

Developed for the Application

Spring-energized PTFE seals for use in high-pressure piston pumps

Particularly well suited for use in cleaning equipment pumps are seals made from modern PTFE materials. PTFE's key properties are nearly universal chemical resistance (e.g. to aggressive cleaning additives), service temperatures ranging from -250 °C up to +250 °C, no water absorption, unlimited weather resistance, no aging and high anti-adhesivity. By combining suitable PTFE base materials with different organic and anorganic fillers it is possible to adapt the PTFE compound specifically to the application's requirements. For dry-running requirements or sealing of aqueous or solvent-containing media, special PTFE compounds such as H521037, HS22111 as well as H522106 have been developed. These compounds have made it possible to combine high wear resistance with high pressure resistance (figures 2 and 3).

Seal Design

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The high-pressure pumps used in cleaners are axially acting plunger

piston types. The cylinder heads of the pumps for professional cleaning equipment are made of brass while the plungers are ceramic. The seals are installed in separate seal carriers made of brass as well. This method makes it possible to fit pumps with different sealing systems, depending on the particular application requirements. High-pressure cleaners specified for hot water are equipped with spring-energized piston seals. For less critical service with cold water, seals made of a elastomer-fabric materials continue to be used. Seals used in high-pressure pumps have to meet the following requirements: pressures of up to 400 bar, high stroke frequencies of up to 50 Hz, plunger piston stroke lengths from 5 to 10 mm (depending on the type of pump). The plunger pistons are manufactured from solid ceramics – surface roughness R 1 – 1.5 µm, required seal service life: 1500 h (hot water operations), max. media temperature: 90



fig.1 The second Generation of homogeneous PTFE-diaphragm allows new designs and has high strength properties under alternating flexural stress

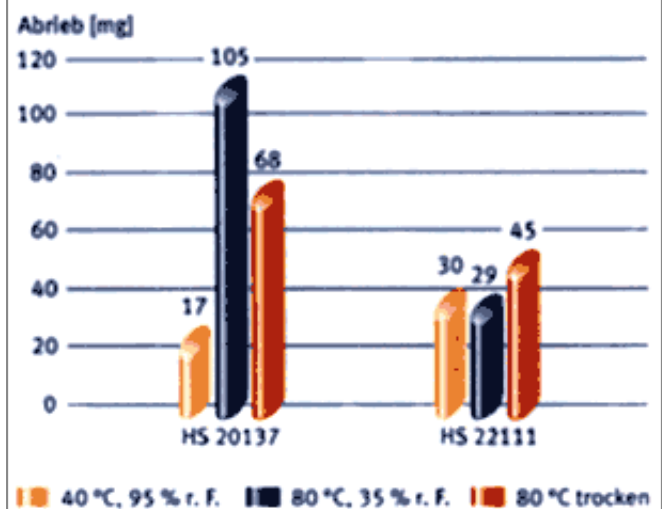


fig. 2: Diagram HS-Compounds wear under various temperatures and moistures; Weight: F = 30 N; stroke speed v = 3,5 m/s; test period = 24 h; needle bearing, hardened; A-D = 22 mm

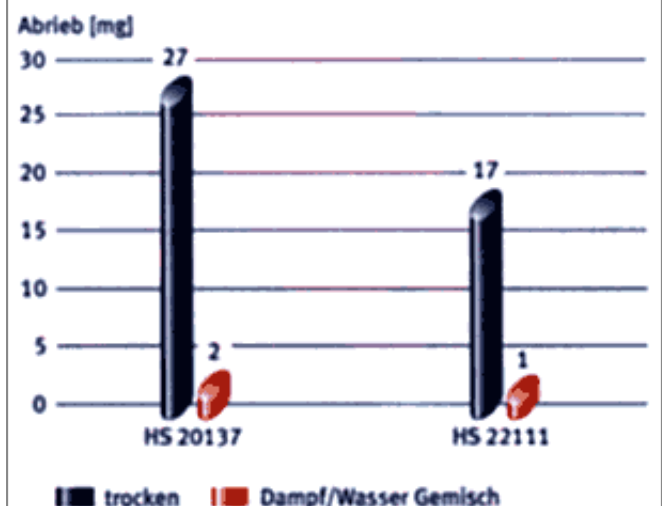


fig. 3: Diagram HS-Compounds wear dry and steam/water mixture Weight: F = 20 N; Test period = 24 h; stroke speed v = 2,2 m/s; D = 14 mm

°C; permanent temperature for hot water: 80 °C. A two-step sealing system is used for these extreme conditions. This means a special primary seal for high pressures and a secondary seal for ambient sealing service. For the design of the primary seal, special importance was attached to optimum power flow with respect to the absorption of the high sealing pressures. This ensures optimum absorption of the resulting shear loads. The secondary seal, on the other hand, has to seal merely a very low pressure of 1 to a maximum of 3 bar, with the same stroke frequency, while the space between the primary and secondary seal is constantly being scavenged (figure 4).

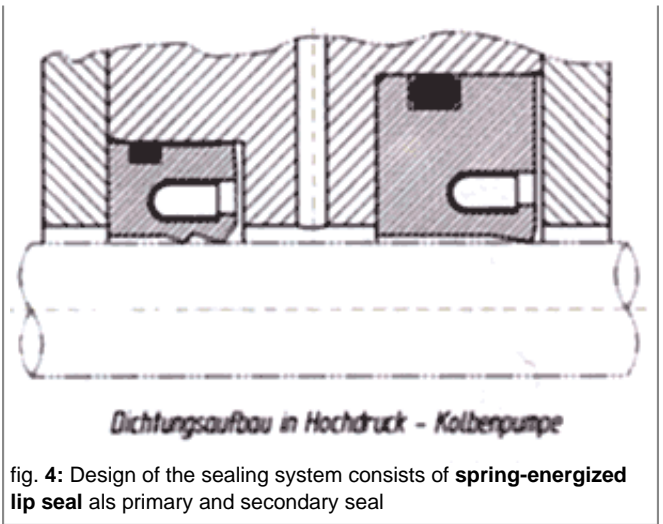
To achieve the service life required particularly for

secondary seals, a uniform contact pressure of the sealing lip across the entire operating period is necessary. This is accomplished by the geometry of the spring-energized piston seals and a respective design of the springs and spring materials used. Any leakage at the secondary seal has an immediate effect on seal wear. Water evaporates, resulting in lime deposits on the plunger piston, which leads to increased wear. The requirements to be met by the seal material are low abrasion resistance when used with water or in complete dry-running conditions. Added to this is low sensitivity to micro-particles which may be contained in the water. For the primary seal, high pressure resistance (low deformation under load) as well as high wear resistance are required.

Improved Operating Properties

The utilization of this sealing system in high-pressure pumps achieves service lives of more than 1500 hours in continuous operations, thus meeting customer requirements. When operating high-pressure pumps with cold water only minor wear has been noted after 1500 hours of service. The PTFE compounds used have universal media resistance, meaning that the type of cleaning additives used can be ignored.

If pumps should inadvertently be operated without water, i.e. in dry-running conditions, this has no negative impact on seal life either: a crucial plus for the use of PTFE seals! Generally speaking, the engineering requirements in terms of pressure, temperature and sliding speed increase, or there are conditions that are difficult to control tribologically, such as low lubrication, present in the applications. In order to be able to offer good sealing solutions even for unusually tough requirements, it is necessary to continuously come up with new ideas for seal design as well as developing suitable materials. Seal endurance tests on special test rigs enable even difficult operating conditions of customer applications to be simulated.



The material PTFE

The chain structure of PTFE has two interesting special characteristics: the carbon-fluorine combination is one of the strongest bonds known in organic chemistry, and the carbon chain is covered almost completely with fluorine atoms, thus being protected from external influences. This is the reason for PTFE's high chemical resistance. The very low inter-molecular forces, among other things, result in PTFE having the lowest coefficient of friction of all solid materials. PTFE has an almost identical static and dynamic coefficient of friction, meaning there is no stick-slip effect. Even at temperatures below 0 °C these favorable sliding properties are retained. At 20 °C and above, there is a minor increase of the coefficient of friction. The modification of PTFE with fillers changes the coefficient of friction merely insignificantly. Because of its exceptional properties, PTFE and its compounds opens up new aspects for resolving technical problems to design engineers. With critical applications, the use of PTFE results in higher service lives, reliability and improved functions, thus giving users additional competitive advantages in difficult markets.

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