Compatibility of elastomeric seal materials in modern hydraulic pressure fluids

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ABSTRACT

The interest in using biological degradable hydraulic pressure fluids for environmental reasons has in recent years increased.

These new fluids, based on polyalkylene glycols, vegetable oils and synthetic esters, have not only different chemistries and polarities to the elastomeric sealing material but also between themselves.

The seal compatibility is therefore restricted and the seal life and functional behavior is determined by the level of chemical and physical interaction between fluid and seal material, and the influence of the fluid additives.

1. Statement of problem

The annual use of about 150.000 tons of hydraulic oil and concentrates containing mineral oil in Germany represents a potential danger of contamination of the soil, underground and surface water arising from leakage, broken hoses or inappropriate disposal methods. With growing environmental awareness a less dangerous alternative for mineral oil was sought, particularly for the mobile hydraulic machinery sector.

Polyalkylene glycols, vegetable oils and synthetic ester oils presented themselves as alternatives, at least with respect to their biological degradability and were brought onto the market with euphoria by the oil manufacturers.

The first seal failures, the turning of vegetable oils to resin, and the dissolving of paints and coatings on tanks and other hydraulic components, warned the first users to be careful.
The seal manufacturers were not consulted during the development of these fluids and had therefore to react quickly to resolve the unexpected interactions between elastomer materials and these new fluids. In 1989 the first discussion took place between hydraulic fluid producers, seal manufacturers and users of coal mining equipment to avoid further problems by application recommendations. Fortunately, the availability of the new basic elastomers, hydrogenated nitrile rubber (H-NBR), carboxylated nitrile rubber (X-NBR) and hydrolysis protected types of polyurethanes (AU) gave possibilities for new, improved sealing materials - this has been reported at the BHRA Seal Conference 1987 in Cannes (1).

The correct choice of sealing material has nevertheless become more difficult because of the many different commercial fluids and their different chemistries.

Only knowledge of the interactions between both components can lead to a satisfactory seal working life or maintenance periods of the hydraulic equipment.

The hope for a universal sealing material has been further delayed due to the large variety of hydraulic fluids.

Mixtures of different base fluids make the prediction of the interaction even more difficult and has today to be checked for nearly each different combination.

2. Hydraulic pressure fluids

The usual hydraulic fluids with appropriate temperatures and sealing materials are listed in table 1.

The new fluids and elastomers are marked in table 1 with shaded fields. For a detailed description of fluids and elastomers see the original literature (3-14). Only for their interactions are necessary details given in key words:

2.1 Mineral oils

The predominantly used mineral oil derivates in the past were

- non polar liquids, which can be sealed with all types of polar elastomer types; naturally under consideration of their maximum working temperature
- they have excellent resistance to temperatures up to about 150°C
- they do not generate products which degrade the seal
- the use of additive packages to improve or protect oil properties is necessary
- the danger of soil and water pollution from their insufficient and slow biological degradation is a fact
- the chemical structure of mineral oil constituents is shown in figure 1.