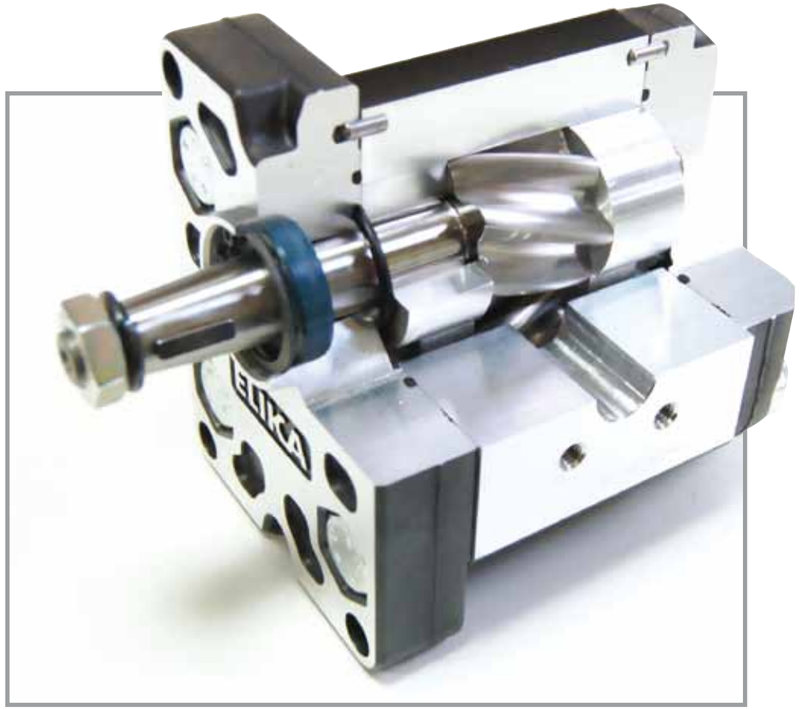
DANILO PERSICI

PRODUCTS & SERVICES

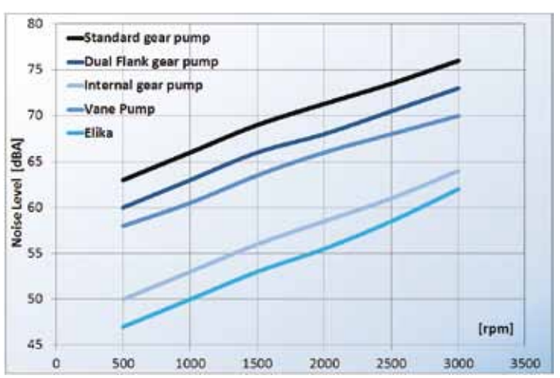
Listen to unreason

PROGRESS IS MADE BY THE UNREASONABLE MAN, IT SEEMS – MEANING THE ENGINEERS WHO CAME UP WITH THIS SERIES OF QUIET, PLEASANT-SOUNDING GEAR PUMPS MUST BE 'INTERESTING' TO DEAL WITH!



Noise pollution has become a major concern for OEMs of mobile and stationary machinery. Finding a solution to noise pollution is a real expense – often high – in relation to the measures that OEMs must take to reduce its impact. 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 and 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 and sets standards for vibration. Low noise emission from industrial vehicles has since become an essential requirement for companies, so managing the noise level is a major concern for most producers of mobile machinery.

George Bernard Shaw once said: "The reasonable man adapts himself to the world; the unreasonable man persists in trying to adapt the world to himself. Therefore all progress depends upon the unreasonable man." This ethos also applies to the two approaches to noise reduction: the first is to take measures to attenuate NVH propagation by applying isolators and dampers to major sources of noise and vibration. Often these palliative modifications, in addition to adding cost, weight and bulk to the final product, are only effective under certain conditions and only for certain frequencies.



ABOVE: **Cross-section of the ELI2 pump**

LEFT: **Average noise comparison between standard external gear pump, dual flank gear pump, internal gear pump, vane pump and Elika pump (displacement 21cc/rev)**

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

Sounds annoying

Gear pump noise has two distinct origins – mechanical and hydraulic. The mechanical noise is what can be expected from any pair of gears and depends mainly on the level of precision and the surface finish of the gearwheels. The hydraulic noise is primarily generated from fluid that becomes trapped between the top and 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 crucial problem for involute gear pumps. During the delivery phase the fluid, being compressible, reaches very high pressure spikes causing high noise, vibration, pressure ripple and mechanical stress.

However, the idea of reducing pump noise through elimination of the encapsulated volume, via a special shape of tooth profile, is not actually new. The first documented application is credited to Francis W. Davis, inventor of the first practical power steering application, who developed a gear pump without encapsulation to reduce the noise in a hydraulic power steering system. A pump using a special tooth profile design was successfully installed on the Pierce-Arrow in 1928 and moved to a Buick in 1932. In the original power steering system, the working pressures came to 70-100 bar and the maximum rotation speed was about 1,800rpm.

Despite the difficulty involved in manufacturing these special toothed wheels, in the following years, Davis continued to study low-noise hydraulic power steering and economic methods to produce non-encapsulated tooth profiles, collaborating with the major American automotive companies and filing numerous patents. Unfortunately, in 1934 the Great Depression forced the inventor to put his research on hold because of the high production costs. Later, at the advent of Second World War, his attention turned towards military applications where low noise and comfort were not a priority.

The story of this American inventor is described in the book *The Unreasonable American* by Houston Branch and Wendell Smith, published in 1968 by the US Academy of Applied Science.

ABOVE: **Assortment of ELI2 pumps**

Grinding your teeth is a good thing

Now, after more than 80 years, Marzocchi Pompe intends to bring this technology to mobile applications with the Elika series of gear pumps. The development of tooth-grinding technology has now made possible the economic production of high-precision toothed wheels. The design of the particular Marzocchi tooth profile was conducted in collaboration with the Faculty of Engineering of Bologna University, using specially developed design software.

However, engaging a pair of toothed wheels without encapsulation requires enormous productive effort, as any errors in profile would immediately produce a lot of noise, interference and poor reliability. Fortunately, modern gear grinding technology solves that problem. The experiments carried out led to the definition of a specific tooth profile capable of obtaining excellent acoustic performance even at high pressure. The helical toothing ensures the continuity of motion despite the low number of teeth, which in turn greatly reduces the fundamental frequencies of the pump noise, making the sound relatively pleasant. In this way it was possible to minimise both the pressure oscillations and their frequency.

The Elika, Marzocchi's new proposal for the gear pumps market, reduces the noise level by an average of 15dBA compared with a conventional external gear pump, and is a perfect fit for all applications that require low noise levels.

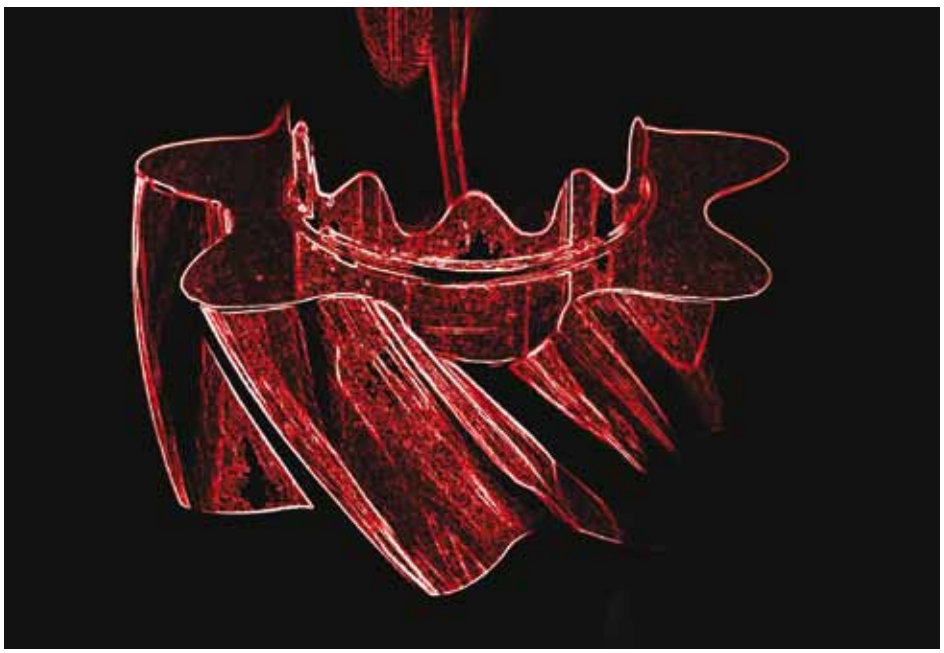
At the heart of the product is the particular shape of the Elika profile, which eliminates the encapsulation typical of normal gear pumps, removing the main source of noise and vibrations. The total elimination of the encapsulated volume produces a considerable reduction in pressure oscillation that causes noise and vibration to be transmitted to the other components

BELOW: **ELI2+2 multiple pump**

connected to the pump, such as hoses, the tank and 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, so there is always a separation line between high and low pressure area, whatever the helix angle.

The special bearing material in the Elika series 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 into the pump cover. Specific compensation areas in the flange and cover, insulated by special gaskets reinforced with anti extrusion, enable the completely free axial and radial movement of the bushings, which is proportional to pump operating pressure.

In this way internal leakage is greatly reduced, ensuring high volumetric and mechanical performance as well as proper lubrication of the pump's moving parts. Internal leakage, generally laminating to the outlet from the inlet and overheating the pump components, is nearly eliminated in the Elika pumps, increasing their reliability. This makes the pump ideal for work operations at low speed and high pressure.



TOP RIGHT: **The study of the Marzocchi patented helical gear profile was conducted in collaboration with the faculty of Engineering at Bologna University**

ABOVE: **A name you can depend on for a quiet life**

Meet the family

Elika is perfectly interchangeable with the ALP2 and GHP2 standard gear pump series. ELI2 is the first series in the family and includes pumps featuring displacements from 7-35cc, also available in a multiple-stage configuration. In a few months, the ELI3 series will also be available, with displacements from 20-87cc. The maximum operating pressures are similar to those of the GHP series and extend up to 300 bar.

Marzocchi has recently introduced a novel and highly robust connecting system for multiple Elika modular pumps. It is extremely compact and makes the pumps interchangeable with the normal multiple pumps, both in terms of dimensions and the torque applicable to the stages. The connection system, in addition to transmitting the torque to later stages, ensures the correct axial balancing at the helical gears. This type of pump perfectly suits any application requiring compact size with several pumps connected in parallel to the single driving shaft of an endothermic engine or electrical motor.

Elika pumps can operate efficiently and quietly at very low speeds, below 500rpm, making them the right solution for designers of many electric vehicles, such as lifting and materials handling equipment, aerial work platforms, waste compacting trucks and other vehicles operating at night in residential areas.

In electric and gas-powered trucks, where low noise is a key requirement, this low-speed operation enables improved control and positioning for various vehicle functions. Elika pumps are also applicable in lifting systems using energy recovery in the descent phases.

Today, precise electric control enables lower-speed operation at high pressures, which is a demanding mode of operation for gear pump products. The very low noise level generated by the pumps makes them particularly suitable for applications where screw pumps, vane pumps or internal gear pumps are traditionally used. **ALT**

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