PAOLO SEGHI

Tube tops

AS SYNTHETIC HYDRAULIC OILS BECOME INCREASINGLY AGGRESSIVE, AND BIODEGRADABLE OILS CREATE NEW CHALLENGES, FLEXIBLE HOSES CAN SUFFER GREATLY. AN INNOVATIVE LONG-LIFE SYSTEM IS THE ANSWER

RIGHT: **Manuli's GoldenISO longlife hose line provides high compatibility with a range of oils**

Trends in hydraulic machinery occur in rapid response to commercial demands and legislative requirements related to reduction of environmental impact and energy costs. These trends have a direct impact on the design of hydraulic systems and components, particularly those made of organic materials such as oils and rubber. As Figure 1 illustrates, the trends in hydraulic equipment development necessitate the development of new high-performance hydraulic oils. Consequently, the use of synthetic-base hydraulic oils (in particular PAO), with a rich additives package, is increasing. At higher operating temperatures, these oils become more aggressive to hydraulic components.

In addition, there are frequent cases of improper use of engine (EO) and transmission (ATF) oils, designed for more severe applications, such as cylinders or gearboxes. Sometimes, this is carried out simply to standardise the oils purchased.

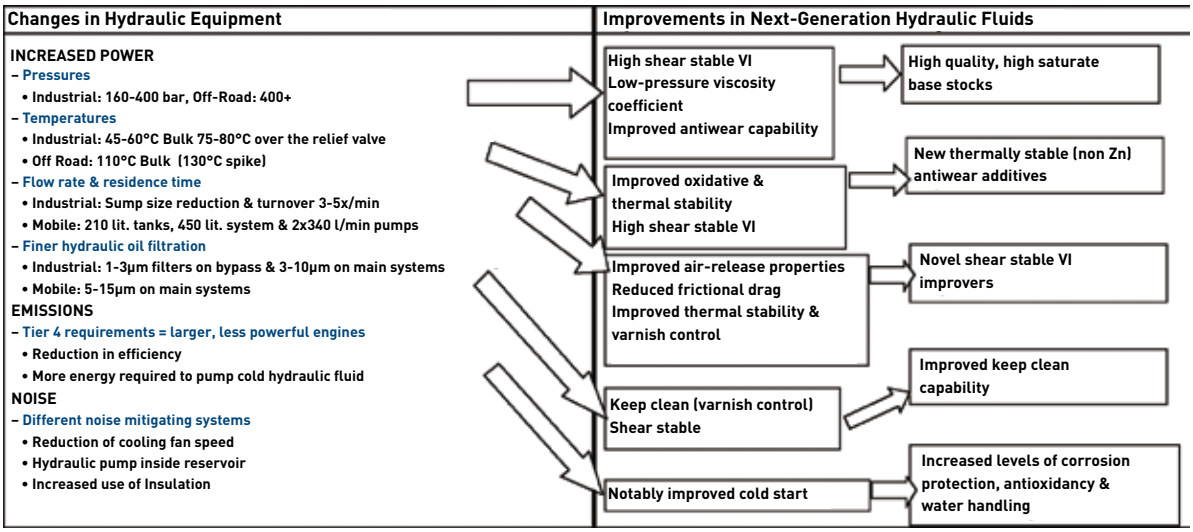
There is also the constant need to ensure compatibility of hydraulic components with biodegradable oils which are being used increasingly often. Such oils are required in applications where it is mandatory to prevent any risk of pollution.

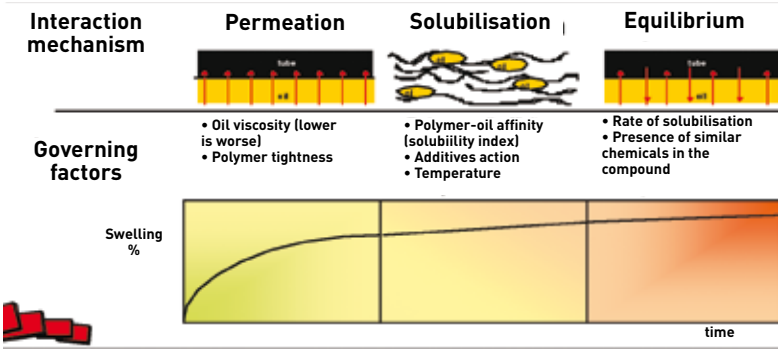
Flexible hoses, which are important for the quality and the safety of hydraulic machinery, are among the components most affected by changes in oil. The (inner liner) tube rubber interacts directly with the oil and the interaction rate (oil-ageing effect) increases exponentially with increasing temperature. Sometimes a hydraulic hose is used improperly in non-hydraulic systems, where the tube rubber may encounter widely different, and potentially aggressive fluids, such as various types of lubricants.

Fluid/rubber compatibility

All elastomers absorb liquids and oils to a greater or lesser extent. Generally, the liquid

FIGURE 1: **Trends in hydraulic equipment and fluids**





absorbed makes a 'swelling' that increases rubber volume and negatively affects the physical and mechanical properties of the rubber compound. But some rubber compounds show an opposite behaviour. In these cases, the liquid acts like a solvent that extracts substances from the compound, which shrinks. In this case, the volume change is a negative value and the impact on the compound properties is even worse, also reducing the sealing effect.

Rubber swelling due to liquids is a diffusion process controlled by the diffusion coefficient of the system, exposure time, temperature and penetration distance. As the diffusion process continues, the size of the rubber piece keeps changing until the concentration of the liquid in the rubber matrix reaches an equilibrium concentration (Figure 2).

The correlation between diffusion distance and the rate of penetration follows a quadratic law: to penetrate a 10-times greater distance, it needs 100 times more time. Consequently, thin rubber components swell and degrade more quickly than thicker ones.

How can the fluid compatibility of hydraulic hose be increased? There are three basic mechanisms for increasing the compatibility between the hose and oil:

• **The type of rubber compound:** This involves the choice of the base polymers and compound formulation. The degree of volume change depends on the chemical compatibility of the rubber polymer matrix with the oil on molecular scale and to a minor extent, on the quantity and quality of the fillers used for the compounding.

• **The thickness of the tube (inner liner) rubber:** This is important because it acts as a thermal insulation layer and as a resistance barrier to oil permeation. Too thin a tube-rubber layer will enable oil and heat to permeate faster through the tube wall into the wire-reinforcement layers of the hydraulic hose. This may accelerate heat ageing of the inter-ply isolation-rubber layer and the hose-cover rubber and may eventually lead to premature leakage at fittings and to loss of adhesion between the different layers, compromising the structural integrity of the hose itself.

• **The tube layer's construction technology:** A seamless tube (extruded on a mandrel or mandrel-less) is better than a spirally wrapped calendared tube layer on a mandrel because the former avoids the junction at the wrapping overlap and provides a smoother non-wavy tube surface of more uniform thickness.

Eco-Tube Plus

Manuli has recently introduced a new proprietary Eco-Tube Plus tube rubber with an innovative NBR-base compound formulation in all of its wire spiral-hose ranges. Compared to the erstwhile Eco-Tube, the new Eco-Tube Plus compound affords a variety of improvements and advantages:

• Higher elastic modulus for higher resistance at the fitting tail end;

• Considerably higher tensile strength and elongation at break for improved mechanical strength and stability at tighter bend radii;

• Better tear resistance over a wider range of test temperatures up to 120°C;

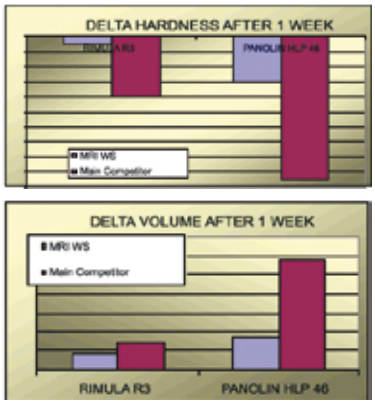
• Higher stability (more gradual changes) on long-term oil ageing in mineral-based hydraulic, engine and transmission-type oils (Figure 3 top);

• Considerably reduced swelling and three-times better stability, even with the most aggressive synthetic biological oils (Figure 3 bottom).

Manuli WS hoses also feature an innovative tube and reinforcement breaker-ply system where there is interpenetration and the breaker gets embedded in the tube rubber, affording a strong adhesion between tube and reinforcement via chemical bonding as well as mechanical anchorage.

Tube dimensions and the breaker-ply thicknesses of Manuli WS hoses are optimised to achieve the best balance between the requirements of hose-structure compactness (for higher flexibility, lower minimum-bend radius, lower weight and lower raw-material costs) and those of fluid compatibility (for long-term resistance to ageing in fluids and hose-structure stability). Manuli WS hoses made with this new technology have already been tested extensively both under laboratory flex-impulse tests and in field applications, including the new isobaric range of hose GoldenISO. The robustness of this technology enabled an upgrade of the WP to 450 bar in the new GoldenISO/45 LongLife line, which anticipates and exceeds the isobaric levels of the new ISO 18752.

Due to its integrated design approach, the compatibility of Manuli WS with oils is best in class in the market. This is shown in Figure 4, providing an assurance of the product's reliability and peak performance, even in the most severe applications. iVT



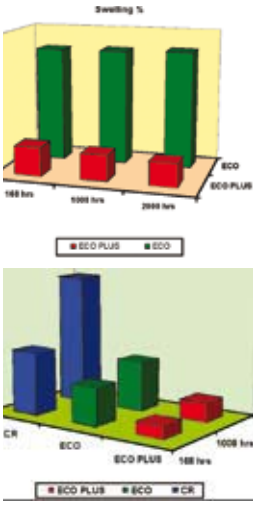


FIGURE 2 (LEFT): **Fluid/ rubber interaction**

FIGURE 3 (ABOVE): **Oil ageing performance comparison: Manuli Eco-tube vs Eco-tube Plus – in mineral base oil at 100°C (top) and in biological oil at 100°C (bottom)**

FIGURE 4 (LEFT): **Oil ageing performance comparison – Manuli Eco-tube Plus vs competition**

Paolo Seghi, CIO at Manuli Rubber Industries, has 30 years' experience in the industry, with a background in rubber, vibration/noise control and high-pressure hydraulics

CONTACT
www.manulirubber.com
info@manulirubber.com