

PARALLEL LINES

It takes a lot of skill, care and forward thinking to connect two or more pumps in parallel. But new connection systems for multiple modular pumps make the whole process simple

Drawing on over 40 years of product development experience, Marzocchi Pompe has recently unveiled several new product lines that look set to take some of the hardship out of connecting hydraulic pumps.

The company was established in 1961 by Guglielmo and Stefano Marzocchi, in Casalecchio di Reno, on the outskirts of Bologna. Today it is the head of an industrial group that employs more than 400 people. This group, owned and led by Adriano and Paolo Marzocchi, operates in the fields of hydraulic pumps and motors and suspension systems for motorbikes and mountain bikes.

Over the years, Marzocchi Pompe has expanded its product range to reach its present position as one of the most important Italian manufacturers of external gear pumps and motors. Due to the trust and respect built up over a long period of time, the company is respected as a very reliable partner, able to provide its customers with specific know-how, high-quality products and excellent service for all hydraulic applications.

Two new lines

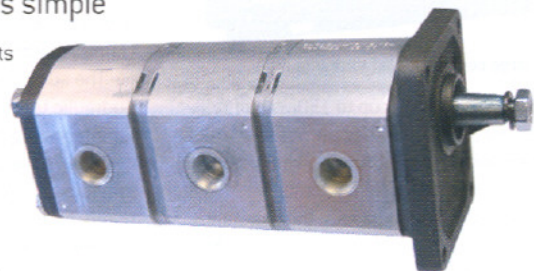
The company's latest range update features the creation of two new lines. The first, called ALP and ALM, includes pumps (ALP) and motors (ALM) with aluminium flanges and covers, and is the natural evolution of the previous production range. The second, called GHP and

GHM, is a new line of products with cast-iron flanges and covers, dedicated to high-pressure applications and to the mobile market.

Marzocchi's project design department put its four decades of experience in this sector to good use to completely revise the design of the products and their production process, revolutionising the industrialisation of all the components. R&D applied the latest FEM simulation techniques that, together with the new tools for the experimental mechanics, have produced specific product optimisation aimed at satisfying current market demands for superb efficiency, reliability and reduced noise levels.

The products range between 0.19 and 200.3cm³/rev (0.0104-12.223in³/rev) and are divided into eight groups according to gear size (0.25, 0.5, 1P, 1, 2, 3, 3.5, 4). Within each group, the different displacements are obtained by changing the width of the gears. 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 average between 230 bar (3,300psi) on aluminium models and 280



One of a new series of GHPC pumps from Marzocchi Pompe

bar (4,100psi) for cast-iron versions. All products can also be supplied with Viton seals; special versions are available for temperatures between -40 to +120°C (-40 to +248°F).

The mono-directional and bi-directional motors are divided into three families (1, 2, 3) covering a range of displacements between 2.8 and 87cm³/rev (0.17-53.1in³/rev). The maximum working pressures for the motors are similar to those established for the pumps, and they can deliver torque up to 250Nm and power up to 60kW. The characteristics of the GHP range make it particularly suitable for most hard, mobile applications.

Multiple choice

Marzocchi Pompe has also introduced a new family of multiple short pumps – two new series of compact pumps with reduced length. These new pumps are divided in two groups: the ALPC group with aluminium flanges and covers, and the GHPC group with cast-iron flanges and covers. These pumps are ideal for any application that requires many pumps to be driven by just one motor, where space constraints do not allow the use of standard multiple modular pumps.

These particular multiple pumps, featuring a short overall length, can be supplied with two or three elements and with different configurations of flanges, shafts, and inlet and outlet ports. The common inlet version is also available with only one port feeding two or three elements. All the connections are made with an internal splined joint, which guarantees excellent torsional strength along with outstanding compactness.



New splined joints of groups 1 and 2



The new splined couplings are hardened for greater robustness

Careful design and the definition of optimal clearance between the elements enables any small misalignments between the shafts of different pumps to be compensated, ensuring the transmission of high torque and power.

State-of-the-art FE modelling software and numerical simulations were used in the design of these short pumps, reducing the time and costs typically associated with prototyping.

Optimum solution

The optimum solution has been found to maximise the ratio between the maximum transmittable torque and the overall dimensions of the connection. The final design results in the whole connection working better, with the high number of teeth allowing much better spreading of the load and giving a very uniform stress distribution on any part of the connection. The high number of teeth also helps to reduce wear caused by misalignments which result in a continuous sliding of the connection relative to the shaft.

The splined shaft ends and the inner splined profiles of the connection are obtained by machining to obtain the necessary clearance between the elements. All elements are hardened to increase robustness.

These pumps are available in family 1 and family 2. The maximum torque of the couplings is close to the values of standard modular multiple pump couplings; maximum torque is 45Nm for group 1 and 100Nm for group 2.

In order to reduce the length of the multiple pumps, there is only one interflange between two stages, whereas standard multiple pumps use two interflanges; consequently, the short multiple pumps are not separable. In all versions the interflanges are aluminium.

The use of an internal splined joint enables a further reduction in length to be achieved. This kind of connection needs low axial clearance.

As a comparison, the group 1 multiple modular gear pump with three equal elements with 6.2cm³/rev displacement has a total length of 306.5mm; the corresponding short multiple pump has an overall length of 183mm (67% shorter); the group 2 multiple modular gear pump with three equal elements with 21.1cm³/rev displacement has a total length of 377.5mm; and the corresponding short

multiple pump has an overall length of 252mm (49% shorter).

This innovation increases the opportunity to use multiple modular pumps, and offers a safe and reliable solution wherever high torques are required in heavy applications.

The following equation can be used to calculate the torque (Mt) required for the correct functioning of a pump subjected to a difference of pressure between inlet and outlet:

$$M_t = [V \cdot \Delta P] / [62.8 \cdot \eta_{hm}] \text{ [Nm]}$$

where:

V = displacement [cm³/rev]

ΔP = pressure differential [bar]

η_{hm} = hydromechanical efficiency (indicative value = 0.85)

For multiple pumps, the driving shaft as well as the shaft of the front pump has to deliver the sum of the torques required by all the pumps (M3 in the figure at the bottom of this page); while the connection between the front and intermediate pumps is the most critical because it needs to withstand the torque required by the intermediate and rear pumps (M2 in the same figure).

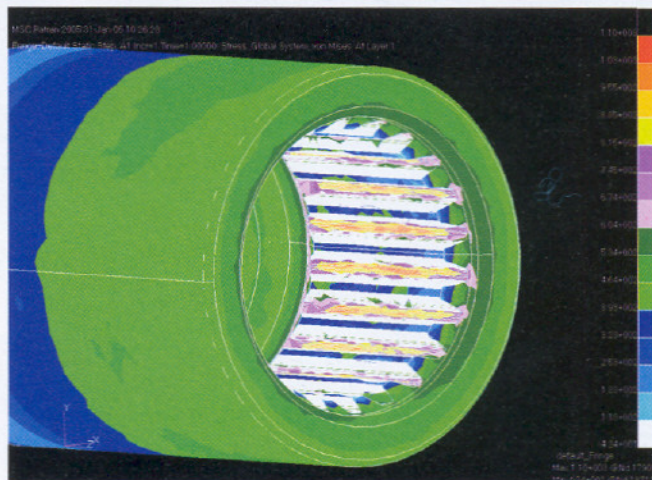
Choosing a pump

When choosing a multiple modular pump, care must be taken to check the operating conditions of the pumps to be sure that all the shafts and connections can safely bear the torque. The use of short modular pumps reduces the size of the hydraulic unit and allows the pumps to be installed in very small spaces.

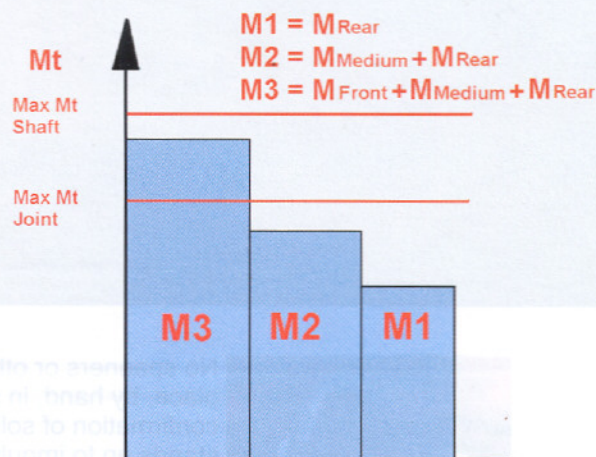
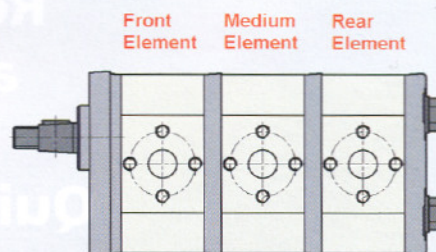
Of course, the Marzocchi technical office is always available to help customers choose the correct dimensions for their multiple modular pumps.

The company's short multiple modular pumps are available in two different groups with either cast-iron (GHP) or aluminium (ALP) intermediate flanges. The direction of rotation must be the same for the front and rear elements. Several configurations are available for flanges, shafts and connections, while customised solutions can also be produced to meet the client's requirements. The separate inlet option is not available on the short modular gear pump.

Maximum operating pressures depend on the displacement and type of pump – they are usually 230 bar (3,300psi) for aluminium versions and 280 bar (4,100psi) for cast-iron versions.



FEA analysis of inner splined shaft



Distribution of torque in a multiple pump

For information about combination of size, possible configurations and relative working conditions, please contact the technical and sales department of Marzocchi Pompe. **IVT**

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