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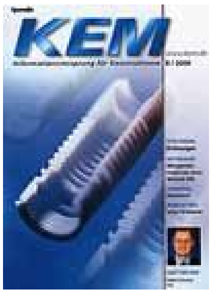
PTFE, the King of Plastics

High-performance compound enables innovative sealing solutions for all industries



High-performance compound enables innovative sealing solutions for all industries Weather resistance, thermal stability and a low coefficient of friction are only a few of the beneficial properties of the high-performance plastic compound, PTFE. The following article describes a wide range of different application examples - from mechanical engineering, painting technology, compressor engineering and medical technology all the way to the automotive industry – illustrating the versatility of this innovative material.


Figure 1: Radial shaft seal with PTFE sealing lip for mechanical engineering


Figure 2: PTFE piston plating and piston rings for compressors


Figure 3: Molded tube for the automotive

PTFE (polytetrafluororethylene) is a non-branched linear polymer consisting of a carbon chain, enveloped by fluorine atoms on all sides. The stable bonding of fluorine and carbon atoms and the nearly complete shielding of the carbon chain give PTFE almost universal chemical resistance. Only carbon combinations containing fluorine and melted alkali metals cause a reversible swelling of PTFE and/or a limited chemical reaction on the surface. Even after extended storage periods, there will be no absorption of water noted. Under extreme climatic conditions, PTFE proves to have nearly unlimited weather resistance. Within a temperature range of –200°C up to +260°C, the compound is thermally stable. In addition, PTFE has the lowest friction coefficient of all solid substances, with the static and dynamic friction coefficients being nearly identical. This means that there is no stick-slip effect even at low sliding speeds. By modifying the molecular chain other properties may be positively influenced as well. In particular cold flow, which is relatively high with unfilled PTFE, can be reduced significantly either by modification or the addition of fillers.

Other possibilities to change PTFE properties are achieved by blending in fillers. In summary, it can be said that fillers have a positive influence particularly on cold flow, thermal and electrical conductivity and, above all, wear (see diagram). Today's special compounds – consisting of a mixture of different fillers – are laid out in such a way that abrasion is very low even under dry-running conditions on a non-cured [non-duroplastic] mating surface. Due to PTFE's numerous positive properties, this compound is suitable for applications in virtually all industrial sectors. The following is merely a small selection of various solutions that are possible:

Radial shaft sealing ring

Shaft seals with a PTFE sealing lip perform their sealing function by the molded lip being pressed against the shaft. An additional spring element is not necessary. The sealing effect/radial force is influenced by the profile design of the sealing lip, the selection of the compound and the processing parameters. PTFE seals enable high shaft circumferential speeds of up to 30m/s and more, short-term pressure loads of up to 15 bar as well as low-lubrication conditions. For this reason, they are primarily used in screw-type and rotational compressors. In addition, the low frictional heat generated by PTFE plays a major role in this regard as well, as the lubricants used in these applications have only limited temperature resistance. To improve sealing performance under high pressure loads and with high circumferential speeds a spiral thread is used for hydrodynamic return feed, which is either applied in the sealing lip or on the shaft protection jacket (figure 1).

Piston plating and piston rings

To generate oil-free compressed air dry-running piston and guide rings are required. Medium piston speeds between 2.5 and 5 m/s, pressure loads between 8 and 15 bar as well as medium piston temperatures from 100 to 150 °C place exacting demands on the compound. Specially developed PTFE high-performance compounds provide the basis for long service life. By making maximum use of the guiding surface, surface compression is reduced to a minimum. The layer of the PTFE guide has a thickness of merely a few tenths of a millimeter. This means that there is only little thermal elongation of the guide band plating, and piston-cylinder play can be minimized. The gas-impervious stroke of the piston ring, which is made from a special PTFE compound as well, provides an optimum sealing effect. Among others, this system is used in dry-running compressors for the food processing and pharmaceutical industries as well as in automotive engineering (figure 2).

industry

Figure 4: PTFE tubes for medical and laboratory technology

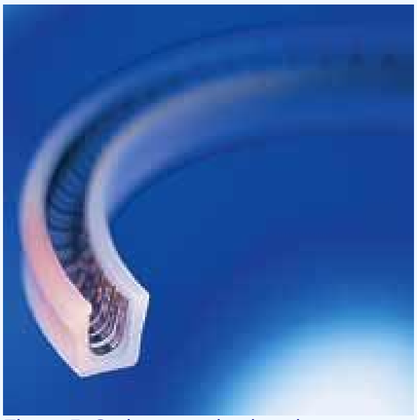
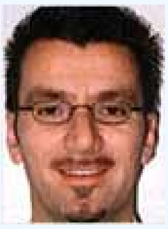


Figure 5: Spring-energized seals



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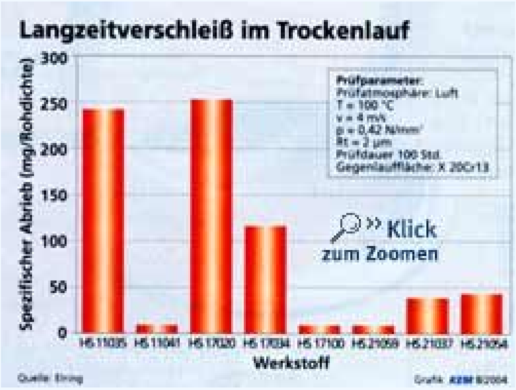
Spring-energized seals

Spring-energized seals are used as needle seals in painting valves. The HS 4080 compound in particular offers the benefit of very good wear resistance when used with abrasive water- as well as solvent-based paints. Spring-energized seals even provide successful sealing performance with recently developed new powder paints.

Precision tubes and molded tubes

The technical operating parameters of a needle seal used in painting technology typically include:l ppaint pressures: up to 30 bar l needle diameter: 3 to 10 mm l needle stroke: up to 20 mm l serviservice life of the seal: up to 1.5 million needle strokes. The mating surface, i.e. the needle surface, usually consists of stainless steel, it is precision-machined and rolled with a very good surface quality of Rz 1 µm and a high material content. Depending on the specific application, in case of particularly critical, abrasive paints and higher stroke frequencies, surface-coated needles are used in order to prevent wear and formation of grooves (figure 5).



Wear diagram of special compounds

In medical technology precision tubes are used primarily in the field of endoscopy . With regard to such applications, the extrusion of multi-lumen tubes offers the possibility of integrating several different functions in a single component. This not only helps to make processes more operator-friendly, but also facilitates assembly, as certain individual assembly components may be eliminated. Due to the tapered ends of the tubes, surgical procedures can be performed with greater flexibility, because vascular occlusions often require the surgeon to continue beyond the original scope of the procedure. The color coding on the tube serves to define the respective areas and/or positions related to the procedure. In addition, the color-coding technology is often used to apply customer-specific logos or markings on the tube. When used in medical applications, such as catheter tubes, bio-compatibility tests are required, specifically cyto-toxicity tests and tests to determine contact-allergenic properties (sensitization) (figure 4).

When using molded tubes for lambda sensors in automotive exhaust systems, resistance to temperature differences between -50° to +280 °C must be confirmed. In addition, ambient underhood and underfloor influences must not damage the compound. Such influences include mineral oil-based greases and oils, cleaning agents and water, water vapor, salt water and any other media that may be present in the engine compartment, all of which cannot be specifically defined in advance. The molded tube itself serves as bending and abrasion protection as well as a sealing system. The lambda sensor located at the beginning of the exhaust system is exposed to extremely high temperatures. This means that for the molded tube contour stability must be assured even under high temperatures. In addition, this component is subjected to extremely high dynamic loads, as the mutual interference between engine vibrations and motions constantly stress the sealing system. These load resistances must be confirmed by endurance tests involving 20 million cycles (figure 3).

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