

# CONCRETE JUNGLE

A renewed product line of pumps and motors has enabled one manufacturer to help a concrete pump manufacturer tackle the hazards of a typical working environment

In the last three years, Marzocchi Pompe has renewed its product range via the creation of two new lines. The first, called ALP and ALM, which includes pumps and motors with aluminium flanges and covers, is the natural evolution of the previous range; the second, called GHP and GHM, is a new line of products with cast iron flanges and covers dedicated to high-pressure and mobile applications.

This change has involved the whole production cycle: the project department, for instance, has completely revised product design and the production process, which has revolutionised the industrialisation of all components.

R&D – in co-operation with the DIEM department of Bologna University – has applied the latest FEM and CFD simulation techniques that, together with new tools for experimental mechanics, have produced specific product optimisation aimed at satisfying market demands for top efficiency, reliability and reduced noise.

Much research has focused on the internal mechanical and hydraulic conditions of the pumps and motors and so, for this purpose, the company's R&D department has been equipped with new experimental test benches for mechanical, hydraulic, acoustic and vibration performance analysis, and durability test benches that are able to simulate the toughest working conditions.

This new test equipment 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 to increase product reliability and reduce noise levels. These innovations were transferred to the production department by a wide-scale renewal of the run-in and test benches.

## A family feeling

The current Marzocchi production range varies between 0.19-200.3cc/rev (0.0104-12.223in<sup>3</sup>/rev) and 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 gear width. A wide range of flange, shaft and coupling configurations are available, and these components can 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 bar (4,100psi) for cast iron versions. All products can also be supplied with Viton seals, while special versions are available for temperatures between -40° to +120°C.

Monodirectional and bi-directional motors are divided into three families (1, 2, 3) covering a range of displacements



Marzocchi ALM2 gear motor

between 2.8-87cc/rev (0.17-53.1in<sup>3</sup>/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 following example was developed in collaboration with CIFA, a world leader in concrete technology, and concerns the fan-drive hydraulic systems used to cool the oil tanks of its product range of truck mixers, truck-mounted concrete pumps and portable concrete pumps.

The oil tank of a truck-mounted concrete pump is relatively small in regard to the required circuit flow rate, so during the operation it is necessary to effectively cool the hydraulic oil. The fan is driven by an aluminium unidirectional motor (ALM2-S-20 14.1cm<sup>3</sup>/rev), and being mounted on the fringes of the compartment, must be able to cope with a very harsh work environment as concrete powder is a very dangerous pollutant for the hydraulic circuit and its components.

The working temperature conditions of 50-60°C are maintained by the continuous variation of oil flow through the heat exchanger.

Being suited for work in extreme conditions, the ALM hydraulic motor was subjected to an internal Marzocchi approval procedure (to which all new/special products are subject) and to a test performed directly by the customer for project validation.

## Endurance testing

Internal approval includes various endurance tests in which the components are checked on the R&D test benches, including being subjected to on/off pressure cycles at the maximum allowed pressure. Periodically, an inspection is made to check the components' condition. Where necessary, tests have been

The high circuit flow rate required of truck-mounted concrete pumps places high demands on oil cooling



RIGHT: The hydraulic systems of truck-mounted concrete pumps demand special solutions

FAR RIGHT: CIFA fan-drive application on concrete pumps

BELOW: CIFA K52 L XRZ truck-mounted concrete pumps



performed under similar operating conditions to the final application, for example, the same pressure cycles, temperature, and oil type, etc.

Once the endurance test has been completed, a comparison is made between the initial and final product performances and a deep analysis of each component is conducted to identify any possible failure. Zero failure and no performance degradation higher than the internal specifications must occur for the project to be validated.

Before leaving the Marzocchi factory, all products are subject to specific run-in and testing procedures. Run-in is the last stage of the manufacturing process and is one of the most important operations because it permits the optimisation and checking of the product efficiencies. During run-in tests, increasingly higher pressure levels are created, and the gears, inflected by the hydraulic load, act as tools machining the pump body, thereby creating the best tolerances among the parts. This process is performed under computer control as the definition of the gradual pressure increase is particularly important because it establishes the machining speed

of the material by the gears and therefore the particle dimension. These particles must be small enough not to interfere with the running of the product under testing and its future performance. Each motor of each group has an individual pressure ramp so that no contaminating material remains in the circuit and the pump immediately attains maximum performance levels.

Reversible motors and pumps are subject to the run-in procedure on both rotations. After this process, product efficiencies are measured at fixed parameters. Testing data is automatically acquired and recorded to produce updated statistics on product performance, which can be supplied on customer request.

**Reproduced conditions**

After a motor has been run-in, another test follows where the relative operating conditions must be reproduced:

- Under braking, when the energy of the fluid is transferred to the shaft to overcome the resisting torque;
- Under back pressure, when the fluid passes through the motor with the shaft free to turn without load.

Under braking, the stress distribution is similar to that existing in the pumps: if there is maximum pressure at the inlet and discharge pressure at the outlet, compensation seals and rotating parts are subjected to the maximum stress according to resisting torque.

Under counterpressure, inlet and outlet are under the same conditions: at maximum pressure the stress on the rotating parts is zero, while the flanges, body and external seals are subjected to the maximum stress. Typical motor working conditions are between these two situations, where part of the energy is transferred to the shaft and part is used,

for example, by another motor connected in series.

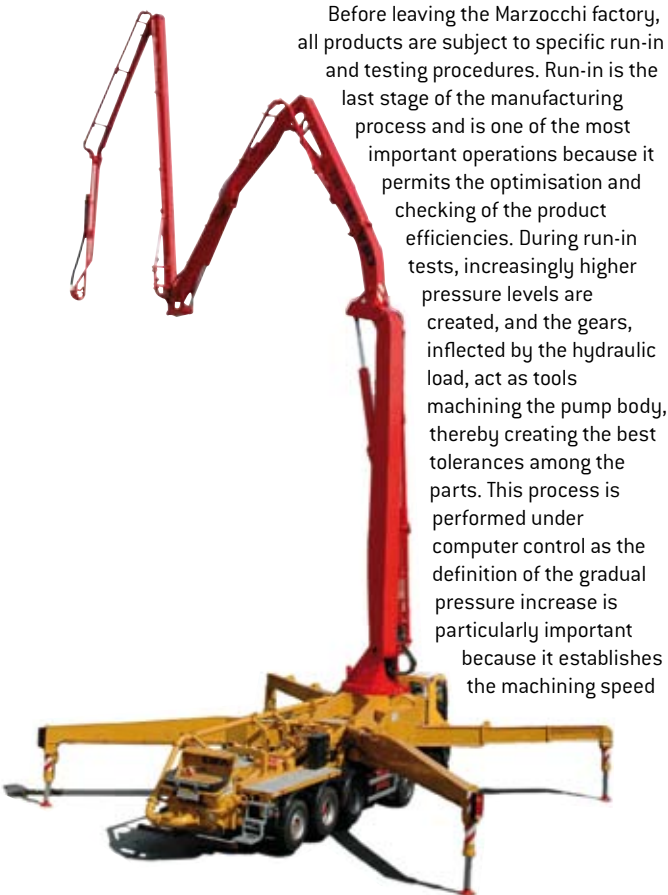
Therefore, on the Marzocchi motors test bench, the final control is divided into three phases. In braking phase, a resisting torque is applied to the motor shaft at an established rotation speed. The application of this torque creates a variation in the fluid's inlet speed and pressure, while the test-bench control system stabilises the motor in fixed conditions in which running parameters are acquired, such as volumetric and mechanical performances and draining flow rate.

In back pressure phase, a fixed amount of oil goes through the motor without any resisting torque applied to the shaft. The outlet line is kept closed and bi-lateral pressure is therefore established. The drain flow rate is measured at these conditions.

In start-up phase, without any resisting torque applied to the shaft, the initial torque is determined by measuring the minimum inlet pressure at which the motor starts running.

With bi-directional motors, the three phases are performed for both rotations. The motor is then delivered to the customer perfectly run-in and controlled, and its reliability makes it suitable for use even under extreme conditions.

Gear pumps and motors are volumetric machines widely used in hydraulic system design. They have simple construction, compact size, are reliable and offer a top cost/performance quality ratio. Forty years of Marzocchi experience supports the choice of these products. **IVT** Danilo Persici leads FEA and CFD analysis in Marzocchi's R&D department in co-operation with Bologna University



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