Successful Material Combination

Giving Cold Flow the Cold Shoulder

PTFE is a popular material for use in valves & fittings applications due largely to its universal chemical resistance. Under pressure however, in applications subjected to high loads such as valve seat rings for example, the material tends to creep. ElringKlinger has now managed to control the issue of cold flow with a material that combines their unique 'Moldflon' melt processible fluoropolymer and PEEK.

The significant properties of PTFE such as high temperature resistance, universal chemical resistance and low friction makes this material ideally suited for use in fittings and process valves. Typical application examples are V-ring packings, spring-energized seals, guide rings and guide tapes as well as customized design elements such as valve diaphragms and PTFE bellows. In the case of valve seats for example which are subject to high loads, the maximum compressive stress of PTFE is often exceeded. High media pressures require greater contact pressures between the valve seat and sealing element. In order to counteract the cold flow of virgin PTFE especially at elevated temperatures, the valve seat requires a complex, fully confined design to be used. Alternatively, filled PTFE compounds can be used however depending on the filler, these may have lower chemical resistance, higher permeation or be more abrasive to the counter surface.

Figure 1: The Moldflon-PEEK compound MF40002 by ElringKlinger offers numerous possibilities for sealing valve seat rings subjected to high loads

Alternatives to PTFE

To overcome some of the dissadvantages of PTFE compounds in high load applications, the use of thermoplastic materials with high temperature resistance can be considered. Frequently, melt-processable materials such as PEEK (polyether ether ketone) are used which can be sufficient in terms of chemical resistance whilst offering advantages regarding creep, permeation and heat deflection temperature. When using virgin-grade PEEK as a material for seat rings, low ultimate elongation and high elastic modulus leads to an extremely hard and inflexible material. In the final application, this has to be accomodated in the form of enhanced surface textures, tighter tolerances and closer controlled geometric features, all of which have a negative impact on cost and product consistency especially where large temperature ranges need to be covered. As the heat deflection temperature of virgin-grade PEEK is about 3 times higher than that of unfilled PTFE, using a combination of PTFE and PEEK is an obvious choice. Such a compound exhibits enhanced mechanical properties however, since PTFE is a sintered material, the structure compared to a melt-processable material is relatively inhomogeneous. The result of which can be inferior surface quality and a reduction in permeation resistance, both of which may have a negative effect on the leak tightness of the finished component (Figure 2).

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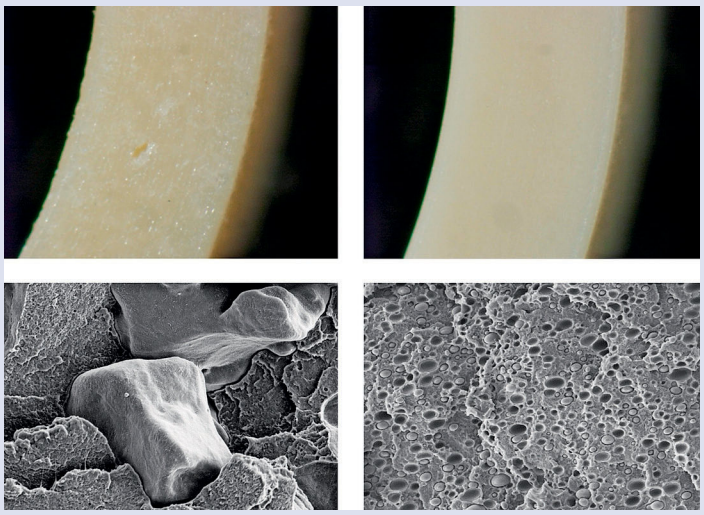

Figure 2: Comparison of the structural morphology of a PTFE-PEEK compound (left) and the Moldflon-PEEK compound MF40002 (right): The more homogeneous structure of MF40002 is clearly visible

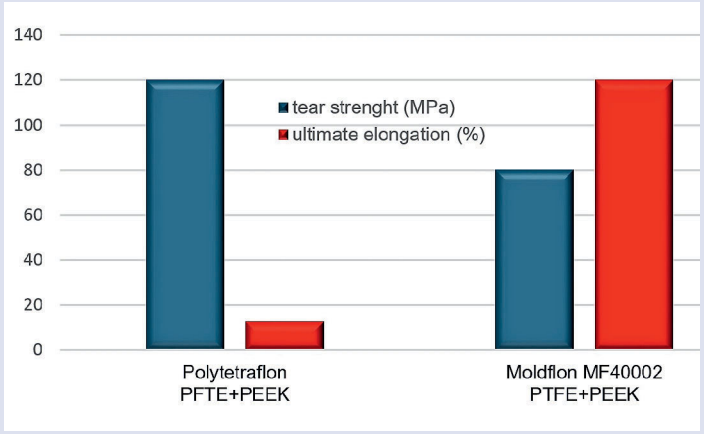

Figure 3: Comparison of tear strength and ultimate elongation: Moldflon MF40002 has 10 times higher ultimate elongation than the PTFE+PEEK compound Polytetraflon

In Pursuit of a Suitable Combination

An ideal valve seat material therefore is one that combines the advantages of PTFE and PEEK to deliver a low creep, highly resistant, temperature stable material with low permeation and good elongation. The problem with combining melt-processable and sintered materials is an inhomogeneous structure (Figure 2), which results in impaired mechanical properties and machinability. Only the combination of PEEK with melt-processable Moldflon PTFE can deliver a material with properties that are perfectly alighned to performance requirements of the final product.

With Moldflon MF40002, ElringKlinger has managed to develop a material with a higher heat deflection temperature than that of PTFE but exhibiting significantly higher elongation and flexibility than virgin-grade PEEK or PTFE-PEEK compounds. In addition to the ultimate elongation being nearly ten times higher (see Figure 3), the structure is significantly more homogeneous than that of PTFE-PEEK compounds. In the light of these advantages, it was possible to transfer the application experiences gained over years of automotive valve engineering to process valves and industrial valves markets. Today, ElringKlinger is able to offer Moldflon MF40002 in sizes up to diameter 850 mm and as the material is both machinable and melt-processible, it is suitable for use in small scale as well as large volume manufacturing processes.

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