

It's always the quiet ones

A NEW SERIES OF GEAR PUMPS THAT CUTS NOISE LEVELS BY AN AVERAGE OF 15dB(A) OVER CONVENTIONAL MODELS COULD SOON BECOME THE AUTOMATIC FIRST CHOICE OF INDUSTRIAL VEHICLE DESIGNERS

▶ One of the main frontiers of development of industrial products is the reduction of noise and vibrations. These requirements have increased considerably of late due to the strict environmental regulations introduced in industrialised countries. Noise emanating from industrial vehicles was once seen as a much less pressing concern than limiting harmful emissions, but the EU already has extensive legislation in place designed to reduce NVH (noise, vibration, harshness) and provide a much more comfortable environment for vehicle operators, not to mention anyone within hearing distance. There are two relevant NVH directives in the EU: 2000/14/EC, which came into force in 2001 and focuses on noise emissions; and 2002/44/EC, which came into force in 2005, setting standards for vibration.

Demand for quieter products is particularly high in Europe and North America. It is now clear that operating with noisy machines has become a burden, so attention to this parameter has increased.

Cut it out

Noise and vibration issues inevitably involve the interaction between the components of a hydraulic circuit, or between components and parts of the structure. There are two approaches to noise reduction: one is to take measures to attenuate NVH propagation by applying isolators and dampers to major noise and vibration sources. Often these palliative modifications – in addition to adding cost, weight and bulk to the final product – merely partially solve the problem because they are only effective under certain conditions and only for certain frequencies.

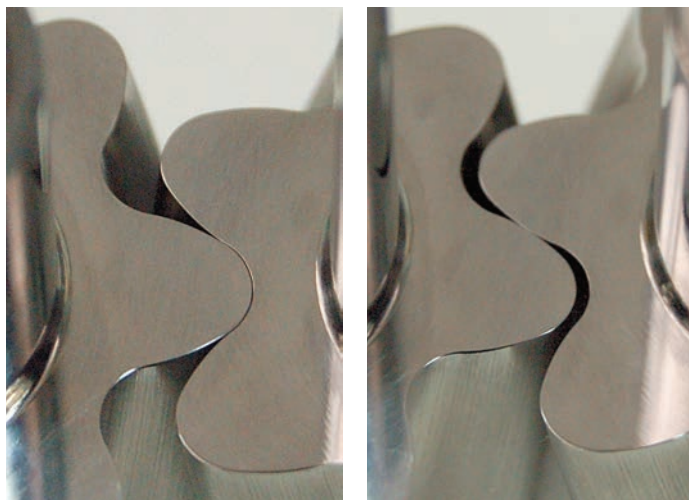
The second, more efficient, approach is to tackle the problem at the source, designing the machine to be as quiet as possible using low-noise technologies. The use of an alternative technology to lower the level of noise is normally the cheapest method and gives the greatest acoustic results. This forward-looking approach may also offer economies compared with the cost of fixing a problem after the event.

Marzocchi Pompe's R&D department is equipped with experimental test benches to acquire mechanical, hydraulic, acoustic and vibration performances, and durability test benches capable of simulating the toughest working conditions. Gear pump noise has two distinct origins – mechanical and hydraulic. The



ABOVE: Assortment of Elika ELI2 pumps

RIGHT: Detail of Elika tooth profile



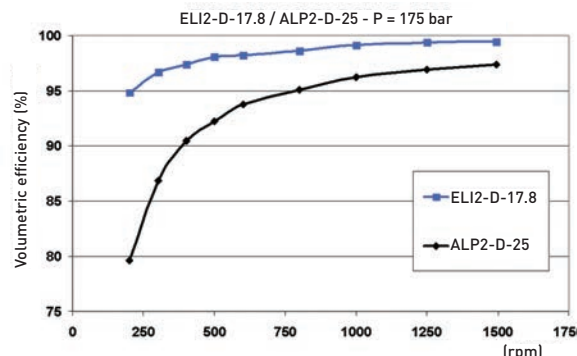
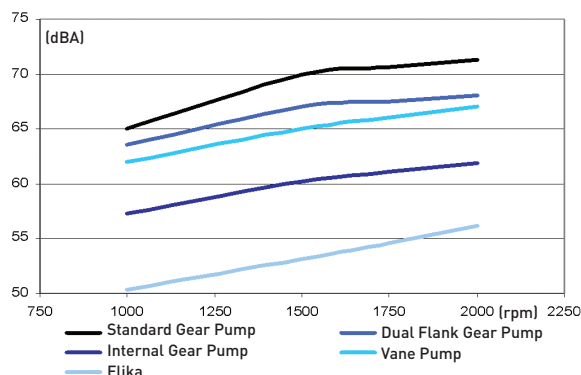
mechanical noise is what can be expected from any pair of gears, and depends mainly on the degree of precision and surface finish of the gear wheels. The hydraulic noise is mainly generated from fluid being trapped between the top and the bottom of the tooth. The pressure peaks that arise from entrapment of the fluid between the top and the bottom of the pump are a major problem for involute gear pumps. During the delivery phase, the hydraulic fluid, being compressible, reaches very high pressure spikes causing high noise, vibration, pressure ripple and mechanical stress. There are various methods that can

reduce the effect of entrapment in external gear pumps and, over time, Marzocchi Pompe examined and studied several prototypes to verify the characteristics of each solution, before reaching a real solution to the noise problem.

The accurate design of special discharges on bushings allows the phenomenon to be reduced slightly without completely eliminating the cause. To be able to completely eliminate the pressure peaks on the entrapped volume, the size of the discharge should be such as to adversely affect the volumetric efficiency. For this reason, the conformation of bushing

FAR LEFT: Noise comparison between standard external gear pump, dual-flank gear pump, internal gear pump, vane pump and Elika pump

LEFT: Comparison of volumetric efficiency at low rotation speed in Marzocchi's GHP 2 and Elika ELI2 pumps of 17.8 cc/rev displacement; pressure P = 200 bar



discharges are a compromise between noise and volumetric performances.

Sweet tooth

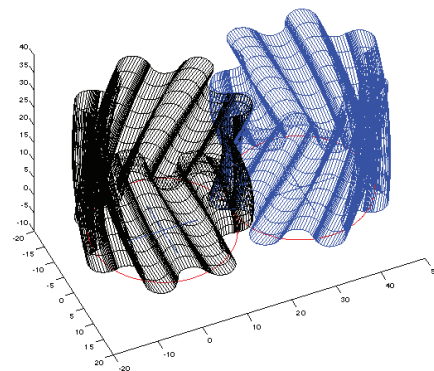
Elika is the new Marzocchi entry into the gear pump market – and an effective response for all applications that require low noise levels. ELI2 is the first series in the Elika family and includes pumps with displacements from 7-35cc/rev; perfectly interchangeable with the standard ALP2 and GHP2 gear pump series. The maximum operating pressures are similar to those of the GHP2 series and extend up to 300 bar.

At the heart of the product is the particular shape of the Elika profile, which eliminates the phenomenon of encapsulation typical of normal gear pumps, removing the main cause of noise and vibrations. The elimination of the encapsulated volume produces a major reduction in the pressure oscillation that transmits noise and vibration to the other components connected to the pump (hoses, tank, valves). During the meshing phase there is a moment at which each point of the tooth profile comes into contact with the other toothed wheel; there is always a separation line between high and low pressure area, whatever the helix angle.

The study of the particular Marzocchi tooth profile was conducted in collaboration with the Faculty of Engineering at Bologna University, with the aid of dedicated design software. Engaging a pair of toothed wheels without encapsulation requires an enormous productive effort, as errors in profile immediately produce noise, interference and poor reliability. The experiments led to the definition of a specific tooth profile, able to achieve the best performance and acoustic characteristics. The helical toothing ensures the continuity of motion despite the low number of teeth. The low number of teeth greatly reduces the fundamental frequencies of the pump noise and makes the sound particularly pleasant. In this way it was possible to minimise both the pressure oscillations and their frequency. Elika reduces the noise level by

an average of 15dB(A) over a conventional external gear pump. The low number of teeth also greatly reduces frequency, making the sound less annoying.

As a common external gear unit, Elika consists of a pair of gears supported in bearing bushings, and a case with a front and rear cover. The special bearing material ensures excellent resistance to galling, especially at low speed. Axial forces induced by the helical teeth are optimally balanced in all operating conditions by the axial compensation system integrated in the pump cover. Specific compensation areas in the flange and cover, insulated by special gaskets reinforced with anti-extrusion, enable fully free axial and radial movement of the bushings, which is proportional to the pump operating pressure. In this way, internal leakage is greatly reduced, ensuring excellent volumetric and mechanical performance as well as proper lubrication of moving parts. Internal leakage, generally laminating to the outlet from the inlet and overheating the pump components, is now practically eliminated, increasing reliability. This feature makes the Elika pump suitable for operation at low speed and high pressure.



ABOVE: The study of the particular Marzocchi tooth profile was conducted in collaboration with the Faculty of Engineering at Bologna University, through the generation of a dedicated design software

Low speed, high pressure

Today, in many hydraulic applications, precise electronic control enables lower-speed operation at higher pressure, which is a demanding mode of operation for gear pump products. Elika is particularly suitable for these applications as its features are an important priority for designers of plastic-injection machines, electric vehicles, lifting and materials handling equipment, electric AWP's, warehouse and refuse trucks, and other mobile equipment operating at night in residential areas. The Elika pump is also particularly suitable for industrial machine tool applications such as presses, milling machines, saws and lathes, and marine equipment.

Comparing Elika pumps with other volumetric pumps, it can be seen that they have a very wide range of use in terms of the rotation speed, working pressure and viscosity range. The very low noise level makes this product ideal for applications where screw pumps, vane pumps and internal gear pumps are generally used. A simple construction, small size and high performance make this product very competitive.

Elika pumps are available in both unidirectional clockwise and anticlockwise rotation; all commercial versions of standard group 2 gear pump flanges are available. The black anodising preprocessing of components sets it apart from other products on the market. The development of the Elika family is still in progress; in the second half of 2013, multiple versions of ELI2 pumps and the ELI3 group in a displacement range of 20-87cc/rev will be available. Based on the results obtained on the first ELI3 prototypes, it is anticipated that this family will have the same characteristics as the ELI2. The high displacement of ELI3 pumps widens the gap between the Elika family and normal external gear pumps. 2014 will see the availability of ELI4 pumps in a displacement range of 87-200cc/rev and in multiple versions. **ivT**

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