications suit the use of the single-direction motor, which is of a construction similar to the pump, but has very low starting torque, high transmitted torque, a wide range of operating speeds, very high efficiency and can be installed without the use of the drainage pipe.

The use of P450 in the radial seal of single-direction motors enables these parts to be safely used in heavy-duty applications, effectively protecting the sealing system on the shaft and preventing any fluid leakage. Marzocchi Pompe's many years of experience with these types of products, along with its continuous development, design and testing, research into specific materials and sophisticated production techniques, ensure the production of high-quality components. **iVT**

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